WILLIAM BUCKLAND, 1784 - 1856:
SCIENTIFIC INSTITUTIONS, VERTEBRATE PALAEONTOLOGY, AND QUATERNARY GEOLOGY.

PATRICK JOHN BOYLAN, BSC, FGS, FMA, MBIM

VOLUME 1.

Thesis submitted in fulfilment of the Regulations for the degree of Doctor of Philosophy of the University of Leicester.

1984

Fig. 1. William Buckland lecturing,
by George Rowe, 1823.

ABSTRACT

PATRICK JOHN BOYLAN, BSC, FGS, FMA, MBIM

WILLIAM BUCKLAND (1784-1856): SCIENTIFIC INSTITUTIONS VERTEBRATE PALAEONTOLOGY AND QUATERNARY GEOLOGY

The thesis establishes a biographical framework for this and future studies of William Buckland, the first professor of geology in the University of Oxford, and eventually Dean of Westminster. This shows the way in which he progressed from a modest provincial background by way of the patronage system of Georgian England, to become an important figure in both the scientific and public life of Regency and early Victorian Britain, and also examines the very wide range of Buckland's scientific activity in many areas and his active involvement in many scientific organisations.

His work with three scientific institutions is examined in detail: the University of Oxford, the Geological Society of London and the British Association for the Advancement of Science. In Oxford, the success of his work led to the establishment of a regius chair in geology specially for him, and through this he both established geology as an important scientific discipline within the University and developed teaching techniques that are still the norm in the teaching of geology today. Buckland's most important contributions to the Geological Society of London were his two periods as President, during the first of which he steered the Society to Chartered status, and in the second of which he held the Society together through the very divisive Devonian and glacial controversies. Within the British Association, Buckland's presidency for the first full meeting held at Oxford in 1832 was particularly influential in terms of establishing both the objectives and the structure of Annual Meetings.

Buckland's work on vertebrate palaeontology is next considered, and a full review of the fauna of his classic fossil hyaena den locality of Kirkdale Cave which established Buckland's international reputation, is included as a "case study". In human palaeontology, Buckland began by expecting that human fossils would be found, but drew back in the absence of secure evidence. His extensive work with Mesozoic vertebrates included the recognition of both land dinosaurs and the first Mesozoic mammals, as well as fossil coprolites. Especially important was his emphasis on the environmental evidence that can be deducted from fossils, and as a consequence he was an important pioneer in both palaeoecology and taphonomy.

Finally, Buckland's work in the field of Quaternary geology is reviewed in detail. His early "diluvialism" is shown to be well-founded in terms of the abundant anomalous field evidence in the areas of England and Scotland studied by Buckland, and he finally found a valid actualistic solution to these anomalies in the glacial theory. Buckland had a central role in the advocacy of the glacial theory in Britain, and his extensive fieldwork of the Autumn of 1840 is described and re-evaluated as a second "case study".

CONTENTS

VOLUME 1

- - - - - - - - - - - - - - - - -

VOLUME 2

FIGURES IN TEXT

- - - - - - - - - - - - - - - - - - -

ABBREVIATIONS USED IN TEXT

AMS	Archaeological Museum, Scarborough
BMNH	British Museum (Natural History), London
CUL	Cambridge University Library
DRO	Devon Record Office, Exeter
Edinb.UL	Edinburgh University Library
GSL	Geological Society of London
GSM	Geological Museum, London (British Geological Survey)
HMG	Hunterian Museum, Glasgow
IGS	Institute of Geological Sciences Library (now British Geological Survey)
LM	Leicestershire Museum and Art Gallery, Leicester
OUM	Oxford University Museum
RSL	Royal Society, London
RSM	Royal Scottish Museum, Edinburgh
SMC	Sedgwick Museum, Cambridge
WES	Wood End Natural History Museum, Scarborough
WM	Whitby Museum
YM	Yorkshire Museum, York
YPS	Yorkshire Philosophical Society, York

ACKNOWLEDGEMENTS

I am especially indebted to Lewis Penny, formerly Head of the Geology Department, University of Hull, for his constant support, encouragement and friendship over more than a quarter of a century. During my postgraduate year at Hull, I was very fortunate indeed in my choice of John Bradley's inspiring intensive course on the history and philosophy of science. He not only set my growing interest in the history of earth sciences in its proper context within the history of science as a whole, but also introduced me to the techniques of history of science research, as the supervisor for my postgraduate dissertation on James Hutton. Antony Sutcliffe introduced me to the formidable problems of cave excavation, encouraged and guided me in my early work on fossil mammals, and then persuaded me to undertake reviews of some of the problematical "classic" fossil mammal faunas, notably that of Sewerby Buried Cliff and of Kirkdale Cave, both in Yorkshire, and to start work on William Buckland (at a time when such an area of research was decidedly unfashionable). This work was noticed by three leading specialists who have been a source of great inspiration and support ever since: Bjorn Kurtén of Helsinki, Bill Sarjeant, now of the University of Saskatchewan, and George White of the University of Illinois.

I have also gained a great deal of benefit from the writings of, and many hours of informal conversation and discussion with, many fellow workers in the field of the history of earth sciences, including in particular Gordon Herries Davies, Cecil Schneer, Martin Rudwick and Roy Porter, as well as Joan and the late Victor Eyles and the late Walter F (= Susan F) Cannon. Discussions with François Ellenberger and Dorinda Outram have been particularly helpful in relation to the Continental perspective, and the latter's published and unpublished work on Cuvier and his circle has been invaluable. A special debt of gratitude is owed to Hugh Torrens and his encyclopedic knowledge of 18th and 19th century British geology (and much else), especially for the many quite unsolicited postcards, notes, letters and photocopies about discoveries relevant to my work which he had come across in many obscure places.

A study of this kind would be impossible without the generous help of the many librarians, archivists and museum curators caring for vital source material. In this case, particular thanks are due to Mrs Edeltraud Nutt, Librarian of the Geological Society, Tony Harvey of the British Museum (Natural History), the late James Edmonds and Philip Powell of the Oxford University Museum, John Thackray, Archivist to both the Geological Society and the British Geological Survey, and to Mrs Margery Rowe and the late Trevor Falla of the Devon County Record Office. (Curators who have assisted with the review of the Kirkdale Cave fossil mammals are separately acknowledged in Appendix 2.)

Over the period of this research I have been consistently very well served at a secretarial level. Particular thanks are due to Jane Sutton (who undertook the typing up of the initial transcripts of some hundreds of key manuscripts from dictation tapes or pencil notes), Jill Lowe, and Laurel Kirby (who has expertly and very accurately produced most of the final typescript). I would also like to record my thanks to Andrew and Christopher Boylan for their very necessary practical assistance during most of the extended periods of fieldwork searching for, and recording, the historic glacial sites on which the 1840 work of Agassiz, Buckland and Lyell was based.

Finally, but by no means least, I am deeply grateful to my supervisors, Biil Brock and Trevor Ford, not only for their guidance, comment and helpful criticism over an extended period of research, but also for their sympathetic and tolerant understanding of the special problems of, and pressures on, part-time research students.

1. INTRODUCTION

1.1 PURPOSE AND OBJECTIVES OF THIS RESEARCH

William Buckland (1784-1856), has been widely recognised as a prominent figure in the development of both geology and organised science in Britain during the Regency and Early Victorian periods. However, there has been much disagreement about his standing in the emergence of geology as a distinct science, and indeed as one of the most prominent and important scientific disciplines of the first half of the 19th century.

Previous research on Buckland is surveyed more fully in Chapter 1.2 below, but it is important to stress at this point that he has been poorly served in the history of science, even at the level of the writing of an adequate biography. The primary objectives of this thesis have been to examine for the first time his influence on the development of two important areas of geology: vertebrate palaeontology and Quaternary geology, and his role within three selected institutions: the development of geology teaching in Oxford University, the growth of the Geological Society of London, and the establishment of the British Association for the Advancement of Science. It has also been necessary to establish a sound biographical and chronological basis for both this and future studies of Buckland.

The first part of this present study has therefore been to prepare what I have termed a "Biographical Framework" within which the other parts of this thesis can be more readily and securely understood, and also to form the basis for the long-overdue full biographical review of Buckland

and his work. The work for this Section, comprising six Chapters outlining the life and scientific work of Buckland, has involved extensive searching of both published and unpublished sources. This has included in particular the detailed cataloguing of the large Buckland family archive in the Devon Record Office, (of which only an outline listing was available) and the transcribing in whole or part of several thousands of original documents in more than a dozen archive repositories (see list of abbreviations used for quotations from manuscript sources). Of these transcripts only a small proportion have been explicitly used in the form of direct quotations in the text of the thesis, although all of this material has been invaluable in forming overall assessments of Buckland's life and work in many areas.

There are obvious dangers in undertaking studies of a single historical figure, particularly in terms of the risk of lack of objectivity. I remember very well the very hostile reaction of a number of Lyell specialists to the admittedly provocative and somewhat irreverent paper by Roy Porter (1976) to the opening session of the Charles Lyell Centenary Symposium at the International Committee on the History of Geological Sciences (INHIGEO), held in London in September 1975. However, a past President of INHIGEO, Reyer Hooykaas, spoke up on behalf of Porter, making it clear that he did not necessarily agree with all of the paper, but defending his right to present it, saying (according to my manuscript note taken at the time): "I thank God that we are going to be allowed to discuss Lyell, and have not come here for the final ceremony of his canonisation, as happened with the INHIGEO anniversary symposium on Agricola".

Thankfully, there is not the slightest risk that anyone would seriously propose the canonisation of Buckland because of either his personal or scientific sanctity, and if it appears that in some places I have been unduly sympathetic to Buckland, I hope this will be seen as redressing the serious imbalance that occurred over a very long period of neglect, or overt denigration, from which Buckland's reputation has only recently begun to recover. Although the ultimate objective of research in the history and philosophy of science must be synthesis, especially on a thematic basis, for most of the geological issues and individuals of Buckland's period we are still, to use archaeology as an analogy, at the stage of careful and systematic excavation in the published and unpublished primary evidence. For the purposes of this study I have been able to use only a small proportion of the available Buckland material, and I very much hope that, to use the archaeological analogy again, my "trial trenching" will not only provide a sounder factual and theoretical basis for future comparison and synthesis, particularly in relation to the emergence of the science of geology in its present-day form, but will also stimulate much-needed further research on Buckland and his milieu.

In terms of the breadth of his interests, ranging over almost the whole field of geology, and taking in many areas of zoology, archaeology, history, agriculture, plant pathology, together with theology and the role of science in the world of politics, Buckland was, perhaps, born more than half a century too late, in that he had much more in common with the robust dilettante tradition of the 18th century than with the emerging professionalised (and specialised) science of the 19th century. However, despite the apparent inconsistency of his position as a polymath dabbling in many different areas of science, Buckland himself played an important role in the professionalising and institutionalising of science. Buckland was by nature very gregarious, and, even disregarding more than 100 honorary memberships of national and local academic and scientific bodies around the world, his enthusiasm for scientific association was amply demonstrated by his active membership of more than two dozen major societies, and was a valued founder member of almost half of these, including the Geographical and Statistical Societies, the British Archaeological Institute, the Ray Society and the Palaeontographical Society, and - most significantly of all - the British Association for the Advancement of Science.

A detailed examination of Buckland's involvement with all of the academic and scientific institutions and organisations in which he was active would probably constitute a major thesis in its own right, without any "Biographical Framework" or re-evaluation of any aspect of his scientific work. For the purposes of the present study three contrasting organisations have been selected for more detailed consideration, in the light of my more general study of Buckland as an institutional "activist". These are the University of Oxford, which afforded Buckland a home, both physically and intellectually, throughout most of his life, and which at least tolerated its somewhat eccentric first Professor of Geology; the Geological Society, which Buckland justifiably regarded as the leading geological organisation in the world for professional geologists, as well as a most agreeable private club; and the British Association, which Buckland visualised as a key "shop window" on science, bringing together both the leading scientists of the day and national and local leaders in the fields of industry, commerce and politics. My assessment of Buckland's involvement with, and response to, each of these three bodies is therefore presented as three chapters that make up Section 3 of the thesis.

Except for his views on Diluvialism and Catastrophism, Buckland's scientific work as such, comprising well over 2,000 printed pages, has attracted surprisingly little attention from historians of science. A comprehensive review is impracticable in a single thesis, so I have concentrated on two fields in which Buckland's influence is undeniable: Vertebrate Palaeontology (concentrating on Quaternary mammals, fossil men, Mesozoic vertebrates and environmental reconstruction), (Section 4), and Quaternary geology (with particular reference to Diluvialism and to Buckland's role in the promotion of the Glacial Theory, (Section 5). In relation to the work on each of these two Sections, I have carried out a detailed "case study", re-examining Buckland's original evidence, and re-evaluating his interpretation and conclusions in the light of present-day knowledge. In the case of the Vertebrate Palaeontology section, the vertebrate fauna of Buckland's classic fossil hyaena den locality of Kirkdale Cave, investigated in 1821, has been re-assessed. This study has been pre-published (Boylan, 1981A) and is reproduced as Appendix 2 below. The second re-assessment is of the more than one hundred localities in Scotland and Northern England seen by Buckland (in the majority of cases in the company of either Agassiz or Lyell) in the autumn of 1840, and which formed the basis of the evidence of the former glaciation of Britain presented to the Geological Society in November and December of that year. These localities (or "voucher" localities in the case of very generalised published locations) have been identified on the ground and re-assessed against the 1840 description and interpretation. Although some of the key localities have been briefly described in a preliminary short paper (Boylan, 1981B), the full study is presented for the first time as Appendix 3 below.

1.2 PREVIOUS RESEARCH ON BUCKLAND

Overall, there has been surprising little primary research on William Buckland over the past one and a quarter centuries considering his undoubted prominence and importance in scientific life in egency and Early Victorian England. There were a small number of commentaries and appreciations published during Buckland's own lifetime, including for example a note in the New-Yorker (Locke, 1837) and another in the Cyclopaedia of Literary and Scientific Anecdote (Keddie, 1854: 25-26), and there is a warm tribute by De la Beche (1848) on the occasion of the award of the Wollaston Medal of the Geological Society to Buckland, but little else.

Following his death in August 1856 obituaries appeared in a wide range of both general and specialist periodicals, reflecting his very many and varied fields of interest and society memberships. Most of these are brief mentions in presidential addresses or annual reports and tend to stress the interest taken by the late Dean in the affairs and field of interest of that particular organisation. However, four examples are worthy of special note. In terms of publication date the first scientific obituary to appear seems to have been that in the November issue of the American Journal of Science (Anon., 1856). However, this is just a reprint of the obituary published in The Athenaeum of 23 August 1856. This is a decidedly odd and imbalanced piece, which damns with faint praise in the opening paragraph:

> Few men have filled a wider space in public estimation for the last twenty-five years than Dr. Buckland. His name is intimately associated in the popular mind of this country with the progress of geology. He may not have possessed the natural acquirements or the philosophical acuteness of many of his contemporaries; but he possessed a heartiness of spirit, an

> indomitable energy of purpose, a geniality of character, which rendered him, even amongst men remarkable for their gifts, the most remarkable. (Anon., 1856: 449-450).

Buckland's work with fossil mammals is well acknowledged, as is his role in the diluvial theory. However, there is no mention at all of his advocacy of the glacial theory, and instead his final abandonment of diluvialism is attributed to a shift to Lyellian orthodoxy.

More substantial and authoritative scientific obituaries followed. In accordance with current practice the Geological Society obituary was incorporated into the Anniversary Address of the President, Col. Joseph Portlock, to the February 1857 Annual General Meeting of the Society (Portlock, 1857), and this included much personal and scientific biographical material. Portlock was something of a light-weight figure in terms of the geological establishment, and his reputation rested mainly on geological work in Ireland and on his military career (he finally became a General), and as far as I am aware he had little direct contact with Buckland. Consequently, Portlock's obituary probably represents the consensus of contributions from many senior members of the Society.

John Phillips, the nephew of William Smith, was a close personal friend of Buckland from Phillips' early work on Yorkshire geology and at the Yorkshire Museum, York, in the late 1820s through to Buckland's final illness, and he was appointed to the Chair in Geology and Mineralogy at Oxford on Buckland's death. Phillips wrote the official Royal Society obituary, which is both warm and affectionate whilst scientifically authoritative and balanced (Phillips, 1857).

Roderick Murchison had been a close personal friend of Buckland even longer than Phillips, and despite many scientific differences, such as the argument over diluvialism in the late 1820s and over the glacial theory from 1840 onwards, these disagreements never became personalised (in marked contrast, for example, with the dispute between Murchison and Sedgwick). Murchison and Buckland had been founder members of the Royal Geographical Society, and Murchison was President at the time of Buckland's death, and at the 1857 Annual General Meeting Murchison was able to follow the Geological Society practice and incorporate in his Anniversary Address a substantial biographical obituary and appreciation of Buckland (Murchison, 1857). This obituary recorded for the first time one of the most-quoted comments on Buckland - the comment of an Oxford Classicist shortly after Buckland became Reader in Mineralogy in 1813:

> Well Buckland is gone to Italy, so, thank God, we shall hear no more of <u>this geology</u>! (Murchison, 1857: cv).

By the time of his death, Buckland's extremely popular and authoritative Bridgewater Treatise <u>Geology and Mineralogy Considered with Reference to Natural Theology</u>, first published in 1836, was already being revised by his elder son Frank (Francis Trevelyan) Buckland with the assistance of various specialists. On completion of the revision for the third edition Frank Buckland wrote his substantial biographical Memoir of his late father, and this was included as a foreword to the third edition (F T Buckland, 1858). Even today, this is still the starting point for biographical work on Buckland.

The traditional "life and letters" volume or volumes with which most eminent Victorians were honoured did not appear until 1894, 38 years after Buckland's death (Gordon, 1894), and even then this was a very slight work, in marked contrast with the substantial 2 volume biographies of such close associates of Buckland as Sedgwick, Murchison or Lyell. The long delay in producing any sort of memorial volume is hard to explain in a period when it was regarded as a clear family duty to write (or persuade someone else to write) a full biography and compilation of interesting correspondence of any member of the family that had achieved high public, ecclesiastical or academic standing. Frank Buckland wrote nothing more, and on Frank's death in 1880 the eldest of his sisters, Mit (Mary Buckland - Mrs Bompas), devoted her efforts to writing a biography of her brother (Bompas, 1885).

The volume on William Buckland was finally written by the second (surviving) daughter, Elizabeth Oke Buckland (Mrs Gordon, 1894). Buckland was nearly 42 years old when he married, and was over 52 when Elizabeth was born in 1836. She was just 10 years old at the time of his appointment as Dean of Westminster, and within four years he was virtually in retirement because of ill health. Elizabeth herself, therefore, can have had little direct knowledge or recollection of Buckland during the greater part of his scientific life. Her mother, Buckland's scientific companion as well as his wife, out-lived him by only one year, and by the time that Elizabeth was working on her biography both of her elder brothers were dead.

The work finally appeared as a single small octavo volume under the title The Life and Correspondence of William Buckland, D.D., F.R.S., Sometime Dean of Westminster, Twice President of the Geological Society, and First President of the British Association (Gordon, 1894). The biographical detail appears to have been drawn mainly from Frank Buckland's 1858 Memoir, but throughout the chronological sequence the broad framework is supplemented by quotations from letters by or to Buckland, anecdotes and appreciations that she had gathered together as a result of her correspondence, and a few personal recollections of family life during her own childhood. She also made use of a detailed journal that her mother had kept throughout her married life: unfortunately this potentially very important volume (or perhaps series of volumes) has not been traced despite extensive enquiries and archive searches by several present-day research workers (including G H O Burgess, in the course of his work on Frank Buckland, and me).

Mrs Gordon's biography has considerable charm, not least because of its straightforward narrative approach and absence of polemics, in marked contrast with so much Victorian biography which so frequently attempts to portray the subject in sycophantic and exaggerated terms. In contrast with so many of her contemporary biographers Elizabeth Gordon has in many places drawn a character that is much smaller than life by minimising or omitting altogether Buckland's many well-documented eccentricities and flamboyant style. By 1890 many of the true and apocryphal stories illustrating Buckland's eccentricities, buffoonery and decidedly un-clerical coarse language had appeared in print. It is quite conceivable that the timing and approach of Elizabeth's book were at least partly in response to an unbalanced presentation of the more colourful side of Buckland's character. Nevertheless, 90 years later it is still the most substantial factual account of Buckland's life and work.

In contrast with the seriousness of Elizabeth Gordon's biography, the anecdotal approach is dominant in a sympathetic discussion of Buckland in Reminiscences of Oxford by William Tuckwell (1900). As has been widely demonstrated in recent years, late 19th and early 20th century views of the history of geology were dominated by decidedly whiggish views of "right" and "wrong" sides of what were perceived as the major geological issues of the various historical periods, for example the Huttonians against the Wernerians, Diluvialists against the Fluvialists or Catastrophists versus Uniformitarians, and geologists such as Buckland, Conybeare and Greenough were held in low esteem because they were perceived as being "wrong" in relation to the Catastrophist-Uniformitarian debate. This view of the history of British geology is seen very clearly in such important syntheses as The Founders of Geology by Archibald Geikie (1897) and the centenary history of the Geological Society of London by Horace B Woodward (1907), and can be traced back (through the many successive editions) to the history of geology presented by Charles Lyell in the first volume of his The Principles of Geology (Lyell, 1830).

One notable exception in the early years of the present century to the then conventional view of the history of British geology in the 19th century was William Sollas, who held the regius chair of geology and mineralogy at Oxford, who included a substantial chapter on "The Influence of Oxford on the History of Geology" in a volume of geological essays and reprints (Sollas, 1905: 219-256), which presented Buckland and his work in a favourable light and recognised their significance in the development of geology during the first half of the 19th century. Sollas subsequently re-examined Buckland's classic Paviland Cave on the Gower, including the "Red Lady" human skeleton in the cave deposit first described by Buckland (Sollas, 1913).

Between the wars Frederick J North began to investigate seriously the history of British geology during the first quarter of the 19th century, a period that was conventionally portrayed by historians of science as at best a period of stagnation between the excitement of the Huttonian/ Wernerian conflicts and the emergence of the self-taught William Smith in the years around 1800, and the sudden emergence of Lyell with the first edition of his Principles in 1830 (a perspective that owed a great deal to Lyell's own efforts in the very distorted view of the history of geology presented in the opening chapters of that very work, as was convincingly demonstrated by Roy Porter at the Lyell Centenary Conference of INHIGEO: Porter, 1976). In addition to rescuing and bringing together in the National Museum of Wales a great deal of geological archive material of this period, North re-discovered and re-interpreted several of the leading British geologists of that "missing" quarter of a century, including Greenough, Buckland, W D Conybeare and De la Beche. His first major paper in the field was an examination of the work carried out in South Wales by what he termed in the sub-title to the paper "the pioneers of geology", and he included in this a short chapter on Buckland (North, 1934: 61-64), and Buckland also figured prominently in other sections of the paper.

This was followed by major papers on Paviland Cave and Buckland (North, 1942), and a centenary review of the origins of the glacial theory (North, 1943). Buckland also figured prominently in his substantial biographical reviews of William Conybeare (North, 1935 & 1956).

There is some evidence to indicate that Buckland's grandson, the late Prof. M A Gordon, FRS, planned, or at least contemplated, a new biography of Buckland, sorting the family archives and other material used by his mother, Mrs Gordon, in her 1894 biography, and attempting to transcribe some examples of Buckland's handwriting, which can be almost indecipherable at times. However, he appears to have made little progress, and he eventually split the material into two groups, depositing the Frank Buckland papers in the Archives of the Royal College of Surgeons, London, whilst all of the William Buckland material, together with more general family papers, were deposited in the Devon Record Office, Exeter.

The centenary of Buckland's death, 1956, appears to have aroused the interest of the late James Edmonds, Curator of the Geological Collections in the Oxford University Museum (which houses large quantities of Buckland specimens and much manuscript material). A short centenary review appeared in *Nature* (Edmonds, 1956A), and a slightly longer though substantially the same version appeared the same year in *The Anglican Catholic* (Edmonds, 1956B). (The choice of the latter journal is most curious. Although Newman attended Buckland's mineralogy and geology lecture series, there was little sympathy in terms of churchmanship between the aestheticism and Romanism of the Tractarians and the robust Broad Church outlook of Buckland - see Morrell and Thackray, 1981: 161-163 & 230-233, and Chapters 3.1 and 3.3 below.) The centenary was also marked by the publication of a fictional verse dialogue between Buckland and Mrs Harcourt: "The Heart of a King: an incident at Nuneham 1856", by the distinguished British poet, William Plomer. Originally written for the BBC Third Programme, the poem was subsequently published in both *The Listener* and in Plomer's *Collected Poems* (Plomer, 1956 & 1960: 162-168). The poem dealt with the notorious legend of Buckland, accidentally or deliberately according to different sources, eating a relic of the heart of the King of France (discussed later), and Plomer's verse was a worthy addition to the tradition of humorous verses about Buckland and his eccentricities that began more than a century earlier.

It is known that as Edmonds' interest in Buckland developed he began research for a projected new biography, going back to primary sources in order to separate fact from the wealth of legend and dismissive assertions on behalf of the then orthodox view of the rise of British geology. Regrettably, Edmonds was still at the research stage when he died (Powell, 1984; H S Torrens, pers. comm.). Only a foretaste of what might eventually have appeared was offered in two excellent papers. The first was an examination of the way in which Buckland, who came from a clerical family of relatively modest means though not without some influence, managed to obtain an Oxford place thanks to local influence and patronage (Edmonds, 1978) - a study that is of wide social and educational history significance. This paper duplicated to a considerable extent the first results of my own research on Buckland's early life, and consequently that part of the "Biographical Framework" (Chapter 2.1) has been considerably shortened to avoid repetition. The following year Edmonds (1979) demonstrated from original sources the way in which Buckland, by then an ambitious though impoverished young don, successfully negotiated not only the establishment of a regius chair in geology at Oxford, but also saw the whole of his ambitions fulfilled when he was himself appointed to this new chair. Earlier, Edmonds had taken over and completed work started by J A Douglas on one of the lithographs that exist of Buckland lecturing in Oxford (Edmonds & Douglas, 1976).

Apart from this, nothing of Edmonds' research of his latter years has been published, nor have his preparatory notes yet been made available to anyone else, so far as I am aware.

The 1960s saw a growing interest in the role of Buckland in the development of geomorphology. My biographical review of Buckland's role in cave science (Boylan, 1967) was the most substantial publication specifically on Buckland for twenty-five years (since North, 1942). However, this fact is more an indication of the continued neglect of Buckland than anything else. The following year Gordon Davies published his very valuable reconstruction of the September-October 1840 expedition of Agassiz and Buckland immediately after the Glasgow British Association meeting looking for evidence of glaciation in the Scottish Highlands (Davies, 1968). This was supplemented by a short paper on the same subject by George White (1970). Also, although not primarily concerned with Buckland, two substantial new histories of geomorphology published in the 1960s gave considerable prominence to Buckland and his close associates: those of Chorley, Dunn and Beckinsale (1964) and of Davies (1969).

An important landmark was the publication in 1967 of a substantial new biography of Frank Buckland by G H O Burgess, who is himself a commercial fisheries scientist, a profession that Frank Buckland created (Burgess, 1967). This included a biographical outline of William Buckland and much valuable material on the Buckland household during Frank Buckland's childhood and student days, making considerable use of the archive collections deposited at the Royal College of Surgeons and the Devon Record Office by Prof. Gordon.

A further examination of Diluvialism in Britain in the early 19th century was given by Leroy Page to the New Hampshire History of Geology Conference (Page, 1969) and the following year I published an analysis of a previously unpublished portrait of Buckland in the early 1820s which is icon-like in its inclusion of many specimens and illustrations of Buckland's recent scientific triumphs (Boylan, 1970) (see Frontispiece). The entry on Buckland for the Dictionary of Scientific Biography was entrusted to Walter [= Susan] Cannon who at that time had done little work on Buckland, and who mainly summarised previous work from secondary sources (Cannon, 1970). However, this entry was by the standards of the time a well-balanced view of Buckland's scientific work, and included some useful corrections to the list of publications given by Frank Buckland (1858). Two years later, the bicentenary of the discovery of Kirkdale Cave, Yorkshire, was marked by my analysis of the scientific significance of the hyaena remains in Kirkdale Cave investigated by Buckland (Boylan, 1972), and by a more general review article on Kirkdale in History Today by A D Orange (1972).

So far as the past decade is concerned, the important biographical studies of Edmonds (1978 & 1979) and of Edmonds and Douglas (1976) have already been referred to. Apart from these there has been little in the strictly biographical sense, but there has been a clearly discernible re-establishment of the reputation of British geology during what had long been regarded as the "dark ages" of ca. 1800-1830, as is for example well demonstrated in several essays and papers in Cannon's Science in Culture (Cannon, 1978). Delair and Sarjeant have drawn attention to Buckland's role in the development of various aspects of vertebrate palaeontology (Delair & Sarjeant, 1975; Sarjeant, 1974; Sarjeant & Delair, 1980).

More recently, my own work on Buckland's role in the recognition of glaciation was presented to the 1978 INHIGEO conference on regional influences on the development of geology, and a summary including a reconstruction of Buckland's geological tour of 1840 (covered in part by Davies, 1968 and White, 1970) has been published (Boylan, 1981). This work is now presented in full as Chapter 5.2 and Appendix 3 of this thesis.

Most recently, Nicholaas Rupke has produced a substantial volume on William Buckland as part of what he describes as the "English School of Geology" (Rupke, 1983), and which is only the second book-length study of Buckland (and the first since Mrs Gordon's biography of 1894). However, as Rupke makes clear in the first sentence of his Preface, this (very important) book is "intended as a contribution to the cultural history of early nineteenth-century England" (Rupke, 1983: vii), and only the briefest outline biography is included by way of introduction. The book is organised under three main themes: "Hyena [sic] Dens and the Deluge: Diluvial Geology as an Adjustment to Oxford Learning", "Worlds before Man: The New Perspective of Progressive Earth History" and "Providence in Earth Science: The Divine Right of Geology and of Political Economy" and is therefore not organised chronologically, although other biographical material is introduced in the text as necessary, in order to illustrate particular topics. Very little in this valuable book overlaps with the themes chosen for the present study.

Finally, it should be noted that although Buckland himself was ill-served by Victorian standards in terms of his own "life and letters" volume, his network of contacts throughout almost every area of public life - science, the arts, the church and politics, together with his public image as an eccentric celebrity in the later years of his life - resulted in frequent references to Buckland throughout much of Victorian biography and autobiography. Because of this, I have found systematic searching of 19th century English biography and autobiography very rewarding and frequently extremely revealing. In addition to examining obvious material, such as biographies and both published and unpublished correspondence of known associates of Buckland in the academic and scientific spheres, I checked some hundreds of volumes relating to persons who, from the point of view of their dates and ages, could conceivably have met Buckland, and as a result found much new material. (The unique facilities of the Gladstone Memorial Library, St. Deiniol's, Hawarden, were especially valuable in carrying out these systematic searches.)

2. BIOGRAPHICAL FRAMEWORK

2.1 CHILD AND STUDENT, 1784-1809

William Buckland was born on 12 March 1784, at Axminster, Devon, into a long-established middle-class Devonshire family, (see Fig. 2 for outline Family Tree). On the Buckland side, the family history has been traced by Wilkie (1933) who showed that his great-grandfather (also William Buckland) was a tanner in Crediton, and his grandfather was the first Rev. William Buckland (1713-1760), the Rector of Wolborough and Newton Abbot from 1746 to his death. His widow was left with four children aged between 5 and 14 years old at the time of his death. The eldest, Rev. John Buckland (1746-1837), was at Blundell's School, Tiverton, at the time of his father's death, but within 18 months had matriculated at Corpus Christi College ("C.C.C.") as an Exeter Diocese Scholar, and stayed in the College becoming a Fellow in 1771, and remaining a resident teaching Fellow of the College until 1797 when he married and took up a Living within the gift of the College. His influence was to be of considerable value to his nephew, William Buckland junior, in whom he took a special interest (Foster, 1891: 183; Edmonds, 1978: 96).

The second son, the Rev. Charles Buckland (1750-1821), and father of William, was educated at first at the local Wolborough School, but later followed his brother to Blundell's School. The financial circumstances cannot have been too easy for his young widowed mother, and whilst he certainly does not seem to have sought great wealth for himself or his family, he was in later years anxious to see that his sons had an adequate income to maintain their traditional standards, as was William in his turn. Charles Buckland was admitted as a pensioner at what was at that time the rather late age of eighteen at Sydney Sussex College,

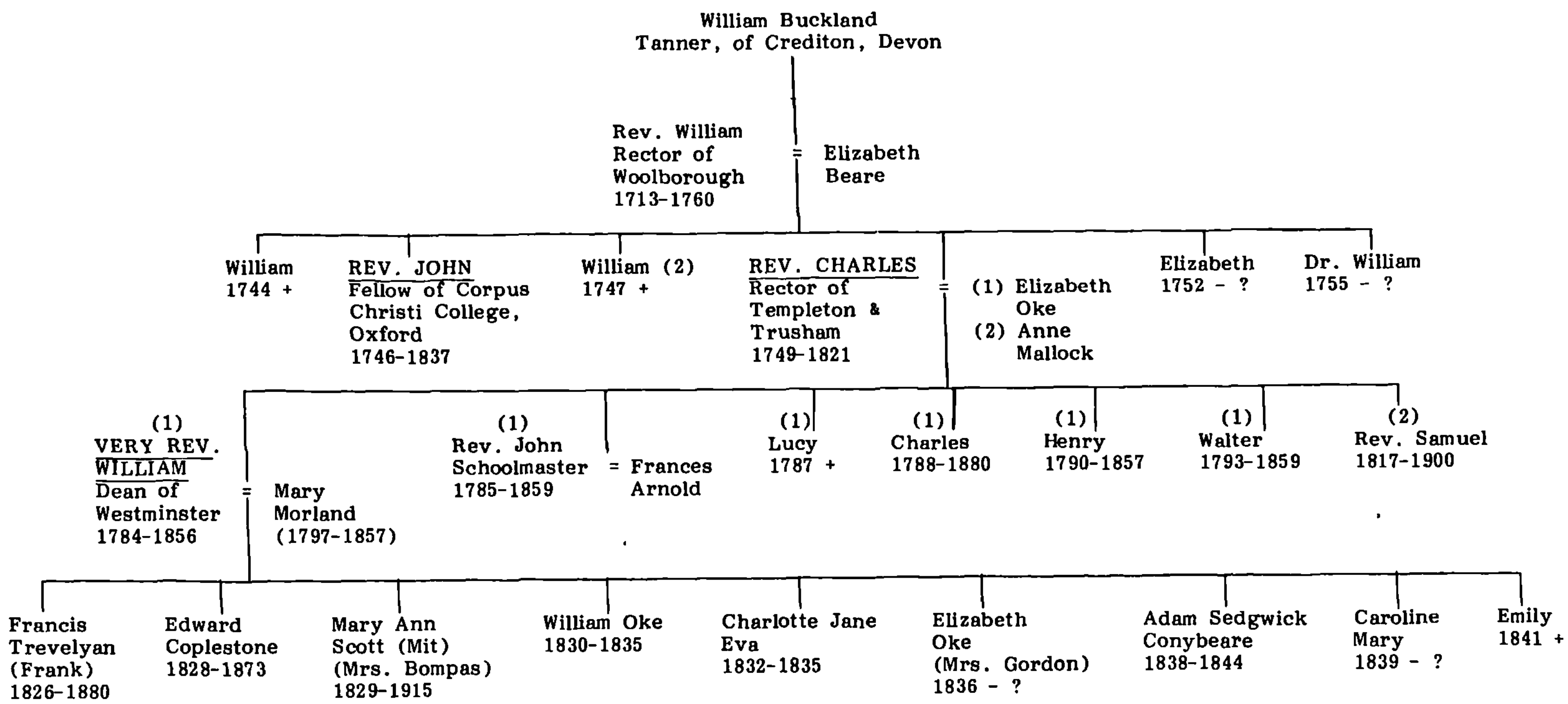


FIG. 2. OUTLINE FAMILY TREE OF THE FAMILY OF WILLIAM BUCKLAND

Cambridge and he matriculated in the Lent examinations, 1769. At this point he was awarded a Peter Blundell's Scholarship at Sydney Sussex, and graduated BA in 1772 and MA in 1776, when he returned to Devon and was ordained. After a few months as Curate of Shute and Colyton in East Devon, he came under the patronage of the Trustees of the Pole family of Shute and became Rector of Templeton, near Tiverton. In 1783 he married Elizabeth Oke who was the daughter of a farmer and landowner of Combpyne, and from a well-known East Devon family, and they set up home at Axminster. As the financial pressures of the steadily increasing family grew, Charles Buckland's patron, Sir John De la Pole, gave him additional absentee Livings to supplement the family income, in accordance with the common practice of the time: those of Trusham, near Chudleigh,Devon, in 1793, and of West Chelborough, Dorset, in 1795 (Venn, 1940: 431; Edmonds, 1978: 96).

Living in some modest degree of comfort a full day's travelling distance from any of his Livings, Charles Buckland appears to have had plenty of time to pursue an intelligent interest in natural history and geology, and throughout his life William Buckland was grateful to his father for arousing his interest and giving him a sound field naturalist's grounding in all aspects of natural history from the earliest days of his childhood.

On presenting the Wollaston Medal to Buckland in 1848, De la Beche referred to his early life saying:

> It may not be generally known, especially to the younger members of our Society, that, while yet a child, at your native town, Axminster in Devonshire, ammonities, obtained by your father from the lias-quarries [sic] in the neighbourhood, were presented to your attention. (De la Beche, 1848: xvii),

and in his biographical Memoir, Frank Buckland (1858, xix-xx) quotes a letter from Buckland to De la Beche about his childhood:

> The love of observing natural objects, which is common to most children, was early exhibited by my aptitude in finding birds' nests, and collecting their eggs. I also made observations on the habits of fishes in the Axe, particularly flounders, minnows, roaches, eels, and millers' thumbs.

By the time William was 9 years old, Charles and Elizabeth Buckland had had five more children, although the only daughter died in infancy. (Following the death of Elizabeth, Charles remarried when he was about 65 years old and there was one further son of this second marriage). From an early age William was regarded as the most academically gifted of the sons by both his father and by his influential uncle, Rev. John Buckland, although the second son, John junior (1785-1859) was also regarded as very able and eventually followed Buckland to Oxford. (He became a schoolmaster and married Frances Arnold, the sister of Thomas Arnold, and jointly with Arnold became the proprietor of a noted Preparatory School.)

The sons were originally tutored at home by their father, but by 1796 wished to prepare the two elder sons for University entrance, and he sought the advice of his brother on this. Although by then Charles Buckland's patron Sir John De la Pole had augmented the family income significantly by granting him the Trusham and West Chelborough Livings, financial considerations were clearly a serious concern, and the pressures on the family about this time were made worse by an accident to Charles Buckland, which left him blind for the remaining 22 years of his life.

As Charles and John would certainly have recalled from their own childhood 30 years earlier, the winning of an adequate scholarship to a good College was crucial. Moreover, since a high proportion of the very limited number of adequate scholarships available were restricted to students nominated by particular schools, it was virtually essential that William and John should obtain as quickly as possible places in good schools that not only prepared students for University entrance examinations, but also had "closed" scholarships at Oxford and Cambridge.

John senior and Charles had themselves each won closed scholarships to Oxford and Cambridge respectively through Blundell's School, Tiverton, and their friend Charles' patron, Sir John De la Pole, had also been at Blundell's before going to C.C.C., Oxford, as Gentleman Commoner, and where John Buckland was his tutor (Edmonds, 1978: 97).

Arrangements were therefore made for William to enter Blundell's School in the hope of following his father and uncle to University, and in fact he took up this place in 1797. However, from more than 20 years' experience as a Fellow and Tutor at Oxford, John Buckland was well aware of the very limited number of adequate scholarships available from Blundell's or indeed any other West Country school, and he advised that William would have a much better chance in relation to both the standard of academic preparation and the likelihood of obtaining a financially adequate scholarship if he could obtain a place at Winchester School.

The sequence of events over the next five years can be reconstructed from surviving papers in the Buckland and Pole-Carew archives but since these have been published by the late James Edmonds (1978), (covering all of the documentary material relating to this that I had also worked on), only the briefest outline is needed here. As Edmonds has pointed out, the story is very revealing of the way in which the patronage "system" of the day ensured that, thanks to the support of his father's old patrons, the Pole family, and the interest of Henry Addingham, Speaker of the House of Commons, William progressed, comparatively smoothly, first to Winchester, and then to Oxford. The influence of John Buckland was also important. For example, on 20 March 1797, he wrote to Charles:

> About a fortnight since I met with Mr Pole-Carew who was so kind as to inform me that the Speaker of the H. of Commons had obtained a promise from the Warden of Winchester to nominate your eldest son at the Election in the Summer of 1798. You will of course express your thanks to Mr Carew on the occasion.... As there is the highest probability that there will be a vacancy for Devonshire at Corpus early in the year 1800, he ought to be ripen'd prematurely for such a purpose which certainly can not be done anywhere so well as at Winchester.... If he fails at Corpus, 'tis to be hoped there will remain for him a fair prospect of success at New College. (M.S. DRO 138M/F19).

As a result of this advice, Charles Buckland entered both the older sons for Blundell's School, Tiverton, and William spent almost a year there on formal classical work, particularly Greek and Latin, and was selected as a Winchester Scholar on 22 October, entering the Fifth Form directly shortly afterwards.

Although Winchester had a very substantial reputation in the Universities for high academics standards, particularly amongst the Scholars, and the School was second only to Eton in public esteem, behind this public facade things were far from well. Less than five years earlier, at Easter 1793, there had been a full-scale rebellion in which the boys had taken over the School in protest against the conditions and brutality, and the occupation was only broken when the Warden brought in a large force of armed Militia (Adams, 1878: 142-152). Thirty-five boys resigned or were expelled and the total numbers in the School fell to about 60 and the unhappy state of Winchester continued through the 1790s. Even H C Adams, the 19th century Wykehamist whose writing on the period is very much a nostalgic apologia for the Winchester system and traditions, and who as a consequence almost certainly underplays the situation, finds it hard to say anything favourable about Winchester during that period other than to note favourably the growing influence of William Stanley Goddard, the "Hostarius" of the College from the time of the Rebellion and who succeeded as Warden in 1800.

Buckland progressed through the narrow formal education of Winchester well enough, although he continued to develop his interest in natural history and geology in his limited spare time at Winchester, and during the School vacations which he usually spent at home in East Devon. At the Wollaston Medal presentation, De la Beche (1848: xvii) stated:

> As a scholar at Winchester, the chalk, with its flints, were brought under your observation, and there it was that your collections in natural history first began.

By October 1800 Buckland had obtained a nomination for the New College scholarship, but was only eighteenth on a waiting list of 20, and it seemed unlikely that he would progress (or be promoted to) the top of the list before he reached the age limit at which he would have to leave Winchester. (Edmonds, 1978: 104).

Consequently, the family began once again to look at his future, and to seek a scholarship elsewhere. His uncle John had been a member of Corpus Christi College, Oxford, as a Scholar, Fellow and Tutor for

35 years, although he had resigned from the College three years earlier, in 1797, when he married and took up the Living of Warborough in Oxfordshire. Nevertheless, John Buckland must still have had considerable influence in the College and this therefore seemed an obvious possibility. On the other hand, under its constitution "C.C.C." was very small indeed with places for only twenty Fellows and twenty Scholars plus a few places for Exhibitioners and Gentlemen Commoners. On the positive side the College had two restricted scholarships for men from the Exeter diocese and these - quite unusually - could be held until the M.A. degree was taken, and could in practice be extended indefinitely until a vacancy for a Fellowship arose if the Scholar wished to proceed to ordination and a College Fellowship (Edmonds, 1978: 104-105). Unlike most scholarships, therefore, it was not possible to predict when a C.C.C. vacancy would occur. At the end of 1800 the two Exeter scholarships had been held by Scholars for eight years and five years respectively, and there was no sign of a vacancy.

However, quite unexpectedly, both Exeter scholarships became vacant at almost the same time at the beginning of 1801, when one of the Fellows resigned enabling the senior Exeter Scholar to advance to fellowship, and very soon afterwards the junior Scholar decided to leave the College to be ordained and take up a curacy at Offwell, Devon. It was obvious that there would be very strong competition for the highly-prized scholarships, particularly since there had not been a competition for them for almost six years, and a considerable number of worthy and well-prepared candidates from the Exeter diocese were likely to have been waiting for several years for this opportunity. Consequently, Charles and John Buckland were both very anxious about the possible strength of the competition. On 22 February 1801 the Rev John Buckland wrote from Warborough to the Rev Charles Buckland at Axminster:

> Dear Br.,
>
> I confess I feel as great apprehension and doubt as you do as to the event of the election. The number of candidates will be unusually great.... It is but lately that I have been made acquainted with the plan of studies William has been pursuing at Winchester, which I certainly do most highly disapprove of. But it is too late to regret it and vain to censure it. To say the least of it, it is very un-improving, and ill-adapted to prepare him for the ensuing examination. (M.S. DRO 138M/F22).

John Buckland therefore recommended that William should be sent to Warborough for private coaching by himself, adding:

> Only I must give you a caution: if you adopt my proposal at all, it will be prudent to keep it secret. It would be best it should not be known to the competitors, for many obvious reasons, that I am pursuing such a design. William might leave Winchester on the pretence of going to enter at Oxford - even Goddard should not be informed of the true reason. (M.S. DRO 138M/F22).

William was quickly extricated as inconspicuously as possible from Winchester as suggested, so as to avoid alerting the "opposition" and went direct to his uncle's near Oxford, arriving at Warborough on 21 March 1801. He even left his furniture and some of his books and clothes behind at Winchester, in order to give the impression that he intended to return, although he appears to have confided in Goddard, who promised him a testimonial if required (letter, William Buckland, Warborough, to Rev Charles Buckland, Axminster, 22 March 1801: M.S. DRO 138M/F21).

Either John Buckland senior was being unduly alarmist about William's university entrance preparation at Winchester and the sample exercises that he had received, or else there was a remarkable improvement in the six weeks or so of intensive study under his uncle's coaching at Warborough, because William came top of the competition, as he explained in a letter of 13 May 1801 to his father:

> I am happy to inform you that I have just been elected the Senior Scholar for Devonshire, after a course of many days' rigorous examination against eight competitors; (F Buckland, 1858: xxiii).

The following day, 14 May 1801, William Buckland was formally admitted to Corpus Christi College, which was to be his home for the next quarter of a century. Despite its very small size in terms of the numbers of students and Fellows, Corpus Christi was one of the most distinguished and influential of all Oxford Colleges at the time:

> Considering the extreme smallness of its numbers at that time, the number of undergraduates varying from about sixteen to twenty, it is truly remarkable to observe the large proportion of distinguished names which occur in the list between 1761 and 1811. (Fowler, 1891: 297).

The atmosphere and undergraduate life of Corpus Christi was described in some detail by John Taylor Coleridge (later a distinguished judge) in a long letter to Dean Stanley which was included in his life of Arnold:

> Corpus is a very small establishment, twenty fellows and twenty scholars, with four exhibitioners, form the foundation. No independent members were admitted except gentlemen commoners, and they were limited to six. Of the scholars several were bachelors, and the whole number of students actually under college tuition seldom exceeded twenty. But the scholarships, though not entirely open, were yet enough so to admit of much competition... and insured a number of good candidates for each vacancy, and we boasted a more than proportionate share of successful competitors for university honours.... We were then a small society, the members rather under the usual age, and with more than the ordinary proportion of ability and scholarship; our mode of tuition was in harmony with these circumstances; not by private lectures, but in classes of such a size as excited emulation, and made us careful in the exact and neat rendering of the original, yet not so numerous as to prevent individual attention on the tutor's part, and familiar knowledge of each pupil's turn and talents. In addition to the books read in lecture, the tutor at the beginning of the term settled with each student upon some book to be read by himself in private, and prepared for the public examination at the end of term in Hall; and with this book something on paper, either an analysis of it, or remarks upon it, was expected to be produced, which insured that the book should really have been read. (Stanley, 1844: 8-10).

Once resident in College, William Buckland appears to have settled down quickly to the sort of undergraduate life that Coleridge describes so vividly, concentrating on the rigorous but very narrow curriculum of the time: Greek and Latin literature and composition, formal geometry, a very narrow range of theology, and little else. Meanwhile, his brother John, who had been withdrawn from the C.C.C. scholarship competition in 1801, had continued at Blundell's School, from which he won a John Ham's Exhibition to Trinity College, Oxford, where he matriculated on 25 May 1802 at the age of 16 years. For the next seven years the two brothers were in close touch with each other at Oxford, and with their uncle at Warborough nearby, until John junior took his MA in 1809 and left Oxford to be ordained.

Little is recorded about Buckland's scientific interests and activities during his undergraduate years, and it seems that he was working very hard at his formal studies. It is however clear that on the coach journeys that he made twice or three times a year in each direction between Oxfordshire and Devon he took a keen interest in the geology and scenery along the route, and that he continued to develop his keen interest in the fossils and rocks that he encountered around Axminster, and eastwards along the coast to Lyme Regis, where he met at a very early date the famous professional fossil collector, Mary Anning.

As William's BA degree examination approached, his uncle appears to have at least advised if not formally coached both his nephews, and was a hard taskmaster. At that time Oxford degrees were unclassified and the examination was entirely viva voce (which was probably just as well as far as Buckland was concerned, bearing in mind his near-illegible handwriting). He submitted himself for the December 1804 examination (3½ years after matriculation), and on 10 December he was able to write to his Uncle:

> Before I came out of the schools they told me I had passed extremely well, and after the 'Liceats' were given out, they came up to me in the school quadrangle and said they were extremely sorry that they had not publicly thanked me in the schools, but that I had passed a most creditable examination. I hope you will now find good reason to change the opinion which you gave me to understand you had formed; viz., that I did not take up enough for my degree, and that I appeared to have no ambition, but barely wished to save my groats. (F Buckland, 1858: xxv).

Returning to Oxford after the Christmas vacation, Buckland formally graduated on 22 February 1805, and then settled into the three years of residence and studies required for his MA degree. His scholarship continued (although with no increase in stipend), so financial matters and the prospects for advancement to a Fellowship or at least supplementing his income through private tutoring, are a recurring concern in letters to his father. For example, on 10 February 1805 he wrote from Oxford to his father at Axminster:

> Yesterday our Battles for last Term came out. I have to pay 8 Pounds on or before the 4th of March. My Uncle has been so kind as to promise to pay ye expenses of my Degree & of Robertsons lectures, but never gave the last hint that he w'd pay my battles. I shall therefore...[?] to you if you if you [sic] will send me by that time the above mentioned sum, and likewise 6 or 7 Pounds to go on with, as after paying my journey, Coalman's Bill, Xmas Fees, & Scouts Bill & Common Room Expenses the sum I had of you when I left home is nearly exhausted. (M.S. DRO 138M/F38).

Although he recognised that it was necessary to concentrate much of his efforts on the formal work in the areas on which he would be examined for his MA, Buckland quickly found time to leave the narrow confines of the College in order to attend the lectures of the various University Readers and Professors. Looking back on the period, Buckland himself wrote:

> The interval between my Bachelor's and Master's degree afforded me leisure to attend the Lectures of Dr Kidd on Mineralogy and

> Chemistry, and of Sir Christopher Pegge on Anatomy; and my position as a Scolar of Corpus College [sic] gave me the advantage of rooms, and a small income from the College, which I augmented by taking pupils; (F Buckland, 1858: xxv-xxvi).

The state and development of the teaching of geological sciences in Oxford is duscussed in some detail in Chapter 3.1 below, but it should be noted here that mineralogy was taught by John Kidd very much as an extension of chemistry as is well illustrated in his own two-volume Outlines of Mineralogy, although it does include some notes on geology, describing both the Huttonian and Wernerian systems (Kidd, 1809). The position was of course very different in Scotland, (Richie, 1952) where Prof John Walker offered a substantial lecture course in geology from 1779 until 1804. Walker published an outline of his mineralogy course (mainly in Latin, but with English names added), (Walker, 1787), and his lecture notes have been published in recent times (Walker, 1966), (see also Walker 1792, 1803 and 1822). In 1804, Walker was succeeded as Professor of Natural History by Robert Jameson, a trained geologist of the Wernerian School, and who immediately raised Edinburgh to international importance for the teaching of geology.

Useful though Kidd's mineralogy lectures were, particularly when Buckland succeeded Kidd in 1813, it is clear that he learned most of his geology informally, from private study and - above all - meticulous field observation. Writing about his early experience in the field, Buckland himself later wrote:

> In my earlier years of residence at Oxford, I took my first lesson in Field Geology, in a walk to Shotover Hill, with Mr William John Broderip (late Magistrate at the Westminster Police-court, then of Oriel College), whose early knowledge of Conchology enabled him to speak scientifically on the fossil shells in the Oxford oolite formation, and of the fossil shells and sponges of the green sand of the Vale of Pusey, near Devizes, as to which he had been instructed by the Rector of Pusey, Mr Townsend, the friend and fellow-labourer of Mr William Smith, the father of English Geology.

> The fruits of my first walk with Mr Broderip formed the nucleus of my collection for my own cabinet; which in forty years expanded into the large amount which I have placed in the Oxford Geological Museum. (F Buckland, 1858: xxiv).

Although all the early biographies that cite this quotation, (for example, Phillips, 1857; F Buckland, 1858; Gordon, 1894), attribute this "first lesson" explicitly or implicitly to the period between Buckland's BA and MA, this hardly seems credible. William John Broderip (1789–1859) was 4½ years younger than Buckland and did not go up to Oxford until 1807, when he matriculated and entered Oriel College at the age of seventeen. Consequently, their first joint expedition to Shotover Hill near Oxford (a favourite field-teaching location of Buckland in later years) is most unlikely to have been before 1807 and could well have been a year or two later. The "Mr Townsend, Rector of Pusey", was the Rev Joseph Townsend, 1739–1816, whose obscurely-titled book <u>The Character of Moses established for veracity as a historian, recording events from the Creation to the Deluge</u> (Townsend, 1813) was perhaps the best English book on stratigraphical geology of its time. This included the earliest detailed description of the work of William Smith amongst much other information, including a fair and balanced summary of the Huttonian theory, (even though Townsend made it clear that he did not accept this), together with meticulous personal observations made both in Britain and on the Continent. Townsend was elected an Honorary Member of the Geological Society on its establishment.

Scientific study certainly did not occupy the whole of Buckland's time. Despite the doubts expressed to his father in the letter of 10 February 1805, he appears to have quickly acquired at least three pupils, although he would presumably receive a fee in respect of only two of these, since the third was his brother John. On 15 December 1805 he wrote to his Uncle telling him of John's success in the previous day's examination and continued:

> This gives me great satisfaction after the trouble I have taken with him - in fact I have given up the whole of my time this term to him, John & Calley, my mornings entirely to Standert & Calley, my evenings to John, till he had been through all his speeches & choruses, & since that entirely to Standert. (M.S. DRO 138M/F40).

The fees received for this private coaching were clearly only a very modest supplement to the continuing scholarship; family correspondence shows that both William and John continued to depend on planned allowances and solicited supplements from both their Father and their Uncle, and the coaching fees were being extracted from undergraduates who were probably in a similar financial position and who could only pay in arrears. There is also some evidence that at times the weight of teaching was such as to interfere with Buckland's own studies, as in for example an undated letter of about November 1805 to his Father (M.S. DRO 138M/F41).

Of even greater concern than the day-to-day shortage of cash was the outlook for the future. For those such as the two Buckland sons who had no personal fortune, there were three basic alternatives after graduating as MAs. The first was to leave University and go into some lay profession such as medicine or the law (the latter being the choice of W J Broderip and, a generation later, Charles Lyell) or perhaps some area of government service (Buckland's younger brother Charles joined the Treasury, for example).

The second course was to seek ordination and leave Oxford for a parish or chaplaincy ministry. Here, however, the support of influential patrons, whether private or institutional, was of even greater importance than that required to obtain a scholarship to a good school or University. Because of differences in past endowments the relative value of apparently quite comparable Livings varied enormously - from as little as just a few tens of pounds through to many hundreds of pounds per year.

The third option open to Buckland was to follow his Uncle into a College Fellowship, supplemented by private students and - perhaps - eventually a University appointment as well. From the surviving correspondence with his family, it seems clear that this was Buckland's preferred course from the time that he first went to Oxford, but it was very uncertain whether a suitable vacancy would occur before family financial constraints forced him into one of the other options, most likely ordination and parish work. (By the time he took his BA both his parents were in poor health, and his mother was soon to die, leaving his blind father to bring up the five sons alone until his second marriage to Anne Mallock in 1815). Thus his letters to his father frequently turned to the prospects of more senior members of the College obtaining advancement, or even rumours of romantic associations. For example, in a letter as early as 20 April 1805 to his father, Buckland wrote:

> My Uncle says that in case of there being a Master Scholar the first Bachelor whose County is not at the present time full becomes fellow, but there is at present no talk of any more vacancies. Thomas I fear has forgot Miss Williams!.... Oriel Election was last week, 3 vacancies, Davis of Oriel Marsh of Wadham and Parsons of University College were elected, some men that have obtained ye public honours were cut out. There is not ye least probability of Woolcome of Oriel vacating till he gets a College Living, but it is said in Corpus (I believe without foundation) that our Woolcome intends to stand there. I think it not improbable. (M.S. DRO 138M/F39).

Even when he was at last able to report the good news that there would definitely be a vacancy for a Fellowship for him, Buckland was still very concerned to explain to his father some of the underlying tensions and pressures surrounding the constant competition for advancement within the College in a letter dated 19 July 1807:

> You will no doubt be pleased to hear that there is a vacancy for me at Corpus. My Uncle who rode in to Oxford last week brought word that Mr Parlevaint is dead. Mr Lockton it is supposed will take the Living. Now I consider this as highly fortunate for me to have a vacancy so unexpectedly made 6 months before I take my Masters Degree. But I am not altogether without hopes of getting a fellowship more expeditiously than by the long process of waiting for Mr Locktons vacancy. Dr Barton has been presented by the A.B.P. [Archbishop] to the Living of... [?Pluckley] in Kent worth 200 a year. It is exactly 10 Pounds in Pope Nicholas's Valor, & is consequently tenable with his Fellowship which it is undoubtedly his own intention.... My uncle when in Oxford last week found all the senior fellows very much displeased at Bartons selfish conduct in taking advantage of the letter of the Statute & keeping a fellowship with a living of 700 a year & the President who cannot but see his views, is very angry indeed with him but he is at present very stout & likely to live these 10 years. (M.S. DRO 138M/F37).

Having been admitted to the degree of MA, and hoping that by virtue of his seniority his election to the forthcoming Fellowship was now a mere formality, Buckland sought ordination. The Bishop of Winchester accepted him without any difficulty on the basis of a formal letter of application supported by a testimonial from the College, and he was ordained Deacon in Winchester Cathedral on 21 March 1808, just one week after his 24th birthday (Willis, 1964).

Certainly by 1808 Buckland had absorbed the mineralogy and geology lectures of John Kidd (discussed below in Chapter 3.1) and was rapidly developing his field geology skills under the guidance of Broderip and others. However, he appreciated that the answers to the major geological issues of the day would only be found through extensive and meticulous field observation and analysis, in contrast with the still dominant emphasis on theoretical studies. Accordingly, in the summer of 1808 he set out on his own on horseback to explore in detail the geology of the western half of southern England, leaving Oxford and exploring first Berkshire and Wiltshire, and then on to Dorset and in particular the Isle of Purbeck. It was here that he made his first significant geological discovery: his recognition of the Chalk in the vertical strata of Purbeck at Corfe Castle, which he related correctly to the Lower Cretaceous below and the Tertiary above in the vertical sequence (F Buckland, 1858: xxvii).

There seems to be no evidence at all as to Buckland's own geological viewpoint at this time. He must however have been familiar with both sides of the Huttonian/Wernerian controversy then current from Kidd's lectures, the substance of which subsequently appeared in his valedictory book on leaving geology (Kidd, 1815). The auction catalogue of Buckland's Library (Stevens, 1856) shows that at some time in his life Buckland had acquired the 1795 two volume Theory of the Earth of James Hutton, Playfair's Illustrations and Werner's Veins. Judging by his earliest published work it seems likely that Buckland had a healthy scepticism about any theoretical preconceptions, and concentrated on the field observation and interpretation for which he became justly famous in later years.

What is certain is that the 1808 tour set a pattern in Buckland's way of life that was to persist for well over thirty years, with much of each summer being spent on increasingly ambitious programmes of field work, first throughout the British Isles and subsequently over much of the Continent, achieving remarkable feats simply in terms of the scale and intensity of his geological travels.

At the beginning of 1809 the predicted vacancy for a Fellow from Devonshire occurred at Corpus Christi and as expected Buckland, as the senior Scholar from Devon, was elected to it. Immediately afterwards he made the arrangements for his ordination as a Priest which would, amongst other things, make him eligible under the Canon Law of 1604 (Canon XXXVI - see Walker, 1923) to apply for a University Lectureship or Readership, which could be held in addition to his Fellowship. More immediately, with a high proportion of the English Livings being held by absentee or "pluralist" rectors and vicars, there was a ready demand for younger clergymen willing to travel and take services in churches throughout the land, and this was recognised as a useful way in which younger Fellows could supplement their income.

The ordination took place at the Chapel Royal, St James's, London, on 16 June 1809, and Buckland at last was able to move out of the crowded Scholars' accommodation into his own Fellow's Room that was to be his home for the next sixteen years:

> There is a large room in the Front Quadrangle, now appropriated to the purposes of an Undergraduates' Library, which was Dr Buckland's sitting-room, and fitted up by him, irrespectively of personal comfort, as a Geological Museum - probably the earliest collection of the kind in Oxford, or perhaps in England, which was arranged on anything like scientific principles. (Fowler, 1898: 201).

2.2 THE EMERGING GEOLOGIST, 1809-1818

At first Buckland's way of life following ordination and taking up his Fellowship appears to have changed very little, except that his situation was far more comfortable in terms of both finance and living space. Perhaps the greatest change was the far greater freedom that his new status gave him, as Buckland himself stressed towards the end of his life:

> ... without the liberal aid of the endowments of the University, I could not have had the means of acquiring the knowledge, and of enlarging it by extensive travellings during vacations, which I enjoyed during a residence of nearly forty-five years in Oxford, from April, 1801, to December, 1845. (F Buckland, 1858: xxvi).

This is not to say that all of his travels were strictly geological. There is, for example, a detailed account of a visit to Southampton, Portsmouth and the Isle of Wight with two Oxford friends between 4th and 16th July 1809 which is described in some detail in a letter to his brother (M.S. DRO 138M/F35). The main objective here seems to have been a major review of the Fleet in which the brother of one of the group was serving ("... we saw over ye ship, had some famous french claret, & returning to dine on shore ..."), after which the party spent a number of days both on the mainland and on the Isle of Wight travelling from house to house visiting (presumably unannounced) various people with whom they had some sort of tenuous second- or third-hand link. One of the people they went to look up was Thomas Arnold whose family had a house in Cowes who was in fact absent so the group "... spent the morning & evening with his mother & sisters, whom Bridges has often seen before & uncommonly pleasant girls they are." (John Buckland subsequently married Arnold's elder sister thus cementing a close friendship between William Buckland and Arnold which continued to Arnold's death.)

On returning to Oxford on 16 July, Buckland went straight to Warborough, whence he wrote the letter to his brother, explaining that their Uncle had left a note expressing his displeasure at the expedition, which was unfortunate since Buckland was hoping that he would finance his planned geological tour through Somerset and East Devon and on to Axminster, where he was due a fortnight later, in case the Vicar needed help with some services (which would further supplement his finances):

> At Warbh. I found ... [?] this morning, of course in a querulous Note saying that I strangely delude myself if I suppose my eccentric project could meet his approbation (indeed I am too old not to have discovered that whatever is done, is wrong in the eyes of some folks) as after a little vapouring on general pursuits, &c says he shall return by next Sunday probably, but wishes me to come there, which I must at all events do, as I must get from him some money. I think I shall leave Oxford on ye 24 or 25, & shall come down by way of Bristol, Wells & Taunton, at each of w/h places I have friends to call on, I think it will be politic to attend ye Wykehamist Meeting at Exeter, & certainly will be pleasant. If I find myself pressed for time, I shall go from Taunton to Exon before I reach Axminster but I wish you to send me by ye end of this week, ye Circular or ye Substance of it, that I may know, when & to whom I am to give notice that I mean to attend. This Plan will enable me to be at Axm. the 6th of August ye Sunday after you leave it, & I ought to succeed you in your duty shd my services be wished for. As we may be treading on ye same ground, I wish you to tell me what Texts you have been preaching on, at K. & M. or elsewhere. You have not I suppose used any of those sermons which I gave you a copy of, with ye intention that you shd use them in ye neighbourhood of Marlow, & not where I might be likely to preach. Let me hear from you by Saturday or Sunday next. (M.S. DRO 138M/F35).

The 1809 geological field work was a landmark in Buckland's scientific career. Prior to the 1808 tour his field experience had been almost entirely confined to the Jurassic and Cretaceous of East Devon and the adjacent parts of Dorset (especially Lyme Regis) on the one hand, and the Jurassic around Oxford on the other. The 1808 tour had enabled him to link the geology of the two areas by a large-scale traverse, but this work had still been largely confined to the Jurassic, Cretaceous and superficial deposits. The summer 1809 tour took him into completely new areas of experience in both geographical and stratigraphical terms, taking in the Carboniferous Limestone of the Mendips with its mineralisation and its caves, the Culm and volcanics of Exeter and mid-Devon, the exposed areas of the Dartmoor Granite and its associated ring of mineralisation (where Buckland collected the first specimens for his mineralogy collection), and the Devonian of the South Devon coast from Plymouth back to Torbay.

An even clearer sign of his growing confidence and maturity in geological fieldwork was his attempt over a three-week period to prepare a geological map of the whole of the Mendips using one of the new Ordnance Survey maps as a working base. Buckland himself referred to this pioneering work in what proved to be his last scientific address, his speech as guest of honour at the first Annual General Meeting of the Somerset Archaeological and Natural History Society held in Taunton on 26 September 1849. In this he told his audience of about 350 people:

> The Chairman then introduced THE DEAN OF WESTMINSTER, (Dr. Buckland,) who said that as it had been his lot first to see the light in a contiguous county - being a native of Axminster - he was no stranger to the county of Somerset: and although it had never been his good fortune to possess property within the borders of that county - he meant property under that usual denomination, which those who had it not, called "dirty acres" - yet he had property in the county which he valued more highly. Scientific men were often justly accused of neglecting pecuniary rewards for their services, and gratifying their ambition by the acquisition of literary or scientific reputation. It had been his lot a quarter of a century ago, to take possession within that county of a large manor - a manor that interfered not with the rights of noble lords or honorable gentlemen, but a scientific manor in which whatever he had done was convertible, if they pleased, to their pecuniary advantage. It had been his lot before he obtained the assistance of his kind friend the Dean of Llandaff [i.e. W D Conybeare], in the completion of this work, during three of the most interesting weeks of his life to travel in solitude - his only companion being an ordnance map, which he had geologically coloured on the spot - over the whole of Mendip, from one end to the other, for the first time that it was ever

> traversed by any individual of the human species, employed, and successfully employed, in ascertaining by personal inspection, the structure of that important range of hills. It had been his lot to traverse the whole of that small mountain chain, and at the end of three weeks, when he had finished his geological map of the district, and stood alone on one of the highest crests of Mendip, viz. on Blackdown, he felt a pride which he never felt before or since; he felt a pride which he trusted it was not improper for him to feel - that he was the first of the human race whom God had permitted to understand the geological construction of His glorious works in that important part of the county of Somerset. (Buckland, 1849C: 9-10).

This mapping, commenced in 1809 (not 1810, as implied by Frank Buckland - 1858: xxviii), and continued intermittently for more than 10 years in association with Conybeare, and was published as part of their joint memoir on the South Western Coal District (Buckland and Conybeare, 1824). His original field map survives (M.S. GSL), but the work actually carried out in the summer of 1809 cannot be distinguished from later revisions and additions.

Returning to Oxford Buckland settled quickly into the academic life of the University with his new-found status of a Fellow. One immediate diversion was the bitterly-fought election for the vacant Chancellorship of the University, in which Buckland, now a member of Convocation as an MA, could vote for the first time. Informing his father of the state of play, he wrote on 10 December 1809:

> The contest lies between Lords Eldon & Grenville. The Post says Lord G has about 300 votes promised, Lord Eldon a little more than 400 & the Duke about 300. There is great danger that the scandalous reports that are industriously circulated all over ye country of Ld Eldons resignation, will stop many of his votes from coming. Dr. Thring wrote to canvass my Uncle for Lord Grenville last Monday having heard that Lord E: had positively resigned.... On the other side Heaven & Earth will be moved to bring up every creature from Scotland Ireland & even Lord Collingwoods fleet to vote for the Grenvilles.... The President gives us a grand Dinner in the Hall on Wednesday. Lord Aylesbury has sent him 3 does, 3 brace of pheasants & 3 brace of hares. Indeed his Lordship has been serving us wh. venison this month past under an idea that Elections cannot go on without good dinners. We have had 3 haunches at our High Table all to ourselves. (M.S. DRO 138M/F34).

It is also clear from the same letter that by this time he was regularly repaying kindnesses (or perhaps supplementing his income) by taking church services on a fairly regular basis for his Uncle at Warborough while resident in Oxford, and in the Axminster area when staying with his family there during vacations. For example, in the same 10 December 1809 letter to his father he wrote:

> I take an early opportunity of informing you that it is my present intention to leave Oxford as soon as possible after the Election & I shall be happy to give Mr. Steen my assistance by taking care of his Church on the 24. 25 & 2 or 3 following Sundays. I do not yet know for certain on what day my Uncle will wish me to resume Warborough but think the 14th Jany will be the latest day I shall be able to assist my friends in Devonshire as I wish to be in Oxford the last week or 10 days of Jan'y & probably my Uncle will also wish me to be at Warbh. on the 21st. (M.S. DRO 138M/F34).

Despite his obvious enjoyment of academic life in Oxford, his financial situation appears to have been a continuing concern (and remained so for the greater part of his life). This was not due to any inherent avarice or even a wish for material comforts, but was probably due to the financial insecurity felt from early childhood because of the very modest circumstances (by contemporary middle-class standards) of his father in relation to the family's financial commitments, and to the heavy expenses necessarily involved in pursuing his geological interests. Before the development and widespread introduction of high-speed powered printing presses in the 1830s and 1840s books, particularly illustrated scientific books, were exceedingly expensive - perhaps equivalent in terms of then current purchasing power to the cost of hand-printed "private press" books today. Before the introduction of the penny post in 1840, postal and freight charges were a very serious burden on participation in scientific interchange by means of correspondence, which was such an important feature of early 19th century scientific, and particularly geological, life, as has been explained so lucidly by Dorinda Outram (1980: 1-7), and were almost prohibitive when heavy geological specimens were involved. However, probably the greatest financial burden of all was that of travel prior to the development of an adequate network of railways in the 1840s, by which time Buckland's enthusiasm for innovation seems to have waned in that he hated train travel and tried to avoid it at all costs. He saw the solution to geological controversies as lying in meticulous fieldwork and until quite late in life maintained his own horse for this purpose. Whilst this was probably an economy compared with coach travel and the hire of horses or carriages locally once he had reached his fieldwork area, even his faithful old horse had to be stabled, fed and generally cared for. Altogether therefore it is probably not at all unrealistic to suggest that Buckland's financial needs in the early years of the second decade of the century were at least three to four times that of a directly comparable young Fellow in a field such as classics, theology or mathematics, whose academic requirement could be entirely satisfied within walking distance of the College in the centre of Oxford.

Certainly, in the early part of 1810 Buckland considered very seriously the possibility of leaving Oxford and formally applied to Lord Sefton for the post of Tutor to his sons, with the prospect of comfortable accommodation first at Eton and later at Oxford, together with the opportunity to travel and - eventually - a reasonable hope of an attractive Living after the boys had grown up. As Buckland explained in a letter to his father dated 22 March 1810:

> As you must no doubt be anxious to know what I have been doing with respect to the business I mentioned to you in my last, I lost no time in informing you that I returned from Town by the night coach this morning & have reason to think that my journeys have not been in vain. Last week Dr. Burton received a letter from Lady Salisbury stating that she had mentioned me to Lord Sefton & that he wished me to call upon him when I might be in Town - in consequence of this I put myself into the coach Sunday night & reached London Monday morning. I did not see Lord Sefton that day as he was gone out of Town. But on Tuesday morning I waited on him & the tenor of our conversation appeared to me very satisfactory. I gave him to understand that my object in making an engagement with a pupil was not present ... [? enrichment] only but a prospect of future Benefit. His Lordship observed that he considered that any Person who shd give up part of the ... [? time] of his life to the education of his sons whd be entitled to some thing more than present compensation, & tho he did not chose (as he had done in the case of Mr. Davidson) to enter into any express contract on the subject, he shd feel himself bound to continue the stipend he shd allow to his Tutor until he could procure him adequate preferrment, but this of course upon the supposition of his not leaving him till his sons education shd be completed. If an opportunity shd offer he shd wish his son to travel - at present there is no prospect of his doing any thing but coming to Oxford but whether the Tutor wd come to Oxford with the eldest or continue at Eton with the younger sons is at present a matter of uncertainty & I think of no very great importance. I hear from my friend Cheese at Eton that the House &c which Davidson has there is one of the most gentlemanly & comfortable establishments in the place. The salary Lord S. tells me is £300 a year which as it is to be continued till Preferment can be procured & as it is better than a living of £400 is an object wh. I think if I decline I may wait some time before I get a better offer. (M.S. DRO 138M/F33).

However, Buckland's apparent diffidence and lack of urgency seems to have backfired since he wrote to his father on 8 April 1910:

> No doubt you have been in daily expectation of hearing from me for some time past as I also have been of hearing from Lord Sefton. The only interpretation I can put upon his silence is that he waits to see Mr. Davidson who as the Eton Holidays begin this week will probably be in Town with the Boys on Wednesday or Thursday next, when if I do not hear from his Lordship, I shall be much at a loss how to proceed. As things stand at present I cannot possibly leave Oxford - I believe it is my own fault that I have not heard from him as when he said he would write to me in a week I was fool enough to beg he would not hurry himself as in truth he has not. (M.S. DRO 138M/F32).

However, nothing came of this approach to Lord Sefton, as is clear from later letters to his father of 15 April (M.S. DRO 128M/F30) and

10 June, in which he passed on further gossip about promotions and appointments in Oxford (M.S. DRO 128M/F29).

In the summer of 1810 Buckland undertook a far more ambitious field survey and mapping programme, as Frank Buckland reported:

> In 1810 he made his first tour of the centre and north of England, exploring the then unknown history and extent of every stratum he came near, and colouring the results on Carey's [sic] map of England. (F Buckland, 1858: xxvii).

This was of course the same base map that William Smith was currently using, and on which his 1815 "Map of the Strata of England and Wales" was drawn and printed. Buckland's itinerary does not seem to have been recorded in any detail, but it is clear that he explored backwards and forwards the whole of the Midlands from the Welsh Border to Lincolnshire and northwards through the Pennines and, probably, the Lake District, judging by detailed observations made on this tour that were noted, often as asides, in later geological papers.

An even more ambitious programme of fieldwork was undertaken the following summer, 1811, by which time Buckland was in correspondence with George Bellas Greenough, the founder President of the Geological Society of London (although Buckland had not yet become a member of the Society). This time Buckland's field excursion must have lasted for the greater part of the summer, since he carried out further work in northern England before going to Scotland for the first time, and thence to Northern Ireland, returning by way of North Wales. It is clear that he travelled northwards from Edinburgh by the old High Road from Perth to Inverness. More than thirty years later he referred to one observation on this journey in his presentation of the glacial theory:

> ... he informed M. Agassiz that he had noticed in Scotland and England phaenomena similar to those he had just examined, but which he had attributed to diluvial action: thus in 1811 he had observed on the head rocks on the left side of the gorge of the Tay, near Dunkeld, rounded and polished surfaces; (Buckland, 1841A: 332).

From Inverness he presumably went south-westwards by Loch Ness to Ben Nevis and thence by the west coast route southwards. He crossed from Port Patrick to Northern Ireland, where he travelled very widely indeed. It seems that he had arranged to meet up with Greenough, and a characteristic letter dated 21 September 1811 from "Beleek" [sic] was addressed to Greenough c/o Thomas Hutton of Dublin:

> Lest you should suppose us to be lost & advertise us in the Dublin Chronicle I write hence to inform you, that we are now on the high road towards that city, having visited Burn Cranna Lifford Raphoe Donegall [sic] Sligo Loch Gill ... [? Donanachair] & Manor Hamilton with pretty fair success in the way of specimens. (*M.S.* CUL, Add. MSS. 7198, Box 2).

The use of "we" in the letter to Greenough strongly suggests that Buckland was accompanied for at least the Irish part of the 1811 tour, and it seems very likely that his companion was John Josias Conybeare, who certainly travelled with Buckland in North Devon and East Cornwall the following summer. The Geological Society's published list of donations for 1812 (although with the column heading misprinted as 1813) lists: "4 Dec. Specimens from Ireland & Cornwall. Rev. I.J. [sic] Conybeare & Rev. Wm. Buckland." (Geological Society, 1814: 543).

1812 must have been a very busy year. Buckland was becoming noticed nationally through the Geological Society, as well as within Oxford, and his rapidly growing reputation and practical experience began to present (probably unwittingly) a very real challenge to the position of John Kidd as Reader in Mineralogy. 1812 was also a year of family distress. When Buckland wrote to his father on 25 May to let him know of his travel plans and of the possibility that Kidd might resign his Readership in Buckland's favour, the reply of 1 June came not from his mother, the devoted amanuensis of his blind father for the past thirteen years, but from his aunt, Mary Oke, telling him of the serious deterioration of his mother's health. He returned to Axminster towards the end of June, but she died soon afterwards and in the latter part of the year he was assisting his father with various matters of family business, presumably as a result of his mother's death.

His geological fieldwork now appears to have been very much linked in to the Geological Society's survey and mapping programme that was being organised by Greenough, whom Buckland frequently accompanied on geological expeditions. Further work was carried out with the Conybeare brothers during the summer of 1812: the Devon and Cornwall tour with John Conybeare, referred to above, and a detailed geological exploration of Kent and Sussex with William Daniel Conybeare. It is in relation to this latter tour that there is the first of numerous references to Buckland's habit of carrying his own specimens rather than employing a servant as a porter as a true "gentleman geologist" would do. (Certainly to begin with this apparent eccentricity was the result of financial necessity.) As Frank Buckland relates:

> The following story is also told by my friend, Mr. Roberts, of Dover, relative to this excursion:-"The common country people judged that persons who carried bags were 'bagmen,' in the common acceptation of the word. The two deans were one day trudging along, when the hour of noon enlarged a National School from durance. A boy mounted on the church wall, as the two dignitaries passed, shouted out, '<u>Bags</u>! <u>Bags</u>!' This boy possessed some tact; for, seeing the reception given

> to them by the incumbent, he enunciated at the top of his voice, - 'Gentlemen do sometimes carry bags.' (F Buckland, 1858:xxix).

Buckland later made his large blue bag his hallmark and his official portrait in the Council Room of the Geological Society shows him in the field with the famous object over his shoulder.

In 1813 John Kidd resigned from the Readership in Mineralogy in the clear expectation that Buckland would succeed him. On resigning, Kidd was persuaded to publish his geological lectures in what amounted to a valedictory address, as he explained in the Preface, which concluded with a very generous tribute to Buckland and his immediate circle:

> In offering this Essay to the public, I take a final leave of the pursuit of Mineralogy; in doing which, I am naturally prompted to express my obligations to those who materially assisted me in that pursuit, and to whose exertions during the last ten years it is principally owing, that the Museum of this University possesses its present extensive and most valuable geological collection.
>
> To the Rev. Philip Serle of Trinity College, the Rev. William Buckland of Corpus Christi College, (my successor in the professorship of mineralogy,) to Henry Drummond, Esq. and the Rev. John and the Rev. William Conybeare of Christ Church, (to all of whom I am united by the firmest ties of friendship,) I particularly express my obligations: for without their assistance I could not, with satisfaction to myself, have continued to deliver those Lectures, which I have now resigned to one, from whom I should have thought it an injustice to the University longer to withhold them. (Kidd, 1815: viii).

The University Readership gave Buckland considerable status, but the office carried no endowment or other stipend: the only income from such a post was the annual sessional fee that the lecturer could charge each student, usually no more than three guineas or four guineas per student per course of lectures. Bearing in mind his own financial circumstances (and perhaps also feeling some sense of injustice on behalf of geology because of the lack of any endowments), Buckland promptly petitioned the Prince Regent seeking financial support for the post. He seems to have held out some hope that the unpaid "Readership" would be granted the salary and title of a Regius Chair, with the prestigious title of "Professor", used unofficially by both Kidd and Buckland outside Oxford (see Chapter 3.1 below), but he was disappointed in this, although the Prince was:

> graciously pleased to annex a Stipend of 100 £ to be paid annually on producing a Certificate of the Delivery of a course of Lectures. (M.S. DRO 138M/F43).

As this stipend was attached to an official University appointment, Buckland was able to accept this and the fees from students attending his lecture course without jeopardising the College Fellowship, as would have been the case if he had obtained a non-University supplement to his income. (The Readership in Mineralogy is discussed further in Chapter 3.1 below.)

Buckland continued to attract notice within the Geological Society, with donations (presented jointly with J J Conybeare) of specimens from Cornwall being recorded by the Society on 15 January and 19 February 1813 (Geological Society, 1814: 543). Following his election to membership further donations to the Society's collections followed, with for example a specimen of chalcedony from Charmouth on 23 April 1813 and specimens from Lauren Hill, Galloway on 3 December 1813 (Geological Society, 1814: 543-545). (Buckland's career within the Geological Society is discussed in detail in Chapter 3.2 below.)

However, undoubtedly the most important and influential work of his career to date was carried out during Buckland's second visit to Ireland during the summer of 1813, particularly the detailed work that he carried out in Northern Ireland in the company of W D Conybeare. This expedition was obviously planned well ahead as can be seen from a series of letters in the Greenough papers (M.S. CUL Add. MSS. 7198, Box 2). On 26 May Buckland wrote telling Greenough of his intention to visit Ireland that summer accompanied by Philip Serle, and yet again with a more detailed itinerary on 16 June:

> I intend to start for Ireland on the 19 of July to go with a Corpus friend direct to Dublin thence thro Wicklow to Killarney Limerick & Galway - from ye latter place along ye western Lough to Ballinrobe & Sligo .... From Sligo I shall take ye circuit of ye North & come down to Belfast but whether I shall return by ye Cumberland lakes or N. Wales I have yet no means of ascertaining. (M.S. CUL Add MSS. 7198, Box 2).

A third letter of the series was written from Sligo on 1st August 1813 and was addressed to Greenough at Edgeworthstown, in which he claimed to have seen the marks of Greenough's hammers "on every Rock we have passed in the last 150 miles". From this letter it is clear that Conybeare (presumably William) and Boissier had been with Buckland from Killarney onwards. Buckland and Conybeare appear to have continued alone to study the crucial sections along the northern coast of Ireland, although in places they appear to have created considerable confusion in the minds of local inhabitants, as Frank Buckland later recorded:

> It was during this tour with Mr. Conybeare that, after a very long and wet day, among the cliffs, the two geologists entered at dark a lone hut, occupied by an aged female. Tired, hungry, and covered with mud and dirt, depositing their fossil bags, they demanded refreshments. The old woman was much puzzled to make out their real character; and having placed the eggs and bacon on the table, was heard to exclaim - "Well, I never! fancy two real gentlemen picking up stones! What won't men do for money? (F Buckland, 1858: xxviii).

This part of the tour gave Buckland his first independent scientific paper: "Description of the Paramoudra, a singular fossil body that is found in the Chalk of the North of Ireland; with some general Observations upon Flints in Chalk, tending to illustrate the History of their formation", although this was not read to the Geological Society until 15 March 1816, and was not published until the following year (Buckland, 1817C).

Far more important, however, was his joint work with Conybeare, which involved amongst other things the preparation of very detailed sections of much of the Antrim coast. The main part of the work was published under Conybeare's name, but with due acknowledgement to Buckland in the title of the paper, as a supplement to J F Berger's paper to the Geological Society on the geology of North-East Ireland (Conybeare, 1816). Although it was the Geological Society's firm policy to exclude what was seen as sterile arguments about the theoretical basis of geology, and in particular the Huttonian/Wernerian conflicts, in favour of cool and detached observation, Conybeare and Buckland could not avoid expressing an opinion on the still current controversies about the origin of basalt, and particularly the columnar basalt of Northern Ireland as seen at the Giant's Causeway. Conybeare therefore offered a compromise. The main text was entirely descriptive and factual in accordance with the Society's requirements, whilst a very long footnote covering in total more than 1½ pages of small print was added firmly rejecting Werner's arguments in favour of the aqueous origin of basalt:

> Desiring to keep that description of facts which must serve as the ground-work of theory, and which seems, in the present state of science, the most useful employment of the geologist, distinct from conclusions merely speculative, I have hitherto studiously refrained from expressing the views which I have been led to form on the origin of basalt, and of the other rocks usually associated under the general name of floetz trap.

But while describing the striking appearances presented by Kenbaan cliffs, I cannot forbear to declare the conviction which this spot first impressed upon my mind, and to express my full assent to the arguments of those who maintain the igneous origin of such formations.

I would observe then that this formation is distinguished by characters so directly opposed to those which all rocks undoubtedly of aqueous origin possess, that no hypothesis which ascribes both to a common origin, can be otherwise than contradictory, and at variance with itself. For

1. Of all other formations, the least ancient are the least elevated; but this, the most recent of all, yet rivals the primitive mountains in height.

2. Of all other formations, the degree of consolidation decreases together with its age, their texture passing from crystalline through the several gradations of sub-crystalline, compact, coarse, and lastly earthy; while in this formation, even where it rests on chalk, the crystalline texture of the oldest rocks frequently recurs.

3. Whin dykes, which are indisputably connected with this formation, differ from all other mineral veins, in the circumstance of their traversing all rocks indifferently; while of other veins, particular classes are exclusively associated with particular rocks.

Such being the negative evidence against the Neptunian hypothesis, I proceed to that which is positive in favor of the volcanists; as

1. The identity of chemical composition in basalt and lava.

2. The constant occurrence of trap rocks in volcanic districts.

3. The confession of the Wernerians themselves, that the basalt of Auvergne is of igneous origin.

4. The testimony of those best acquainted with districts still exhibiting active volcanoes. Such persons, as Dolomieu and Spallanzani, have uniformly maintained the igneous origin of basalt, while those who have contended against it have generally been unacquainted with countries of this description. (Conybeare, 1816: 208).

Although the Geological Society had been overwhelmingly Wernerian in terms of its philosophy and outlook at the time of its formation less than ten years earlier, in November 1806, the arguments of Conybeare and Buckland on the origins of basalt within the Society and eventually in its Transactions were decisive, although the Society continued to honour Werner as a mineralogist, and to use his stratigraphical terminology for at least a further decade.

More local fieldwork continued to take up much of Buckland's time both in the Oxford area, and in his old stamping ground of East Devon, around his family home, and the adjacent areas of Dorset. It must have been at about this time that through the Anning family of collectors Buckland met Henry De la Beche, who was to become one of Buckland's closest friends and geological associates. Even when living in temporary lodgings, Buckland quickly managed to reduce his surroundings to the state of eccentric chaos that was remarked on so often by visitors to successive homes in Oxford:

> The vacations of his earlier Oxford time were often spent near Lyme Regis. For years afterwards local gossip preserved traditions of his adventures with that geological celebrity, Mary Ann Anning, in whose company he was to be seen wading up to his knees in search of fossils in the blue lias; 'of his breakfast-table at his lodgings there, loaded with beefsteaks and belemnites, tea and terebratula, muffins and madrepores, toast and trilobites, every table and chair as well as the floor occupied with fossils whole and fragmentary, large and small, with rocks, earths, clays, and heaps of books and papers, his breakfast hour being the only time that the collectors could be sure of finding him at home, to bring their contributions and receive their pay; of his dropping his hat and handkerchief from the mail to stop the coach and secure a fossil; of the old woman who, finding him asleep on the top of the coach, relieved his pockets of a quantity of stones; of his travelling carriage, built extra strong for the heavy loads it had to carry, and fitted up on the forepart with a furnace and implements for assays and analysis.' [sic: no identification of person(s) quoted]. (Gordon, 1894: 7-8).

Another important geological guide of this period was the Rev Benjamin Richardson of Bradford-on-Avon, who was an old friend of Smith and Townsend (and presumably through them Broderip), and it appears that Buckland often broke his journey between Oxford and Axminster to see Richardson:

> a most acute observer and a large collector of organic remains; who has published nothing, but who imparted to him his first knowledge of the details of superposition of the oolite and green sand formation between Bath and Warminster. (F Buckland, 1858: xxix).

As his fieldwork increased, Buckland invested in a horse that was, like its master, a legend in its own lifetime:

> He rode a favourite old black mare, who was frequently comparisoned all over with heavy bags of fossils and ponderous hammers. The old mare soon learnt her duty, and seemed to take interest in her master's pursuits; for she would remain quiet without any one to hold her, while he was examining sections and strata, and then patiently submit to be loaded with interesting but weighty specimens. Ultimately she became so accustomed to her work, that she invariably came to a full stop at a stone quarry, and nothing would persuade her to proceed until the rider had got off and examined (or, if a stranger to her, pretended to examine) the quarry. On one occasion Dr. Buckland was in some danger from the falling stones as he was climbing up the side of one of these quarries. He was told of his danger by the bystanders. 'Never mind,' said he; 'the stones know *me*.' (F Buckland, 1858: xxix-xxx).

In 1814 William Conybeare resigned his Oxford Fellowship to take up a Living in Suffolk, taking with him Buckland's hope that the Suffolk parsonage "might prove to be founded on a bed of elephants" (Gordon, 1894: 4), although the two continued to collaborate closely by correspondence, continued joint fieldwork, and - above all- their growing involvement in the Geological Society.

In Oxford, Buckland used his new status as Reader in Mineralogy to try to do something about the appalling state of the geological collections of the Ashmolean Museum. Most of the collections had been stored away in a most unsatisfactory manner, and many gifts had never been unpacked on their receipt. Buckland put much of his energy into the task during the spring of 1814 in particular, assisted by the Rev Philip Serle, who had been one of his companions on the summer 1813 expedition to Ireland, and who was now a Fellow of Trinity College. At one point the two were reported to be unpacking a barrel of specimens a day, identifying the specimens and putting them out in proper order (Edmonds & Douglas, 1976: 142-143). Buckland also began work on the preparation of large-scale geological maps and diagrams for teaching purposes - a major innovation in geological teaching. (Some of this material still survives today in the Buckland Archives of the Oxford University Museum.)

He also introduced field excursions as an integral part of his teaching, and startled students were instructed to assemble on horseback at 2 pm for an expedition to Shotover Hill, as was recorded by Murchison a decade later in his lecture and excursion notes (reproduced as Appendix 1.2 below).

However, most of Buckland's own fieldwork and research appears to have been directed towards the Geological Society's attempt at a complete geological survey of England, under the leadership of Greenough (who continued to direct this part of the Society's work even though he had given up the presidency in 1813). Buckland's role became more and more central to the project, and he was entrusted with the key task of preparing comparative tables of strata not only for the English map itself, but also to suggest comparisons with Continental geology. Although at that time his only overseas experience was of Ireland and the Isle of Wight he had a voracious appetite for information about foreign geology and, particularly, for foreign specimens. Correspondence and foreign travel by friends was of special importance here, particularly because of his wish to make the Ashmolean the best geological museum in the country, but he also passed on duplicate material to the Geological Society's collections. His first donation of foreign material was received by the Society on 4 March 1814 - specimens of "Coal and Coal Slate from Sweden" (Geological Society, 1814: 544). The range of his current interests at the time is well illustrated in a letter of April 1814 to Conybeare:

> I was not a little surprised to find from Greenough that he was in great hopes you would go with him to Paris to see Kings and Emperors, and Cuviers and Crocodiles. Should this actually take place, I need not, I trust, remind you to return loaded with a grand suite of specimens for the museum, and to establish a correspondence between Oxford and Paris, founded on an exchange of specimens. Illuminate Cuvier on the gypsum of Shotover, and press him to come and see us if he visits England. My lecture on the basin of Paris will be among the last of the set, so that you will be back in time to enrich it with your importation piping hot. I have made considerable progress with Serle in the last three days in arranging the specimens in the lower cabinets, from granite to mountain limestone. If you go to Paris, pray send me the notes you had begun touching Moses and Huttonianism, and which you took with you to finish, should there be opportunity. Send me also your map of Germany, if you do not take it with you, that I may transfer its contents to my map of Europe for the lectures. (Gordon, 1894: 14).

Buckland's summer fieldwork in 1814 certainly included a period in Cumberland and Westmorland during September, accompanied by G B Greenough (Buckland, 1817A: 105), and it seems quite likely that he also travelled through Wales, since his friendship with Lady Mary Cole and Miss Jane Talbot of Penrice Castle in the Gower began at about this time.

Buckland clearly recognised the importance of the geological complex area between Appleby and Cross Fell in terms of the Geological Society's mapping project, and perhaps also in terms of establishing his own reputation within the Society, since he appears to have put aside his earlier work on Northern Ireland and the "Paramoudra" in order to bring forward a paper and map on the new area.

The first public sign of this very significant work was the deposit of a series of voucher specimens from the Dufton area which was donated to the Geological Society on 21 March 1815 (Geological Society, 1816: 429), and the following week he read his paper to the Society under the title "Description of an Insulated Group of Rocks of Slate and Greenstone in Cumberland and Westmoreland [sic], on the east side of Appleby, between Melmerby and Murton" (Buckland, 1817A). (It is interesting to note that in the heading to the paper Buckland is referred to as "Professor of Mineralogy in the University of Oxford" rather than by his correct University title of "Reader": this distinction persisted for many years, with Buckland being universally referred to as "Professor Buckland" while in Oxford he was still only honoured as a "Reader".)

It is clear that the primary objective of Buckland and Greenough was to unravel the complex area now known as the Cross Fell Inlier. An area of almost 250 sq. km. was in fact surveyed and covered by the accompanying map, and one of the accompanying sections was of the New Red Sandstone sections of the Cumberland coast around St Bee's Head.

In referring to the Dufton to Cross Fell area Buckland said, in the first sentence of the paper:

> Few rocks in this country present in a small compass a structure more complicated and difficult to be understood than those which occupy a small district in Cumberland and Westmoreland, on the east side of Appleby, between the villages of Melmerby and Murton. (Buckland, 1817A: 105).

Detailed descriptions of observations within the Inlier, and suggestions of possible correlations, were followed by an outline description of the geology of the surrounding area, from the Old Red Sandstone and Carboniferous of the Pennines, of the New Red Sandstone of the Appleby, Carlisle and Cumberland coast (which was correctly distinguished from the Old Red Sandstone and correlated instead with the Red Sandstones, gypsum and salt deposits of Cheshire, Shropshire, Lancashire and Yorkshire, and shown to be younger than the Magnesian Limestone), the whole being accompanied by three north-east to south-west sections across the area, in addition to the coastal section from St Bee's Head to Whitehaven already referred to.

Soon after this Buckland produced the first of several versions of a comparative table of strata in the British Isles detailing formations, names, descriptions, localities, greatest observed thickness, and possible comparisons with the Continental classifications of Werner. According to Frank Buckland (1858: xxiv) the earliest version of this was issued in 1815, but it is not at all clear whether the table was published that year in the strict sense, or whether in fact an 1815 version was intended as a working tool for members of the Geological Society undertaking its recording and mapping work. There is better evidence of the issuing of a large broadsheet under the title "Order of Superposition of Strata in the British Islands" sometime during 1816, and this was further developed after Buckland's Continental travels in that year, resulting in what may be regarded as the definitive text which is undated, but which cannot be earlier than 1818, since Buckland's qualifications listed include his B.D. taken in 1816 (Edmonds & Douglas, 1976: 155) and also his F.R.S., to which he was elected in 1818. This last version is often found bound in copies of the later editions of Forster's Treatise on a Section ... from Newcastle ... to ... Cross Fell (e.g. Forster, 1821). Buckland's table is here cited as "Buckland, 1818", in the absence of firm dating evidence.

There seems to be little else by the way of direct evidence of Buckland's activities during 1815 except that he appears to have taken a special interest in the geology of South Wales, according to correspondence with Lady Mary Cole, W C Trevelyan and Miss Jane Tolbert (Gordon, 1894: 16).

He had also spent some time in the company of Conybeare in April 1815 looking at the basal Tertiary of the London Basin (Buckland, 1817B: 284). This appears to have been a follow-up of work started in the Reading area in July 1814, and resulted in a substantial paper read to the Geological Society on 6 January 1816 under the deceptively modest title of "Description of a series of Specimens from the Plastic Clay near Reading, Berks: with Observations on the Formation to which those Beds belong." (Buckland 1817B). Using the top of the Chalk as a datum Buckland described in some detail the Eocene succession beneath the London Clay, and suggested that this sequence corresponded to that identified by Cuvier and Brongniart in the Paris region. Despite the title of the paper the localities described included several in the London area (eg Woolwich, Lewisham, Blackheath, Plumsted and New Cross), as well as those of the Sussex coast around Newhaven and Arundel. The paper concluded with an Appendix describing occurrences of "submerged forests" in the lower Thames valley.

Again, the presentation of the paper was accompanied by the donation of a comprehensive set of specimens illustrating each of the beds described to the Geological Society's collection, which in less than nine years had grown to over 9,500 specimens, judging by the registration numbers given to the "Plastic Clay Formation" specimens when they were donated on 5 January 1816.

Two months later on 15 March 1816 Buckland read to the Geological Society his delayed paper on the "Paramoudra" flints found in the chalk of Northern Ireland, together with his views on the origin of flint in chalk (Buckland, 1817C), and argued that the Paramoudras were in fact siliceous sponge fossils - a view that was hotly contested for half a century or more before this interpretation was generally accepted.

However, Buckland's mind was now turning very much to the Continent, which he had still not visited at that time. It seems clear that William Conybeare suggested that Buckland, Greenough and himself should make an extended tour of much of continental Europe during the summer and autumn of 1816, because on 21 February 1816, Buckland wrote to Greenough:

> 'I have received from W. Conybeare a most important communication of which the object is to establish between you, him and myself a geological triumvirate which in the course of the next summer shall spread conquests more extensive over the subterraneous world than were ever accomplished by our less penetrating predecessors, the superficial triumvirs of Rome. I am so thoroughly convinced that by working thus in concert we should do more in three months together, than singly in three years that I am disposed to make almost any sacrifice for the accomplishment of so important an union. I have all but absolutely engaged to be one of the party on condition that you can manage to make the third,

> and should this triple alliance be consummated would make every effort to be ready to move the beginning of June. (M.S. C.U.L. Add. MSS: 7918, Box 2).

All three agreed, but before departing Buckland had to give his University course of lectures, and amongst the students was a newly-arrived seventeen year old Scotsman from Exeter College, Charles Lyell, who was to become Buckland's most important and successful geological student.

There is no doubt that the 1816 tour with Conybeare and Greenough, which lasted over five months, had a deep and lasting effect on Buckland, not merely in terms of scientific observations and experiences, as well as the obvious development of personal friendships, but also in terms of his view of the organisation of scientific teaching, scientific observations and of the role of the state in scientific advancement. On the role of science, however, the tour was something of a mixed blessing, in that it left Buckland very dissatisfied indeed with the lack of public support for science of all kinds in Britain, a constant theme to which he was to return over and over again for the rest of his life.

On the more positive side, the Geological Society of London was certainly well known throughout the Continent as the first independent national geological society, and the travellers were clearly very well received in most of the places that they visited because of the reputation of the Society and, particularly, that of Greenough as its Founder-President.

Not unexpectedly, they went first to Germany seeing first Goethe, who was a noted geologist as well as a major literary figure, at Weimar, and went on to Saxony to meet the great Werner at Freiberg . This was obviously a disappointment in geological terms, since Buckland recorded that he:

> gave us a grand supper, and talked learnedly of his books and music, and of anything but geology. . (F Buckland, 1858: xxix).

They continued northwards through Silesia into Poland. Their journey southwards was described in a later letter from Buckland to Lady Mary Cole:

> highly satisfied with his tour, having accomplished every point that was in contemplation before he set off. Entering Hungary, he descended by the gold-mines of Kremnitz and Schemnitz over a most picturesque country, full of extinct volcanoes, to the great plain at the head of which stands Presburg; thence to Vienna, where are noble collections in Natural History, by Styria and Carinthia (countries equal to Switzerland in sublime Alpine scenery) to Venice; hence by the Euganean Hills (extinct volcanoes breaking up through chalk), Vicenza, Verona, Mantua, and Parma, visiting by the way the fossil fish quarries of Monte Bolca, which are in a formation above and lying on chalk, and allied to the English Sheppey clay and French calcaire grossier. Monte Bolca has also the same fossil plants as Sheppey. (Gordon, 1894: 19-20).

He also added that he had made a rich collection of fossil shells of the Sub-Appenine Hills which resembled those of the Tertiary of Hampshire, although unfortunately he was arrested in the act of making this and was promptly sent off to the prison in Parma (Gordon, 1894: 19). It seems that the group finally returned to England by way of Switzerland and France, since Bigot (1943: 130) notes that Buckland and Greenough visited amongst others the collection of Defrance.

Buckland's geological experience and observations on this tour were to be used in much of his subsequent work. For example, his experience of Gailenreuth and the other bone cave excavations of southern Germany aroused, apparently for the first time, serious interest in fossil mammals and the contents of caves, whilst his Alpine and Apennine observations formed the basis of his far-reaching and pioneering study of the origin of the Alps.

Also, the Oxford collections, both those of the Ashmolean and those kept in Buckland's increasingly overcrowded and chaotic room, were greatly enriched by the material that Buckland collected and despatched back, or carried with him. For example,on 1 August 1816 the Geological Society received "Specimens of the Brunswick encrinus" as a gift from Greenough, Conybeare and Buckland (Geological Society, 1817: 456), and on 2 February 1817 a much more substantial collection of "Fossil Organic Remains from Germany" were presented by Greenough and Buckland (Geological Society, 1817: 457).

Buckland's 1817 course of lectures was an even greater success because of his growing reputation and all the new information that he had gathered during his protracted tour the previous summer. Lyell's father wrote (apparently with some anxiety) about Charles Lyell's response: "Buckland's Mineralogical lectures are engaging him heart and soul at present." (Wilson, 1972: 44).

During the summer Buckland again left Oxford for several months, this time on a series of geological tours within Great Britain. His financial circumstances were far from happy in relation to his very heavy travel expenses. Edmonds (1979: 34) estimated that at the standard rate of two guineas for an initial course of sixteen lectures, and a fee of only one guinea for any subsequent course, Buckland's total income from the Readership (including the one hundred pounds Stipend) was only one hundred and eighty pounds by 1818, on top of which he had his College Fellowship of two hundred pounds per year. With the freight charges on a single box of specimens donated to the University costing as much as three guineas (paid for out of his own pocket), and with travelling expenses running into some hundreds of pounds per year, Buckland was clearly under financial pressure. From that point of view alone a "high profile" was clearly a necessity in terms of attracting fee-paying students to his lectures, and even if students came at first to find out if his lecturing style was really quite as racy, and interspersed with jokes and profane language as reported, they might stay long enough to learn something of this new and important science that Buckland so vigorously promoted in the University and the country at large. A tradition quickly developed under which the leading members of the Geological Society went en bloc to Oxford for a week every June, and not only mixed with Buckland's students, but also were taken out into the field on his expeditions. Buckland's buffoonery on these expeditions was legendary, and one story even found its way into serious taxonomic literature. James Sowerby recorded in his "Mineral Conchology" an incident on one such expedition (almost certainly during the June visit to Oxford in 1817) in which Buckland found an ammonite which was so large and heavy that even Buckland could not balance it properly on the back of his long-suffering horse. Refusing to leave a good specimen behind, Buckland found a solution:

> ... The inner whorls being gone so as to allow his head and shoulders to pass through, he placed it as a French horn is sometimes carried, above one shoulder and under the other, and thus rode with his friendly companions, who amused him by dubbing him an Ammon Knight; and thus the specimen was secured by diverting the tedious toil otherwise hardly to be borne. (Sowerby, 1818: 69).

Sowerby named the specimen *Ammonites Bucklandi* in honour of the occasion, and concluded his description of the new species with a prophetic sentence:

> May his zeal for information always be rewarded: may his abilities continue to meet that attention that they have hitherto so deservedly gained: may his horn be exalted with honour. (Sowerby, 1818: 69).

A few weeks later Charles Lyell went to visit Sowerby in London, and identified his house by the very same specimen which Sowerby had taken away to draw and to describe, and which was lying on the steps of the house! The "Ammon Knight" story must have been circulated by Sowerby as a pre-print, since although that volume of the "Mineral Conchology" did not appear officially until 1818, Lyell had obviously seen it the previous summer. Describing his visit to Sowerby to his father in a letter of 20 July 1817, Lyell wrote:

> I went in and introduced myself, telling him by what means I had discovered his house. 'Ah,' said he, 'little I believe did they think at Oxford what advantage I should take of that joke.' I exclaimed involuntarily, 'Well he might be,' which he took in good part, laughing heartily. (Lyell, 1881A: 40).

Bearing in mind Buckland's own reputation for frivolity and humour, at least in later years, it is interesting that he was "perfectly astonished" that Sowerby should have included such a piece in such a serious and definitive taxonomic work. The warm scientific relationship between Buckland and Lyell is further illustrated in the latter's correspondence of the latter part of the summer of 1817. For example on 28 July 1817 he wrote to his father from Yarmouth:

> Between Dr. Arnold's long catalogue of Norfolk fossils, and a map which I think I shall be able to make of this country, I flatter myself I shall compile some interesting information for Buckland, (Lyell, 1881A: 44),

and Lyell made some detailed observations for Buckland of the columnar basalt of Fingal's Cave, Staffa, during his subsequent extensive geological tour of the Scottish Highlands and Islands (Wilson, 1972: 53-54).

On 20 November 1817, Buckland was nominated for election as a Fellow of the Royal Society, the sponsors being (in the order listed on the nomination paper): (Sir) Everard Home, Henry Warburton, William Blake, Charles König, William H Fitton, William H Wollaston, Samuel Turner, Samuel Carlisle, Robert Harry Inglis, S P Rigaud, A B Granville and Davies Gilbert. The nomination paper was in the usual form, i.e. "we the undersigned do of our personal knowledge recommend him as deserving of that honour & likely to prove a useful & valuable member", and described Buckland as "Fellow of Corpus Christi College & Professor [sic] of Mineralogy in the University of Oxford" (M.S. RSL Nominations Papers). The nomination was read at the next ten meetings as required, and on 26 February 1818 the formal ballot on the nomination was held. With such a distinguished and varied list of sponsors there can never have been much doubt about the outcome of the ballot, and Buckland was formally elected.

At the February 1818 "Anniversary Meeting" of the Geological Society, Buckland's rapidly growing reputation was officially recognised by his election direct to the office of Vice-President, even though he had not served an "apprenticeship" as an ordinary member of the Society's Council. Having spent most of the autumn and winter away from Oxford on fieldwork, Buckland returned to Oxford for the summer term to give his annual series of lectures, which by that time although still nominally on "mineralogy" had been broadened to include general geology and even palaeontology. On 25 May 1818 he wrote to his father:

> I have been too much occupied by my Lectures during the last 5 weeks to write or think much of my plans in the vacation. Another week will now bring me to the close of these & my audience has been more than usually large. At one of my first lectures I had my Uncle for a pupil, & exalted myself many degrees in his estimation, by talking an hour & half at full speed on subjects above his comprehension, or rather out of his time & therefore of course considered by him more sublime & difficult. He is going to present a syllabus of my Lectures to Lord Eldon & Sir W. Scott, with comments on the author. I was absent from Oxford ye 3 first days of Whitsun Week attending our annual Geological Meeting, wh. for this time has been transferred from Oxford to Clifton. We had Mr Bennet Mr Greenough & Warburton Stokes & Ellison from London, 3 from Oxford & Mr De la Beach [sic] from Lyme, who is a very active & intelligent geologist & likely to be of great service to the Society. He draws also very beautifully. (M.S. DRO 138M/F24).

Certainly, in May 1818 Buckland did not seem to be anxious about his own position, other than the obvious heavy workload that he had, otherwise he would almost certainly have confided in his father, as was his usual practice. However, during the summer of 1818 he began to canvass the idea of establishing a second Regius chair, this time in Geology, to be held alongside the Mineralogy Readership. Certainly his Uncle was amongst his advisers in this enterprise, and the reference to his proposal to send copies of Buckland's syllabus to Sir Walter Scott and to Lord Eldon (the unsuccessful rival of the University Chancellor, Lord Grenville, in the last election for the office) suggests that John Buckland senior was preparing the ground.

The events of the autumn of 1818 were researched in some considerable detail by Edmonds (1979), and are discussed in Chapter 3.1 below rather than here. However, it should be recorded that Buckland's efforts were finally supported by the Hebdomadal Board of the University and forwarded to the Prince Regent in the form of a "Memorial" and on 20 November the Prime Minister wrote confirming the appointment of

Buckland as Professor of Geology. However, the Stipend attached to the post was only £100 (the same as that for the Mineralogy Readership), compared with the £500 total Stipend payable to the Woodwardian Professor at Cambridge. In his evidence Buckland had shown that his own direct out-of-pocket expenses on geological work were exceeding £200 per year, and he immediately tried to petition against the inadequacy of the salary attached to the new Chair but without success. Nevertheless, in financial terms this was a very considerable improvement in his income: he could reasonably expect a further £70-£100 in student fees so the effect of the new appointment was to increase his total income by around fifty per cent in return for a comparatively modest increase in his teaching commitment, since he had already been teaching geology as part of his Mineralogy responsibilities. Any remaining disappointment about the financial outcome seemed to have been quickly set aside as he threw himself into the preparations for his new appointment. Even if he was still not a full Professor in the eyes of the University and Crown, even the most distinguished members of the Royal Society regarded him as such, and Buckland was determined to behave like one.

2.3 THE REGIUS PROFESSOR, 1819-1825

The Oxford of 1819 was still basically a religious institution within which science other than formal mathematics and medicine had little or no standing. However, from 1809 it had been possible for students to be examined in either "Lit. Hum." or Mathematical and Physical Sciences, though the examination rubric was still constrained by the Statutes of 1803 which stated:

> In preference, therefore, to all other subjects, the elements of religion are to claim first place. And the examiners are to keep in mind and religiously observe this construction of their oath, that a defect on that head cannot be compensated by any other merits of the candidates, be they what they may: so that any person who does not satisfy the examiners on this most momentous subject is to obtain no testimonial whatsoever. (Ward & Heywood, 1851: 62).

The growing interest in geology was seen by many Dons as bringing with it the threat of secularisation of the University, and Buckland seems to have appreciated from the beginning that if only from the point of view of University politics his Inaugural Lecture had to be planned with considerable care. From the time of the Northern Ireland tour William Conybeare and Buckland had discussed from time to time the relationship between geological evidence and the Biblical record, and particularly in relation to the Mosaic account of the Biblical Deluge. This was of course a very old theme in "theories of the earth" and theology, and was still a current topic of discussion, as was shown by recent publications of Townsend (1813) and Kidd (1815).

Within the period of at the most two or three weeks from the formal endowment of the Readership in Geology, Buckland prepared an outline for his Inaugural Lecture on the basis of attempting to demonstrate "the inseparable interests of science and religion" and an "attempt to shew that the study of geology has a tendency to confirm the evidences of Natural Religion; and that the facts developed by it are consistent with the accounts of the Creation and Deluge recorded in the Mosaic writings" (Buckland, 1820: Dedication).

He sent an outline of his proposals to Conybeare, who replied on 1 January 1819;

> I am much delighted with yr. letter. It gives me sincere pleasure to see your career of science become daily more brilliant. I highly approve the sketch you have given of topics for an inaugural lecture - make it a classical exposition - & publish it. I wish however to add to the subjects wh. you intend to introduce. Do not be ready with the objection that the materials wd. thus become too .... [? bulky] for the purpose - a spirited outline will always be preferable on such an occasion to a detailed portrait & much may be got in in this way - just touching on the summits of things. I have then to propose that you should proemize your historical sketch by some general remarks on the extent, objects, & task of Geology as a science.... (M.S. DRO 138M/F548).

Conybeare continued by discussing many of Buckland's points in detail, and making extensive suggestions for improvement, particularly in terms of the approach and presentation, but also suggesting additional sources and references, before finishing with a good-humoured jibe about Buckland's substantial increase in income: "P.S. you can afford to pay postage with your fat salary."

The Inaugural Lecture was delivered before a very large audience of the University on 15 May 1819, with the Chancellor, Lord Grenville, amongst those present, under the title "Vindiciae Geologicae; or the Connexion of Geology with Religion Explained", and this was published by the University Press (although apparently at Buckland's expense) the following year (Buckland, 1820). The order in which Buckland listed his qualifications and honours on the title page was very interesting in terms of his own perception of their relative importance, or perhaps of the image that he wished to present: "B.D. F.R.S. M.G.S. Fellow of the Imperial Societies of Mineralogy and Natural History at Petersburg and Moscow, Fellow of Corpus Christi College, Oxford, and Reader in Mineralogy and Geology in the same University." The printed text ran to 38 quarto pages, and was preceded by a dedication to William Wyndham, Baron Grenville, FRS, the Chancellor of the University, and also included a Preface:

> If it should appear that, in the present Lecture, reference is made to many facts and phenomena of Geology which presuppose a knowledge of this subject; it may be sufficient to state, that although this inaugural Lecture was delivered subsequently to the endowment of the office of Reader in Geology in 1819, yet that Lectures had been annually given on this subject since the year 1814 by myself, and, prior to that period, by my friend and predecessor in the office of Reader in Mineralogy, Dr. Kidd, a gentleman whose scientific and classical labours in these subjects have been long known to the public through the medium of his works, and to whom we owe the foundation of that valuable collection of specimens in Geology which the University now possesses. (Buckland, 1820: Preface - unnumbered).

After preliminary tributes to the Prince Regent and Lord Grenville for their efforts in advancing the sciences, particularly geology, Buckland nailed his colours to the mast with a very firm statement on both the utilitarian and educational benefits of geology: and to the growing status of science in continental universities - all themes to which Buckland was to return frequently throughout his life:

> Under such auspices have the foundations of geological knowledge been laid in Oxford; and from the general favour and approbation with which it is now regarded, from its intimate alliance with Physical Geography, and its national importance as connected with Statistics and Political Economy, we may henceforward consider Geology as exalted to the rank of sciences, the teaching of which forms a part of our established system of education.
>
> This ingrafting (if I may so call it) of the study of the new and curious sciences of Geology and Mineralogy, on that ancient and venerable stock of classical literature from which the English system of education has imparted to its followers a refinement

of taste peculiarly their own, has obviously resulted from the rapid improvements in Physics, that during the last half century have dignified with the name Sciences many subjects, which had perhaps too long been considered only as Experimental Arts: and information on these and similar sciences of modern growth, that are intimately connected with them, has been now so generally diffused, even amongst the imperfectly educated classes of society, that if they had not been for their own sakes deserving our attention, it might to a certain degree have been imperative on us to admit them to a place in our Academical Establishments, in deference to the general feeling in their favour that now prevails, and to that knowledge of them which is so very rapidly diffusing itself through the scientific world.

For some years past, these newly created sciences have formed a leading subject of education in most Universities on the continent, and a competent knowledge of them is now possessed by the majority of intelligent persons in our own country; and though it might on no account be desirable to surrender a single particle of our own peculiar, and, as we think, better system of Classical Education, there seems to be no necessity for making that system an exclusive one; nor can any evil be anticipated from their being admitted to serve at least a subordinate ministry in the temple of our Academical Institutions." (Buckland, 1820: 2-3).

He continued by referring to developments outside the strictly academic field, for example the establishment of the Geological Society, the expansion of the British Museum to cover collections of rock specimens and fossils, the emergence of county collections, and of geological maps. Nor were nationalistic sentiments lacking. In a paragraph that Buckland has underlined in his own copy of the Vindiciae Geologicae (M.S. DRO 138M/F64) he stated:

England is considered as classic ground by the best Geologists of the continent, and the transactions of the Geological Society of London are quoted as standard authority, wherever this science has been admitted. (Buckland, 1820:4).

In terms of geological philosophy, the Inaugural Lecture is quite uncompromisingly Catastrophist, for example:

Now when it is recollected that the field of the Geologist's inquiry is the Globe itself, that it is his study to decipher the monuments of the mighty revolutions and convulsions it has suffered, convulsions of which the most terrible catastrophes

> presented by the actual state of things (Earthquakes, Tempests, and Volcanos) afford only a faint image, (the last expiring efforts of those mighty disturbing forces which once operated;) these surely will be admitted to be objects of sufficient magnitude and grandeur, to create an adequate interest to engage us in their investigation. (Buckland, 1820: 5).

In accordance with the best traditions of Inaugural Lectures, Buckland analysed the place of his new science in relation to longer-established and accepted sciences, including zoology, botany, chemistry, pure mathematics, hydrostatics, emphasising:

> But it is now admitted on all hands, that no man can be qualified to enter any of the highest walks of science, who is acquainted only with one branch of natural knowledge; and the mutual dependence of them all is now so positively demonstrated, that the philosopher of our days can no longer be allowed to remain satisfied with those inquiries which belong exclusively to any single branch, but must extend his investigations over the whole range of sciences, and illuminate his path by the varied combinations of them all. Newton was perhaps the first who carried his eye over this extensive and almost unbounded prospect: he has been since followed by D'Alembert, La Place, Biot, Playfair, Leslie, Brewster, and Wollaston. (Buckland, 1820: 10).

Nor was Oxford's almost overwhelming emphasis on the study of religion overlooked. Buckland clearly considered that it was at least as important to emphasise the conformity and interdependence of geology with revealed religion (bearing in mind his audience) as his demonstration of the place of geology in relation to the physical and biology sciences:

> In this place [i.e. Oxford University] it belongs peculiarly to the excellent course of studies which we pursue, to unite the highest attainments of abstract science and literature with the much more important purposes of Religious Truth. And any investigation of Natural Philosophy which shall not terminate in the Great First Cause will be justly deemed unsatisfactory, I feel no apology to be necessary for opening these Lectures with an illustration of the religious application of Geological science. "Haec," says the immortal Newton, "Haec de Deo; de quo utique ex phenomenis disserere ad Philosophiam Naturalem pertinet." (Buckland, 1820: 11).

In a further paragraph that is side-lined in Buckland's own copy of the Inaugural Lecture, he argued strongly that in many aspects of the geology of the world, for example occurrences of minerals and their accessibility:

> ...in the benevolent provision of almost inexhaustible stores of salt and fuel to supply the wants and reward the industry of man in these latter ages of the world; and in causing the vast respositories of coal to be accumulated from the wreck and ruins of disturbances that [underlined in Buckland's personal copy] affected our planet long before the existence of the human race; ... in all these and a thousand other examples that might be specified of design and benevolent contrivance, we trace the finger of an Omnipotent Architect providing for the daily wants of its rational inhabitants, not only at the moment in which he laid the first foundations of the earth, but also through the long series of shocks and destructive convulsions which he has caused subsequently to pass over it. (Buckland, 1820: 12).

Similarly he saw in the "whole machinery" of the water cycle, including springs, rivers, the sea, evaporation and precipitation:

> ...such undeniable proofs of a nicely balanced adaptation of means to ends, of wise foresight and benevolent intention and infinite power, that he must be blind indeed, who refuses to recognize in them proofs of the most exalted attributes of the Creator. (Buckland, 1820: 13).

The strict conformity of geological evidence with Natural Theology, particularly in relation to the classic argument for the existence of God from Design was reviewed, quoting approvingly from Newton, Paley, Woodward and De Luc, concluding the first half of the Lecture with:

> Thus Geology contributes proofs to Natural Theology strictly in harmony with those derived from other branches of natural history; (Buckland, 1820: 18).

Even the faulting of the Coal Measures was seen as a sign of the Deity's benevolent concern for Man, making it easier to extract coal:

> From their inclined position the thin strata of coal are worked with greater facility than if they had been horizontal; but as this inclination has a tendency to plunge their lower extremities to a depth that would be inaccessible, a series of faults, or traps, is interposed, by which the component portions of the same formation are arranged in a series of successive tables, or stages, rising one behind another, and elevated continually upwards towards the surface from their lowest points of depression. (Buckland, 1820: 19).

and this faulting was also seen as beneficent in terms of reducing the risk of flooding or "the ravages of accidental fire". Buckland summarised the conclusions of his consideration of faults in coalfields with a paragraph that is once again both side-lined and underlined in his own copy (DRO 138M/F64):

> We may surely therefore feel ourselves authorized to view, in the Geological arrangements above described, a system of wise and benevolent contrivances prospectively subsidiary to the wants and comforts of the future inhabitants of the globe, and extending itself onwards, from its first formation through all the subsequent revolutions and convulsions that have affected the surface of our planet. (Buckland, 1820: 21).

The second half of the Vindiciae Geologicae was devoted to a spirited argument in favour of the conformity of geological evidence with "the Accounts of the Creation and Deluge recorded in the Mosaic Writings" (Buckland, 1820: Dedication - no page number). There is some internal evidence to suggest that at least the force of his argument, if not the inclusion of the topic at all, was provoked by one of the periodic outbursts against the alleged near-atheistic scepticism of geologists:

> If the fact [sic] I now allude to were not so generally notorious, that a recent Author[g] [footnote: g The Rev. Dr. Chalmers] in one of our northern Universities has thought the subject of sufficient importance to devote a chapter of his work on the Evidences of Christianity to what he calls the scepticism of Geologists; it might have been superfluous to introduce the mention of this subject before those who know the strength of the irrefragable moral evidence, on which the general authority of the sacred writings is established, and which cannot be invalidated by occasional differences touching minute details of historical events, or by objections on grounds so hypothetical

> and uncertain, as those afforded by the yet imperfect science of Geology. (Buckland, 1820: 22-23).

In an interesting analogy, Buckland admitted that there were some "slight difficulties":

> ... the evidence of facts unequivocally confirms the statement of these records in all points of most essential importance; and that our science stands on the same ground which astronomy occupied on the first publication of the system of Copernicus. (Buckland, 1820: 23).

The place of the Vindiciae in the development of Buckland's Diluvialism is considered in more detail in Chapter 5.1 below, but the flavour of his argument is perhaps best seen in the first full paragraph devoted to this:

> Again, the grand fact of an universal deluge at no very remote period is proved on grounds so decisive and incontrovertible, that, had we never heard of such an event from Scripture, or any other authority, Geology of itself must have called in the assistance of some such catastrophe, to explain the phenomena of diluvian action which are universally presented to us, and which are unintelligible without recourse to a deluge exerting its ravages at a period not more ancient than that announced in the Book of Genesis. (Buckland, 1820: 23-24).

It is perhaps the *ultimate irony in terms of Buckland's subsequent* reputation that this paragraph - the first thing that he ever wrote on the Diluvial Theory - has been much the most frequently quoted (or mis-quoted) extract from all his writings, and his subsequent advocacy first of a very long pre-Biblical geological time-scale (in 1822) and of the glacial theory (in 1840) have received scant attention.

Overall, the Inaugural Lecture was very well received in Oxford and in the country at large. The robust advocacy on behalf of geology, and the firm rebuttal of allegations that geologists were almost by their very nature antagonistic to the Scriptures, was particularly welcomed by the geological community itself. Obviously, this was particularly so amongst geologists who were also clerics, and Buckland's views seem to have been just as acceptable to those who shared his fairly mild Toryism and a clerical view that became known a decade later as "Broad Church" just as much as they did to scientific clerics of the Whig outlook. One immediate effect was that those attending Buckland's mineralogy and (especially) geology lectures began to include an even higher proportion of the more senior members of the University, including not only well-established Fellows but also Heads of Colleges.

However, those of a more evangelical view both in the Church of England and outside it were less happy from the beginning, although on the whole they bided their time. (They did not have to wait long, since within four years Buckland was to abandon the Mosaic chronology, laying himself open to a ferocious onslaught on his religious orthodoxy.)

Buckland continued by giving his first course of geological lectures as Reader. One of those attending (although apparently not at that time a registered student for the course) was John Henry Newman, who wrote to his mother on 4 June 1819:

> The Dean [Kinsey] is uncommonly good-natured. He has taken me, since Bowden left, continually to the Geological Lectures. They are very entertaining, but I am not sufficiently up to many things from not knowing the principles of science. (Ker and Gornall, 1978: 65).

Newman expanded on this much later in his life in his (unpublished) "Autobiographical Memoir":

> This was in February, 1819; also in the Summer Term of the same year there may have been some relaxation of his diligence, Bowden being called away by a domestic affliction, and the Dean, Mr Kinsey, who treated Newman with the familiar kindness of an older brother, taking him off to Professor Buckland's Lectures on Geology, at that time a new and interesting Science, but in no degree subserving the interests of candidates for a first class in the examination Schools. (Tristram, 1956: 44).

(Newman registered formally as a student for both the Mineralogy and Geology Lectures in 1821, and a very detailed set of his notes of the Mineralogy Lectures survives: see below under 1821, also Chapter 3.1 and Appendix 1.1).

Buckland's 1819 summer fieldwork programme appears to have concentrated on the English Midlands, and in particular the "Diluvial" phenomena of the superficial gravels. Starting with a search for a possible source for the abundant quartz pebbles in the superficial gravels of the Midlands and Upper Thames Valley, Buckland appears to have surveyed in some detail large areas of Worcestershire (where he suggested the Bromsgrove/ Lickey Hill area as one of the major sources), and both the high level and valley gravels in an area stretching from Evesham, Stratford upon Avon and Towcester in the north to Wootton Bassett and Reading in the south. The geological map that he produced as part of this work covered in some detail an area well in excess of 2,500 square kilometres, and can fairly be claimed as the first major "Drift" map ever produced, certainly in Britain, and perhaps in the world. Buckland's study extended into the East Midlands, although for Leicestershire, Rutland, Northamptonshire and Buckinghamshire he made use of work carried out by W D Conybeare and others.

During part of this fieldwork Buckland was accompanied by Count Breunner of Vienna (Buckland, 1821D: 506). He also appears to have been accompanied on 9 and 10 September by the recently-graduated Charles Lyell, who recorded in his journal:

> Sept. 9th 1819. Between Oxford & Woodstock passed numbers of Gypsies. The country between Woodstock & Euston much resembles that between Fontainebleau & Avallon in France from the shape of the Oolite hills. But the winding of the road in England prevents its being so tedious as the same country is in the straight roads of France.
>
> We met a man driving mules which, the Coachman informed us, were going to the West Indies.
>
> ... At Stratford the red sandstone formation has succeeded to the Oolite & continues to Birmingham.
>
> Friday 10 Sept. Sutton. Observed numbers of rounded pebbles in red sandstone. Litchfield [sic] cathedral with 3 spires. Here we began to get out of the red sandstone which had afforded a rich & well-wooded country from Stratford to this place. Coal now began & and poorer soil. Large brick kilns. (Wilson, 1972: 85).

On completing this fieldwork Buckland appears to have gone to Axminster to see his family, and perhaps to write up his important new observations for a projected paper to the Geological Society. However, about the beginning of October near-disaster struck, in that Buckland became temporarily almost completely blind following an eye injury. This incident must have seemed particularly ominous since his own father had lost his sight completely as the result of an accident just 20 years earlier. However, Axminster was within easy reach of the excellent and very advanced facilities of the Royal Devon and Exeter Hospital in Exeter, and after some difficult surgery the problem was overcome. The story itself is well known from a number of sources, particularly a letter from Buckland to Lady Mary Cole reproduced in Elizabeth Gordon's biography but has only quite recently been dated by the late James Edmonds, who identified the original letter, which is in fact dated 29 October 1819 (Edmonds, 1979: 46 & 51):

> You have no doubt been wondering what is become of me and my projected tour into Glamorganshire, and I am sorry to inform you that all my movements have been deranged, and my plans thwarted, by an accident that befell me a month ago near Sidmouth, from the falling of an ignited spark of iron from my hammer into the cornea of my eye, which I did not discover to be fixed there till some days after, when it began to oxydate. The result has been a series of five or six operations to cut out the minute rusty fragments, and a degree of inflammation which has prevented me from reading or writing during the last three weeks. I am happy to say the cause of injury is now totally removed, and in a few days I shall again take wing for Oxford. As I like always to extract all possible good out of the evil that befalls me, I have learnt two curious facts in physiology from my oculist at Exeter. First, that he once drew a tooth out of a patient's eye (literally an eye-tooth), growing between the bony orbit and ball of the eye, and I have seen the specimen. Second, that the belladonna leaf has the singular and useful property, if laid on the eyelid, of causing a great expansion of the pupil and iris, which is of the highest service, in cutting for cataracts, to render visible the inner chambers of the eye, and, in cases of diseased pupil, by drawing the iris backwards in every direction, preserves it from contact with the central injury.
>
> But, what is most important, I have been taught to appreciate still more highly than I did before the value of the organs of vision as the fairest inlets of knowledge and pleasure to the soul. (Gordon, 1894: 20-21).

His recovery appears to have been swift and complete, since there seems to be no subsequent comment or discussion of eyesight problems.

Buckland ended 1819 with his first major scientific paper on the Quaternary, including some notes on the occurrence of fossil mammals, submitted to the Geological Society, which must have set the seal on an already highly successful year. This was a long (38 quarto pages plus two maps) report on his summer fieldwork and mapping, which was read to the Society on 3 December 1819 under the very long title of: "Description of the Quartz Rock of the Lickey Hill in Worcestershire, and of the Strata immediately surrounding it; with considerations on the evidences of a Recent Deluge afforded by the gravel beds of Warwickshire and Oxfordshire, and the valley of the Thames from Oxford downwards to London; and an Appendix, containing analogous proofs of diluvian action. Collected from various authorities". Because of the already growing backlog in publication of major papers for the Society's Transactions this substantial work, which is discussed in detail in Chapter 5.1 below, did not appear in print for almost two years (Buckland, 1821D).

On 17 December 1819 Buckland completed the formal reading of his Lickey Hill and "Diluvial" gravels paper to the Geological Society, and began to present to the Society a very substantial joint paper with Conybeare on the geology of the Bristol region. Buckland had in fact lectured to the Geological Society: "On the Geological Structure of the South Western Coal District" on 18 December 1818 and 1 January 1819, and an abstract appeared in the Annals of Philosophy (Buckland, 1819), but he had then turned to joint collaboration with his old friend W D Conybeare who had by then moved from Suffolk to Bristol, where he was very active in local institutions and with the geology of both Somerset and the adjacent areas of South Wales (North, 1956: 136-137).

The joint paper was provisionally titled "On the Coal Fields adjacent to the Severn" and was almost certainly much the most ambitious contribution that had been presented to the still-young Geological Society up to that date. Accompanied by detailed maps, geological sections (one of them by Henry De la Beche) and 26 detailed descriptions of individual pits by the time it was published in 1824, the presentation of the paper took 3½ full evenings at the Geological Society, starting on 17 December 1819, continuing on 7 and 21 January, and concluding on 17 March 1820.

Summaries were published promptly in some of the review journals (e.g. Buckland & Conybeare, 1820), but it is clear from references in the final text that work continued on the study long after its formal presentation to the Society (certainly up to mid-1823), and - significantly - when this massive and comprehensive work finally reached the Geological Society's Transactions (Buckland & Conybeare, 1824) it was described on the title page as a "Memoir" with no reference to the dates on which it was read to the Society (contrary to normal practice). Consequently, it seems more appropriate to consider this under the 1823-24 period, rather than here, except to note that this comprehensive analysis of the geology of an interesting and important region greatly enhanced the reputations of the joint authors, and firmly established their national pre-eminence in the fields of both stratigraphical geology and geological mapping.

During the same period Buckland must have been working on the proofs of the Vindiciae Geologicae which finally appeared in the spring, and was widely distributed by him both at home and abroad, and not merely to the scientific community. He continued to work on the growing geological collections during the winter months, and was starting to have some success in obtaining geological material from British expeditions and territories overseas. Using his growing network of political contacts, Buckland persuaded the Foeign Secretary, Earl Bathurst, to pass on information and specimens received from overseas to him for evaluation, allowing at least a selection of the specimens to be retained for the teaching collections at Oxford. As a result of such arrangements Buckland, who never travelled further north than Germany, east than Czechoslovakia, or south than Sicily, produced in the course of his career important original scientific papers about areas stretching from the high Arctic to Australia.

On 5 May 1820 he read to the Geological Society the first of a number of such studies under the descriptive title: "Notice on the Geological Structure of a part of the Island of Madagascar, founded on a Collection transmitted to the Right Honourable the Earl Bathurst, by Governor Farquhar, in the year 1819; with Observations on some Specimens from the Interior of New South Wales, collected during Mr Oxley's Expedition to the River Macquarie, in the year 1818, and transmitted also to Earl Bathurst." (Buckland, 1821A: 476).

The background and objective was set out clearly by Buckland:

> As our knowledge of the rocks which occur in the island of Madagascar is as yet very imperfect, I beg to lay before the Geological Society a few notices, which, by the favour of the noble Secretary of State for the Colonial Department, I have been enabled to extract from a series of specimens lately transmitted to his Lordship by Governor Farquhar. As these specimens were not collected by persons accustomed to inquiries of this kind, they are not accompanied by any geological memoranda, or account of the extent and position of the rocks from which they were taken; they are however valuable for the authentic information they give us of an unknown region, and as affording a useful index to future investigations.
>
> As far as can be ascertained from these specimens, it appears that the north-east portion of the island, from which they were taken, consists of primitive rocks, sandstone, and trap, presenting a similar geological structure with that of the adjacent continent of Africa, in the neighbourhood of the Cape of Good Hope. (Buckland, 1821A: 476-477).

This introduction was followed by descriptions of rock specimens received from various localities, with suggestions as to their geological age and comparisons with known localities in Europe and elsewhere, and comments on their economic potential. Two examples from the Madagascar descriptions give a good idea of Buckland's general approach:

> Another variety of rock, nearly allied to the granitic series, is made up of equal quantities of decomposing flesh-coloured felspar and lamellar graphite. This felspar, if separated from the graphite, would afford an useful clay for pottery; there is a specimen of it from a spot called Effetou. The graphite is disseminated equally through the felspar in small flat grains resembling dark mica. A similar rock occurs on the Danube between Lintz and Passau, and supplies Vienna with graphite for black lead pencils. (Buckland, 1821A: 477).
>
> The sandstone of St. George's Hill is of an intensely bright brick red colour, and composed of fine grains of quartz loosely adhering by a cement of red oxyde of iron, and occasionally of ferruginous clay. In some specimens it is united by shining haematitic iron. Brilliant grains of mica appear dispersed irregularly throughout the sandstone. Its intense redness gives it a very marked and decided character, and connects it with the enormous tracts of a similar formation which occur in the neighbourhood of the Cape of Good Hope, and which appear also to form the base of many of the great sandy deserts of Africa and Asia. It resembles in every particular of its colour and composition the newer red sandstone of the English series. (Buckland, 1821A: 478).

Even more interesting is Buckland's confident assertion on the current formation of limestone on Madagascar by natural processes:

> Besides these rocks, all of which have a strong resemblance to formations that occur in Europe, the Island of Madagascar presents a variety of that species of modern and daily accumulating limestone, which is of frequent occurrence near sea-coasts that are exposed to the action of violent seas, being composed of sand and minute fragments of ground shells, which being first accumulated on the shore, and subsequently drifted inland, are in short time consolidated into fixed masses and compact strata.
>
> The specimens of a rock of this formation from Madagascar, exhibit a firmly compacted cream-coloured limstone, composed of granulated fragments of shells, agglutinated by a calcareous cement, but too much broken to allow any of their species to be ascertained. Limestone of this kind is applicable to most of the ordinary uses of that mineral, and is often the only calcareous rock that occurs on volcanic islands.
>
> There is a curious specimen of such limestone in the library of the East India House, which contains imbedded in it a small and recent bird's egg, with the shell unchanged. This specimen is from St. Helena; and bones of modern birds are said to abound in the same rock, and also to lie loosely scattered over certain parts of its surface. This is easily explained by the circumstance of the origin of the limestone, from periodical driftings by the

> wind of calcareous sand, over districts frequented, as these are said to be, by innumerable flocks of small birds. Such rocks are also liable to contain the exuviae of modern land shells. (Buckland, 1821A: 479-480).

This carefully observed "Actualism" is far removed from the caricature of Buckland's position on the Uniformitarianism debate as presented by many general studies of the history and philosophy of science.

The notes on his specimens from New South Wales shows the same utilitarian interest in the possible presence of economic minerals in the area covered by the explorers, but Buckland urged further exploration for these and for fossils:

> There is nothing in any of the specimens indicative of valuable metals or precious stones, or any kind of animal or vegetable remains; to the collecting of which latter it is of the highest importance that the attention of travellers in all distant countries should be directed, and more especially in this, where the character of many of its present animal inhabitants is so singularly peculiar. (Buckland, 1821A: 480).

Buckland continued by noting that in the coastal area were coal deposits which he considered might be comparable with the Coal Measures of England, and he reported seeing fossils which appeared to be comparable with those of the Carboniferous Limestone of England and Ireland from near Hobart, Van Diemen's Land (Tasmania). Taking all of these facts, together with his (correct) suggestion that the red sandstone formations of the Karroo in South Africa and Madagascar were equivalent to the New Red Sandstone of England, Buckland concluded:

> It is satisfactory to find, on comparing rocks from such remote parts of the southern hemisphere with those of Europe, that none of them afford any varieties that may not be referred to species that occur also on this side of the equator, and that as far as they go, they lead us towards a conclusion, that there is not only an identity in the older formations of rocks that constitute the

> earth's surface, but also a strong resemblance in the leading features of many of the secondary strata that follow and repose upon them. (Buckland, 1821A: 481).

Buckland had been familiar with the large Jurassic fossil reptiles that were being found in many places, most notably by Mary Anning at Lyme Regis, for at least fifteen years, but the discovery of what was clearly a completely new form (later named Plesiosaurus by De la Beche & Conybeare, 1821), led Buckland into a new area, that of vertebrate palaeontology. The leading comparative anatomist in the world at the time was Baron Georges Cuvier whose Recherches sur les Ossemens Fossiles ... (Cuvier, 1812) marked the start of scientific vertebrate palaeontology. In contrast with Britain where in 1820 the Government's sole contribution to geology and palaeontology seems to have been the two 100 pound Stipends attached to Buckland's two Readerships, the French Government supported the science most handsomely. (Buckland frequently complained about the unfavourable treatment of British science in comparison with that of the Continent, see Section 3 below.) Cuvier was provided with a substantial laboratory within the Muséum in the Jardin du Roi and was served by a team of hand-picked scientific and technical assistants, as Lyell recorded when he visited Cuvier for the first time (Lyell, 1881A: 248-251).

Buckland had certainly visited the Muséum and had presumably met Cuvier on his continental tour with Greenough, and had reached the status of one of Cuvier's recognised correspondents (something that was by no means automatic regardless of status: see Outram, 1980: 1-5), so Buckland seems to have served as the intermediary when Conybeare and De la Beche needed Cuvier's advice on the new fossil which, as they described it in the title of their paper, was in their view "a new Fossil Animal forming a link between the Ichthyosaurus and the Crocodile" (De la Beche & Conybeare, 1821). From Cuvier's side the subsequent correspondence was conducted by his Irish assistant, Joseph Pentland (1797-1873), who appears to have been totally forgotten until his letters to Buckland covering the period 1820 to 1832 came on the market in 1970, and were acquired for the Manuscripts Collection of the Nottingham University Library (Delair & Sarjeant, 1976; Sarjeant & Delair, 1980). The earliest letter of the series is an extremely long one (undated, but postmarked June 1820) replying to two letters from Buckland himself with one attached from Conybeare which consists mainly of very detailed criticism and correction of what must have been an early draft of De la Beche and Conybeare's paper on the Plesiosaurus, in which amongst other things Pentland approved of the name that the two discoverers proposed to give to the new animal, and concluding:

> On the whole I think Mr Conybeare will render to the fossil Zoology & comparative Anatomy a great service by publishing his present observations & continuing his researches on those animals, and am sure that, although having fewer opportunities than Sir E. Home, he will, from that Philosophical spirit of research and investigation which he has shown in his Geological memoirs, render a much more essential service than that which have rendered the different abstruse, incomprehensible and for the most part uninteresting (except by the Plates) papers of the London Baronet [Sir Everard Home], which, crowding the Transactions of the oldest Scientific Society of Europe [Royal Society], have often prevented the publication of others much more interesting for the scientific world and much more honorable to the Society from which they were worthy to have emanated. I shall be very happy to see Mr Conybeare's paper as soon as published and am extremely obliged to you for your kind offer to send it to me as soon as it appears.
>
> Mr Conybeare's letter gives me a still higher opinion of its author than that which I had from what you told me of him. I wish he would come over to Paris after the publication of his paper, and to prepare himself for the subsequent ones which he intends to give on fossils; it would be of great service to him. (Sarjeant & Delair, 1980: 257-261).

During the summer, Buckland went on a further extended tour of the Continent, in the company of Greenough and Count Breüner of Vienna for at least part of the time. From London he went straight to Paris:

> Three days brought me from London to Paris, where my first business was to call on Cuvier, who after receiving me with the greatest cordiality, and saluting my cheeks with more than English familiarity, immediately made a dinner for me, inviting Humboldt, Biot, Cordier, Bowditch the African traveller, Frederick Cuvier, and several others of the savants of Paris, and giving me admission to the entire establishment of the Jardin du Roy. I attended three lectures on geology by Cordier, two on entomology by La Traille, and three on ornithology by Geoffrey St. Hilaire. I admired exceedingly the French style of lecturing: the manner and matter were extremely good, but the classes as ill-looking and ungentlemanly a set of dirty vagabonds as ever I set eyes on, and not more numerous than my own at Oxford. I attended also a meeting of the Institute at which was announced the death of poor Sir Joseph Banks, who is not less regretted in France than in our own country. I saw there Guy Lusac, Menard, Vaguelin, Henry Raymond, Brockard, Bindon, and most of the first scientific men of France, whose love of Science, however, does not induce them to attend without receiving about eight shillings a head for their hour's work....
>
> I saw a great deal of Humboldt, whom I liked exceedingly, and with whom I am likely from henceforth to be in continual correspondence. He talks more rapidly and more sensibly than any man I ever saw, and with a brilliancy that is indicative of the highest degree of genius. He is on the point of publishing a most interesting work, a comparative view of the geological structure of Europe and South America, and, according to the documents he showed me, the identity of the phenomena of the two continents is more absolute than the most sanguine wishes could have anticipated. He has given me a section of the valley of Santa Fè de Bogota, which is the exact counterpart of the valley of Glamorganshire, which I shall publish with my account of the Severn district in our Transactions. He will make use of my list of the order of succession of English strata, and in almost all points but the history of the Old and New Red Sandstone, which is the great stumbling-block of continental geologists, we are fully agreed. On this, however, I have made a convert of Bindon, and hope soon to convince Humboldt. (Gordon, 1894:37-40).

Travelling southwards from Paris Buckland went direct to Clermont-Ferrand to study the volcanic area of the Puy-de-Dôme in the Auvergne which he felt: "is the finest thing by far in Europe" (Gordon, 1894:40). From the Auvergne he continued south to Lyon (which was a serious disappointment). His exact route from there is not so clear, but it appears that he carried out extensive fieldwork and observations travelling eastwards throughout the Alps of France, Switzerland, Austria, after which he continued through Bohemia. After visiting Prague, where he saw Count Sternberg, Buckland travelled through Germany before returning to England. Frank Buckland (1858: xxxiv) correctly records that Buckland gathered much geological material for his museum at Oxford, as well as many important new observations, in the course of this tour, but appears to have mistaken Buckland's route and gives this in reverse.

Buckland appears to have returned to England in the early part of September 1820. On 20 September Pentland wrote to Buckland at Corpus Christi College in reply to two letters from Buckland, beginning by thanking Buckland for a generous offer of the donation of a rhinoceros skull. Pentland's comment on this gift is an interesting illustration of the way in which the complex pattern of favours and corresponding indebtedness operated in early 19th century society:

> Mr Cuvier desires me for the moment to thank you for the superb present you intend to make him, he will write to you very soon himself more fully on the subject. I am sure nothing can be more liberal on your part as [sic] such an offer, which at the same time that it will render Mr Cuvier under an obligation to you personally, will advance in his hands considerably the history of this interesting and extinct species ... (Sarjeant & Delair, 1980: 261).

Pentland wrote to Buckland again on 6 November 1820 (Sarjeant & Delair, 1980: 263-265), referring first to Buckland's views on Diluvian gravel "which you were so good as to discuss with me" - presumably during Buckland's stay in Paris during the summer. Although Pentland was convinced that the movement of large displaced blocks could be attributed to the action of water (and cited in support of this the effect of recent storms on the French and English coasts), and continued:

> ... But in adopting your ideas on the diluvian gravel I am very far from supposing with you that the remains of Animals contained therein belong to individuals which formerly lived in the latitudes where they are actually found. The climate of our northern latitudes must have materially changed to have allowed Rhinoceros & Hippopotamus, now limited to the torrid zone, to exist where their bones are actually found. Such a change of climate is inconsistent with the established laws of Meterology & astronomy, and I cannot see, were it possible to introduce such an hypothesis, any service that it could be towards the explanation and full confirmation of the last diluvian 'Cataclysm'. ... In my humble opinion it is much easier to suppose a general dispersion of the remains of certain genera & species all over the globe's surface by the effects of the last and very recent diluvian action, than to call into our aid a deterioration in which certain climates [words missing] or an universal equality in the distribution of heat over [deletion] the globe in order to allow the same beings to exist from the Pole to the Equator. Either of those latter suppositions are, I may say, equally absurd, the laws of Necessity and Astronomy cannot admit them, and I am sure no Zoologist who is acquainted with the actual distribution of organic life over the surface of this Planet will attempt to call them to his assistance: I have adduced the Elephant for example, I might have equally taken the Mastodonte à dents étroites, the Lion of Gaylenreuth and the Hyaena certainly never lived in Franconia, although it be the opinion generally adopted that they died where their bones are found. Such an opinion were natural enough from the local accompanying circumstances, had they not been found elsewhere dispersed in the Diluvian gravel. (Sarjeant & Delair, 1980: 263-264).

These comments of Pentland are particularly significant and throw completely new light on the development of Buckland's views of extinct mammal fossils. It has generally been assumed that he first became convinced that apparently tropical species of mammals had lived in temperate latitudes in "antediluvian" times while he was working on Kirkdale Cave from December 1821 onwards, whereas the recently discovered Pentland letter shows that he was arguing against the generally accepted view that the tropical animals were dispersed by the Deluge while in Paris 18 months earlier.

On 9 November 1820 Buckland donated to the Geological Society the skull of a Rhinoceros found at King's Newnam, near Lawford Church, Warwickshire (Geological Society, 1821:649). (This specimen was excluded from the rest of the Society's Museum when this was transferred to the Museum of Practical Geology in the early years of the 20th century, and is still in the Society's Rooms in Burlington House.) This was presumably the specimen referred to by Pentland in his September 1820 letter, and by 21 January 1821 Pentland wrote to Buckland again saying that Cuvier:

> is under the greatest obligation for the Rhinoceros' head, which he expects with impatience as he is just about to finish the article Rhinoceros for his new edition (Sarjeant & Delair, 1980:265).

What must presumably have been a plaster cast of the skull was eventually despatched in February 1821, since Pentland wrote to Buckland on 21 February 1821:

> I received your letter of the 16 Inst announcing the departure of the Rhinoceros's head (Sarjeant & Delair, 1980: 267).

The other letters of Pentland dating from the winter months of 1820-1821 show that Buckland must have been working on his forthcoming study of the geology of the Alps and the relationship *between* British and Continental stratigraphy, judging by the various queries answered by Pentland in letters of 23 December 1820 and 21 January, 21 February, 26 February and 24 April 1821 (Sarjeant & Delair, 1980: 265-269). The same series of letters are also revealing in relation to Buckland's standing with Cuvier personally. In some cases at least Pentland replied to letters that must have been addressed to Cuvier himself, making the excuse that the great man was too busy at that moment but was about to reply personally. Even in reply to Buckland's announcement of the despatch of the Rhinoceros skull it was Pentland who replied on 21 February 1821:

> he requests me 'de vous faire de sa part ses remercimens [sic] & de vous demander mille pardons pour n'avoir pas encore repondre à votre lettre obligeant', but as soon as he shall have a moment's leisure he shall write to you. (Sarjeant & Delair, 1980: 267).

At the Geological Society's Anniversary Meeting on 2 February 1821, Buckland was re-elected Vice-President, and on returning to Oxford he began the preparations for his annual Mineralogy lecture course. This year Newman formally registered as a student, and recorded in his diary:

> Monday, 12 February 1821 returned to Oxford
> Buckland's lectures in Mineralogy cost me £2.2
> (Ker & Gornall, 1978: 99).

Newman made very detailed notes of the lecture course, which survive in the Newman Archives at Birmingham Oratory. These geological notes: "The Substance of a Course of Lectures on Mineralogy delivered by the Professor at Oxford in Lent Term 1821" have never been published, but offer a very valuable insight indeed to both Buckland's mineralogical and geological views at the time, and also his teaching methods, so they are reproduced verbatim as Appendix 1.1 below. (Large bundles of Buckland's own teaching notes are in the Oxford University Museum Archives. Preliminary surveys of these, and more detailed evaluation of specific topics by Rupke (1983) and me (see Sections 4 and 5 below, for example), show their research value. However, these papers are in a very sorry state of disorder in archival terms. Most of the notes are no more than the very briefest outlines. Some lectures were written out in the form of detailed notes from which Buckland could expand or wander as he wished, but others consist of little more than a few scribbled words of scraps of paper, including notices and agendas for meetings of the Oxford Gas Company that Buckland set up in the face of much opposition in 1818, and of which he was Chairman for many years.) A far clearer picture of Buckland's views, oratory, jokes and tendency to coarseness can be obtained from student notes such as those of Newman (Mineralogy, 1821), Murchison (two lectures and a field excursion to Shotover Hill in 1825) and Jackson (both Mineralogy and Geology courses in 1832), all of which are reproduced from the surviving unpublished manuscripts in Appendix 1.

For example, Newman's notes show that the very first lecture of the 1821 Mineralogy course had a theme that was to become ever more pressing throughout his life - the governmental neglect of science and science education, and the mis-management of the nation's mineral resources. His views on the need for state intervention in so many areas of society were far closer to those of Revolutionary France or the military-style control of the Austrian Empire than of his own Tory philosophy in other areas of life within Regency England. This theme is discussed further in Section 3 below. However, it is hard to imagine how his audience, which must have consisted almost entirely of ordained Fellows and students working for their MA in preparation for ordination, felt about his assertion that under the Continental system the "younger sons & brothers of noblemen, in fact all such people as with us block up the entrances or the inside of the church" would instead be sent out by the State to supervise the mining industry! (Appendix 1.1).

It is also clear that he made extensive use of original specimens which were handed around the class, together with large lecture room-sized diagrams and maps (some of which still survive in the Oxford University Museum Buckland Archives). For example, Newman recorded that in his lecture on "Incrustations" he displayed contemporary "petrified" objects (presumably collected at Clermont-Ferrand during his Continental tour the previous summer):

> You see for sale petrified flowers, fruit, branches, insects, fish, cats, dogs in short all kinds of things. This basket of grapes was petrified there; it is however you see broken & spoilt by the carelessness of the Custom-house officers - not the English for they are always very attentive but in France. (Newman M.S. - see Appendix I.1).

Newman appears to have been captivated by Mineralogy as such, and wrote to his father on 20 March 1821:

> I have been with Mr Kinsey to Abingdon, to the house of a gentleman who has a fine collection of Minerals. We were employed in looking over them from one to four o'clock. Some of them are most beautiful. When I come home, I shall make various excursions to the British Museum, if open for the sake of the Minerals. (Tristram, 1956: 54).

However, although he attended Buckland's Geology Lectures (at a cost of £1.1 since it was his second science subject - Ker & Gornall, 1978: 106), Newman found these much less appealing. On 8 June 1821 he wrote to his mother:

> I have been very much to myself this term. Buckland's lectures I had intended to take down, as I did last Term, but several things prevented me:- the time it takes; and the very desultory way in which he imparts his information. For, to tell the truth, the science is so in its infancy, that no regular system is formed. Hence the lectures are rather an enumeration of facts from which probabilities are deduced, than a consistent and luminous theory, of certainties illustrated by occasional examples. It is, however, most entertaining, and opens an amazing field to imagination and to poetry. (Ker & Gornall, 1978: 109).

However, the occasional point in Buckland's lectures appealed to Newman's aestheticism. For example he recorded in his Journal on 5 June 1821:

> Buckland has just noticed in his geological lecture the extraordinary fact, that, among all the host of animals which are found and are proved to have existed prior to 6000 years ago, not one is there which would be at all serviceable to man; but that directly you get within that period, horses, bulls, goats, deer, asses &c are at once discovered. How strong a presumptive proof from the face of nature of what the Bible asserts to be the case. (Tristram, 1956: 167).

Newman's final judgement on his old Professor's advocacy is perhaps best summed up in two letters written to Pusey on 13 and 21 April 1858:

> Then on the other hand I have a profound misgiving of geological theories - though I cannot be sure that facts of considerable importance are not proved. But in the whole scientific world men seen going ahead most recklessly with their usurpations on the domain of religion. (Dessain, 1968: 322).
>
> I quite feel what you say about Buckland's Reliquiae. It has made me distrust every theory of geology since; and I have used your words 'Why take the trouble to square Scripture with facts and theories, which will be all changed tomorrow, and be obliged to begin over again?' (Dessain, 1968: 326).

In parallel with the spring and summer lecture courses Buckland continued to work on a number of projects, including - increasingly - work on fossil mammals. Much of this work appears to have been carried out for Cuvier, who in return supplied plaster casts of important fossils to Buckland for his Museum in Oxford. For example, on 7 May 1821 Pentland noted:

> The cast of Palaeotherium's head is ready. We do not know whether to send it immediately or to wait until 22 other casts which we destined for you to be ready. The head is extra magnificent, write to me if you wish it directly, if so I shall send it!!! (Sarjeant & Delair, 1980: 271).

On 28 May 1821 Pentland again wrote to Buckland:

> Cuvier desires me to say that he will be highly gratified by the drawings of the bones of Rhinoceros, whatever those bones may be. = either Vertebrae or long [b]ones. For the manner and position in which those drawings should be made, I only refer you to Cuvier's plates of living Rhinoceros, only on a much larger scale if possible, the long bones at least 1/3 or 1/2 or natural size. They will be published in the beginning of his second volume, when Cuvier will have another opportunity of speaking of Miss Morland's talents and of your liberality and zeal. (Sarjeant & Delair, 1980: 271).

Buckland can have had no idea of the significance of the reference to Miss Mary Morland (a keen and knowledgeable naturalist and gifted artist who was at that time working for Cuvier, making drawings of fossils in various English collections). The two had met accidentally some time earlier, as was recorded by a family friend, Miss Caroline Fox, in 1839:

> Davies Gilbert tells us that Dr. Buckland was once travelling somewhere in Dorsetshire, and reading a new and weighty book of Cuvier's which he had just received from the publisher; a lady was also in the coach, and amongst her books was this identical one, which Cuvier had sent her. They got into conversation, the drift of which was so peculiar that Dr. Buckland at last exclaimed, 'You must be Miss Morland, to whom I am about to deliver a letter of introduction.' He was right, and she soon became Mrs. Buckland. She is an admirable fossil geologist, and makes models in leather of some of the rare discoveries. (Gordon, 1894: 91).

In fact, 4½ years later they married, and in the intervening years Mary Morland worked closely with Buckland as both an illustrator, and as a valued and perceptive geological confidant, while Mary spent much of her time working from the house of Sir Christopher and Lady Pegge in Oxford.

At the end of June 1821 a very substantial paper "On the Structure of the Alps and adjoining Parts of the Continent, and their Relation to the Secondary and Transition Rocks of England" was simultaneously published in the Annals of Philosophy in England and the Journal de Physique in France (Buckland 1821B). In the introductory paragraph Buckland stated that the purpose of the paper was to give a "brief summary" of a "future and more extensive communication" to the Geological Society, although this in fact never appeared.

In fact, "this prospective notice" contained very little on the structure of the Alps in the modern sense, but instead concentrated on the stratigraphy of the Alpine region from the Alpes Maritimes in southern France to the Danube, taking in the whole of northern Italy to the south, and the Jura, lowland Switzerland, and much of southern Germany and Austria to the north of the Alps proper, and to make stratigraphical correlations between

Alpine and British geology.

As was widely recognised on the Continent, the paper was a considerable tour de force, particularly for a British geologist, and was based on close personal observation and investigation throughout the region. Altogether well over 130 different localities were cited by name, most if not all from Buckland's personal experience.

However, as Buckland made very clear at the beginning of the paper, his primary purpose was not merely to produce a useful descriptive account. Although by 1820 the basic stratigraphy of both Britain and Western Europe from the "Transition" (i.e. Upper Palaeozoic) upwards was well established both north and south of the English Channel respectively, there was still very considerable disagreement about the correlation between Britain and the Continent. The survival of Wernerian stratigraphy on much of the Continent did not help, and partly contributed to a continuing confusion in some quarters between the Old Red Sandstone (i.e. "Transition") and the New Red Sandstone (i.e. "Secondary"). Even more serious confusion surrounded the various major limestone Formations, where Buckland perceived much of Continental (and indeed British) interpretation as hopelessly muddled. He quite correctly realised that only detailed stratigraphical studies and correlation aided by both ground surveys along outcrops over long distances and careful comparison of fossil remains would resolve the confusion.

Buckland had first attempted detailed stratigraphical comparisons across the Channel in his comparative tables of strata of 1815 and 1816, and this work was now greatly reinforced by the massive amount of additional data that he had built up in subsequent visits to the Continent, particularly his 1820 geological tour.

In a detailed description of the Alpine stratigraphy in descending order from the Tertiary, Buckland described each of the major elements and suggested comparisons with the established British sequence. In dealing with the Secondary Formations he recognised that Werner's "Muschel Kalk" was not a single formation, and once that problem was resolved he was able to make detailed correlations between the Cretaceous, Jurassic and New Red Sandstone of England and the Continent, and that all of the major limestones of the Alpine region fell within the Jurassic or Cretaceous. Of even greater importance was his correlation of the Red Sandstones and gypsum and salt deposits underlying the main sequence of Alpine limestones with the New Red Sandstone and Magnesian Limestone series of England - one of the major break-throughs in the history of Alpine geology. In fact, until these basic stratigraphical problems had been correctly resolved there was no way in which the investigation of the structure of the Alps (in the strict sense) could start. In Britain the structural geology challenge was taken up by Sedgwick and Murchison, whose very substantial Geological Society paper of 1832 on the structure of the Alps was founded on Buckland's detailed observations and stratigraphy, and in many ways served as the major paper to the Society originally promised by Buckland in 1821. In this paper they emphasised the importance of Buckland's correct placing of the Alpine red sandstone group beneath the main Alpine limestones:

> Dr Buckland was, we believe, the first who ventured to regard the group above described as the equivalent of a part of the new red sandstone and magnesian limestone series of England, thereby excluding every part of the great zone of Alpine Limestone from the order of transition rocks. This by itself was a great

> step towards an explanation of some of the perplexing phenomena of the Alps; and all geologists who have examined the question appear to be now so far agreed, as to place the red sandstone and the gypseous marls at the base of the secondary system of the chain. (Sedgwick & Murchison, 1832: 319),

and they returned to this same point in the final conclusions of their major paper:

> The identification of this group with the new red sandstone was published by Dr. Buckland in 1821; and was, in itself, a step of no ordinary importance; as it at once separated the whole zone of Alpine limestone from the order of transition rocks. (Sedgwick & Murchison, 1832: 409).

In his paper Buckland summarised the stratigraphy and the correlation with England in a very detailed stratigraphical table which occupied 6½ large octavo pages in the French text. He then concluded the paper with summaries, and notes of the distinguishing features, of each of the three kinds of deposit that had led previous workers into highly confused stratigraphies: the four conglomerates, the four gypsum series, and the five dolomites.

The immediate impact on the Continent was somewhat mixed. Pentland reported to Buckland on 2 July 1821:

> I have distributed your Alpine paper, as you desired. Humboldt has promised to give me some notes on the subject which I shall send to you. He still holds out for his old opinion on Bunter Sandstone: he is not of yr. opinion as to Pappenheim, whereas Brongniart is, and as to the Diableretz he still wishes to make it an Alpen-Kalk: I shall send you also an account of what Brongniart will say on the subject. (Sarjeant & Delair, 1980: 274),

and six days later wrote again:

> Brongniart is very highly pleased with your Alpine paper. You differ from him on some few points, but as to the great essential ones you & he agree perfectly. He has read his his [sic] paper on Monte-Bolca & Northern Italy, which I shall send you as soon as I can get proof sheets which he has promised to give me. (Sarjeant & Delair, 1980: 279).

The first of many foreign honours quickly followed, with Buckland's election as a member of the Société Géologique de France, a Corresponding Member of the Muséum d'Histoire Naturelle au Jardin du Roi, and an honorary membership of the Societa Reale Borbonica Accademia Scienze of Naples (Gordon, 1894; 277). His growing interest in palaeontology, particularly vertebrate palaeontology, was also recognised with his election as a Fellow of the Linnaean Society.

Summer fieldwork appears to have been rather curtailed in 1821 by pressing family business. Buckland's father had died in January, leaving a step-mother (who was only eight years older than Buckland himself) and a step-brother, Samuel, who was only three years old. Although his father's estate was not very large, since even his plural Livings had produced only a modest income and his outgoings must have been very high through the greater part of his married life because of the cost of educating the four sons, there were various small properties and investments to be dealt with by Buckland, as the eldest son.
There seems to have been no serious thought of Buckland himself taking over his father's Livings, and instead their long-standing patron passed all three to John Buckland junior who, like their father, never lived in any of the three parishes, but instead continued to run his successful private school. However, at some time during the summer of 1821 Buckland noted the strange series of mounds of gravel and sand (part of the Bradford Kaims) by the side of the Great North Road at North Charlton in Northumberland, as he later recalled in his 1840 paper to the Geological Society on the glacial theory (Buckland, 1841A: 346).

Returning to Oxford the correspondence with Pentland was resumed, with further discussions about exchanges of casts of specimens and about Pentland's hopes of obtaining a permanent position, perhaps as Keeper at the British Museum.

Some time around the middle of November, Bishop Legge of Oxford told Buckland of the discovery of a bone cave on a site part of which belonged to the Bishop of Durham, at Kirkdale on the north side of the Vale of Pickering, Yorkshire. Buckland learned that the cave had been broken into in June 1821 by the workmen of a small quarry just by the side of the river, but its significance was not recognised until these fossils were seen by a local surgeon, John Harrison, and a visitor from London with some scientific interests, John Gibson. The material was traced back to the Kirkdale Quarry and very soon the discovery was known to a number of local cultivators of science, notably the Rev George Younger Whitby, the Rev William Eastmead of Kirkbymoorside, and William Salmond of York, all of whom employed workmen to excavate in the cave during the late summer and autumn of 1821. The Rev Vernon Harcourt, the nephew of the Archbishop of York, who was to play a key role in the foundation of both the Yorkshire Philosophical Society and the British Association for the Advancement of Science, also appears to have notified Buckland of the discovery and sought his assistance in the proper identification and interpretation of the very large numbers of fossil bones and teeth that were being discovered (and at the same time widely dispersed).

Buckland's role in the investigation of Kirkdale Cave became much clearer with the publication and careful analysis of his correspondence with Lady Mary Cole by North (1942), and has now been documented and analysed in considerable detail (Boylan, 1972). Buckland's work on Kirkdale Cave was of major significance in terms of his scientific career and development in terms of both his views on Diluvialism and Fossil Mammals, and these are discussed further below in Chapters 5.1 and 4.1 respectively. Consequently, at this point only a brief outline, sufficient to maintain the biographical narrative, is included.

The exact date of Buckland's departure for Kirkdale is still somewhat unclear. He was certainly working there by 26 November 1821, when he described the cave to Miss Jane Talbot of Penrice Castle in a letter:

> is 200 yards long and is entirely paved with Bones and Teeth of Hyaenas, many of them polished and worn by the trampling of their successive generations. With these are bones & teeth of Elephant, Rhinoceros, Hippopotamus, Horse, Ox, Deer, Fox, and Water Rat.
>
> How the latter got there is not easy to be conceived unless they be either the wreck of the Hyaenas' Larder, or were drifted into a fissure by the Diluvian Waters; both are possible causes, but the latter assumes that there was a fissure open at the top, and the account I at present have of it states that the aperture is a Cavern covered all over at Top with continuous Beds of Lime St. and if so, we can only suppose the Bones to be the wreck of Animals that were dragged in for food by the Hyaenas; (North, 1942: 97).

Since the publication of my 1972 study, the discovery of the Pentland-Buckland correspondence has thrown further light on the issue. From these it seems clear that Buckland wrote to Pentland on 18 November 1821 notifying him and Cuvier of the discovery and indicating that he hoped to go to Yorkshire. Pentland replied in two separate letters on 24 and 26 November 1821, the first of which addressed to Buckland at Kirkbymoorside:

> I am very happy to hear that you intend paying a visit to Yorkshire - it is Mr Cuvier's sincere wish that you should do so, and he desires me to advise you to it in his name. -

> The Yorkshire Cavern will now become no less celebrated than those of Gaylenreuth & Schartzfeld - and the product is in your hands & may give origin to as interesting a work as those of Escher [sic] & Rosenmuller. I am confident Mr Cuvier will afford you every assistance in his power. I have written to you at Kirkdale in Yorkshire, in hopes you may hear from me when on the spot. (Sarjeant & Delair, 1980: 284).

However, the continued correspondence with Pentland continued to cover many other areas, and a letter of 10 December 1821 included a paragraph detailing French Government support for natural history and geology, which must have added to Buckland's disappointment and impatience about the negligible level of support for science in Britain:

> The Jardin du Roi receives annually £12,000 Sterling, whch is divided into three parts: the Botanical, Mineralogical-Agricultural & Zoological Departments. - Out of this latter the collections of Comparative Anatomy, the Cabinet d'Histoire Naturelle & the Menagerie is supported, Menagerie which contains more living animals than any other in Europe. Add to this that out of the same £12,000 - 13 Professors and 13 and [sic] naturalists are paid upwards of £3,800 Sterling, that the Buildings of the Establishment are repaired &c. (Sarjeant & Delair, 1980: 289).

Buckland knew very well that these massive staff and other resources were being used by the French to build up a major world-wide collection of geology by purchase, gift, direct collecting and exchange. (Cuvier's team of technicians preparing high-quality casts of important fossils was of special value in terms of producing desirable replicas available for exchange.) In contrast with this, the British Museum scientific collections could at best be described as moribund and anything that Buckland bought for the Oxford collections had to be paid for out of his own pocket, as for example was the case with his purchase of the White Watson Derbyshire section in December 1821, which was figured in the "Geological Lecture Room, Oxford" lithograph of 1823 (Edmonds & Douglas, 1976: 165).

With Britain already so obviously disadvantaged in terms of geological collections in comparison with France, Buckland appears to have been less than enthusiastic to see that in the first volume of the new American Journal of Science established by Benjamin Silliman, Brongniart had written a fairly blatant advertisement soliciting donations, under the pretext of offering advice to the Americans "Concerning the method of collecting, labelling, and transmitting specimens of fossil organized bodies, and of the accompanying rocks" (Brongniart, 1819).

In reply, Buckland submitted to Silliman a wider-ranging note of "Instructions for conducting Geological Investigations, and collecting Specimens" (Buckland, 1821E). One passage is especially interesting in relation to Buckland's current preoccupations:

> Fossil plants, corals, shells, fish, and bones of all kinds, with a portion of the rock in which they are found, are of all specimens the most valuable. Also fossil tusks and teeth and horns of elephant, rhinoceros, hippopotamus, ox, stag, &c. &c. which abound in diluvian gravel over Europe, North America, and Siberia.
>
> If there be any example of petrified human bones, specimens of them, accompanied by *portions of the substances in which* they occur, and a minute description of their situation and circumstances, are particularly requested: they should be sought in beds of diluvian gravel, which are spread abundantly over the surface of all great vallies [sic] in the world. (Buckland, 1821E: 251).

In marked contrast with what has frequently been asserted over the past century, particularly in relation to Buckland's failure to recognise the co-existence of extinct mammals and fossil men in some of the British caves, from the time of the Vindiciae onwards, Buckland expected that fossil human remains would eventually be found. His main concern was to ensure that when the evidence finally emerged that it was firmly based.

However, the most important purpose of the American Journal of Science notice was unequivocally stated in the final paragraph:

> Every specimen should be wrapped in a separate piece of paper, and the whole closely packed with moss or hay, in a barrel or strong box, to be sent by ship to London, directed to "Rev. Professor Buckland, Museum, Oxford, to the care of Mr. Hunneman, 5 Mead-street, Dean-street, Soho, London." The bill of lading, with notice of the arrival of the vessel, should be sent to Mr. Hunneman, who is Mr. Buckland's agent, and will duly forward the package to Oxford.
>
> [Footnote]
>
> It is desirable to get sent to England a list of the best maps and books descriptive of foreign countries, specifying how far they are correct, and their time and place of publication; and also a list of the names and address of all the naturalists that may be resident in them, stating to what department of natural history they have given most attention, and whether they would be willing to correspond with persons in England who are devoted to the same pursuit. (Buckland, 1821E: 251).

Buckland's campaign for donations of foreign material in particular appears to have had some effect, and where practicable he split these donations between Oxford and the Geological Society. For example, quite soon after the appearance of the American Journal of Science paper, he received a collection of material from the Bahamas, part of which was donated to the Geological Society by Buckland on 21 June 1822 (Geological Society, 1824: 437).

Buckland returned from Kirkdale Cave with a collection that was large in terms of the number of specimens and very nearly comprehensive in terms of the range of species covered, and the material survives today in the collections of the Oxford University Museum (Boylan, 1981A). He must have worked very quickly indeed on Kirkdale, identifying and analysing the fossil remains, developing his interpretation of the cave of a habitation site for a pack of hunting hyaenas who lived in "Antediluvian" times, and reviewing the literature on the habits and behaviour of hyaenas.

By 1 February 1822 Buckland was in London for the Anniversary Meeting of the Geological Society, at which he was re-elected a Vice-President, this time under William Babington as President. Although by then it had been arranged that his detailed report on Kirkdale Cave would be presented not to the Geological Society but to the even more prestigious Royal Society, Buckland's finds of bones, teeth, and - especially - what he identified as fossil hyaena dung was the highlight of a dinner that followed the formal meeting, as Charles Lyell reported to Gideon Mantell:

> The Professors of Cambridge [Sedgwick] and Oxford were present at our dinner, and Buckland was called upon to explain the vast quantities of bones which he found in the summer, in a cave at Kirkdale in Yorkshire, of which he had a large bagful with him: innumerable jaws of hyaenas, teeth of elephant, rhinoceros, &c., unmineralised like those in the limestone caves in Germany full of bears. He produced some light balls or pellets, which he said he brought to town at first doubting what they could be. Dr. Wollaston (I think) first pronounced they were like some calculi sometimes found in some species of Canis. Upon being taken to Exeter Change by Dr. Fitton, the man there recognised the production, and exclaimed, 'Ah, that is the dung of hyaena!' (Lyell, 1881A: 115).
>
> Buckland in his usual style enlarged on the marvel with such a strange mixture of the humorous and the serious that we could none of us discern how far he believed himself what he said, take the following as an example of the whole.
>
> 'The hyaenas, gentlemen, preferred the flesh of elephants, rhinoceros, deer, cows, horses etc., but sometimes unable to procure these & half starved they used to come out of the narrow entrance of their cave <u>in the evening</u> down to the water's edge of a lake which must <u>once have been</u> there, & so helped themselves to some of the innumerable water-rats in which the lake abounded - thus you see the whole stalactite & the other bones stuck over with the teeth of water rats.' (Wilson, 1972: 95).

The reading of the formal paper under the title "Account of an Assemblage of Fossil Teeth and Bones belonging to extinct Species of Elephant, Rhinoceros, Hippopotamus, and Hyaena, and some other Animals discovered in a Cave at Kirkdale, near Kirby Moorside [sic], Yorkshire", took up the whole of three weekly meetings at the Royal Society on 7, 14 and 21 February 1822.

This was not however the first scientific report on the Cave: letters from the Rev George Young were read to meetings of the Wernerian Natural History Society of Edinburgh on 15 and 19 December 1821, although they were not published for over a year (Anon. 1823), and the first edition of Young and Bird's Geological Survey of the Yorkshire Coast including Young's description of Kirkdale together with one Plate of fossils, was published in the early part of February 1822 (Young & Bird, 1822). Young offered what was for the time a perfectly straightforward Diluvial Geology interpretation of the origin of the fossil bones and teeth found in Kirkdale Cave - indeed an account that Buckland himself would have found quite unobjectionable less than two years earlier.

However, Buckland's novel interpretation that the remains in the Cave were the "wreck of the larder" of a hunting pack of hyaenas that had lived in the Cave before the Deluge (which was relegated to the role of a mere provider of the thin covering of mud), was an immediate sensation in scientific, theological and indeed more popular circles.

The first published scientific account of Buckland's views was a very clear and balanced summary in the Annals of Philosophy the following month, March 1822, which although unsigned bears all the hallmarks of Buckland himself or at the very least someone who worked from Buckland's original text (Buckland, 1822A). This was quickly followed by the publication of the full text with detailed illustrations in the Philosophical Transactions (Buckland, 1822B), and over the next few months re-prints, detailed abstracts and translations appeared in a considerable number of scientific journals in England, Scotland, France and Germany. (Examples are listed under Buckland, 1822C, in the Bibliography.) The scientific implications of Buckland's work on Kirkdale Cave have been reviewed in detail elsewhere (Boylan, 1972) and is discussed further in Chapters 4.1 and 5.1 below.

The publication immediately made Buckland a celebrity (perhaps even a curiosity) far outside the narrow confines of the London scientific community, although it was probably the Royal Society's decision to award him the Copley Medal in recognition of his geological work, and particularly the Kirkdale paper, that gave him most pleasure.

Although Buckland's relegation of the Deluge to a very minor role in the Kirkdale story is today often regarded as the beginning of the end for the Diluvial Theory, Buckland himself certainly did not appear to have seen his novel interpretation of Kirkdale as in any way threatening the Diluvial Theory, and on 19 April 1822 he presented a highly Diluvialist interpretation of the geology of East Devon and South Dorset to the Geological Society under the title "On the Excavation of Valleys by diluvian Action, as illustrated by a succession of Valleys which intersect the South Coast of Dorset and Devon". Again the Annals of Philosophy published a well-balanced abstract in its July issue (Buckland, 1822D), although the full text did not appear for almost two years (Buckland, 1824A). The paper included a detailed composite section of the Lias of the area around Axminster, his birth-place and family home, and much other local detail. He also brought together what was by then almost a quarter of a century's exploration of the geology of East Devon and West Dorset into a fine geological map covering the area from Tiverton and Chudleigh to the west and Sherborne to Portland in the east, together with two large perspective sections of the coasts between Lyme Regis and Portland and between Sidmouth and Beer.

Cave studies, particularly of Kirkdale continued. On 19 April 1822 Charles Lyell noted that:

> Buckland has received from the Yorkshire Cave the bones of the weazel, the rabbit, the pigeon, and I believe one other bird in a beautiful state of preservation, and which are being drawn for the R.S. (Lyell, 1881A: 120),

and on 22 April Michael Faraday recorded in his diary a series of chemical analyses that he carried out that day on "Album Graecum" (i.e. fossil hyaena droppings) and a piece of bone all from Kirkdale Cave (Faraday, 1932: 65-66).

The national publicity about Kirkdale Cave led to many other finds of fossil bones, both in surface gravels and in caves, being reported to Buckland, and he appears to have spent much of the summer of 1822 following up various reports of this kind. For example, the Lawford locality near Rugby which had produced the fine Rhinoceros skull produced a complete skull of hyaena from "Diluvial" gravel, which was held up by a triumphant Buckland as evidence of the former existence of live hyaenas in Britain, and an answer to the critics who claimed that the extremely fragmentary material at Kirkdale Cave had been washed northwards from more tropical lands in the Deluge.

Towards the end of June Buckland was told of the discovery of a new cave at Kirkbymoorside. Since Kirkdale Cave had been greatly disturbed by collectors over a period of two-three months before Buckland first visited it, he sent a message immediately requesting that the new cave should be sealed until he was able to visit it. In July 1822 he went back to Kirkbymoorside accompanied this time by Sir Humphry Davy and Henry Warburton to supervise the opening of the new cave. This proved to be sterile, but while they were there one of the "Windypit" fissures in Duncomb Park nearby was opened and was found to contain some relatively modern bones which, however, demonstrated to Buckland the way in which bone accumulations could occur under natural pit-falls. The party also visited Kirkdale Cave where, in Buckland's words:

> I had also the satisfaction of demonstrating on the spot to Sir H. Davy and Mr Warburton the actual state of many of the phenomena described in my account of Kirkdale. (Buckland, 1823A: 52).

Other visits were made to the newly-discovered third Oreston Cave, Plymouth, Devon, and to the caves of the Chudleigh district (also in Devon). It seems most likely that he would also have visited the Torquay caves, including Kent's Cavern during this visit. However, in none of these cases did Buckland carry out any systematic excavations at that time.

His main priority for the latter part of the summer appears to have been to re-visit the great cave of Gailenreuth in Franconia (South Germany), which he had visited during his 1816 Continental tour. During the 1822 tour he visited the collections at Bonn, Frankfurt and Dresden looking at "Diluvial" and cave remains, and in addition to the planned re-visit of Gailenreuth, he investigated the Artz caves of Scharzfeld, Baumans Höhle and Biels Höhle, and in Franconia Forster's Höhle, Rabenstein Cave and Zahnloch Cave and Kühloch Cave, in addition to Gailenreuth itself.

Buckland's objective was to expand the Philosophical Transactions paper into a comprehensive book setting his Kirkdale discoveries in a far wider context in terms of both cave palaeontology and Diluvial geology.

Work on the proposed new book was already far advanced when new discoveries came to light in Derbyshire and South Wales within a matter of two or three weeks of each other in December 1822. The first of these was the Dream Cave, discovered by lead miners at Wirksworth, Derbyshire, where Buckland found a very large talus cone beneath a choked pothole, with many bones including large parts of the skeleton of a rhinoceros scattered over the surface of and within the talus. The second discovery was made by Buckland's old friends, Lady Mary Cole of Penrice Castle, Gower, and her daughter (by her first marriage) Miss Jane Talbot. The latter had tracked down and sent to Buckland some fossil bones from a cave at Crawley Rocks near Swansea that had been found about thirty years later, and these had been exhibited at the meeting of the Geological Society on 19 November 1822. The new cave was Goat Hole or Paviland Cave. On 24 December 1822 Buckland wrote to Lady Mary Cole asking for further details and for samples of the finds, but explaining the difficulties that he was under because of the pressure of work:

> I should gladly have come into Glamorganshire at this time with Sir H. Davy and Dr. Wollaston, had I not been under the necessity of preparing immediately my account of the German Caves I have visited in the past summer for my Book which is forthcoming at Murrays in a Month or 2. (North, 1942: 102).

However, Buckland managed to spend a few days in South Wales in January 1823, and L W Dillwyn recorded in his diary that Buckland arrived on 18 January 1823 and "We were engaged together geologically all day", and on 21 January he again met Buckland, this time at

Paviland Cave (North, 1942: 104). The most important discovery was a substantial part of a human skeleton covered with a red pigment amongst the "Antediluvian" species including fossil elephant, rhinoceros, bear and wolf. However, although the skeleton was clearly in the same deposit as fragments of elephant only a very short distance away, there was some disturbance in that part of the cave and the overlying deposit did not cover the human remains, with the result that Buckland decided that this must have been some sort of "post-diluvial" prehistoric or Roman burial intrusive into the "ante-diluvian" horizons.

Buckland returned to Oxford, where he was an unsuccessful candidate for the office of President of Corpus Christi College. News of the Paviland discovery aroused much interest in Oxford, and on 15 February 1823 Buckland wrote to Lady Mary Cole:

> I have this day been occupied in lecturing to an overflowing Class amongst whom I reckon the Bishop of Oxford & 4 other Heads of Colleges, & 3 Canons of Ch Ch [Christ Church], on the newly discovered Caves, & have puzzled them all as well as myself to account for the Phenomena of the Cave of Paviland. (North, 1942: 108).

The human remains had by this time been dubbed the "red woman", and Philip Duncan enlivened the lecture even further by passing around the latest humorous verse about Buckland:

> Have ye heard of the Woman so long under Ground
> Have ye heard of the Woman that Buckland has found
> With her Bones of empyreal hue?
> Oh, fair one of Modern Days! hang Down your head,
> The Antediluvians rouged when Dead -
> Only granted in lifetime to you! (Gordon 1894: 69).

It must be realised that throughout this whole period Buckland had many other commitments in addition to his work on caves and the proposed new book. He was for example closely involved in moves within York to ensure that at least a proportion of the treasures from Kirkdale Cave should be preserved in the area. The result of this was the formation of the Yorkshire Philosophical Society with the Rev William Vernon as the Founder-Secretary, and Buckland as one of the most active honorary members. In the middle of the new discoveries in Derbyshire and South Wales the Society sought Buckland's advice and assistance in developing its scientific programme and, particularly, its library. In his reply, dated 29 December 1822 (M.S. YPS, Letter Book No. 1), Buckland stressed "beyond all" the Geology of England and Wales of Conybeare & Phillips (1822) - "2 or 3 copies of it so as to be in constant circulation as your text book". Two copies of The Theory of the Earth of Cuvier, translated by Jameson (1822) were also recommended, and other high priorities (in a list of over 30 titles including 7 periodicals), included Cuvier's Ossemens Fossiles, the Organic Remains and Oryctology of Parkinson (1804-11 & 1822), the Mineral Conchology of Sowerby (1812-1821), both the Mineralogy and Geological Essay of Kidd (1809 & 1815), the Character of Moses of Townsend (1813), the System of Mineralogy of Jameson (1804-1808), and a full set of William Smith maps together with Greenough's map of England, and his First Principles of Geology (Greenough, 1819).

One other important piece of the jigsaw fell into place at about the same time when Buckland was able to carry out an experiment with a live menagerie hyaena which, presented with a quarter of an ox, proceeded to devour the meat and break up the bones in precisely the same manner as the Kirkdale Cave hyaenas had done long before. The next morning Buckland was able to collect not only split and gnawed bones which matched exactly specimens found in Kirkdale Cave, but also - to Buckland's special delight - droppings that were in every way identical to those identified from the Cave (Buckland, 1823A: 38; Boylan, 1972).

In 1823 Buckland appears to have reversed the usual order of his two lecture courses by giving the Geology Lectures first, and the statutory notice was given that:

> THE READER IN GEOLOGY will begin his Course of Lectures on the Composition and Structure of the Earth, the Physical Revolutions that have affected its Surface, and the Changes in Animal and Vegetable Nature that have attended them, on Thursday, February 6th, at the Museum, at One o'Clock. (Edmonds & Douglas, 1976: 148).

Up to 1823 Buckland had begun with the Mineralogy lectures, but these were far less controversial than his Geology lectures, and hence were not so well supported. Since each student had to pay two guineas for their first science lecture course but only one guinea for their second, there was considerable financial advantage in having the more popular subject first to collect as many two guinea students as possible, rather than have students joining for the second course only, having taken another course, perhaps Anatomy or Chemistry during the Lent Term!

Edmonds and Douglas (1976) have investigated the 1823 Geology course in considerable detail because it was commemorated in a very interesting lithograph of Buckland lecturing to the course, possibly of the 15 February 1823 lecture when Buckland presented his Paviland Cave discoveries. Of the 52 who registered for the Geology course, only 19 were undergraduates, and 3 were Heads of Colleges and 19 others were Fellows (Edmonds & Douglas, 1976: 148).

In March 1823 the University accepted Buckland's offer to donate his own Corpus Christi geology and natural history collection to the University, and Convocation agreed, in recognition of this gift, to make various modifications to Buckland's Lecture Room in the Ashmolean and to provide £300 for new cabinets to house the collection within the Museum. It was also agreed that J S Miller, Curator of the Bristol Institution, should come to Oxford during the summer to help with the removal, and to catalogue Buckland's collection (Edmonds & Douglas, 1976: 153-154).

Buckland was in even greater demand as a lecturer and raconteur during 1823. On 28 April, at a meeting of the Managers of the Royal Institution the President, Earl Spencer:

> having stated that he had some reason to hope that Professor Buckland would be disposed to give a Course of Lectures on Geology gratuitously during the present Season, provided his Lordship were impowered to request him to confer that favour on the Royal Inst.
> Resolved,
> That the Managers feel themselves much obliged by the President's communication, and beg leave to desire him to make such an application to Professor Buckland. (Managers' Minutes, VI: 390-391).

However, Earl Spencer had been misinformed in his "some reason to hope" and at the next meeting of the Managers on 5 May 1823 it was minuted that:

> The President reported that he had been informed that there was no prospect of Prof. Buckland's lecturing here this Season. (Managers' Minutes, VI: 392).

Buckland was never a great supporter of the Royal Institution and, although certainly not avaricious, an invitation from such a comparatively wealthy organisation for Buckland to travel backwards and forwards between Oxford and London giving a lecture course "gratuitously" would certainly not have been received by Buckland with any great enthusiasm.

The book that Buckland had been working on, amplifying his Philosophical Transactions paper was published at the beginning of June 1823 under the title: Reliquiae Diluvianae; or, Observations on the Organic Remains contained in Caves, Fissures, and Diluvial Gravel, and on other Geological Phenomena attesting the action of an Universal Deluge (Buckland, 1823A). The text had grown almost five-fold from the Royal Society paper of 12 months earlier, with 303 quarto pages and 27 plates. An initial edition of 1,000 copies was completely sold out within six months, and Murray printed a "second edition" (in reality a virtually unchanged re-print) early in 1824. The contents are discussed further in Chapters 4.1 and 5.1 below, but one footnote to the publication of the Reliquiae Diluvianae is worth recording here. Most of the reviews in the serious journals were very favourable indeed, that in the Quarterly Review was especially so, as Buckland reported to Lady Mary Cole on 3 December 1823:

> I am very proud of the rapid sale my Book has had - not a copy has been left for some time, & Mr Murray is very busy in bringing out a 2nd edition of 1,000 copies more (you,of course, have seen the very flattering Review of it in the Quarterly - it is by Dr Copleston). (North, 1942: 112).

However, there was soon a widespread rumour that Copleston had, at the very least,had the active "assistance" of Buckland himself in writing the review, and Lyell later recorded in May 1830 when Lockhart, editor of the Quarterly Review, asked Lyell whether he would object to G P Scrope reviewing the forthcoming first volume of his Principles of Geology. Lyell replied:

> Certainly not, but I told you not to consult me because I might get into as great a scrape as Buckland when he concocted with Coplestone [sic] a review of his own Reliquiae Dil. which is never forgotten against him & not without reason. (Wilson, 1972: 273-274).

In June 1823 Buckland turned away temporarily from the problems of Diluvial geology and fossil mammals to one of the outstanding arguments about Secondary correlations between the Isle of Wight and the English mainland. In 1822 Charles Lyell had visited the Isle of Wight and became convinced that the accepted correlation of Thomas Webster of the greensand and blue marl of the Isle of Wight with the Wealden of the mainland was incorrect. Instead, Lyell correlated the Isle of Wight deposits with the Gault of the mainland. In June 1823 Lyell and Buckland went together to the Isle of Wight, where in due course Lyell was able to convince his old teacher, although not without some difficulty, as Lyell explained to Mantell:

> The section from Compton Chine to Brook is superb, & we see there at one view the whole geology of your part of the world, from the chalk with flints down to the Battle beds, all within an hour's walk, & yet neither are any of the beds absent, nor do I believe they are of less thickness than with you. - This is so beautiful a key that I should have been at a loss to conceive how so much blundering could have arisen if I had not witnessed the hurried manner in which Buckland galloped over the ground. - He would have entirely overlooked the Weald clay if I had not taken him back to see it. (Wilson, 1972: 114).

1823 saw further personal honours from scientific societies both at home (Philosophical Society of Bristol and the Shropshire and North Wales Natural History and Antiquarian Society), and abroad (the Naturforschende Gesellschaft zu Halle) as well as his first national appointment, as a member of the Committee appointed by the Royal Society to advise the Government on the selection of the stone to be used in the new London Bridge.

The publicity that followed the Paviland discoveries and the subsequent publication of the Reliquiae Diluvianae considerably boosted the status of Buckland and indeed of geology in Oxford, and he had a record number of students registered for his 1824 Geology course. Also, by the beginning of 1824 Buckland had managed to shed part of the onerous responsibility for the University's geological collections, since following the temporary appointment of Miller to assist during the summer of 1823 the University appointed John Shute Duncan, a Fellow of New College and a keen follower of Buckland's geology and mineralogy courses, as Keeper of the Ashmolean Museum (Ingram, 1837: 13).

At the Geological Society's Anniversary Meeting on 6 February 1824 Buckland was elected President, with Charles Lyell and Thomas Webster as Joint Secretaries. One of his first tasks was to bring to a successful conclusion the Society's protracted negotiations for the granting of a Royal Charter, and this matter was swiftly brought to a very satisfactory conclusion (see Chapter 3.2 below). A different kind of honour was bestowed in February 1824, with the announcement by M.Levy of the University of Paris that he proposed to name a newly-discovered mineral from a mine at Neskiel in Norway "Bucklandite" "in honour of the celebrated Professor of Oxford" (Levy, 1824).

On 20 February 1824 the Geological Society had what was, by all accounts, a vintage evening, with Buckland and Conybeare presenting papers on newly-discovered fossil reptiles, and vying with each other in theatricality. For once, Buckland's presentation appears to have been the more restrained, although with hindsight it was much the more important one. Conybeare spoke first "On the Discovery of an almost perfect Skeleton of the Plesiosaurus" (Conybeare, 1824). This genus had been erected by De la Beche and Conybeare (1821) from fragmentary material, but during the winter of 1823-1824 the Anning family found an entire skeleton at Lyme Regis, the excavation of which reputedly required the removal of twenty thousand loads of earth! The specimen was so large that it was transported to London by ship, and was then removed to the Geological Society's Rooms in Bedford Row, although all attempts to carry the massive specimen (10 feet x 6 feet) up the stairs to the first floor meeting room failed, so it had to be put on display in the entrance hall. De la Beche was unable to travel to London for the meeting, so Conybeare wrote to him explaining in some detail what had happened, saying "I made my Beast roar almost as loud as Buckland's Hyaenas" (North, 1956: 138).

On this occasion Buckland had nothing to match Conybeare's specimen in terms of completeness but his "Notice on the Megalosaurus or great Fossil Lizard of Stonesfield" (Buckland, 1824C), was an important milestone as the first ever scientific description of land dinosaurs, as has been pointed out by Delair and Sarjeant (1975). Equally important, it included reference to the occurrence of mammals in the Mesozoic. The implications of this paper are discussed further in Chapter 4.3 below.

In the Megalosaurus paper Buckland had referred to (but not figured) some vertebrate material that Gideon Mantell had been finding in the Weald, but which he had apparently not seen as a collection. Although he had to return first to Oxford, Buckland arranged through Lyell to see Mantell's material without delay, and in his Journal for 6 March 1824 Mantell recorded:

> Professor Buckland came express from Oxford, with my friend Mr Lyell to inspect my Tilgate fossils. I had met the Professor at a meeting of the Geological Society, about three weeks since, and shewn him some specimens of bones and vertebrate of the Megalosaurus from Tilgate Forest. (Curwen, 1940: 51).

During this visit Buckland saw the growing number of fragments of dinosaur remains that Mantell had been finding in the Lower Cretaceous of the Weald and recognised that these were comparable to the Jurassic remains from Stonesfield that Buckland had just named Megalosaurus, and he provisionally assigned Mantell's specimens to the same new genus. Buckland then found himself in difficulties with the Council of the Geological Society, despite his office of President. He wanted to modify considerably the paper that he had given to the Society on 20 February by adding an account of Mantell's collection, and whilst this was not an unacceptable practice in principle (providing the amended version was received in time to be submitted to the referee appointed to deal with the paper), the Committee of Publication was very concerned that this should not delay the issue of the whole Part of the Transactions, nor that the cost of artist's fees and printing be increased any further because of the addition of extra plates.

On 12 March Henry Warburton wrote firmly on the subject to Buckland:

> Whatever you have to say on the subject of the Stonesfield animal found at Cuckfield must be forwarded at once, since the papers will be required for printing in a fortnight. I hope that no new plates of the Cuckfield specimens are intended for that paper; it is not a correct practice, and one repeatedly prohibited to other authors to be putting in last words at the very eve of publication; and as President you are required to stand by, & see fair play to all parties concerned in authorship. (M.S. DRO 138M/F71).

Warburton continued by explaining the difficulty of having additional plates made for the Society at that time since the lithographic artist that the Society preferred to use, George Scharf, was already fully committed, and there was a serious danger that if Buckland diverted Scharf to work on any additional plates for his own paper on Megalosaurus (or to prepare plates of Mantell's specimens for Cuvier) the whole Part of the Transactions would be delayed. Evidently a compromise was reached, and the 11 figures (arranged on three plates) of the Stonesfield material were drawn by Mary Morland and lithographed by Henry Perry.

It is evident that the Publication Committee was having similar problems with Conybeare about his Plesiosaurus paper and had had to bring in Chantrey, Wollaston and Stokes as additional referees in support of the Committee's view that a plate of 24 x 11 inches would be quite large enough "to exhibit all the faculties of the original" (M.S. DRO 138M/F71). The Publication Committee's impatience with Buckland and Conybeare was perhaps understandable since most of the forthcoming Part of the Transactions was already committed to Buckland and Conybeare's paper on the "South-Western Coal District" which, at more than 100 pages and with 14 complex sections and three large maps, all hand-coloured fold-outs, was far and away the most complex and expensive publishing venture that the Society had attempted in its 16 years' existence, and further heavy demands from Buckland and Conybeare were not at all welcome.

Eventually, mutually acceptable compromises were reached, and the Part appeared more or less on time in the early summer. As was noted above, the major paper "Observations on the South-western Coal District of England" (Buckland & Conybeare, 1824) was presented as a "memoir" without any reference to a date on which it was formally "read" to the Society, since this was basically a completely new paper, although prepared with reference to interim papers given to the Society between 1818 and 1822. As was so often the case with the papers of both Buckland and Conybeare (and indeed other members of the Geological Society) at the time, the title of the paper was a very considerable under-statement of its scope and objectives. Certainly the work had a strong utilitarian emphasis on economic minerals, with very detailed descriptions of both the Somerset and Forest of Dean Coalfields based on very close observation and detailed analysis of mine records. However, the paper went much further than this, setting the two Coalfields in the context of the regional geology, with detailed sections and correlations across into the South Wales Coalfield, and also relating the Coal Measures to both the underlying and younger geology. The work included, for example, further notes on the geology of the Mendips, and a very detailed large-scale geological map and series of sections of the Avon Gorge and Bristol. The overlying New Red Sandstone, Jurassic and Superficial deposits were also described in considerable detail, and the paper included, for example, the first detailed descriptions of the classic sections along the southern bank of the Severn of Westbury and Aust (including the Rhaetic Bone Beds).

Notes on the "diluvial and alluvial deposits" included references to finds of fossil mammals in the area in both surface deposits and caves, and this was followed by detailed notes on the geology of the coastal marshes and the esturaine peats and salt marshes, right through to notes on finds of the Roman period. Two appendices were added. The first was a note "On some early Geologists, who have noticed the south-western Coal-district", and the second was a note "On Red Sandstone" which followed up Buckland's (1821B) resolution of the common confusion of red sandstones on the Continent with a further clear explanation of the distinction between the Old Red Sandstone, the Millstone Grit and the New Red Sandstone in both Britain and the Continent. The accompanying map and section of the Avon Gorge bears a linear scale which indicates that the effective scale of the map is approximately 1: 10,000. An analysis of measurements between known fixed points, such as towns and villages shows that the topographical base map used for the geological map of the Bristol and Forest of Dean region (Plate 38) is somewhat variable, but overall the scale averages approximately 1: 200,000.

Although by 1824 a substantial amount of geological work had been carried out on the chosen region, stretching from Gloucester to the north to Glastonbury in the south, and stretching as far inland from the Severn as Bath and Frome (including, of course, the classic work of William Smith), Buckland and Conybeare's study set a completely new benchmark in terms of both geological interpretation and synthesis and geological mapping, and was to have a major influence on the subsequent development of these techniques in Britain, most enduringly on the Geological Survey when this was officially launched under De la Beche a decade later.

During the summer Buckland made an extensive geological tour of Scotland. Charles Lyell wrote from the family home of Kinnordy (near Kirriemuir, Angus) to his father on 6 September 1824:

> I have received a most friendly letter from Buckland, in which he tells me that he has just finished his expedition to the Hebrides, and wishes me to accompany him on a visit to Sir George Mackenzie's at Cowl (in Ross-shire ?), and on a short tour, by Aberdeen, Inverness, down Loch Ness, Fort Augustus, &c., all to take less than ten days. He offers to make his time in some measure suit mine. I have chosen within two days of what he proposes, and have told him he must spend one day here, that I may show him the place, and also some specimens on which I have doubts, besides my map, &c. It will be I expect about the 15th of this month. I look forward to no small amusement in being ten days with him, when he is so full of new matter, as he must be after a visit to the Western Isles, so interesting and disputed a field for geological inquiry. (Lyell, 1881A: 155).

Three weeks later, in a letter to his sister from Sir George Mackenzie's house at Cowl below Ben Wyvis in Easter Ross, Lyell included a graphic description of the hectic agenda of fieldwork, travel and socialising that Buckland had set for them from his arrival at Kinnordy:

> But I must now beg leave to treat you with a little restrospective history of my adventures. Mr. Buckland was so desirous of clearing up some puzzles which presented themselves on the banks of the Carrity near Kinnordy, that he agreed to see the Isla, and as this was found more than a day's work, we accepted Captain Ogilvy's pressing invitation, and dined and slept at Airlie Castle, and finished the Isla and Melgum next day, and after dining again with Captain O. returned to Kinnordy, and started next morning for Stonehaven. Saw Dunnotter Castle the same evening, and next day boated it to Aberdeen, and saw the termination of the Grampians in the sea cliffs. At Aberdeen we were in high luck, for Dr. Knight, Professor of Natural Philosophy, was an acquaintance of Mr. Buckland's, and invited us to go with him to an annual dinner, at which we saw the Principals of the two Universities, Dr. Jack and Dr. Brown, and all the Professors. The next morning we breakfasted at Dr. Knight's, then dined with Dr. Forbes, Professor of Natural History. The Duke of Gordon, Chancellor of the University, was there, an old man of eighty, not at all superannuated, and well worth seeing. We attended the same day the assizes, and heard the Chief Justice Clerk condemn a thief for burglary. The next morning we breakfasted with Dr. Glennie, Professor of Moral Philosophy, a clever man, married to the niece and representative of Dr. Beattie the poet. There is in their room a most beautiful portrait of Dr. Beattie by Sir Joshua Reynolds, which has kept its colour. After seeing everything worth examining in geology at Aberdeen, we left it in company with a young advocate, son of Sir J. Hall, an acquaintance of Buckland's, who left us the day after. He was an agreeable addition to our party, as far as he went, viz. to Peterhead, from whence to Cowl I have little to speak of, as we passed it rapidly, but Portsoy, Elgin, and Inverness presented us with some things worthy of notice. (Lyell, 1881A: 157).

From Lyell's description of the route, it seems clear that Buckland was particularly anxious to explore the "Diluvial" phenomena, which he was later to recognise as evidence of glaciation since there are a number of references to localities in, for example, Glen Isla in his November-December 1840 paper to the Geological Society on the Glacial Theory (Buckland, 1841A). This is certainly true of features near Sir George Mackenzie's house, which Buckland specifically states he had seen in 1824 in presenting his evidence for the former existence of glaciers in Scotland (Buckland, 1841A). The remainder of the tour is also detailed by Lyell, in a letter written to his mother from Edinburgh on 18 October 1824;

> In my way through Perth I learnt that my father was expected at Kinnordy on the eleventh. I conclude, therefore, that he is now there, and take an opportunity of giving you some account of my proceedings since I left Cowl. Mr. Buckland went from Ross-shire to Brora in Sutherland, and in examining that district we got within a moderate day's journey of John O'Groat's House. We then returned to Inverness, and travelled thence, in a gig, along the Caledonian Canal, by the Fall of Foyers and Fort Augustus, then visited the parallel roads of Glen Roy beyond Letter Finlay, one of the grandest natural phenomena in Great Britain. We next went by Glen Spean, Dalwhinnie, and Dalnacardoch to Blair Athole, with which and Glen Tilt we were much pleased. We then came by Killiecrankie and Perth to Edinburgh. Here we have worked very hard for a week in the geology of the neighbourhood, and in cabinets, museums, &c., and have had an excellent opportunity of seeing all the leading characters in the University. We have been at breakfasts and dinners without end, at Professor Jamieson's twice, at Professor Wallace's, Dr. Hibbert's, Mr. Allen's, four times, Dr. Greville's, &c. &c.
>
> From Edinburgh we made a geological excursion with Dr. Hibbert to Linlithgow, Falkirk, and Stirling, which proved very successful. We then went to Dunglass, Sir James Hall's, a very elegant and stylish place, about eight miles from Dunbar. The old gentleman is far past his prime, but luckily Captain Basil Hall, the author of the 'Voyage to South America,' was there, whom I had often met in town. He is one of the most gentlemanlike and clever men I have ever met with. We made some great expeditions to St. Abb's Head and other parts of the coast with Sir James and his son, and a Mr. Allison, advocate, on a visit there. Lady Helen Hall is daughter of the late Lord Selkirk; the two unmarried daughters are very pleasant, one of them very pretty. We came home yesterday morning in order to spend the forenoon and dine at Craig Crook Castle, the country house of the far-famed Francis Jeffrey. This was a great treat. He is a little man, of very gentlemanlike appearance and manner. Shines in conversation, whether on trifling or important topics. After his showing us round the grounds and neighbourhood, we met at dinner, Sir H. Parnell, M.P., and Mr. Murray, and others. The dinner and wine in great style. Among others at the dinner was Mr. Maculloch, who gave the celebrated lectures on Political Economy in town last summer, which I attended. He was an acquaintance of mine, and pressed me to dine with him to-day, which I am to do. I expect much amusement from the party. Mr. Buckland left this to-day for Alnwick Castle. I return to Kinnordy to-morrow. (Lyell, 1881A: 158-159).

Deep striation and grooving of freshly-exposed rock surfaces were amongst the phenomena that appear to have interested Buckland particularly at the time, and he subsequently reported seeing these at the foot of Ben Nevis, and in Edinburgh on the top of Calton Hill and in a sandstone quarry near Lord Jeffrey's house, all in 1824. At that time Buckland presumably regarded these as firm evidence of catastrophic diluvial scouring, but by 1840 he had recognised them as evidence of glaciation, and referred to each of these localities in his paper on the former existence of glaciers in Scotland to the Geological Society (Buckland, 1841A).

Buckland returned to Oxford by early October, 1824, and appears to have turned his attention almost immediately to vertebrate palaeontology once again. First he received a long letter from the eccentric Thomas Northmore (1766-1851) introducing himself and describing his current investigations in Kent's Hole, Torquay. The start of the letter, dated 29 September 1824, was unpromising:

> Having come to this place partly with the view of ascertaining whether the cavern, or rather series of caverns, called Kent's Hole, were, or were not a Druidical temple, a friend of mine informed me that you had made some mention of the said cavern in your Reliquiae Diluvianae, which work he kindly sent for my perusal; and no sooner had I got through your account of the organic remains in the cave at Kirkdale, than it occurred to me that Kent's Hole might contain similar fossils, and I have now only to express my regret that your notice of this very extensive cavern should be contained in the short compass of two lines - p. 69. (M.S.: Coll. J M Eyles).

Northmore continued with a description of the location of Kent's Cavern and of Ash Hole, on Berry Head, and then gave some details of a survey that he had carried out in Kent's Cavern before proceeding to describe the discovery of bones and teeth under a stalagmite floor:

> Advancing 50, or 60 feet further, I commenced working under a stalagmitic incrustation, and soon found within a few inches of the crust a pretty large tooth, with 2 fangs, which I take to be an hyaena's; this was succeeded by several others, which I will cheerfully send for your inspection, if it will be agreeable to you. Advancing another step I found more teeth and bones, similarly situated under stalagmite; and contiguous to the pool, a tusk, in good preservation, which seems to be that of a bear or hyaena. There is, generally speaking, mud above the incrustation, and marl or clay underneath, sometimes of a red, and other times of a brown colour. A few stones, called here ... [? fossiles], were found mixed with the teeth. I have discovered also 2 jaw bones, full of teeth, but whether these were left accidentally in the cave, or dropt out of the basket, they were not to be found when I returned to my lodgings. They belonged apparently to the wolf species, but I am no good judge of comparative anatomy. (M.S. Coll. J M Eyles).

The rest of the letter rambled through Northmore's eccentric views on, amongst other things, the Druid religion, but he concluded by offering to send the bones and teeth to Buckland should he want to see them. Buckland evidently replied with some enthusiasm, and offered to show Northmore over his collection at Oxford, as is clear from Northmore's further letter of 6 November 1824 (M.S. Coll. J M Eyles). This initial contact led Buckland directly to his still-controversial involvement with Kent's Cavern (discussed further in Chapter 4.2 below).

On 4 October 1824 Buckland sent to the Annals of Philosophy a short, but significant, paper reporting the first British discovery of a Tertiary mammal of the kind that was becoming well known in the Paris Basin through the work of Cuvier and Brongniart (Buckland, 1825B). He reported that he had himself looked for such mammal remains during his brief visit to the Isle of Wight in 1822 but had found only inconclusive fragments. Buckland had now recognised a well-preserved molar tooth in the collections of Thomas Allan in Edinburgh who had collected the fossil several years earlier on the Isle of Wight. Buckland further reported that his identification had been confirmed by Pentland who described the find to Anoplotherium commune. The short note was illustrated by two actual-size drawings signed "M M del." - clearly Mary Morland again.

Sometime during October or early November Buckland paid a short visit to Somerset, as he explained to Robert Jameson in a letter from Oxford dated 14 November 1824:

> Since my return I have been called into Somersetshire to examine another Cave full of Bones in the Mendip Hills. I have sent a short Account of it to the Courier Paper this Day, as a less correct Statement has appeared in some other Journals. It promises to produce the largest no of Bones of any of our Caves as the Bed containing them is nearly 40 feet thick of Bones & Mud - it is not a Den but an Accumulation of the Remains of Animals that had fallen in by a fissure in the Roof which communicated with the Antediluvian Surface but was choked up as usual with large Stones, Mud & Sand by the diluvian Waters & has ever since been closed & the Rubbish filling it cemented by Stalagmite. There have also been found more Bones of the Bear & other Carnivora in Kents Hole near Torquay & Parts of an Hippopotamus at Wantage. (M.S. Pollok-Morris: Jameson Letters).

With the resumption of the winter programme of the Geological Society, Buckland would also be travelling by coach or on horseback to London every fortnight for the Geological Society - a journey that involved between 10 and 12 hours travelling time for the round trip, and either a night in London or an overnight return journey to Oxford. However, on 5 November 1824 a group of 30 Fellows of the Society, including Buckland, Greenough, Warburton and Lyell formed themselves into the Geological Society Club, as a private dining club, the meetings of which enlivened considerably Buckland's regular visits to London.

At the beginning of November the Edinburgh Philosophical Journal published a substantial article by Rev John Fleming, Minister of Fliske, Scotland, and a well-known member of both the Royal Society of Edinburgh and the Wernerian Natural History Society of Edinburgh,under the seemingly innocuous title: "Remarks illustrative of the Influence of Society on the Distribution of British Animals" (Fleming, 1824).

Most of the paper was a very straightforward descriptive account of declining populations of many types of wild animals and birds because of human interference either directly by hunting or through the destruction of the habitat, and this was followed by descriptive comments about extinct forms found in the superficial deposits of Britain. However, Fleming concluded the main text of his paper by arguing strongly that the extinctions of large mammals were due mainly to hunting:

> though we can feel no hesitation in admitting, that murrains, severe seasons, and local inundations, may have accelerated their ruin. (Fleming, 1824: 304).

However, he then added a final note that was a frontal attack on contemporary geologists, and especially on Buckland (who had been mentioned by name in the main text of the paper):

> The preceding remarks, offered on a very interesting department of the natural history of the earth, may serve to point out the rashness of those attempts which have been made to unite the speculations of geologists with the truths of Revelation. Without controversy, the works and the words of God must give consistent indications of his government, provided they be interpreted truly.... It would be favourable to the progress of geology, were its cultivators more disposed to examine the structure of the earth, and the laws which regulate the physical distribution of its inhabitants, and less anxious to give currency to their conjectures, by endeavouring to identify them with deservedly popular truths. It would be equally favourable to the interests of Revelation, were the believer to reject such faithless auxiliaries, and, instead of exhibiting a morbid earnestness to derive support to his creed from sciences but remotely connected with his views, calmly to consider, that Geology never can, from its very nature, add the weight of a feather to the moral standard which he has embraced, or the anticipations of eternity in which he indulges, even should he fancy that it has succeeded in disclosing the dens of antediluvian

> hyaenas, in exhibiting the skeleton of a rhinoceros drowned in the flood, or in discovering the decayed timbers of the ark. This indiscreet union of Geology and Revelation can scarcely fail to verify the censure of Bacon, by producing Philosophia phantastica, Religio haeretica. (Fleming, 1824: 304-305).

Buckland's first reaction appears to have been to ignore Fleming's attack completely, even though - as an ordained cleric (albeit a highly unconventional and irreverent one) - the charge of heresy was a very serious one. In his letter of 14 November to Jameson (who was joint editor with Brewster of the Edinburgh Journal of Science) he wrote:

> I fear I shall be too much occupied with my 2d Vol to give any Reply to Mr Flemmings [sic] Paper in your Journal so pray do not expect it, nor keep any Place for it. (M.S. Pollok-Morris: Jameson Papers).

However, Buckland appears to have been advised that he ought to reply to Fleming's charges. (Buckland had already been a candidate at least once and probably twice for the office of Head of a College, and was certainly hoping for some form of University or ecclesiastical advancement, and a public charge of heresy from a prominent Doctor of Divinity had to be taken seriously.) Buckland therefore wrote again to Jameson, this time from Sidmouth, South Devon, on 4 December 1824:

> I have been advised in consideration of the high Character of Dr Fleming as a Naturalist to draw up a short Reply to him to be inserted as you propose in your Journal. It will not I think occupy more than 15 or 16 pages of which about one half are written & I hope to get ready the other Half on Friday or Saturday next before which I shall not have an hour to sit down to any thing. I think I may depend on sending off the Parcel on Monday 13th. I hope this will be in time for you. Meanwhile You will oblige me by a line to me if this will do for your next No. (M.S. Pollok-Morris: Jameson Papers).

The promised response to Fleming was in the form of a letter from Buckland to Jameson dated 16 December, 1824 under the title "Reply to some observations in Dr Fleming's Remarks on the Distribution of British

Animals" (Buckland, 1825A). Throughout, Buckland ignored completely the attack on his religious orthodoxy, and concentrated entirely on a fact-by-fact refutation of Fleming's misunderstandings and misinterpretations of Buckland's position. On the face of it the "Reply" was entirely calm and detached, but in reality the tone was set by the first paragraph, which is a classic example of Buckland's well-known senses of humour and irony:

> Allow me, through the medium of your Journal, to express my obligations to Dr Fleming, for the handsome manner in which he has spoken of my Reliquiae Diluvianae in your last Number; and for the mild and gentlemanly tone he has maintained, whilst expressing his opinions on certain points whereon he differs from me. (Buckland, 1825A: 304).

Buckland then continued:

> I perfectly coincide with that eminent naturalist, as to the expediency and the necessity of illustrating the history of the Fossil World, by the analogies afforded by the structure and habits of living plants and animals, and the operations of nature now passing before us; but I see not how the charge of neglecting all these things can, with propriety, be advanced by him, against the present cultivators of the science of geology, whose foundation-stone (as far as relates to the history of fossil animals) is laid by Cuvier on the most accurate analysis of the structure of recent skeletons, from which he argues most rigidly, as to that of the fossil species ....
>
> With respect to the matters at issue between Dr Fleming and myself, as it appears to me that his objections arise chiefly from a mistaken or imperfect view of the facts on which his arguments are founded, I beg to submit to his consideration, and that of the readers of your Journal, the following points, on which I consider his ideas to be erroneous; forbearing to enter into the arguments he has derived from them, since, if the facts are misconceived, his conclusions will, of course, follow the fate of the premises from which they are deduced. (Buckland, 1825A: 304-305).

Nor was Jameson himself spared as Buckland piled observation upon observation. It was his usual practice to add editorial footnotes to papers in the Journal, either agreeing or disagreeing with the author on a particular point, or adding additional information or views of his own. He had added a number of notes to Fleming's paper, and Buckland was quick to ridicule one of these:

> In reply to the note at page 300, in which the authority of Professor Goldfuss, is quoted by the editor to support an opinion, that the elk and hyaena are the animals intended by the terms schelch and halb-wolf in the romance of the Niebelungen written in the 13th century, and enumerated among the beasts slain in a hunt a few hundred years before that time, in Germany; I have only to observe, that the authority of the same romance, would equally establish the actual existence of giants, dwarfs, and pigmies, of magic tarn caps, the using of which would make the wearer become invisible; and of fire-dragons, whose blood rendered the skin of him who bathed in it of a horny consistence, which no sword or other weapon could penetrate. (Buckland, 1825A: 317-318).

After Christmas Buckland returned to his usual routine, and chaired the first Geological Society meeting of 1825 at Somerset House on 7 January. Although this meeting must have seemed quite routine and unexceptional at the time, historically it was very significant on two counts. First, the young Charles Lyell, the first of Buckland's Oxford geology students to establish a national reputation, presented his first scientific paper to the Society. This was an account of the shell-marls of the series of small lochs between Kinnordy and Forfar that Lyell had been studying independently, and which he had shown to Buckland during their stay at Kinnordy the previous September. Second, the wealthy Roderick Impey Murchison, who had grown tired of a life of fox-hunting and had turned to the serious study of science under the guidance of amongst others Sir Humphry Davy, attended his first meeting after his election as a Fellow of the Geological Society. Murchison later wrote of the occasion:

> I entered the Society, Professor Buckland of Oxford being President, and on the 7th of January took my seat, and had my hand shaken by that remarkable man, who was then giving such an impulse to our new science, and was of course my idol. One of the honorary secretaries, then a young lawyer, was Charles Lyell, who then read his first paper, on the marl-lake at Kinnordy, in

Forfarshire, the property of his father. (Geikie, 1875A: 123).

Two meetings later, on 8 February, Buckland vacated the chair and presented a substantial paper of his own: "On the Formation of the Valley of Kingsclere and other Valleys by the Elevation of the Strata that enclose them; and on the Evidences of the original Continuity of the Basins of London and Hampshire". The full text and the accompanying map and section across the Vale of Newbury, did not appear for over four years (Buckland, 1829A), but a fairly detailed summary appeared in the Annals of Philosophy for June 1825 (Buckland, 1825C).

This was a significant paper in terms of physical geography as well as geology. Although Buckland interpreted the great majority of valleys as the result of erosion by catastrophic inundation and drainage, he demonstrated that the Kingsclere Valley south of Newbury had formed along the summit of a marked anticline in the Chalk. He had found a number of other examples of this kind of valley over a wide area of southern England and concluded:

> The drainage of these valleys is generally effected by an aperture in one of their lateral escarpments, and not at either extremity of their longer axis, as would have happened had they been simply excavated by the sweeping force of rapid water; and as it is utterly impossible to explain the origin of any valleys of this description by denudation or alone, indeed without referring the present position of their component strata to a force acting from below, and elevating the strata along their central line of fracture, I shall venture so far to involve this theory of their origin with the facts which they display, as to designate them by the appellation of Valleys of elevation: of course due allowance must be made for their subsequent modification by diluvial denudation. (Buckland, 1829A: 122-123).

Buckland continued by discussing some even larger chalk anticline structures where older, softer, deposits were exposed between two escarpments:

> The cases I now allude to, are the Vale of Pewsey to the east of Devizes, that of the Wily to the east of Warminster, and the valley of the Nadder extending from Shaftsbury to Barford near Salisbury; in which last, not only the strata of green-sand are brought to the surface, but also the still lower formations of Purbeck and Portland beds and of Kimmeridge clay.
>
> It might at first sight appear that these valleys are nothing more than simple valleys of denudation; but the fact of the strata composing their escarpments having an opposite and outward dip from the axis of the valley, and this, often at a high angle, as near Fonthill and Barford in the vale of the Nadder, and at Oare near the base of Martinsell Hill in the Vale of Pewsey, obliges us to refer their inclination to some antecedent violence, analogous to that to which I have attributed the position of the strata in the inclosed valleys near Kingsclere, Ham, and Burbage. (Buckland, 1829A: 123-124).

Buckland completed the first part of the paper with a discussion of the structure of the Weald of Kent and Sussex, of which:

> I think the slightest inspection of the sections I have referred to, will at once convince us, that no power of denudation by water could have produced the doubly inclined position of the entire body of the strata within this district, as well as of the chalk by which it is surrounded; and that we must here again have recourse to a force producing elevation from beneath, along the axis of the valley, if we would find an adequate cause for the effects that have been produced in it along an extent of 60 miles in length and 20 miles in breadth. (Buckland, 1829A: 124).

The second half of the paper was devoted to a discussion of the geological age of the folding that led to the formation of the "valleys of elevation". After examining the field evidence and making detailed sections, Buckland was quite convinced that this folding post-dated the deposition of the Lower Tertiaries including the London Clay, and that therefore the London and Hampshire Basins had at the time of their formation been a single area of deposition that had subsequently been split by the elevation of the area that now divides the two Basins. Moreover, Buckland considered that some at least of the high level sands and the large sarsen stones that are very widely scattered over the area, and which had been used to construct the stone circles of Stonehenge and Avebury, were remnants of the Tertiary deposits that had once covered the whole area, but which were now largely destroyed.

Even before Buckland's response had been published, Fleming returned to the attack again in the January 1825 Edinburgh Philosophical Journal with: "Remarks on the Modern Strata" (Fleming, 1825), but the Geological Society had had enough. "Pound the Scotch Doctor well in the next number of Jameson's. A little scratching won't do. He will attack you again in order that you may scratch him on the other side", wrote Sedgwick to Buckland on 12 February 1825 (M.S. DRO 138M/F80). In similar vein, when Buckland's reply to Fleming, written the previous December, finally appeared in April (an issue which contained a further paper by Fleming "On the Neptunian Formation of Siliceous Stalactites"!), Sir Humphry Davey wrote to Buckland:

> I have read your answer to Fleming with much satisfaction: why publish it in that contemptible journal? There is an article in it by a Scotch net salmon fisher which is very disgraceful to the Editor. He endeavours to prove that the way to increase the propagation of fish is to catch them in the sea before they reach the river, the only place in which they breed. (M.S. DRO 138M/F83).

In the absence of Mary Buckland's missing journal or of any private letters between the two of any kind, it is impossible to speculate on the development of a romantic relationship between Buckland and his future wife. Their daughter, Elizabeth Gordon, is completely silent on the subject and mentions nothing between the story of their original meeting on a coach because Mary Morland was reading the latest volume of Cuvier's Ossemens Fossiles and their marriage at least five years later. It is however clear that Buckland and Mary Morland were in contact with each other at least intermittently through the whole of that period, because of the frequent appearance of her signature on drawings illustrating Buckland's papers. She appears to have travelled a good deal independently, but must have spent most of her time at her father's house close to Oxford, so presumably they must have met socially from time to time. Perhaps the first hint of the possibility of marriage came on 3 March 1825. Most of the Colleges had a number of attractive Livings within their gift but which were traditionally reserved for Fellows wishing to marry and leave the College. (This tradition had a beneficial effect on the Colleges, since every time a Fellow was appointed to a Living under this kind of arrangement "promotion" opportunities occurred right down the line.)

Amongst Corpus Christi College's more attractive Livings of this kind was that of Stoke Clarity, near Whitchurch in Hampshire, and when this became vacant Buckland applied for it, and on appointment resigned his Fellowship on 3 March in accordance with the rules.

The following month Buckland's efforts on behalf of the Geological Society were rewarded with the formal sealing of the Royal Charter of Incorporation of the Society on 23 April 1825, in which King George IV named Buckland as the first President of the incorporated Society.

The same month the Annals of Philosophy carried a detailed report of chemical analyses carried out on samples of the soil in the cave of Kühloch that had been carried out for Buckland by Chevreul, and which had been submitted for publication by Buckland. This was very interesting in demonstrating the presence of considerable amounts of organic material, including fatty acids and ammonia derivatives, supporting Buckland's interpretation of the cave as a fossil cave bear hibernation den (Chevreul, 1825).

British bone caves were once again occupying much of Buckland's attention, particularly those of the Mendips and of South Devon. He had made one visit to Kent's Cavern to see Northmore's work on the hyaena den in February or March 1825 (Pengelly, 1873: 53), and further visits were made in April and during the summer. Other cave visits and excavations in South Devon during the first half of 1825 included Pixies' Hole, Chudleigh, Ash Hole, Brixham, and a cave in Ansty's Cove, Torquay (Boylan, 1967A: 244).

In between meetings of the Geological Society and short fieldwork visits Buckland had, of course, to undertake the commitments of his two Readerships, and in 1825 Buckland appears to have reverted to the normal pattern of offering the Mineralogy course first, followed by the Geology course. His lectures continued to attract many senior members of the University as well as distinguished visitors from outside. By late May Buckland had struck up a friendship with the new Geological Society member, Roderick Murchison, whom he invited to Oxford to attend some of his lectures. Murchison readily accepted this invitation, and detailed notes that Murchison took during lectures on 7 June 1825 ("On Springs"), 8 June 1825 ("Rivers"), and a geological expedition to Shotover Hill also on 8 June, survive in the Murchison Papers. These notes are transcribed as Appendix 1.2 below, and show not only Buckland's current teaching, but also the theatrical way in which he began the lecture:

> The lecture room at the Museum being arranged - a globe in rilievo suspended - maps around it & models ready (viz. preparatives of ½ an hour) the Professor began pulling on his gown & talking from the corner of the room as if in conversazione having previously sucked 2 oranges - then sat down whilst illustrating his first point & afterwards taking his largest black board to reach all parts of his Museum he entered more vigourously [sic] into his subject & soon assumed his wonted eloquence & his wonderful fluency & ease of speech. (M.S. GSL - Murchison Papers).

In recalling this experience later, Murchison described his journey to Oxford in the company of Buckland, and the state of his Fellow's Room in Corpus Christi College:

> My first real field work began under Professor Buckland, who having taken a fancy to me as one of his apt scholars, invited me to visit him at Corpus Christi College, Oxford, and attend one or two of his lectures. This was my true launch. Travelling down with him in the Oxford coach, I learned a world of things before we reached the Isis, and, amongst others, his lecture on Crustacea, given whilst he pulled to pieces on his knees a cold crab bought at a fishmonger's shop at Maidenhead, where he usually lunched as the coach stopped.
>
> On repairing from the Star Inn to Buckland's domicile, I never can forget the scene which awaited me. Having, by direction of the janitor, climbed up a narrow staircase, I entered a long corridor-like room (now all destroyed), which was filled with rocks, shells, and bones in dire confusion, and, in a sort of sanctum at the end, was my friend in his black gown looking like a necromancer, sitting on the one only rickety chair not covered with some fossils, and cleaning out a fossil bone from the matrix. (Geikie, 1875A: 124-125).

Corpus Christi were probably relieved to know that Buckland would shortly be moving out of the College, if only out of fear for the physical safety of the building, bearing in mind the size and weight of the geological collections that he kept in his first floor room. However, Buckland had no definite plans for alternative accommodation once he moved out of the College, and there must have been a very real risk that after his planned marriage he would disappear into rural Hampshire and be virtually lost to Oxford, except for his obligation to give the two dozen lectures per year. The Chancellor of the University, Lord Grenville, again intervened on Buckland's behalf with Lord Liverpool, the Prime Minister, and a satisfactory solution was found. In July 1825 Buckland was appointed a Canon of Christ Church Cathedral, Oxford, an office that carried with it a fine house in the Christ Church Quad, and a good stipend, and the terms permitted him to retain both Readerships and their more modest income. Lyell mentioned the news in a letter of 20 July 1825 to Mantell:

> Buckland, you know, is made by Lord Liverpool a canon of Christ's Church, a good house, £1,000 per annum, and no residence or duty required. Surely such places ought to be made also for lay geologists. (Lyell, 1881A: 161).

At least part of the summer must have been taken up with the removal of his collections and personal effects from Corpus Christi, which had been his home for the previous 24 years. Nevertheless Buckland appears to have made further visits to both the Banwell Bone Cave in Somerset and to the South Devon caves. His intervention was by now unwelcome in Northmore's eyes, who wrote of his excavation in Pixies' Hole, Chudleigh:

> I deeply lament that the Professor of Geology should have destroyed this relick so valuable to the admirers of antiquity; a small portion now only remaining. (Blewitt, 1832: 127).

Returning to Oxford, Buckland appears to have found that his office of Canon gave him a new respectability within the University, particularly since he took his D.D. degree immediately on appointment to the canonry. As a result he was, for example, asked by Newman to act as an arbitrator in a dispute between St Alban Hall and a former servant who claimed that he had been unjustly dismissed by the College.

Work on his new house at Christ Church appears to have taken much of his energy in the autumn of 1825, as he explains to Vernon Harcourt: "I find the hunting of brick-layers and carpenters for the present entirely supersedes that of crocodiles and hyaenas." (Gordon, 1894: 87).

There were however some diversions, and it is from this period that one of the best known stories of Buckland's many eccentricities dates. During a Geological Club dinner in November 1825 a light-hearted argument developed about the quite frequent reports of "solid" stones being broken open to reveal toads in cavities within them. Bets on the chances of survival were placed, and twenty-four toads were carefully sealed into holes carved into blocks of porous oolitic limestone and impervious siliceous sandstone, with glass inspection panels over the top of each cell (see also Chapter 3.2 below). All the toads were buried at a depth of three feet in Buckland's garden on 25 November 1825, and on re-excavation of the blocks of stone on 10 December 1826 it was found that all of the toads in the sandstone were dead but a majority of those in the porous limestone, through which some air and water could penetrate, had survived. Buckland eventually submitted a report to the Edinburgh New Philosophical Journal, where it was published in July 1832, which was quickly reprinted in at least three overseas journals (Buckland, 1832A). The story subsequently received far wider and more popular circulation as one of Frank Buckland's Curiosities of Natural History (F Buckland, 1857: 46-54).

Buckland's appointment as a Canon of Christ Church brought with it not only a far more comfortable style of living in terms of accommodation and finance, but also in terms of social recognition. He had come to Oxford 24 years earlier as a relatively impoverished scholarship boy from rural Devon whose social assets (at a time when such things mattered very greatly) amounted to little more than a rather tenuous link with a country patron who had been a fellow-student at Cambridge of his blind father, and an uncle who had been a respected but in no way exceptional College Fellow at Oxford. At a time when the undergraduate sons of the nobility could be recognised immediately in the street in Oxford because of the distinctive academic dress that such students wore under the Statutes, Buckland retained, and apparently deliberately cultivated, his rural manners and West Country speech. (A detailed analysis of the mis-spellings of unfamiliar words in the Jackson Lecture Notes of 1832 - see Appendix 1.3 below - shows that Buckland must still have had a marked Devonshire accent at that time which was faithfully recorded in Jackson's attempts at phonetic spelling of strange names and other words.)

Equally, however, it is clear that Buckland assiduously cultivated titled, wealthy and other influential friends. There is however no evidence of snobbery in this, and there are many accounts which show that he retained throughout his life the ability to hold a conversation just as easily and comfortably with an illiterate quarryman or miner as with Archbishops, Prime Ministers, Dukes and Royalty. For someone who travelled so extensively throughout Britain and on the Continent, there was also an intensely practical side to Buckland's dense network of wealthier friends and acquaintances, since there were few parts of the country in which he could not guarantee a few nights' free accommodation with good food and drink and access to horses, servants and other useful facilities to assist in his fieldwork. Indeed at many great houses he became such a familiar figure that he did not need to announce his proposed visit in advance. More than one fellow-traveller from Britain or overseas looked on in astonishment as Buckland diverted from their planned route and rode up to the front door of, for example, Inveraray Castle and enquired whether His Grace was at home and able to accommodate

Professor Buckland and a few scientific colleagues for a night or two!

It also appears that he never went anywhere without his large blue canvas shoulder bag in which he carried his hammers, notebooks and the latest specimens. The blue bag even accompanied him to formal dinner parties where it would be taken into the dining room, and used in much the same way as a magician's top hat to produce the latest extraordinary finds of fossil bones, teeth or hyaena dung. However, his eccentric appearance sometimes led to misunderstandings, as in one of Buckland's own favourite stories:

> The greatest honour which my bag ever had was when Lord Grenville insisted on carrying it; and the greatest disgrace it ever had was when I called on Sir Humphry Davy 3 or 4 times in one day, and always found him out. At last Sir Humphry Davy asked his servant, 'Has Dr Buckland not called to-day?' 'No, sir; there has been nobody here to-day but a man with a bag, who has been here 3 or 4 times, and I always told him you were out'. (Gordon, 1894: 85-86).

At the age of 41, and less than a quarter of a century from the anxious days of competition for an Oxford scholarship, Buckland held two Regius chairs and a Cathedral Stall in Oxford, was a Royal Society medallist and the Charter President of the most prestigious geological organisation in the world. He was at the height of his scientific powers and appeared supreme and virtually unchallenged in British geology.

2.4 THE FAMILY MAN AND BRIDGEWATER AUTHOR, 1826 -1836

On 31 December 1825 Buckland married Mary Morland in the Parish Church of Marcham, Berkshire. Although the bride was 28 years old, the marriage was registered as: "by Licence with consent of Parents", and all three witnesses were Morlands: two of Mary's sisters, Elizabeth and Georgina, together with her brother Thomas Thornhill Morland (M.S. DRO 138M/F343).

Mary was the eldest daughter of Benjamin Morland, a landowner and farmer, of Sheepstead House, near Abingdon, near Berkshire, and the estate appears to have been of some size. Frank Buckland recorded that Thomas Morland, when he inherited the estate, was Master of the Berkshire Hunt and kept the hounds at Sheepstead (Bompas, 1891: 22). She clearly had a very considerable understanding of a wide range of science, as well as being a most accomplished artist. She also began to act as an amanuensis to Buckland, which must have been a considerable relief to the Geological Society's typesetters, since, although her own handwriting was firm and characterfull, it was reasonably legible, in contrast with Buckland's by now chaotic hand, which resulted in letters and manuscripts that were the calligraphic equivalents of the chaotic state of his rooms at Corpus Christi, as described by Murchison. In his obituary of Buckland, Murchison wrote that she was: "a truly excellent and intellectual woman, who aided her husband in several of his most difficult researches" (Murchison, 1857). Frank Buckland wrote of her:

> Not only was she a pious, amiable, and excellent helpmate to my father; but being naturally endowed with great mental powers, habits of perseverance and order, tempered by excellent judgment, she materially assisted her husband in his literary labours, and often gave to them a polish which added not a little to their merit.
>
> During the long period that Dr. Buckland was engaged in writing the book [Bridgewater Treatise] which I now have the honour of

> editing, my mother sat up night after night, for weeks and months consecutively, writing to my father's dictation; and this, often till the sun's rays, shining through the shutters at early morn, warned the husband to cease from thinking, the wife to rest her weary hand.
>
> Not only with her pen did she render material assistance, but her natural talent in the use of her pencil enabled her to give accurate illustrations and finished drawings, many of which are perpetuated in Dr. Buckland's works (see several drawings in Vol. II. of this Treatise, likewise in Cuvier's "Ossemens Fossiles"). She was also particularly clever and neat in mending broken fossils; and there are many specimens in the Oxford Museum, now exhibiting their natural forms and beauty, which were restored by her perseverance to shape from a mass of broken and almost comminuted fragments. It was her occupation also to label the specimens, which she did in a particularly neat way; and there is hardly a fossil or bone in the Oxford Museum which has not her handwriting upon it. (F Buckland, 1858: xxxv-xxxvi).

However, although the burden of supporting Buckland and, very soon, bringing up a family, must have taken much of her time, Mary Buckland continued to retain and develop her own scientific interests, particularly in the field of present-day marine biology and microscopy, where she could make especially effective use of both her artistic and scientific abilities. She continued to work to the very end of her life, working at her microscope the day before she died. T H Huxley wrote of her on 9 April 1855:

> I shall be glad to see Mrs Buckland's Echinoderm. I think it must be a novelty by what you say. She is a very jolly person, but I have an unutterable fear of scientific women. (Huxley, 1900: 125).

Buckland's original intention appears to have been to leave England for an extended tour of Italy and Sicily with his new bride for a period of nine or ten months (Gordon, 1894: 90), but in the event the visit was considerably shortened at both ends. Pressure of work seems to have delayed their departure for the Continent considerably. The Bucklands did not leave until sometime in February, and they started their return to England in October, arriving back by the beginning of November, by which time Mary was 7½ months pregnant.

His Lecture Courses and fossil mammal matters appear to have taken much of Buckland's time between his marriage and the departure for the Continent. He wrote a note for Jameson on his 1825 work at Kent's Cavern, which he interpreted as a further example of the Kirkdale Cave kind of hyaena den, and contrasted both with the natural pitfall deposits under cave shafts and fissures, such as those at Oreston and Banwell (Buckland, 1826). He also distributed, with considerable delight, copies of a letter received from a Captain Sykes, a serving army officer in India, who had at Buckland's request investigated the dens of living hyaenas in India. Although not published until the following year (Buckland, 1827A), the information in it was quickly distributed to supporter and sceptic alike. Lyell's comment in a letter of 3 January 1826 to Mantell is one of the most frequently quoted of all the epigrams about Buckland:

> Buckland has got a letter from India about modern hyaenas, whose manners, habitations, diet, &c., are everything he could wish, and as much as could be expected had they attended regularly three courses of his lectures. (Lyell, 1881A: 164).

The honeymoon tour has been summarised in some detail by Elizabeth Gordon (1894: 92-99), who made use of her mother's now-missing diary. The Bucklands appear to have gone more or less directly to Paris where Mary was introduced to all of the leading figures of the scientific community, and particularly to Cuvier, with whom she had only corresponded before that date. She appears to have found the visit somewhat disappointing, at least in social terms:

> "The Cuvier's parties are by no means brilliant; he is very taciturn, and so cautious that he never utters an opinion in

> company; but though so cold in appearance, he is very friendly in his conduct. (Gordon, 1894: 93).

They then travelled southwards through France and through the whole length of Italy into Sicily. It was here in the Cathedral of Palermo that Buckland recognised that the bones on display for veneration as the relics of St. Rosalia were in fact those of a goat, causing a great scandal locally (Gordon, 1894: 95-96). (However, perhaps for reasons of "delicacy", Elizabeth Gordon failed to record an even more notorious exposure of a pious fraud, when Buckland dipped his finger in a pool of perpetually moist, miraculous "blood" in another Italian church, and pronounced the liquid to be bat urine!)

The Bucklands travelled northwards through Italy, through the Appennines and the Alps, before turning along the Mediterranean coast towards Montpellier on hearing that Marcel de Serres was conducting excavations in a fossil hyaena den in the Lunel Cave (Buckland, 1827B) and travelling northwards to the Besançon area where they studied further cave excavations in the Grotte d'Ozelles (Buckland, 1827C).

While they were away, Fleming returned again with an even more explicit attack, this time on both Buckland and Cuvier, under the title "The Geological Deluge, as interpreted by Baron Cuvier and Professor Buckland, inconsistent with the testimony of Moses and the Phenomena of Nature" (Fleming, 1826), but this time Buckland decided to ignore the jibes.

The Bucklands were back in England by early November, and on 9 November they were staying with Lyell in London. In a letter to his sister, Lyell said that Buckland "looks 5 years younger & is so full of health, spirits & information that to be with him is quite exhilarating." (Wilson, 1972: 159). Buckland was at the meeting of the Geological Society on 17 November, when he gave a report on his work at Lunel Cave, and it seems likely that the Bucklands had stayed in London for this. However, they were both back at their house at Christ Church, Oxford, on 17 December 1826, when their first son, Frank Buckland, was born (Bompas, 1891: 1). Frank Buckland later recorded that Francis Chantrey was present on the day of his birth,and assisted Buckland in weighing the new-born child: "in the kitchen scales against a leg of mutton, and that I was heavier than the joint provided for the family dinner that day." (Bompas, 1891: 1).

A chart prepared later by Frank Buckland detailing the births, baptisms, illnesses and in some cases deaths, of the children survives in the family papers (M.S. DRO 138M/F886) and is the authority for all subsequent family details of this kind. In this he records that he was successfully vaccinated by Mr Bull at the age of 2 months. It is perhaps not surprising that two progressive, scientifically minded, parents should have had all of their children vaccinated at this early date when vaccination was still a matter of very considerable public controversy, but it is interesting to have written confirmation of this.

The child was given the Christian names Francis Trevelyan in honour of Buckland's friends, Francis Chantry and Sir John Trevelyan, and at the baptism in Christ Church Cathedral on 28 June 1827, Chantry and Trevelyan were the godfathers, with Frances Buckland (wife of John Buckland junior and sister of Thomas Arnold) as the godmother.

The two Bucklands, and soon their very intelligent and gifted eldest child, were quickly joined in the Christ Church house by a veritable menagerie, in which:

> ... besides the stuffed creatures which shared the hall with the rocking-horse, there were cages full of snakes, and of green frogs, in the dining-room, where the sideboard groaned under successive layers of fossils, and the candles stood on ichthyosauri's vertebrae. Guinea-pigs were often running over the table; and occasionally the pony, having trotted down the steps from the garden, would push open the dining-room door, and career round the table, with three laughing children on his back, and then, marching through the front door, and down the steps, would continue his course round Tom Quad.
>
> In the stable yard and large wood-house were the fox, rabbits, guinea-pigs and ferrets, hawks and owls, the magpie and jackdaw, besides dogs, cats, and poultry, and in the garden was the tortoise (on whose back the children would stand to try its strength), and toads immured in various pots, to test the truth of their supposed life in rock-cells. (Bompas, 1891: 8).

Frank Buckland's biographer also recorded that:

> In summer afternoons, after the early three o'clock dinner, Dr. Buckland would drive out Mrs. Buckland and their children, in a carriage known as the bird's-nest, to Bagley Wood, to hunt for moles and nests, or to Port Meadow to gather yellow iris and water-lilies, and fish for minnows, and often to set free a bright-hued kingfisher (they were plentiful in those days) which he had redeemed from some mischievous urchin with a sixpence. Or another day to Shotover, to dig in the quarries for oysters and gryphites; or again to Iffley, to gather snake's-heads (Fritillaria). Both father and mother were devotedly fond of flowers, and their horse stopped automatically at every nursery garden, as at every quarry.
>
> Some of the graver Dons were perhaps a little scandalised by such vagrant proceedings, but how much happiness and wisdom were gathered in these excursions! (Bompas, 1891: 9).

Although his first period of office as President of the Geological Society was completed, Buckland continued to travel to London for most of the fortnightly winter meetings of the Society, and was frequently seen "about Town". For example, on 17 February 1827, Gideon Mantell recorded in his Journal:

> Called on Mr Lawrence, the Surgeon, Dr. Armstrong, and Mr Lyell; dined with Relfe; and afterwards went with him and his wife to the Adelphi Theatre where we met Dr. Buckland; the 'Flying Dutchman' was performed - the scenery was admirable. (Curwen, 1940:61).

On 20 April 1827 he reported to the Geological Society on the work that he had done on the fossil bear den in the Grotto of Osselles during his honeymoon tour (Buckland, 1827C). A comment towards the end of this short paper appears to be the starting point for the numerous legendary accounts of Buckland's use of the sense of taste in the investigation of geological specimens:

> He also proposes, as a test for distinguishing bones of this antiquity, their property of adhering to the tongue if applied to them after they are dry; - a property apparently derived from the loss of animal gelatine; without the substitution of any mineral substance, such as we find in bones imbedded in the regular strata. This test extends equally to the bones of the osseous breccia of caverns and fissures, and to those in all superficial deposits of diluvium, excepting such as are too argillaceous to have admitted the percolation of water; but the property of adhesion is rarely found in bones from recent alluvium, or from peat bogs, nor does it exist in human bones, which the author has examined from Roman graves in England, and from the druidical tombs of the ancient Britons, nor in any of the human bones which he has discovered in the caves of Paviland and Wokey Hole.
>
> Dr. Buckland proposes to apply this test to the much disputed case of human bones, said by M. Schlotheim to have been discovered in the cave of Kostriz in contact with those of the rhinoceros and other extinct animals. (Buckland, 1827C: 22).

Mantell's diary confirms that Buckland was back in London again on 18 May (Curwen, 1940: 62).

The first serious challenge of the traditional and formal education of the two English Universities began to consolidate itself during the early summer of 1827. Under the pretext of reviewing five books on Scottish and Continental universities, Charles Lyell (anonymously) launched a frontal attack on the rigidity and narrowness of Oxford and Cambridge in an unsigned article in the Quarterly Review, and work in the Murray Archives by Leonard Wilson (1972: 164) shows that Lyell consulted Buckland in confidence and received detailed comments from him on two drafts in May and June 1827. Judging by Lyell's comments Buckland appears to have been much less hostile than Lyell had expected, although defensive about some of the more explicit attacks on Oxford, as Lyell explained to John Murray in a letter of 6 June 1827:

> My university Art. is at length finished but the sensitiveness of Ox. & Camb. is amusingly great & the softening down of passages where the naked truth came out too clearly, some more of which a letter from Oxford this morning made necessary, would amuse you if you saw my correspondence. (Wilson, 1972: 164).

In fact, Lyell mentioned very favourably the successful lecture series on geology given at Oxford by Buckland and at Cambridge by Sedgwick and he argued strongly for a broadening of the examination system (Lyell, 1827). Buckland appears to have been in London during early June 1827 for meetings of the Geological Society, and got together a large and most distinguished group of scientists who together rushed off to Kent to examine a newly discovered cave near Maidstone. The cave proved to be sterile geologically, but the expedition as a whole was a riotous (almost in the literal sense) success, largely because of Buckland's constant buffoonery.

On his return Buckland was approached by Leonard Horner, Lyell's close friend and future father-in-law, who had been appointed Principal of the proposed new London University, which clearly presented a more direct challenge than Lyell's Quarterly Review strictures to Oxford and Cambridge. Horner now turned to Buckland for advice on the project and wrote on 12 June 1827:

> I was very sorry not to be able to join the Maidstone party, for although you did not make any great discovery, you appear from Fitton's account to have had a great deal of pleasure.
>
> You have perhaps heard of my being appointed to an important & very responsible office in the University of London, and in order to make myself acquainted with many things relating to the University of Oxford which it will be useful for me to know in reference to the plans now forming for this new institution, I have thoughts of going to Oxford for a day or two in order to consult such of my friends as I may chance to find there. I hope you will be at home next Friday: I shall probably go down by the afternoon coach.
>
> I do not know whether you approve of the London University but I am very sure that you will not withold your advice in any matter the object of which is the advancement of sound learning. (M.S. DRO 138M/F93).

While resident in Oxford, Mary Buckland became a noted hostess, welcoming young students and distinguished members of the University and the wider scientific community alike to dine or stay at the Christ Church house, and these parties were often arranged to coincide with geological expeditions. A reply to one such invitation from the author and artist John Hughes (1790-1857 - the father of the author Tom Hughes) was preserved by the Bucklands since it incorporated a fine caricature of one of these expeditions, with Buckland in full academic dress on horseback, brandishing a geological hammer, and charging at full gallop with a group of students all brandishing either hammers or fossil bones struggling to keep up with the unconventional Professor (M.S. DRO 138M/F169a).

The Bucklands seem to have spent most of the summer in Oxford, and in July Buckland helped Lyell with the proofs of the latter's review for the Quarterly of G P Scrope's "Memoir on the Geology of Central France". Buckland disagreed with both Scrope and Lyell on the geology of the

Auvergne but appears to have been quite detached and helpful, suggesting that Lyell should add "a hit at the Penn school & the authors of the 'Scriptural Geology' " (Wilson, 1972: 173).

The Bucklands were still in Oxford on 31 August 1827, when Mantell called on them unexpectedly (Curwen, 1940: 65), and it appears that soon after this the Bucklands resumed their interrupted honeymoon tour with a further Continental visit taking in this time Germany, Austria and Switzerland (F Buckland, 1858: xxxvii).

The Bucklands were back in Oxford by December, when the Rev Henry Duncan, Minister of Ruthwell, Dumfriesshire, wrote to Buckland giving him details, a drawing and a small specimen, of what he considered to be fossil footprints on bedding planes in the New Red Sandstone of the Ruthwell area. Buckland pressed his growing menagerie into service, and replied to Duncan on 12 December 1827:

> 1st, I made a crocodile walk over soft pye-crust, and took impressions of his feet, which shew decidedly that your sandstone foot-marks are <u>not</u> crocodiles.
>
> 2d, I made tortoises, of three distinct species, travel over pye-crust, and wet sand and soft clay; and the result is, I have little or no doubt that it is to animals of this genus that your impressions on the new red sandstone must be referred, though I cannot identify them with any of the living species on which I made my experiments. The form of the footstep of a modern tortoise corresponds sufficiently well, but the relative position of the impressions to each other does not entirely coincide, and this I attribute to the different pace at which the animal was proceeding; for I found considerable variety in these positions as my tortoises moved more or less rapidly; and as most animals have three distinct kinds of impression for their three paces of walk, trot, and gallop, so I conceive your wild tortoises of the red sandstone age would move with more activity and speed, and leave more distant impressions, from a more rapid and more equable style of march, than my dull torpid prisoners on the present earth in this to them unnatural climate. (Duncan, 1828: 202-203).

Duncan read a report on the finds to the Royal Society of Edinburgh on 7 January 1828, and deposited the main specimens with the Society. On Friday 10 January 1828 Buckland reported on Duncan's discovery to a large gathering at the Murchison's where amongst other things he induced one of his tortoises to repeat its performance on some freshly-prepared pastry. Not for the first - or last - time the audience was both entertained by Buckland's theatrical performance, whilst - not for the first or last time - they found it hard to decide whether or not this was yet another of Buckland's practical jokes. Sedgwick, who had missed the fun because of examination duties in Cambridge, was highly sceptical and wrote to Murchison on 13 January:

> I wish I had been at your soirée to have had a fight with Buckland; at the same time I can't help saying that the fight against the footsteps is almost to destroy the evidence of our senses; and this is going a long way. In plain truth I don't in this case know any better argument than that clencher of my uncle Toby, viz. - 'By G -- [sic] they are not footsteps.' (Clarke & Hughes, 1890: 314).

Buckland's views and experiments were included as a footnote to Duncan's Royal Society of Edinburgh paper, but otherwise appear to have been regarded as so eccentric and absurd in Britain that Buckland's only contemporary paper on the subject was published in the Annales des Sciences Naturelles (Buckland, 1828B). The role of Buckland in the interpretation of fossil footprints is discussed further in Chapter 4.4 below. There was further excitement at the Rooms of the Geological Society later in January, when a major collection of fossils including many previously unknown forms arrived from Burma. A diplomat, John Crawfurd (1783-1868) had been sent on a diplomatic mission to Ava, Burma, in 1826 and had returned with twelve chests filled with fossil remains of mastodon, rhinoceros, hippopotamus, and plant remains. The investigation of these new finds was shared between

Buckland, who analysed their geological significance, and William Clift of the Museum of the Royal College of Surgeons, who dealt with the taxonomy.

At the February 1828 Anniversary Meeting of the Geological Society, W H Fitton was elected President, and Buckland re-joined the Council (after an interval of two years), as Vice-President. With his teaching duties and Mary expecting their second child Buckland was obviously over-committed, and wrote to Jameson on 20 March 1828:

> I ashamed to say my half finished Notice on some more Hyaenas Dens in India has never been lookd at since I was interrupted in writing it for your Journal last July. I will return to it at my first leisure but this is a word & thing of rare occurrence in my Dictionary. I hope you are satisfied that Dr Duncans Fossil Footsteps are what my living Tortoise announces them to be. (M.S. Pollok-Morris: Jameson Autograph Book).

Nevertheless, the report on the Burmese specimens was completed on time and the whole of the Geological Society's meeting of 18 April 1828 was given over to Clift and Buckland. The subsequent publication history was even more complicated than usual. Abstracts appeared in the Proceedings and were quite widely reprinted and translated (Clift,1828; Buckland, 1828C), and a year later the full papers were published both in the Transactions (Clift, 1829; Buckland, 1829B), and versions of these full reports were included as a joint Appendix to a book on the Ava expedition by Crawfurd (1829).

On 14 May 1828 the second child was born, a son who was given the Christian names Edward Copleston after Buckland's old friend, Edward Copleston, who was by then Bishop of Llandaff. As with Frank, Edward was vaccinated by Mr Bull when 2 months old, and when he was baptised on 1 August 1828 the Bishop of Llandaff was one of the godparents.

On 6 June 1828 Buckland again presented a paper to the Geological Society, this time on what was for him, at least in publication terms, the completely new area of Jurassic fossil plants: "on the Cycadeoideae, a new family of fossil plants, specimens of which occur silicified in the Free-stone quarries of the Isle of Portland". Although quite short, this paper was an important landmark in fossil botany. In it, Buckland described two species and erected both a new genus and a new family to accommodate them. He also discussed the relationships of the new forms to existing plants, and by analogy suggested that they indicated a tropical climate:

> In external and internal structure, these plants approach more closely to the existing family of Cycadeae than to any other; and they supply, from the fossil world, a link to fill the distant void which separates the Cycadeae from the nearest existing family, the Coniferae. Their occurrence in the Portland oolite adds another to the many facts which indicate the climate of these regions, during the period of the oolitic formations, to have been similar to that of our tropics. (Buckland, 1828A: 81).

The final version of the paper appeared in the Transactions a year later and included seven excellent large-scale lithographs by George Scharf, arranged on three plates (Buckland, 1829C).

During the summer Buckland was very much involved in establishing a new museum of comparative anatomy in Christ Church, having discovered that the College had accumulated over £1200 in a special fund established for this purpose in the 18th century, and out of this sum the College spent £500 at the sale of the Brooksian Museum. A note in the September Edinburgh New Philosophical Journal claiming that the waters of the Irawadi had turned solid teak piles driven into the river to stone in only ten years prompted Buckland to take up his pen and gently point out the absurdity of the claim (Buckland, 1829J, and an Appendix within his Ava fossils report, Buckland, 1829B). Throughout this period too Buckland was working intermittently on a planned second volume of Reliquiae Diluvianae which had been promised since 1825, and in which he planned to cover all of his new cave discoveries and to modify further his Diluvial theory to take account of his "Valleys of Elevation" hypothesis. (This projected work was never completed.)

Buckland also took great trouble to help and advise fellow geologists, whether enthusiastic beginners or prominent figures in the science, whether at home or abroad, and two typical examples can be cited from 1828.

First, the American Journal of Science had reported that the American geologist, G W Featherstonhaugh, had recently returned from a geological tour in which he had been assisted for a considerable period of time by Buckland:

> But what will be extremely interesting here, is the capital series of osseous remains of the varieties of animals found in diluvial deposits in the various caves; a branch of geology illustrated and brought to light by the genius and eloquence of that extraordinary person, Dr. Buckland. Mr. F. travelled a great deal with Dr. Buckland; they visited in company the celebrated cave at Torguay [sic], from whence Mr. F. brought the bones of eleven different animals: all the circumstances of this cave confirm Professor Buckland's opinions, as expressed in the Reliquae Diluvianae, of which we gave an analysis and review in vol. 8, of this Journal. (Featherstonhaugh, 1828).

Second, Charles Lyell left England in May for his first extended Continental geological exploration, accompanied by the Murchisons during the first part, a tour of France. Not only did Buckland spend a great deal of time in briefing Lyell in great detail on places to see and people to meet, but he also kept in close touch with Lyell by correspondence throughout his tour. Almost anywhere that Lyell went Buckland was able to write a letter of introduction or even, in the case of the visit to a remote part of Sicily, the name of an old priest who had given the Bucklands a free night's accommodation. Nor was cautionary advice lacking, as Lyell explained in a letter to his sister written from Naples on 9 November 1828, just before he set off for Sicily:

> Dr. Daubeny's letter came yesterday, with many good hints on Sicily, and a joint letter from Dr. and Mrs. Buckland this morning is full of good practical hints, as well as scientific. It is a most kind service to have done me, for as they are persons who make no difficulties, I am sure that whatever they recommend is indispensable. So I have bought tea, sugar, cheese, and four bottles of brandy, which Mrs. B. says will keep off malaria, and their weak wine will not. It seems that even in winter this evil attacks those who live poor, and where inns are few and bad, you cannot live well unless you provision your mule. (Lyell, 1881A: 215).

With the benefit of hindsight it is now clear that December 1828 was a turning-point not merely in the development of the Geological Society, but also in the emerging science of geology itself on a much wider stage. The move to the new accommodation coincided with the death of Wollaston, an event that not only marked a further break with the far more modest founding years of the Society, but also provided the Society with a handsome bequest, part of which was used to establish what is even today still regarded as the most prestigious honour for outstanding geological research, the Wollaston Medal. Even more important, the first two evenings in Somerset House were given over entirely to the reading of a seminally important paper "On the excavation of valleys, as illustrated by the volcanic rocks of Central France" by Buckland's most outstanding geological pupils, Lyell and Murchison (1829). Since Lyell was still in the middle of his European tour, the paper was presented by Murchison alone, although the tone of the uncompromising advocacy of strict uniformitarianism in the published paper has all of the hallmarks of Lyell's incisive style, soon to be seen to even greater polemical effect in the Principles of Geology (Lyell, 1830).

Various accounts of the reception of the paper reached Lyell when he arrived in Rome in January 1829, as he explained in a letter to his sister, Marianne, written in Rome on 21 January:

> My letters from geological friends are very satisfactory, as to the unusual interest excited in the Geological Society by our paper on the excavation of valleys in Auvergne. Seventy persons present the second evening, and a warm debate. Buckland and Greenough furious, contra Scrope, Sedgwick, and Warburton, supporting us. These were the first two nights in our new magnificent apartments in Somerset House. (Lyell, 1881A: 238).

On 16 January 1829 Buckland contributed an "Appendix" - "Observations on the Secondary Formations between Nice and the Col di Tendi" - to the substantial paper on the Geology of Nice by De la Beche (Buckland, 1829D; 1835C). This was a closely observed, but uncontroversial (apart from his support of De la Beche), description based on a 50 mile traverse made with Risso during his honeymoon tour of 1826.

However, a potentially more controversial paper was given just a fortnight later, on 6 February. This was in effect three separate short notes on recent finds and observations in the Lias of Lyme Regis: "On the discovery of a new species of Pterodactyle [sic]; and also of the Faeces of the Ichthyosaurus; and of a black substance resembling Sepia, or Indian Ink, in the Lias at Lyme Regis" (Buckland, 1829E).

The pterodactyl skeleton had been found at Lyme Regis by Mary Anning, and was investigated and recognised as a new species, which Buckland named Pterodactylus macronyx, and a much more detailed taxonomic description and discussion was accepted for publication in the Transactions, although because of the Society's large publishing backlog the paper did not appear for almost six years (Buckland 1835A).

Buckland's decidedly scatological sense of humour had already been given full rein for six years with his graphic accounts of the fossil hyaena dung that he had identified in Kirkdale Cave, and although a written text of both the preliminary notes on the far wider recognition of coprolites (Buckland, 1829E, 1829F) and the again delayed full account in the Transactions (Buckland, 1835B), are written in an entirely serious and scientific manner, his actual presentation of his new discoveries to the Society was, not for the first or last time, so bizarre that many members found it hard to decide what part, if any, of his arguments should be taken seriously. As so often was the case, the mood was captured perfectly by De la Beche, with his privately printed lithograph "A Coprolitic Vision" in which the "Reverend Professor of Mineralogy and Geology in the University of Oxford" in academic dress and holding a geological hammer is shown addressing in a large cave an audience consisting of pterodactyls, crocodiles, hyaenas, a leopard, a bear, and a deer, all of whom are defecating, and with rows of stalagmitic columns stretching into the distance, which are in reality piles of coprolitic 'bezoars' as described in Buckland's papers (McCartney, 1977: 48-49). The significance of both the pterodactyl and the coprolite finds are discussed further under vertebrate palaeontology in Chapter 4.3 below.

The controversy, indeed notoriety, aroused by the section of the 6 February 1829 paper on coprolites had the unfortunate effect, then and subsequently, of overshadowing completely Buckland's claim, equally controversial in scientific terms, that he had identified the fossil ink sacs of cephalopods, from which he had been able to reconstitute the dried up fossil ink. Yet, even if he had published nothing else in the scientific field, Buckland would deserve at least a footnote in the history of geology for the perceptiveness of his observations and deductions, and the lucidity and intellectual elegance of his argument in this brief note:

> Fossil Sepia. - An indurated black animal substance, like that in the ink-bag of the cuttle-fish, occurs in the lias at Lyme Regis; and a drawing made with this fossil pigment, three years ago, was pronounced by an eminent artist to have been tinted with Sepia. It is nearly of the colour and consistence of jet, and very fragile, with a bright splintery fracture; its powder is brown, like that of the painter's Sepia; it occurs in single masses, nearly of the shape and size of a small gall-bladder, broadest at the base and gradually contracted towards the neck; these are always surrounded by a thin nacreous case, brilliant as the most vivid Lumachella; the nacre seems to have formed the lining of a fibrous thin shelly substance, which together with this nacreous lining was prolonged into a hollow cone like that of a belemnite, beyond the neck of the ink-bag; close to the base of the ink-bag there is a series of circular transverse plates and narrow chambers, resembling the chambered alveolus within the cone of a belemnite; but beyond the apex of this alveolus, no spathose body has been found.
>
> The author infers, that the animal from which these fossil ink-bags are derived, was some unknown cephalopode, nearly allied in its internal structure to the inhabitant of the belemnite; the circular form of the septa showing that they cannot be referred to the molluscous inhabitant of any nautilus or Cornu-ammonis. (Buckland, 1829E).

The early part of 1829 was, of course, a period of considerable political uncertainty and unrest and Buckland, always a Tory although of a Peelite persuasion, became more actively involved in politics, particularly in relation to Catholic Emancipation. His personal papers include a letter of 13 February 1829 from Lyttleton referring to this (M.S. DRO 138M/F109), and in a letter from Paris dated 23 February 1829 to his sister, Lyell refers to Buckland's stance more explicitly, and in a somewhat disapproving tone, together with a hint that the independent-minded Mary Buckland may not have agreed with his position either:

> Murchison and his wife have been with Mrs. Somerville, spending a week at Christ Church, and he laments that Buckland voted for the anti-Catholic petition, which conduct, he says, Mrs. Buckland assured him was to be attributed to his Sicilian expedition, and he trusts my journey has not made me intolerant. (Lyell, 1881A: 250-251).

By 2 March Buckland was investigating further finds of coprolites this time from the Lias of Westbury-on-Avon and Aust, near Bristol, and was also arranging for chemical analyses to be carried out, as is clear from a letter to Murchison (M.S. DRO 138M/F110). (He had, of course, had some chemical analyses made of hyaena coprolites from Kirkdale Cave in 1823, as has already been noted above.) This time the analyses were carried out by Prout rather than Faraday, and the findings entirely supported Buckland's interpretation, as he duly reported to the Geological Society on 3 April 1829 (Buckland, 29G).

However, although little appears to have been said openly about it, it is clear that by this time Buckland, together with perhaps a majority of the other "elder statesmen" of the Geological Society, most notably Greenough and Conybeare, were rapidly losing the centre ground within what were perceived as the current central issues of British geology in the face of what was very soon to emerge as the Lyellian "doctrine" of strict uniformitarianism. The stage had been set with the Lyell and Murchison joint paper on the excavation of valleys that had opened the first sessions of the Geological Society in Somerset House the previous December (a paper that was in fact published in the more liberal forum of the Edinburgh New Philosophical Journal, rather than the Society's Transactions). It was clear that what has been characterised in modern times as the "catastrophist" tradition within the Society would have to reply, and the response finally appeared five months later in the form of a substantial paper by Conybeare "On the Hydrographical Basin of the Thames, with a view more especially to investigate the causes which have operated in the formation of the valleys of that river, and its tributary streams", read over two full evenings of the Geological Society on 15 May and 5 June 1829 (Conybeare, 1829).

In this, Conybeare began by analysing the opposing fluvialist and diluvialist positions on the formation of valleys, and then continued by examining the Thames Valley in particular. The apparent diversion of the Upper Thames from its natural course north-eastwards to its present eastward course through the Chilterns was ascribed to a "catastrophic" cause, as were the extensive deposits including many erratics in the Thames Valley and, particularly, in the Cotswolds and the Lower Thames Valley of the London area. Most tellingly, Conybeare attempted to reconstruct the uniform geological plane that would have been required in order to produce these various phenomena by means of normal "fluvialist" processes, and demonstrated the severe difficulties that such an interpretation gave rise to, and finally arguing that a "diluvialist" interpretation fitted the observed phenomena far better than the "fluvialist" approach of Lyell and Murchison. (From a 20th century viewpoint much of Conybeare's argument has overwhelming force, even though it is necessary to substitute glaciation for Conybeare's "deluges" as the predominant mechanism for the discordant geomorphology and deposits, as Buckland was to recognise in 1840.)

However, in the absence of a more convincing mechanism, Conybeare was thrown back once again to explaining the phenomena in terms of a succession of gigantic floods, and by 1829 the majority of members of the increasingly secular Geological Society had little or no time for what sounded suspiciously like Biblical literalism, particularly from the Vicar of Axminster (Conybeare) or a Canon of Christ Church (Buckland). As Lyell explained in a letter of 16 May 1829 to Mantell, who had been unable to attend the meeting:

> A splendid meeting last night. Sedgwick in chair. Conybeare's paper on valley of Thames directed against Messrs. Lyell & Murchison's former paper was read in part. Buckland present to defend the "diluvialists" as Conybeare styles his sect & us he terms "fluvialists". Greenough assisted us by making an ultra speech on the impotence of modern causes. "No river," he said, "within times of history has deepened its channel one foot!" It was great fun for he said - " 'Our opponents say, 'Give us Time & we will work wonders,' So said the wolf in the fable - to the lamb - 'why do you disturb the water?' - 'I do not; you are further up the stream than I.' - 'But your father did' - 'he never was here' - Then your grandfather did so I will murder you.' 'Give me <u>time</u> & I will murder you,' so say the fluvialists" Roars of laughter in which G. joined against himself. What a choice simile! M. & I fought stoutly & Buckland was very piano. Conybeare's memoir is not strong by any means. He admits 3 deluges before the Noachian! & Buckland adds God knows how many catastrophes besides so we have driven them out of the Mosaic record fairly. (Wilson, 1972: 264).

A fortnight later, when the second part of the paper was read, the debate was even more animated, and Buckland was this time anything but "very piano", as Lyell again explained to Mantell in a letter dated 7 June 1829:

> My dear Mantell, - The last discharge of Conybeare's artillery, served by the great Oxford engineer [i.e. Buckland] against the Fluvialists, as they are pleased to term us, drew upon them on Friday a sharp volley of musketry from all sides, and such a broadside at the finale from Sedgwick, as was enough to sink the 'Reliquiae Diluvianae' for ever, and make the second volume shy of venturing out to sea. After the memoir on the impotence of all the rivers which feed the 'main river of an isle,' and the sluggishness of Father Thames himself, 'scarce able to move a pin's head,' a notice by Cully, land-surveyor, was read on the prodigious force of a Cheviot stream,'the College,' which has swept away a bridge, and annually buries large tracts under gravel. Buckland then jumped up, like a counsel, said Fitton to me, <u>who had come down special</u>.

> After his reiteration of Conybeare's arguments, Fitton made a somewhat laboured speech. I followed, and then Sedgwick, who decided on four or more deluges, and said the simultaneousness was disproved for ever, &c., and declared that on the nature of such floods we should at present 'doubt, and not dogmatise.' A good meeting. (Lyell, 1881A: 253).

Three days later Lyell wrote an even more detailed (and presumably partisan) letter to Fleming, in which he referred first to the preparation of the final text of his joint paper with Murchison, and later claiming that Buckland wrote half of Conybeare's paper:

> I was glad to hear from you, and can assure you that I have been so busy since my return that I had no correspondence with any one except on business, though I would gladly have written to you at any time, if I had not been always hoping to have sent you a paper, we think a floorer, of Buckland's diluvial question. You will get a separate copy, and I wish it may be an antidote to a sharp attack which I hear Conybeare and Buckland have levelled at you, in the same number, about 'climate,' &c. Buckland was so amazingly annoyed at my having had such an anti-diluvialist paper read, that he got Conybeare to write a controversial essay on the Valley of the Thames, in which he drew a comparison between the theory of the Fluvialists, as he terms us, and the Diluvialists, as (God be praised) they call themselves.
>
> Of course, in defining the Fluvialists, they (for Buckland wrote half the memoir) took care to build up their man of straw, and triumphantly knocked him down again. But in the animated discussion which followed the reading of the first half of the essay, at the Geological Society, we made no small impression on them. And when, last Friday, the remainder came on, we had a hot encounter. Buckland came up on purpose again, and made a leading speech. But after we had exposed him, and even Greenough, his only staunch supporter, had given in in many points, Sedgwick, now president, closed the debate with a terribly anti-diluvialist declaration. For he has at last come round, and is as decided as you are. But you must know that Buckland now, and Conybeare, distinctly admit three universal deluges, and many catastrophes, as they call them, besides! But more of this when we meet. (Lyell, 1881A: 253-254).

Except for the short report in the Proceedings, copied into other periodicals, Conybeare's paper was never published, and Wilson (1972: 264) suggests that its non-publication might indicate that Conybeare "had some hesitancy ultimately about the validity of his conclusions". In fact, the Geological Society's records show that the full manuscript was sent to Buckland as the Geological Society's referee appointed to consider the paper, and was mislaid for more than a decade in the well documented chaos of Buckland's dining-room! The relevant letter from Buckland to the Society is quoted and discussed later. If, however, Buckland really was in effect a co-author with Conybeare, and became aware of the fact that Lyell had found this out, this might explain his claimed "oversight" of this substantial and important paper. Even Buckland would have been hard pressed to explain away the refereeing of what would have been, in effect, one of his own papers, bearing in mind his alleged manipulation of one of the major reviews of his Reliquiae Diluvianae in 1823.

During the spring and summer of 1829 a wide range of other matters also required Buckland's attention, including of course his teaching commitments at Oxford and his growing family responsibilities. More or less from the time that Frank Buckland could first walk his father devoted at least one afternoon a week to walks in the countryside, introducing him to natural history and the art of observation, and by the time Edward was 9 or 10 months old they knew that Mary Buckland was pregnant for the third time, and was probably in poor health (since she seemed to have had a succession of difficult pregnancies, although there appears to be no direct reference to her state of health in respect of this particular one). Buckland therefore appears to have ruled out the possibility of extended periods of travelling and fieldwork in the summer of 1829, in contrast with most previous years, although shorter journeys, for example to London, seem to have continued. For example, on 19 June 1829 he read a short paper to the Geological Society on the formation of agates in sedimentary (as opposed to volcanic) rocks, which was a typically lucid analysis of detailed observations (Buckland, 1829H, 1835D).

The following month, on 8 July, Buckland wrote to the Philosophical Magazine reporting the virtual destruction of the important fossil bone deposit in the Franconian Cave of Kühloc described by Buckland in Reliquiae Diluvianae, as reported to him by two of his proteges, Lord Cole and Philip Egerton (Buckland, 1829I).

Family pressures were reduced with the safe delivery of their third child, and first daughter, on 13 October 1829, and who was baptised Mary Anne Scott, with Viscountess Sidmouth, Miss Sarah Fitton and Philip Duncan as the godparents (M.S. DRO 138M/F888).

Throughout the summer the diluvialist/fluvialist controversy had continued, with several of the leading figures, most notably Lyell, Sedgwick and Murchison, carrying out extensive field observations on Conybeare and Buckland's "diluvial" localities. However, the overall result was a hardening of positions. For example, Lyell wrote to Fleming on 31 October 1829:

> Sedgwick and Murchison are just returned, the former full of magnificent views. Throws overboard all the diluvian hypothesis; is vexed he ever lost time about such a complete humbug; says he lost two years by having also started a Wernerian. (Lyell, 1881A: 256).

Buckland was apparently still very much involved in the defence of the diluvial theory, although he appears in the main to have concentrated on what De la Beche termed his "Coprolitic Vision" as Lyell told Fleming in the same letter of 31 October:

> 'The father of stercoraceous chemistry,' as Buckland called himself in a letter, has strengthened his theory, but had to retract also on one or two points. (Lyell, 1881A: 256).

However, there appears to have been no serious personal rancour in the disagreement, and despite Sedgwick's conclusion that Buckland had been wrong eight years earlier on certain points relating to the geology of the Alps, Murchison and Sedgwick included a handsome tribute to Buckland's pioneering work in their own major paper on the geology of the Alps read to the Geological Society on 20 November and 4 December 1829. Moreover, the second of these two evenings was shared with Buckland, who gave a further major paper on vertebrate palaeontology (again discussed in more detail in Section 5 below): "On the discovery of the bones of the Iguanodon, and other large reptiles, in the Isle of Wight and Isle of Purbeck" (Buckland, 1830A; 1835E). The memorable evening was referred to by Lyell in a letter of 5 December 1829 to Mantell:

> We were all disappointed at your not being here yesterday, for Murchison told us you were to have been here. Sedgwick and his wind-up on the Alps went off splendidly in a full meeting. You and the iguanodon treated by *Buckland with due honours, when* exhibiting some great bones of a little toe from Purbeck. He greatly amazed my friend Sir T. Phillips by his humour about the size of the said giant, compared to the small genteel lizards of our days. (Lyell, 1881A: 258).

An eventful, potentially highly divisive, geological year ended with the Geological Society's meeting of 18 December, which was also an opportunity for protagonists and antagonists alike to meet for a dinner at the Crown and Anchor as well. As Gideon Mantell noted in his diary: "Passed the evening most delightfully." (Curwen, 1940: 73).

Publication of the first volume of Lyell's Principles of Geology (Lyell, 1830) with its utterly uncompromising uniformitarian stance at the beginning of 1830 could only intensify the differences between the two factions, although initially at least, none of the principal participants in the debate about the Principles ventured forth publicly. Lyell himself had told Fleming on 3 February that he was determined that:

> I will not go to the expense of time in pamphleteering. I shall work steadily on at V. II., and afterwards, if the work succeeds, at edition 2, and I have sworn to myself that I will not go to the expense of giving time to combat in controversy. (Lyell, 1881A: 260-261).

He also added that Buckland "is working so hard at organic remains - iguanodons, pterodactyles, and fifty other things" (Lyell, 1881A: 261).

However, Buckland was soon back into the fray, and on 10 March he wrote to Murchison:

> I am as you rightly conjecture at this moment deeply busy in the midst of my joint Weymouth Paper with De la Beche whose sections are quite ready & have been for some time. So indeed is the rough description arranged & half written but requiring still a good many hours work to be fitted up in its details & done out fair. I am not entirely without hope it may be ready by the next meeting. If I had nothing also to divide my attention I wd promise it to be ready by the time you ask for it, but I have about as much command of my time here as the Keeper of a Turnpike Gate & as I have not your valuable military talent of early rising I cannot steal a march upon the evening by setting over the ground before breakfast. (M.S. DRO 138M/F274).

However, only a few days later a further, very attractive, distraction was put before Buckland by W H Fitton, who wrote on 18 March 1830 asking Buckland to take over the very interesting fossil bones and the associated observational notes from the high Arctic explorations of Captains Beechey and Belcher, including important new evidence on the occurrence of fossil mammoths and other species in the permafrost, (M.S. DRO 138M/F274A). Despite his many other pressures, Buckland accepted the challenge immediately, as is clear from a letter to him from Captain Edward Belcher dated 20 March 1830 (M.S. DRO 138M/F274B).

An interesting Buckland letter sold recently dates from this period, (M.S., Sotheby's Manuscripts Sale 13 March 1979, lot 196). This was dated 20 March 1830, and was addressed to the well-known artist, Thomas Phillips, who was painting a formal portrait of Buckland in academic dress, holding a fine specimen of the species Ammonites bucklandii, named in his honour by James Sowerby. In the letter Buckland wrote that he was sending the artist a consignment of fossil shells, including "a large Nautilus" and the specimen eventually figured in the painting, and enclosed a pencil sketch of the correct orientation etc. of these two fossils.

The reading of the joint paper with De la Beche took up the whole of the Geological Society's evening meetings on 2 and 16 April 1830, under the title of "On the Geology of Weymouth and the adjacent Parts of the Coast of Dorset". As was often the case at that period the first published version was the abstract in the Phil. Mag. (Buckland and De la Beche, 1830A), followed by the abstract in the Society's Proceedings (Buckland and De la Beche, 1830B). However, also typically for the period, the full text did not appear in the Transactions for five years (Buckland and De la Beche, 1835), by which time much of the heat had gone out of the 1829-1830 confrontation between the uniformitarians and the catastrophists.

The final published version (1835) was taken up by a closely observed and very detailed stratigraphical and structural description of the geology of much of southern Dorset, and included a large-scale geological map and 18 excellent geological sections, presenting evidence gathered over a period of more than 15 years' work in the area in the case of De la Beche, and almost 30 years' work in the case of Buckland. The quality and significance of this work is perhaps best illustrated by the fact that 117 years later, in his now-classic Geological Survey Memoir on the region, W J Arkell (1947) cited Buckland and De la Beche as his original authority on 10 significant points, reproduced one of their sections, and drew particular attention to the special significance of their correct explanation of the Ridgeway Fault as a reversed pressure fault, overthrust to the north.

Although well over three-quarters of the paper was given over to closely observed geological descriptions and non-contentious interpretations, the remainder challenged (by reasoned argument based on the described observations) the advancing new orthodoxy of Lyell. The authors recognised five "disturbing forces", of which the first four "1. Elevation; - 2. Depression; - 3. Contortion; - 4. Faults" (Buckland and De la Beche, 1835: 32) were largely if not wholly uncontentious. *However, the fifth: "Denudation producing Valleys"*, and to some extent a short section on "Diluvium" made not the slightest concession to (or even mention of) Lyell's Doctrine of Uniformity, and the final summary of the authors' conclusions similarly ended with a classic catastrophist interpretation:

> 6thly, All these deposits appear to have been succeeded by a tremendous catastrophe, producing elevations, depressions, and contortions of the strata; and intersecting them with enormous faults.
>
> 7thly, These movements of the land have been succeeded by inundations, competent to excavate the valleys of denudation, and partially to overspread the country with diluvial gravel.
>
> 8thly, This denudation has been followed by a state of tranquillity, which has remained undisturbed to the present hour. (Buckland and De la Beche, 1835: 46).

Despite this, even their strongest opponents on the theoretical interpretation recognised the great merits of Buckland and De la Beche's Weymouth and Dorset Coast study overall. For example, writing of Buckland to Gideon Mantell on 23 April 1830, Lyell wrote:

> He is gone down to Lyme, so there is something in the wind - a paper on the new beast perhaps, that fish-like concern which Mary Anning wants to make a grand wonder of, and the Dr. a memoir, as I suppose. His and De la Beche's on Weymouth read last time - good, but some diluvial heresy tacked on, at which I fired a shot. (Lyell, 1881A: 265).

The absence of any personal rancour between Lyell and Buckland is also well illustrated by the correspondence between Lyell and Lockhart, editor of the Quarterly Review, discussing possible reviewers for Lyell's Principles. Buckland was apparently ruled out only because he "has not time" (Wilson, 1972: 273).

Even with the Weymouth paper out of the way, the work pressures were if anything increasing. The amount of scientific correspondence was clearly increasing, and often led to interesting discoveries, as for example a letter from a Mr J E Dekay of New York, who had just discovered coprolites in the USA, and which warranted a short note in the Phil. Mag. (Buckland, 1830B). Far more significant still, Buckland was selected by the Trustees of the Will of the late Earl of Bridgewater to write the geological volume in the series of "Bridgewater Treatises".

The decidedly eccentric 8th Earl of Bridgewater, the Rev. Francis Henry Egerton, had died the previous year in 1829, and amongst the many elements in his Will was a bequest of £8,000 to the Royal Society for the commissioning of a work or series of works:

> The Testator further directed, that the person or persons selected by the said President should be appointed to write, print, and publish one thousand copies of a work On the Power, Wisdom, and Goodness of God, as manifested in the Creation; illustrating such work by all reasonable arguments, as for instance the variety and formation of God's creatures in the animal, vegetable, and mineral kingdoms; the effect of digestion, and thereby of conversion; the construction of the hand of man, and an infinite variety of other arguments; as also by discoveries, ancient and modern, in arts, sciences, and the whole extent of literature. He desired, moreover, that the profits arising from the sale of the works so published should be paid to the authors of the works. (Buckland, 1836A: unnumbered front papers).

Under the Will the responsibility for executing Bridgewater's wishes in this respect rested primarily with the President of the Royal Society, at that time Davies Gilbert, and presumably because of the quasi-religious objective of the proposed scientific texts he quickly involved both the Archbishop of Canterbury and the Bishop of London in his detailed planning.

The evolution of the series of volumes, eventually covering eight different subject areas, has been discussed in detail by W H Brock (1966). It is clear that there was some considerable uncertainty about the eventual form of the work, and as late as June 1830 Gilbert was still thinking in terms of eight essays by different authors grouped into two octavo volumes, rather than the eventual solution of eight separate books, four of them, including Buckland's, running to two large octavo volumes each (Brock, 1966: 166).

So far as Bridgewater's "mineral kingdom" was concerned, Buckland appears to have been the obvious and natural choice of author from the beginning, although the Archbishop of Canterbury, William Howley, was impressed by the prospectus for a volume on the "proofs and illustrations of the attributes of God" of the Scottish geologist, John Macculloch (Brock, 1966: 166).

There was, however, no formal announcement of the final form in which the Royal Society had decided to execute that part of the Will until March 1831 (Gilbert, 1831), and even this appears to have been prompted largely by a direct appeal to Gilbert from Buckland for such a statement, because he was appalled by the many rumours that were by then circulating about the project, and particularly the accusation that prospective authors were competing amongst themselves for this apparently lucrative contract (Brock, 1966: 170). In fact, in Buckland's case at least, the financial terms proved to be decidedly unfavourable, in that the work took the greater part of his time over a period of more than five years (and was in fact the last Bridgewater Treatise to appear), and throughout most of this period he was employing at his own expense out of his £1,000 share of the legacy three artists in the production of 87 plates and 705 figures (Buckland, 1836A, vol. 2, p. vii), to say nothing of the massive amount of artistic and other work carried out by Mary Buckland. Indeed, on 28 February 1837 Buckland wrote to Gilbert seeking additional funds in the form of a share in the accrued interest received by the Royal Society on the original bequest of £8,000 (Brock, 1966: 171-172), but the outcome of this approach does not seem to have been recorded. With the commencement of royalty payments on the first edition of 5,000 copies, and a second edition in press, the financial pressures caused by his extremely heavy investment in illustrations would have begun to ease, so the issue was no longer quite so serious as it had been only a few months earlier.

Although not apparently referred to by Buckland personally, one possible disappointment of the summer of 1830 was the fact that despite his international standing, Buckland was passed over in favour of Conybeare for a vacancy as a Corresponding Member (i.e. honorary foreign member) of the Institut de France. Lyell reported current French feeling in a letter from France to his sister, dated 9 July 1830:

> D'Aubuisson said this morning: 'We Catholic geologists flatter ourselves that we have kept clear of the mixing of things sacred and profane, but the three great Protestants, De Luc, Cuvier, and Buckland, have not done so; have they done good to science or to religion? - No; but some say they have to themselves by it. Pray, gentlemen, is it true that Oxford is a most orthodox university?' Certainly. 'Well then, I make allowances for a professor there, dividing events into ante and post-diluvian: perhaps he could get no audience by other means.'
>
> This attack against Buckland convinces me that the French Institute chose Conybeare before Buckland, because they considered the latter as trading in humbug, which I am sorry to say is notoriously true of Cuvier, but not of Buckland, for although I am convinced he does not believe his own theory now, to its full extent, yet he believed it when he first started it. (Lyell, 1881A: 276).

Later in the year Buckland came down very firmly on the side of the "professionals" in the much-discussed and debated controversy within the Royal Society over the respective nominations of the scientist Herschel and the royal Duke of Sussex for the vacant presidency of the Society (MacLeod, 1983). The DRO Buckland archives include several undated or incompletely dated letters which quite clearly date from November 1830. For example, on 22 November he replied to Murchison: "I certainly think it very desirable that Herschel shd be elected to the Chair & shall vote for him if a ballot arises" (M.S. DRO 138M/F258). However, Buckland was concerned about two things: first, the risk that Herschel would only remain in office for one year, and second, what Buckland regarded as most improper threats and pressures attributed to some of the Herschel "party". In another letter to Murchison dated simply "Wednesday", he stated:

> Herschel is certainly the man who I think most deserving of the Chair of the Royal Society - & most proper to be placed there if he will retain the Office when placed into it & not abandon it as he proposes at the end of one year in which case we shall all be at sea again.
>
> Still even for a years term of office I shall be disposed if I can come up to the Election to vote for Herschel unless a report which I have heard since I wrote you last but I can scarcely believe shd. prove true viz. that many of his supporters have intimated their intention to withdraw their names from the Society in case he shd not be elected. Now this appears to me so unjustifiable a mode of attempting to force on a Society the Candidate adopted by the party using such a threat that I should feel it my duty if it be true to abstain from joining the Party so conducting themselves & tho I wd not vote against Herschel I could not for him under such circumstances as I have just alluded to.
>
> I hope therefore to receive from you a direct contradiction to the report to which I have alluded - & in such case I shall readily sign the paper you have forwarded to me & will if possible come up to the election. I am at present extremely busy preparing the notes for Captn. Beechy whose book is waiting for me. (M.S. DRO 138M/F256).

Buckland also had other worries at the time, apart from the constant pressure because his failure to complete the geological section was holding up the whole of the Beechey report at the printers. Mary Buckland was in the final weeks of her fourth pregnancy in less than five years, and there was the imminent threat of serious Chartist riots in the Oxford area, as Buckland explained to Murchison the Friday before the election (i.e. 26 November):

> If it be a very hard run thing I shall feel it my duty to come up to Town & vote for Herschel as President of ye R.S. but I shall be very sorry to leave home on Monday next without a most urgent necessity for my wife's father & Brother 6 miles from here are in hourly expectation of a Mob from Abingdon to set fire to their premises & there are threats of a Mob coming into Oxford from the neighbourhood of Benson, & our streets every night are on the point of a Row between the Town & Gown. (M.S. DRO 138M/F257).

Although neither the Buckland nor Morland families nor their properties seem to have come to any serious harm in the civil disturbances, Buckland evidently recovered some kind of small incendiary device and sent some of the constituent material to Michael Faraday at the Royal Institution for analysis (M.S. DRO 138M/F255).

The fourth child, and third son, was safely delivered on 12 December 1830 and was baptised William Oke Buckland on 11 June 1831, with W D Conybeare, William Broderip and Mrs Jones, wife of the Rector of Exeter College, as the godparents (M.S. DRO 138M/F886). Five days after the birth of William, the fourth birthday of Frank Buckland was celebrated, and on the occasion his mother gave him his first natural history specimen cabinet, of which Frank later wrote in an inscription fixed to the cabinet "It is the nucleus of all my natural history work. Please take care of the poor old thing." (Bompas, 1891: 3). Bompas also records that:

> About this time a clergyman travelled from Devonshire to Oxford, to bring Dr. Buckland some 'very curious fossils.' When he produced his treasures Dr. Buckland called his son, who was playing in the room, 'Frankie, what are these?' 'They are the vertebrae of an ichthyosaurus,' lisped the child, who could not yet speak plain. The dumbfounded clergyman returned home crestfallen. (Bompas, 1891: 3-4).

The year ended with the receipt of a letter from Mary Anning of Lyme Regis, reporting not only the discovery of a young Plesiosaurus which was "without exception the most beautiful fossil I have ever seen" (M.S. DRO 138M/F254) but which provided the final confirmation of Buckland's deduction that some "beozars" were the fossil faeces of plesiosaurs:

> and what makes it still more interesting is that resting in the bones of the pelvis is its coprolite finely illustrated. (M.S. DRO 138M/F254).

Except for his teaching duties and growing family responsibilities, Buckland seems to have spent most of 1831 working solidly on the Bridgewater Treatise. There were, however, two interesting and in some ways prophetic diversions in the early summer, in the form of a week's visit by leading Cambridge scientists, including Sedgwick and Whewell, to Oxford, followed by a return expedition of Oxford men, including Buckland, Conybeare, Lyell and Charles Daubeny, to Cambridge for a full week from 26 May, as Lyell reported to Mantell:

> We were lionised with a vengeance - lectures, experiments (optics, polarisation), feasting, geologising, and evening-party going, and nocturnal smoking and cigars, and by way of finale, Conybeare and I took our ad eundem degrees, and were admitted M.A.s of Cambridge. (Lyell, 1881A: 318).

Immediately on his return to Oxford Buckland was visited by John Phillips, Keeper of the Yorkshire Museum, York, who wanted to discuss with Buckland not only current issues of geological research, but also the proposal for a "General Meeting of friends of Science" to "take place annually in some central town of England, with the view of promoting unrestrained communication of scientific opinions and discoveries" (First Circular for what became the British Association for the Advancement of Science, dated 25 May 1831, Morrell & Thackray, 1981: fig. 18). Phillips was partly successful in his mission in that he obtained Buckland's firm promise of full support for the project, although in the event because of family pressures Buckland was unable to attend the first meeting, held in York from 26 September 1831 (and during which it was agreed that the first full meeting of the British Association should be held in Oxford in 1832 under Buckland's presidency). Buckland's role in the development of the British Association is considered in some detail in chapter 3.3 below.

Soon afterwards he was visited in Oxford by Murchison who was accompanied by "his wife and maid, two good grey nags and a little carriage, saddles being strapped behind for occasional equestrian use" (Geikie, 1875A: 180). In his Royal Geographical Society obituary, Murchison (1857) made special reference to this particular visit and to the great importance of Buckland's advice in guiding him to the starting point, both geographically and metaphorically, of his Silurian research, and there was a similar tribute in his manuscript autobiographical memoir:

> I took notes from Dr. Buckland of all that he knew of the slaty rocks, or grauwacke as it was then called, which succeeded to the Old Red Sandstone, and the relations of which I was determined to begin to unravel; and I recollect that he then told me that he thought I would find a good illustration of the succession or passage on the banks of the Wye east of Builth. (Geikie, 1875A: 180).

As the inaugural meeting of the British Association at York approached, there was a further attempt to persuade Buckland to attend, this time in the form of a letter from Vernon Harcourt, enclosing a very tempting invitation from his uncle, the Archbishop of York, asking Buckland to stay at Bishopthorpe Palace as the Archbishop's guest. Buckland replied on 13 August saying that he could not "at this moment absolutely promise in the affirmative" (Morrell & Thackray, 1981: 74). In fact, because of the state of Mary Buckland's health, he was unable to attend and wrote to Vernon Harcourt expressing his "bitter disappointment" at his absence (Gordon, 1894: 120). (Elizabeth Gordon states that the reason for his absence was "the death of a child". However, at the date of the York meeting the fourth child, William, was barely 10 months old, and Frank Buckland in his detailed manuscript notes on the children of the marriage (<u>M.S.</u> DRO 138M/F886) records no live birth in 1831, so it seems most likely that the incident causing Buckland's enforced absence was in fact a miscarriage.)

Buckland appears to have spent at least part of the summer in Oxford, rather than take the whole family to the coast as was his usual practice, presumably because of Mary's condition and the pressure of work on the Bridgewater Treatise. His presence at Christ Church was noted by the young William Gladstone in his diary for 18 August 1831: "Buckland made me exhibit my gown to a foreign lady." (Foot, 1968: 375). However, Gladstone did not succumb to the charms of any science, least of all Buckland's robust geology, although his own library preserved at St. Dieniol's, Harwarden, contains Buckland's Reliquiae Diluvianae, Bridgewater Treatise, as well as a number of other Buckland pamphlets and sermons.

By the time that the Geological Society resumed its fortnightly meetings in November 1831 Buckland was back in full circulation again, although clearly disturbed about the political instability of the time. On 17 November Lyell noted:

> Buckland is, I think, in pretty good spirits, though certainly very gloomy at times, and croaking about the state of the country. So are Stokes, Broderip, and many others.... Even Whewell is frightened about the Reform Bill. (Lyell, 1881A: 352-353).

Buckland returned to London for the 13 December meetings of the Geological Society Club and for a paper on the Whin Sill of Yorkshire, "Buckland speaking five times, but not once too often" (Lyell, 1881A: 357), and Lyell also noted that Murchison had broken off from pheasant shooting in the country in order to attend as well! Buckland, together with Daubeny and Baden Powell, was also by then very much involved in the promotion of the British Association for the Advancement of Science within Oxford, and the practical arrangements for the 1832 meeting, to be held in Oxford under Buckland's presidency. Buckland was quite clearly determined not only that the British Association should succeed at a national level, but that the Oxford Meeting should be the greatest manifestation of the current state and importance of science that Oxford had ever seen. The three professors worked closely together in the recruitment of new members, and by 18 December 1831, Daubeny as Local Secretary, was able to report to John Phillips that they had recruited no fewer than 42 intending members, including seven heads of houses and six Professors (including the Regius Professor of Divinity) (Morrell & Thackray, 1981: 121).

Looking at Buckland in 1831 from a present-day viewpoint, much the most significant event was the publication of a very substantial geological section in Captain Beechey's Voyages (Buckland, 1831). Perhaps because this account is buried in one of a very large number of travel and exploration books of the period, Buckland's analysis of the nature and origin of the mammoth remains found by Beechey's expedition in the Eschscholtz Bay area of the Russian Arctic received little scientific attention at the time, and has been rarely noticed subsequently. However, Buckland's report is very much a turning point in his work on the Pleistocene, particularly because of his recognition of the importance of temperature changes. (This study is discussed further in both Sections 4 and 5 below).

One of the matters of great concern to Buckland at the beginning of 1832, with the British Association visit in prospect, was the state of the

University's geology collections. Although from 1824 onwards J S Duncan, Fellow of New College, had been making some progress on the scientific collections, with assistance from Buckland and indeed from Mary Buckland as well, the old museum premises were grossly overcrowded. Also, with the continued growth in interest in geology the small museum room was hopelessly inadequate for use as a lecture room. Buckland convinced the University authorities that something had to be done:

> The collection having now become much too large to be contained in the room allotted to it in the Museum, and the room itself insufficient as a lecture room, in 1832 the western portion of the middle and upper stories of the Clarendon was assigned by the university to receiving the collections in geology and mineralogy; thus affording ample space for the exhibition of these interesting and in many respects unique collections. Their most remarkable contents consist of fossil bones and other organic remains of a former world.... The convenient space and handsome provision now made by the university for the exhibition of specimens, combined with the advancement of science, must operate as a strong motive to the continual addition of similar benefactions. (Ingram, 1837: 15-16).

Buckland continued to work on the Bridgewater Treatise, which was the subject of a good deal of banter. Lyell wrote to Mantell:

> Buckland is reported to have said to his wife, when she asked him what he should do for the Bridgewater prize of £1,000, 'Why, my dear, if I print my lectures with a sermon at the end, it will be quite the thing.' (Lyell, 1881A: 367-368),

and later in the year Mantell recorded in his Journal:

> Returned to Dr Buckland's Hotel and sat till 3 o'clock looking over and assisting him revise some parts of his new book, for which he is to have one of the thousand pounds left by the Earl of Bridgwater [sic] !!! (Curwen, 1940: 110).

On 24 January 1832 De la Beche wrote to Buckland:

> Having lately been tormented with a vile face ache (now happily gone) which confined me to the house, I amused myself being fit for nothing else by drawing caricatures, amongst the best, the two herewith sent, which I have lithographed.

> I shall take off a few copies for myself and if you think there is few enough in the know and that they may do for your Presidentship's Table at the grand meeting of Philosophers at Oxford in June next, you can take off as many copies as you please by writing an order to that effect to Gardner, (it being always stipulated, made and provided that the said copies be taken off, printed and impressed, at the cost, charges, and expense of the said person here addressed, that is to say at the cost &c of Revd. Dr. Buckland, DD, Canon of Christchurch, President Elect of the Grand British Omniological Society, &c &c &c). (M.S. DRO 138M/F249).

One of the two lithographs must certainly have been "Awful Changes! Man found only in a fossil state; reappearance of Ichthyosauri", in which "Professor Ichthyosaurus" is giving a lecture on a human skull to an attentive audience of Jurassic reptiles, saying:

> You will at once perceive that the skull before us belonged to some of the lower order of animals; the teeth are very insignificant, the power of the jaws trifling, altogether it seems wonderful how the creature could have procured food.

It is quite clear that almost all of the copies of this lithograph were printed for Buckland and at his expense, and were distributed by him. Most if not all of the recipients appear to have assumed that "Professor Ichthyosaurus" was in fact Buckland, and this interpretation became universal. Gordon (1894) included the plate in the biography of Buckland without any comment. However, as P J McCartney (1978) has convincingly demonstrated, the real objective of "Awful Changes!" was not light-hearted flattery of Buckland's legendary lecturing technique, but was in fact a sarcastic lampoon of Lyell's cyclical theory of organic development.

Family responsibilities also continued to increase, not only through the increasing demands of the children as they grew older, but also because the family continued to expand. On 29 January 1832 he apologised to Murchison for his failure to attend the Geological Society: "but as my wife still hangs fire I am beginning to despair of its possibility, as I cannot stir till all is well over.", and again: "I wish I cd report progress in my wife's facsimiles of the Oxford Professor but no. 5 still hangs on the hook & fear will not be launched before Wednesday is passed." (M.S. DRO 138M/F248). The fifth child (and second daughter) Eva, was eventually born on 6 February 1832, although her baptism was postponed until 24 June - in the middle of the British Association Oxford Meeting, when she was given the names Charlotte Jane Eva, with Mrs Charlotte Murchison (wife of Roderick Murchison), Mrs Jane Gaisford (wife of the Dean of Christ Church), the Marquess of Northampton and Adam Sedgwick as the godparents (M.S. DRO 138M/F886).

One of the issues confronting both the local and national organisers of the British Association in relation to the 1832 meeting was the vexed issue of the admission of women. None of the Learned Societies admitted women as full members, although the Royal Institution in Albermarle Street, London, allowed women to attend public lectures and in fact had a substantial female audience. On 27 March 1832 Buckland wrote to Murchison on the subject, including an often-quoted comment about the views of Mary Somerville on the question:

> I was most anxious to see you to talk over the proposed meeting (Brit. association at Oxford) in June. Every body whom I speak to on the subject agreed that if the meeting is to be of scientific utility Ladies ought not to attend the Reading of the papers - especially in a place like Oxford - as it wd at once turn the thing into a sort of Albermarle dilettanti meeting instead of a serious Philosophical Union of Working Men.
>
> I did not see Mrs Somerville but her husband decidedly informed me that such is her opinion of this matter - & further I fear that she will not come at all. (M.S. DRO 138M/F244).

The following week, on 5 April, Buckland again wrote to Murchison:

> I find Mrs Somerville has decided not to come & so also Mrs Chantry but we depend on seeing Mrs Murchison and giving her Frank's bed in the attics which we wish were better.
>
> We have had no discussion yet as to ladies attending the meeting. Mrs Somerville's opinion as confirmed by her husband is clearly in the negative.
>
> Their presence at private parties is quite another thing - & in this I think the more Ladies there are the better. (M.S. DRO 138M/F243).

In the same letter he reported that H.R.H. the Duke of Sussex, as President of the Royal Society, had provisionally accepted an invitation to attend the British Association, and had accepted Buckland's offer to provide "such accommodation as my house in Ch. Ch. enables me to afford, limited as they are to two Bed Rooms and a small Sitting Room" (M.S. DRO 138M/F243).

Possibly it was the thought of the impending royal stay in his fairly spacious but by no means palatial Christ Church house that prompted Buckland at about this time to rent a house in the country. However, Lyell put a different interpretation on this:

> Did I tell you to what a fit of desperation the interruptions of genial Oxford have at last driven Buckland? Literally obliged to hire another house out of town, five miles, and to leave his library and other conveniences! Had he not got the £1,000 we should never have had another volume from him; but, luckily for his fame, it became at last his duty, and he was driven to the plunge. The loss of time in travelling to his library, and going for books of reference, will be immense. I think I should have given out that I was dying, and fee'd a physician to have given bulletins. But then one's relations would not have kept the secret. I reckon that the loss of time, of reference even now and then to one book, as far off as G.S. from me, is so great, that it is cheaper in general to buy. Only think of his going five miles from his books! (Lyell, 1881A: 385-386).

Certainly not for the first or the last time in his life Buckland found himself seriously over-committed, because in addition to the massive amount of work that he was putting into the Bridgewater Treatise, to the organisation of the Oxford British Association Meeting, and to his regular informal tutorial sessions with his children, he had to maintain his teaching programme, giving the Mineralogy course in the spring term and the Geology course in the summer term of 1832. The very detailed student notes in the manuscript notebooks of J E Jackson, later of Leigh Delamere, Wiltshire, (M.S. IGS 1/635, and reproduced as Appendices below) show that Buckland was in excellent form, despite these pressures. The notes of the Geology lectures are particularly interesting since Newman wrote up and retained only the Mineralogy course notes in 1821, and Buckland's own working notes (M.S. OUM Buckland Lecture Notes) are at best only sketchy outlines, and at worst totally chaotic and almost completely indecipherable scribbles on the back of, for example, spare agendas for meetings of the Oxford Gas Company, of which he was Chairman!

Jackson's notes record that in fact Buckland in 1832 gave "only ½ a course - in consequence of ye Philosophers Congress at Oxon in June", beginning with an introductory lecture on 22 May. The first paragraph of Jackson's notes belies the conventional view in much general writing on the history and philosophy of science of an atmosphere of conflict or confrontation between Buckland and his associates against Lyell and the Uniformitarians:

> Books recommended. Conybeare. Miller's Crinoidea (fine specimen of analysis.) Lyell. (Fellow of Exeter) his book excellent for those who are read in Geology: hard for beginners. Theories in 1st volume have not Buckland's assent, & are not sufficiently proven. For general readers, Cuvier's theory will do. (M.S. IGS 1/635: Geol. Lect. 1).

In addition to the extensive use of illustrations and specimens, the lectures were peppered with jokes and humorous asides, many of them carefully recorded by Jackson, as when he explained that a Coprolite "is ye name of ye fossil faeces .... 'These I made myself', says ye Professor!" (M.S. IGS 1/635: Geol. Lect V). (One only hopes that the professorial "coprolites" were safely enclosed in a suitable receptacle such as a glass jar rather than a Christ Church chamber pot.) The financial utility of geology was also stressed, both seriously and in jest, as in Lecture VIII on Quaternary animals:

> These facts may seem ludicrous, & unimportant. But says B. they are not so - "I made £500 by my book: & ∴ as a mere matter of pocket they are important!"

A particularly significant bon mot, confirming the carefully calculated way that Buckland approached the initial presentation of revolutionary ideas is included in some of the miscellaneous notes that Jackson added to the back of the Geological Lectures notebook:

> [8] advice - never to try & persuade ye world of a new theory - persuade 2 or 3 of ye tip top men - & ye rest *will go with* ye stream, as Dr B. did with Sir H. Davy & Dr. Wollaston in case of Kirkdale Cave. (M.S. IGS 1/635).

Buckland's role in the official activities of the British Association visit to Oxford is discussed further in Chapter 3.3 below, but it should be noted here that the event was also a social triumph for Buckland as well, as many contemporary accounts, such as that of Gideon Mantell (Curwen, 1940: 102-104) testify and as has been demonstrated in the recent very substantial and detailed study of Morrell and Thackray (1981). The numbers registered as official participants on Monday 18 June 1832 was more than double that of the York meeting the previous year, and in addition many local people, both town and gown, were involved in the more public events, such as the conferring of honorary degrees of D.C.L. on four distinguished scientists attending the Meeting, John Dalton, Robert Brown, Michael Faraday and David Brewster (not one of whom was an Anglican), or the bizarre mass geological excursion, led by Buckland personally, to Shotover Hill (where refreshment tents were provided together with a group of quarry workers selling local fossils!). Even more local people joined the "visiting philosophers" on the closing night, Saturday, 23 June, to hear Buckland repeat (with even greater embellishments) a lecture that he had given on the recently discovered South American Pleistocene fossil *Megatherium*, to the Geological Society in London the previous week.

Judging by the published and sanitised versions (Buckland, 1833A, 1834C) few if any of even his closest geological associates could have been sure at times as to whether Buckland was being serious or not, and it seems clear that he went far beyond the bounds of even fairly tolerant Regency society, let alone the standards of decorum expected of a Canon Residentiary and a Regius Professor addressing a large public meeting. Amongst those present was his young student, J E Jackson, who recorded some of Buckland's comments and banter in some additional notes added to the back of his Geological Lectures notebook, including an exchange with Brunel about the suitability of using a *Megatherium* for digging his Thames Tunnel, and:

> Ld. Northampton during a speech during this Evening meeting mentioned "politics". Dr B. rose again & amused ye audience by explaining "what were politics of ye Megatherium." "He lived on roots, therefore he may be presumed to have been a Radical. He cd. not dig deep holes, only scratch, so he was not Broughmonger: his Teeth were "Tricolor". (Mr Clift of ye Hunterian Museum had painted his Teeth of 3 colours). - "& all who witnessed his enormous behind must agree, that no one was better fitted to be ye Premier of a broad bottomed Administration." (M.S. IGS 1/635).

These large public meetings and the excursions represented something of a compromise in relation to the admission of women to the Association, since although they were not accepted as members or admitted to the meetings of the scientific committees, they were welcomed on the excursions and at the public lectures, as Frank Buckland recalled in his biographical memoirs. Frank was certainly pressed into service for the Megatherium lecture, and sat during the lecture inside the fossil pelvis to demonstrate its immense size, and he appears to have accompanied the expedition to Shotover Hill, since he recalled the attendance of "both veterans in science and ladies", and noted that Buckland "took the opportunity of enforcing the importance of the application of a knowledge of geology to agricultural improvement" (F Buckland, 1858: xxxviii).

During the meeting Buckland also led a hectic social life. The Duke of Sussex did not, after all, stay with the Bucklands but Lord Northampton stayed at his house in Christ Church instead, together with the Murchisons and Sedgwick. Since all of the British Association members lunched and dined together, there was no opportunity for Buckland to offer hospitality at the more conventional times, so instead he threw a substantial breakfast party every day for most of his geologically inclined colleagues, as well as many others. Moreover, in addition to the Megatherium lecture, he gave inspiring opening and closing presidential addresses (Buckland, 1833B, 1833C) and presented a paper to the Geological Committee on the need for a standardised scale of colours for use on geological maps (Buckland, 1833D), and, on learning of the death of Cuvier, Buckland immediately gave the Association an impromptu eulogy which amongst other things produced a handsome list of subscriptions for forwarding to the Institut's memorial fund.

Despite a somewhat mixed press reaction to the new Association, the very real success of the meeting became quickly known throughout scientific circles. Although Robert Jameson had himself missed the meeting, he commented in a letter to Buckland dated 31 July 1832:

> The Oxford Meeting must have been very interesting - & not the less so according to some of my friends, when good cheer was the order of the day & night. (M.S. DRO 138M/F241).

In fact Buckland (rather than Daubeny or Powell) had set the new Association on a pattern of increasingly lavish and spectacular hospitality and entertainment by the host town which in fact proved to be a mixed blessing to the Association in subsequent years (Morrell & Thackray, 1981: 157-159).

The second half of 1832 seems to have been spent far more quietly, presumably working hard on the Bridgewater Treatise, although with the opening of the Geological Society's winter session he resumed his practice of going up to London once a fortnight for meetings of the Society. At the 5th December meeting of the Geological Society, Buckland behaved in a wholly uncharacteristic and surprising way, criticising in a very personal manner Mantell's paper on the *Hylaeosaurus*, and temporarily offending Mantell in the process (Curwen, 1940: 110-111). Buckland was certainly working far into the night, day after day, on the Bridgewater Treatise at the time, with Mary taking over his working notes and draft texts soon after dawn and preparing fair copy and detailed working drawings for the artists and engravers from Buckland's overnight work. At the same time, Buckland took an interest in, and visited regularly, his Hampshire Living even though he was an absentee parson, and the strain of this hectic life began to show on both him and Mary Buckland at about this time, hence, perhaps, his totally unexpected behaviour towards Mantell, and Mary's second miscarriage during Christmas week, 1832 (M.S. DRO 138M/F238).

One of Buckland's major areas of interest at this time, inspired by his current work for the Bridgewater Treatise on Proofs of Design in the structure of both fossil and recent animals, led him to re-examine the South American sloths from the point of view of their adaptation to their arboreal habitat. Most people at the time regarded sloths as some kind of zoological freak or absurdity, even the great Cuvier. However, Buckland was convinced that the truth was the exact opposite of this, and that in fact the sloth was an outstanding proof of Design because of its excellent adaptation to its highly unusual habitat and mode of life:

> Does it not follow from the above comparisons of the habits of the Sloth with its form and structure, that so far from being in any respect an imperfectly constructed animal, it is fitted with admirable perfection of mechanism to its unusual habits and peculiar condition of life? ... The charge of imperfection, therefore, can with no more justice be advanced against the construction of the Sloth because its locomotive powers upon the ground are slow, than against the structure of fishes, because they are not furnished with legs. (Buckland, 1837A: 26-27).

Buckland gave a substantial paper, accompanied by appropriate demonstrations, to the Linnean Society at its 19 March 1833 meeting, and an abstract was published almost immediately in the Phil. Mag. (Buckland, 1833E), although because of the Society's apparently perennial publication backlog the full text did not appear in the Transactions for four years (Buckland, 1837A).

The spring of 1833 also saw a very public reaction to the previous summer's British Association visit to Oxford in the form of the Rev. Frederick Nolan's 1833 Bampton Lectures (a long-established and prestigious annual University series) which Nolan devoted to: "The Analogy of Revelation and Science" (Nolan, 1833). Buckland, Daubeny and Powell had drawn the greater part of their Oxford support from their own Broad Church and moderately liberal Tory political viewpoint, and by means of their assiduous advance preparation for making any sort of public announcements, the success of the British Association visit was largely assured (even though the "opposition" did manage to insert a fairly absurd choice of preacher for the official University Service arranged for the Association). The high church Tractarians, led by Keble, Newman and Pusey, largely stood aloof and detached in their aestheticism, but the more aggressively Evangelical Anglicans were simply furious. Buckland, as not only the President of the British Association, but also a University Professor, Canon and a Bridgewater author, was the central target of evangelical wrath, all the more so because his appointment as Reader in Geology in 1818 and his Inaugural Address, Vindiciae Diluvianae of 1819, had been seen by most evangelicals as heralding a major revival of Scriptural Geology, (see Morrell & Thackray, 1983: 229-236).

It does not seem to be at all clear whether Nolan's appointment as the 1833 Bampton Lecturer was by rotation, gratuitous, or the result of careful behind-the-scenes plotting by the evangelicals (perhaps taking a leaf out of Buckland's book in this respect), but Nolan's nomination seemed to present the Evangelicals with an ideal opportunity to hit back by means of one of the University's most respected and best-publicised lecture series. In the event, however, Nolan missed his opportunity: instead of concentrating on comparing and contrasting the philosophical basis of theology and science, he immediately descended to barely concealed personalised attacks on individual scientists, above all Buckland, dragged out all of the old biblical literalist claims that the promotion of science inevitably leads to the destruction of religion and its replacement by materialism and outright atheism, and at the same time attempted to explain geological phenomena (of which he knew virtually nothing) in terms of Bishop Ussher's Biblical chronology of the world proposed more than a century earlier (Nolan, 1833). In one respect at least Nolan's attack had the desired effect, in that Buckland was quite outraged by the attack, and very concerned about the possible impact of Nolan's tirades on the standing of both the British Association and of science as a whole in Oxford. He therefore urged Vernon Harcourt to act in defence of the Association:

> In my humble opinion it is highly expedient for the interests of the Association and of the University that you should take up the subject in a manner which no man can do as well as yourself, to set the question at issue before the public on its right footing. (Gordon, 1894: 136).

Mary Buckland commented on the current situation in a letter to Whewell dated 12 May 1833:

> we have had the Bampton Lecturer holding forth in St. Mary's against all modern science (of which it need scarcely be said he is profoundly ignorant), but more particularly enlarging on the heresies and infidelities of geologists, denouncing all who assert that the world was not made in 6 days as obstinate unbelievers, etc. etc. We have had two sermons about the flood concerning which he has a theory, but his hearers cannot justly make out what it is ... Alas! My poor husband - could he be carried back half a century, fire and faggot would have been his fate, and I daresay our Bampton Lecturer would have thought it his duty to assist at such an 'Auto da fé'. Perhaps I too might have come in for a broil as an agent in the propagation of heresies. (M.S. C.U.L. W.P. a.66).

However, even the Bampton Lectures were soon overshadowed by a serious family crisis as Buckland explained to Murchison on 26 May 1833:

> We have been most seriously alarmed on the afternoon of Wednesday last by the sudden & dangerous illness of my wife who during 2 hours was in a state of imminent peril arising from a miscarriage attended by a succession of faintings from loss of blood which at then happily subsided but left her in a state of extreme debility from which she has thank God been ever since slowly but steadily recovering, & is today returned to meat diet tho still unable to leave her bed. (M.S. DRO 138M/F234).

In the event it appears to have been agreed that the reply to the Bampton lectures should come from Daubeny (1833), and Powell (1833, 1834), and they were quickly joined by Sedgwick, Buckland's successor as President of the Association, in his Discourse On the Studies of the University (Sedgwick, 1833).

By June Mary Buckland was sufficiently recovered for them both to travel to Cambridge for the meeting of the British Association where Buckland continued his 1832 practice of offering breakfast parties for large numbers of participants in the Meeting, this time in his lodgings, and amongst his special guests was, once again, the Marquess of Northampton. After the Meeting the Bucklands, the Murchisons and Gideon Mantell all proceeded from Cambridge to Lord Northampton's house at Castle Ashby where they stayed for the greater part of a week being lavishly entertained, studying Northampton's excellent geological and shell collections, and during the daytime travelling around the surrounding countryside looking at the geology. The Bucklands then returned to Oxford by private carriage, taking Mantell with them so the differences of the previous December must have been resolved (Curwen, 1940: 117-119).

Back in Oxford, Buckland appears to have returned once again to the Bridgewater Treatise, which continued to take up most of his time for the rest of the year, although with the resumption of the winter session of the Geological Society, he continued to travel backwards and forwards to London for most fortnightly meetings.

Buckland found himself drawn more heavily into University affairs in the first half of 1834. With the death of his long-standing patron, Lord Grenville, the office of Chancellor became vacant, and the Duke of Wellington was appointed Chancellor, and was formally installed on 8 June. Buckland could not resist the temptation to play the fool as the 7½ year old Frank Buckland recorded in his diary:

> A live turtle was sent down from London, to be dressed for the banquet in Christ Church Hall. My father tied a long rope round the turtle's fin, and let him have a swim in "Mercury," the ornamental water in the middle of the Chirst Church "Quad", while I held the string. I recollect, too, that my father made me stand on the back of the turtle while he held me on (I was then a little fellow), and I had a ride for a few yards as it swam round and round the pond. As a treat I was allowed to assist the cook to cut off the turtle's head in the college kitchen. The head, after it was separated, nipped the finger of one of the kitchen boys who was opening the beast's mouth. This same head is now in my museum. (Bompas, 1891: 5).

The appointment of the Duke of Wellington as Chancellor was an astute move in terms of "defending" the University against the threat of Parliamentary interference, especially in relation to the continuation of Religious Tests, an issue which divided the University on political and sectarian lines (although of course within the Anglican tradition) through much of 1834 (Hampden, 1834). Buckland at first stood out against signing either of the "Declarations" by senior members of the University against the Parliamentary Bill intended to remove Religious Tests that in practice restricted admission to Oxford to Anglicans, but eventually signed under pressure when it was found that he was the only Canon of Christ Church outside the orthodox fold, and apparently persuaded by the argument, summarised concisely by Hampden (1834: 41) that:

> If our system is to be relaxed on any point, the University, as a Church-of-England institution of education, should be left to the choice of those means, which it may deem consistent with the preservation of its Church-of-England character.

As Newman wrote to R H Froude on 14 June 1834:

> N.B. all the recusants came in but Evans and Head - the latter declining on Tory principles, viz that one ought not to resist authority. Shuttleworth and Buckland. The latter abstained from the Declaration till names were placed what V. Thomas calls 'collegiately' - then he found himself the sole recusant Canon, and adhered. (Ker and Gornall, 1980: 274).

During the summer Mary Buckland took all the children to Malvern for an extended holiday in the countryside and reported that they "scramble and slide to the terror of all the passengers" (Bompas, 1891: 6). Buckland continued to work in Oxford through the summer, although he received many scientific guests from both Britain and overseas, including in August 1834 alone Arago and Pentland from Paris, and Louis Agassiz from Switzerland, making his first tour of Britain to study fossil fish (Gordon, 1894: 137). Arago and Agassiz certainly accompanied Buckland northwards to Edinburgh in late August, and it seems most likely that Pentland was also a member of the party. Buckland had arranged an itinerary taking in a selection of interesting collections and localities together with, no doubt, ample hospitality at a succession of great houses, since by this time there were few if any parts of the country in which Buckland could not be assured of a night's free lodging for himself, together with a few distinguished visiting scientists! The party arrived in Edinburgh by 31 August, and appear to have spent a few days there before the official opening of the British Association Meeting, largely arranged by James Forbes, on 8 September. It was during this visit that Lord Greenock drew Buckland's attention to the extensive glacial polishing and striation on the side of Blackford Hill, Edinburgh (Buckland, 1841A: 337), although neither he nor Agassiz recognised the significance of these. Once again, the local organisers tried to outshine those of the previous town, and Arago was granted the Freedom of the City of Edinburgh, whilst in order to outdo the spectacular firework display mounted for the Cambridge Meeting the previous year, Edinburgh laid on an explosion of quite unprecedented scale using literally tons of explosives, in Craigleigh Quarry. Lyell summed up the Meeting in a letter to Fleming:

> There was so much done in debate, that one may be excused for being a bad reporter. The sections answered well. The evenings badly - too much display to suit with my notions of what philosophers should do. (Lyell, 1881A: 445).

At the beginning of 1835 Buckland was playing an active part in the committee appointed to report to the Board of Ordinance and the Chancellor of the Exchequer on the future of geological surveying, assessing the work of De la Beche on the mapping of Devon, and considering the future arrangements. The prospect of a national Geological Survey had apparently worried Murchison, who feared that it might compete with his own mapping work in Wales, and on 12 [? January] 1835 Buckland wrote to Murchison telling him of the committee's decisions and reassuring him on the question of the mapping of Murchison's current research area:

> Our answer to question 3 is short and simple. We have recommended that a subordinate Geological Department be added to the General Survey to be conducted by De La Beche with the assistance of such persons as may be placed under him by Col. Colby - & at a cost not exceeding £1500 per an. We have not said a word as for detail but I have explained to Col. Colby who has been here this morning the matter communicated to me in your letter of Thursday. He desires me to assure you that he will take care that your District shall be left to the latest pen as possible - & on calculation it appears that there is no

> chance of any part of it but the N. margin of the Welch coalfield being finished for 4 or 5 years. It will possibly be longer. I think that this will satisfy all your alarms of any kind. (M.S. DRO 138M/F221).

At the end of January he wrote again to Murchison, this time making "my first experiment on a Minifote Writing Apparatus just presented to me by Lady Sidmouth" (apparently some kind of device for producing a pencil duplicate copy of a letter at the same time), saying: "I do not think I shall be in Town before the Anniversary being very busy with a Book now in the press at last." (M.S. DRO 138M/F227). The book must have been the Bridgewater Treatise, although it was in fact a further year before it actually appeared. Certainly work on at least the plates was still continuing, because on 17 February 1835 Buckland wrote to Agassiz thanking him for the return of the manuscript of Buckland's section of a Bridgewater Treatise on fossil fishes, saying: "I am highly gratified to find it meets your approbation & much obliged by the corrections you have supplied to it." (M.S. DRO 138M/F226). (The letter in the DRO Buckland papers is accompanied by three sheets of drawings, together with detailed notes and questions relating to different points on the fossil fish section of the Treatise, annotated with the replies of Agassiz.) It is evident that in a covering letter received at the same time Agassiz had offered to make a translation of the book, with a view to publication on the Continent, and in his reply of 17 February Buckland expressed his delight at this and agreed to take up the matter with his publisher.

Within a few days of this family considerations again came to the fore, when all five children contracted whooping cough. The youngest, Eva, died on 1 March and 5 year old William junior died two days later on 3 March, both being buried in the North Transept of Christ Church Cathedral near Dean Jackson's statue (M.S. DRO 138M/F886).

On 29 April Buckland gave a short communication to the Geological Society on a very large vertebra of a reptile larger than the Iguanodon found near Buckingham (Buckland, 1835E, 1835F). His University lecturing duties continued as usual, and in addition to the paying students registering for each course, Buckland usually had some distinguished visitors who either attended his lectures at his own request, or who were taken along by senior members of the University for both enlightenment and entertainment. For example, though Newman was no enthusiast for Buckland or his scientific views, this did not stop him taking John Mozley to one of Buckland's lectures during a stay in Oxford in June 1835. Mozley wrote to his mother:

> We fell in with a lecture of Dr. Buckland on Fossil Fishes, which was very interesting and amusing, for he enlivened it with numerous small jokes, not perhaps quite to be expected of an Oxford professor. (Mozley, 1962: 51).

Buckland was evidently in particularly high spirits in the Geological Course of that summer term. Henry Acland, newly arrived at Christ Church as an undergraduate, was quickly enrolled for the course, and more than 50 years later wrote to Elizabeth Gordon:

> I can never forget my debut as his pupil .... He lectured on the Cavern of Torquay, the now famous Kent's Cavern. He paced like a Franciscan Preacher up and down behind a long show-case, up two steps, in a room in the old Clarendon. He had in his hand a huge hyena's skull. He suddenly dashed down the steps - rushed, skull in hand, at the first undergraduate on the front bench - and shouted, 'What rules the world?' The youth, terrified, threw himself against the next back seat, and answered not a word. He rushed then on me, pointing the hyena full in my face - 'What rules the world?' 'Haven't an idea,' I said. 'The stomach, sir,' he cried (again mounting his rostrum), 'rules the world. The great ones eat the less, and the less the lesser still.' (Gordon, 1894: 31).

By this time too the Buckland family had between them turned not only their Christ Church house but also much of the Christ Church Quad into a veritable menagerie, with a succession of exotic animals including Frank Buckland's monkey, Jacko, who from time to time was dressed up by Buckland in academic robes and introduced to visitors as the Cathedral Sub-Dean!

The 1835 British Association Meeting was held in Dublin, rather later than in previous years, from 8 to 14 August with a lavish social programme that if anything outdid that of Edinburgh, and which included the public knighting of one of the principal local organisers, W R Hamilton, the astronomer and mathematician, in front of the whole assembled Meeting by the Lord-Lieutenant of Ireland.

The most obvious precedent for the kind of "peripatetic philosophy" practised by the British Association was that of the Gesellschrift Deutscher Naturforscher und Artze. During 1835 some British Association Council members floated the idea of sending a British "expedition" to attend the 1835 meeting of the Deutscher Naturforscher to be held at Bonn in mid-September. The fairly large English party included the Bucklands, the Lyells, Leonard Horner (Lyell's father-in-law and a former British Consul at Bonn) and they were also joined by Buckland's publisher, John Murray, who was on an extended continental tour (Smiles, 1891: 360-363). The Bucklands appear to have spent several weeks on the Continent prior to the official opening of the meeting on 15 September, and Murray recorded that over 300 German scientists applauded Buckland's appearance in the hall. After the meeting the Bucklands continued to explore the Rhineland, visiting Alexander Braun in

Karlsruhe on 8 October (pers. comm.: from Gaston Mayer, Landessammlungen fur Naturkunde Karlsruhe), from where they travelled down the Rhine by steamboat. From the boat, he wrote to J G S Van Breda, at Leiden, asking him to make arrangements for visits to see particular collections and specimens in the museums in Leiden and Haarlem (M.S. Private Archives of Van Breda, Teylers Museum Library, Haarlem, Netherlands). It was presumably during this continental tour that the Bucklands both received the head injuries in a carriage accident which, according to Frank Buckland's post mortem report, eventually caused both of their deaths more than 20 years later, although Frank Buckland stated that the accident happened while his parents "were travelling to a scientific meeting in Berlin" rather than Bonn (F Buckland, 1857: xlviii). Soon after their return, Buckland met Agassiz who was carrying out a survey of British fossil fishes funded by the British Association, and who was currently working in Oxford. One of the more interesting palaeontological problems that Buckland had been investigating during his continental tour was the nature of some strange beak-shaped fossils from the British Jurassic and Cretaceous. None of the scientists at the Bonn meeting had been able to help, but during his visit to Van Breda, Buckland had seen a skeleton of a rare present-day fish *Chimaera*, and Buckland had "instantly recognised in the upper and lower jaws of this animal the object of my long research". (Buckland, 1836A: 5). Agassiz confirmed Buckland's interpretation and was very excited by the find because *Chimaera* was at that time unknown as a fossil. Buckland therefore reported immediately on the discovery in a short paper read to the Geological Society on 4 November 1835 (Buckland, 1836A; 1837B).

In 1836 Buckland acquired a new undergraduate student who was to become second only to Lyell in terms of his eventual national and international reputation - John Ruskin. Joining Christ Church, the young Ruskin was quickly taken under the wing of Henry Acland, 1½ years his senior, and by the whole of the Buckland family. From his autobiography Praeterita it is clear that he already had a keen interest in some aspects of geology before his arrival at Oxford, following his travels in the Swiss Alps the previous year, and he was very soon attending Buckland's lectures and receiving invitations to Buckland's famous breakfast parties:

> Dr. Buckland was extremely like Sydney Smith in his staple of character; no rival with him in wit, but like him in humour, common sense, and benevolently cheerful doctrine of Divinity. At his breakfast-table I met the leading scientific men of the day, from Herschel downwards, and often intelligent and courteous foreigners, - with whom my stutter of French, refined by Adèle into some precision of accent, was sometimes useful. Every one was at ease and amused at that breakfast-table, - the menu and service of it usually in themselves interesting. I have always regretted a day of unlucky engagement on which I missed a delicate toast of mice; and remembered, with delight, being waited upon one hot summer morning by two graceful and polite little Carolina lizards, who kept off the flies. (Ruskin, 1908, Vol. 35: 205).

Speculation about the continued non-appearance of Buckland's Bridgewater Treatise grew through 1835 and the early months of 1836, since by then all the other volumes of the series had appeared, and Babbage's unofficial Ninth Bridgewater Treatise was also expected at any time. In fact a very favourable review (probably by G P Scrope - Wellesley Index) appeared in the Quarterly Review of April 1836, presumably written from the proof sheets that Buckland had been correcting and sending around for comment, but there was still no sign of the book itself, and by the beginning of June Lyell, who commented "we are tired of waiting for it, as it has been reviewed in the 'Quarterly' two months" was promised that "it will be out in six weeks" (Lyell, 1881A: 466-467).

However, even at the time of the British Association Meeting in Bristol in the second week in September the book was still not officially published. Buckland was in excellent form at the Meeting, giving one of the public evening lectures in a wholly characteristic manner, as Murchison noted:

> the fun of one of the evenings was a lecture of Buckland's. In that part of his discourse which treated of Ichnolites, or fossil foot-prints, the Doctor exhibited himself as a cock or a hen on the edge of a muddy pond, making impressions by lifting one leg after the other. Many of the grave people thought our science was altered to buffoonery by an Oxford Don. (Geikie, 1875A: 234).

On the last day of the Bristol Meeting Buckland had one further surprise, in that he ceremoniously produced one set of the two volume Bridgewater Treatise <u>Geology and Mineralogy Considered with Reference to Natural Theology</u> (Buckland, 1836B) and presented it to the Marquess of Northampton, that year's President of the British Association, and within a few days the work was at last with the booksellers. Buckland then returned immediately to Oxford for the birth of another child, baptised Elizabeth Oke Buckland, his eventual biographer, who had William Broderip, Mrs Jane Gaisford (wife of the Dean of Christ Church) and Mrs Charlotte Murchison as her godparents (<u>M.S</u>. DRO 138M/F886). Mary appears to have recovered quite quickly from the birth, since Lord Broughton records that on 2 October 1836 Buckland was a house guest at Kinmel Park, the seat of Lord Dinorben, and commented:

> The guest in whom I took the most delight was Doctor Buckland, who was an agreeable mixture of sense and simplicity. I took particular notice of what he said as to the probable exhaustion of our great coal-fields, and the shameful waste of that material, the true source of our wealth and grandeur, which is going on unceasingly at the pit mouths. (Broughton, 1910: 138).

It had been clear for many months that the demand for the Bridgewater Treatise was going to be very great, and consequently the publisher, William Pickering, agreed to an initial printing of 5,000 copies of the two-volume work, five times the number required under the terms of the Bridgewater Will, and yet this very large print run proved wholly insufficient, as Lyell told his father only 2½ weeks after the official release of the work:

> He then told us, what Gardner the map-seller has since confirmed, that Buckland's edition of 5,000 of the 'Bridgewater' is all sold, and 5,000 more printing, each of which editions, Fitton says, will produce the professor £2,000 - a piece of news I am truly glad to hear, for from what I have read of the book, I think it will do much good in spreading correct notions of the science, and probably popularise it much. (Lyell, 1881A: 473).

Buckland was quick to capitalise on the unprecedented success of the work by offering a special "Course of Eight Lectures demonstrating the principal Organic Remains of a former World, which are figured and referred to in his Bridgewater Treatise" commencing on Thursday 10 November (printed handbill, DRO 138M/F291).

As for the content of the Bridgewater Treatise, it was clear that Buckland was only half-joking in his suggestion, four years earlier, that all he needed to do was print his full geological lecture course with a sermon tacked on to the end. This is well demonstrated by a simple analysis of the relative amounts of space allocated to the various major elements of Volume I. Overall the 388 large octavo pages (65% of the total) were given over to an excellent, authoritative, and yet very readable account of the classification, palaeoecology and functional morphology (amongst other things) of the whole fossil kingdom, and this was preceded by an equally authoritative 94 page (16%) summary of stratigraphy. In addition, virtually the whole of the 87 plates and

705 figures, together with their explanatory commentaries, that made up Volume II was also given over to stratigraphy and palaeontology. For its time, the more than four-fifths of the book devoted to historical geology and palaeontology was quite without parallel, and remained in heavy demand as a standard text for a full 40 years, through three further editions, two of them posthumous revisions (Buckland, 1837E, 1858, 1869). The only geological work of its period written in English that was in any way comparable was Lyell's Principles of Geology which was similarly authoritative in terms of its scientific content whilst very accessible to any reasonably intelligent and well-educated non-specialist. Indeed, Buckland's and Lyell's works were in many ways complementary to each other in terms of their scientific contents, with Buckland's excellent palaeontology covering a major gap in the Principles with its emphasis on geological processes, "hard rock" geology and a much weaker handling of the palaeontological evidence within Lyell's very substantial coverage of stratigraphy.

Buckland sandwiched his main geological presentation between comparatively short opening and closing sections containing the theology required of him as a Bridgewater author. In fact the main introductory section, Chapter II "Consistency of Geological Discoveries with Sacred History", rejected totally the Scriptural Geology of the Evangelical literalists, although he was careful not to attack directly the Mosaic description of the origin of the world:

> If the suggestions I shall venture to propose require some modification of the most commonly received and popular interpretation of the Mosaic narrative, this admission neither involves any impeachment of the authenticity of the text, nor of the judgment of those who have formerly interpreted it otherwise, in the absence of information as to facts which have but recently been brought to light; and if, in this respect, geology should seem to require some little concession from the literal interpreter of

> scripture, it may fairly be held to afford ample compensation for this demand, by the large additions it has made to the evidences of natural religion, in a department where revelation was not designed to give information.
>
> The disappointment of those who look for a detailed account of geological phenomena in the Bible, rests on a gratuitous expectation of finding therein historical information, respecting all the operations of the Creator in times and places with which the human race has no concern; as reasonably might we object that the Mosaic history is imperfect, because it makes no specific mention of the satellites of Jupiter, or the rings of Saturn, as feel disappointment at not finding in it the history of geological phenomena, the details of which may be fit matter for an encyclopedia of science, but are foreign to the objects of a volume intended only to be a guide of religious belief and moral conduct. (Buckland, 1836B: 14-15).

Later in the chapter he discussed at some length the meanings of the opening verses of Genesis, and in particular the significance of the opening words "In the beginning" (to which Buckland ascribed an immense and immeasurable period of time) and the significance of the "days" of creation (Buckland, 1836B: 20-26). Some of the other arguments advanced in this chapter were ingenious if at times a little bizarre, as in his demonstration of the correctness of the Genesis account of the creation of light from the clear palaeontological evidence of the existence of eyes in ichthyosaurs and the trilobites of some of the earliest fossiliferous rock deposits.

There is one other quasi-theological section within the more strictly geological parts of the text, Chapter XIII "Aggregate of Animal Enjoyment increased, and that of Pain diminished, by the Existence of Carnivorous Races" which rehearsed at some length Buckland's view, well known to those who attended his lecture courses, that far from being evidence of the existence of a cruel or uncaring Deity, the hunting and scavenging roles of carnivores were a positive benefit to the rest of the animal kingdom, because carnivores rapidly despatched the aged, sick or helpless creatures that would otherwise suffer a lingering death due to disease or starvation. Hence, the existence of carnivores was a sign of divine consideration and kindness (Buckland, 1836B: 129-134).

It is even more difficult to take seriously much of Chapters XIX to XXIII, which successively argued the "Proofs of Design" from the stratigraphy and structure of the Carboniferous and the effect of folding and faulting in making coal and other mineral reserves readily accessible near the surface to await exploitation by man or the hand of a Creator in the geology of water supply, all affording "probable evidence that it is the result of Foresight and Design" (Buckland, 1836B: 525). Were it not for the fact that a number of these arguments were recorded by Jackson in his 1832 student notes on Buckland's Geology Course, much of the concluding chapters of the Bridgewater Treatise might well be dismissed as yet another example of Buckland's buffoonery or else a cynical device to ensure that there was no argument about the paying over of the £1,000 due to each author on the publication of "a work On the Power, Wisdom, and Goodness of God, as manifested in the Creation" as required by the Bridgewater Will. However, there is little doubt that were he still alive, the eccentric eighth (and last) Earl of Bridgewater would have been more than satisfied with Buckland's concluding chapter, with its confident assertion of the harmony existing between geology and theology:

> Whatever alarm therefore may have been excited in the earlier stages of their development, the time is now arrived when Geological discoveries appear to be so far from disclosing any phenomena, that are not in harmony with the arguments supplied by other branches of physical Science, in proof of the existence

> and agency of One and the same all-wise and all-powerful Creator, that they add to the evidences of Natural Religion links of high importance that have confessedly been wanting, and are now filled up by facts which the investigation of the structure of the Earth has brought to light. (Buckland, 1836B: 586).

With the Bridgewater Treatise published after taking up the greater part of six years of his life, Buckland could at last turn to other issues again. On 14 December 1836 he read to the Geological Society his latest memoir "On the occurrence of silicified trunks of large trees in the new red sandstone formation or Poikilitic series, at Allesley, near Coventry". This identified at last the source of the common, and very interesting, erratics of fossil wood found in the superficial gravels of Warwickshire, (Buckland, 1837E, 1837F). With this short paper Buckland, perhaps prophetically, returned to the geographical area and the field of work that helped Buckland to establish his reputation as a major figure in British science, the geology of the "diluvial" deposits of the Midlands first described in his "Lickey Hills" paper read to the Geological Society in 1819 (Buckland, 1821D).

2.5 THE SCIENTIFIC CELEBRITY, 1837 - 1844

Relieved at last of the heavy and prolonged burden that the Bridgewater Treatise (including the revisions and corrections for the second edition) had placed on them, Buckland and his wife clearly began to enjoy their new-found freedom and it is evident that they started to spend a good deal of time on more relaxing and social activities. Already well established and accepted in more scientifically inclined aristocratic and political circles, the coarsely spoken (in both senses of the phrase) scholarship boy from a comparatively poor Devonshire clerical family became a national celebrity as a result of the extraordinary popular success of the Bridgewater Treatise, and he and his wife, the daughter of the Berkshire village squire, became highly desirable party and house guests throughout fashionable society. There must also have been a marked improvement in their financial situation, since Buckland had been funding out of his own pocket the employment of the artists used for the Bridgewater Treatise plates, and although it was reported that much of his £1,000 fee from the Bridgewater Will was spent on the plates (Brock, 1966: 178) at least he was no longer in debt to the artists, and in accordance with the Will he was receiving all of the author's royalties on the sales of the book.

It was presumably during this period that the most notorious of all the incidents involving Buckland took place - Buckland's accidental or deliberate (according to different versions) eating of a treasured relic of the Harcourt family, a dried up fragment of the heart of King Louis XIV of France. The best-known version of the story is that of the raconteur and gossip Augustus Hare:

> Talk of strange relics led to mention of the heart of a French King preserved at Nuneham in a silver casket. Dr. Buckland, whilst looking at it, exclaimed, 'I have eaten many strange things, but have never eaten the heart of a king before,' and, before any one could hinder him, he had gobbled it up, and the precious relic was lost for ever. Dr. Buckland used to say that he had eaten his way straight through the whole animal creation, and that the worst thing was a mole - that was utterly horrible. (Hare, 1900: 358).

In recent years the alleged incident has become well known again through a verse dialogue between Mrs Harcourt and Buckland written by the poet William Plomer for the BBC Third Programme, and broadcast to mark the centenary of Buckland's death in February 1956. The poem, with its particularly memorable couplet:

> I little thought I'd live to see the day
> When I'd incorporate Le Roi Soleil

was subsequently published both in The Listener (Plomer, 1956) and in subsequent editions of Plomer's collected works.

Although serious scientific work seems to have diminished, at least for a period of time, some important work continued to appear. For example, on 1 February 1837 he gave a particularly significant short paper to the Geological Society in which he demonstrated that the upper part of the New Red Sandstone of England and Wales was in fact the Keuper of the Continent, and that the Middle Triassic of Europe, the Muschelkalk, was absent in Britain (Buckland, 1837C; 1838A).

Two weeks later, on 17 February, Buckland must have been delighted to hear a very extensive and entirely complimentary review of the Bridgewater Treatise (taking up six printed pages) included by Lyell in his presidential Anniversary Address to the Geological Society including:

> Gentlemen, - Although I have already extended this Address beyond the usual limits, I cannot conclude without congratulating you on the appearance of Dr. Buckland's Bridgewater Treatise, a work in the execution of which the author has most skilfully combined several distinct objects. He has briefly explained the manner in which the materials of the earth's crust are arranged, and the evidence which that arrangement affords of contrivance, wisdom, and foresight. He has also given us a general view of the principal facts brought to light by the study of organic remains; thus contributing towards the filling up one of the greatest blanks which existed in the literature of our science, while at the same time he has pointed out the bearing of these phaenomena on natural theology. (Lyell, 1838: 517).

Nor were Lyell's flattering remarks merely a courtesy. A month later, in a private letter to his sister, he wrote:

> After the ladies were gone, Lord Holland asked me about Buckland's book, and whether he knew much of geology. He seemed not to have formed a high estimate of the said Bridgewater, so I spoke up in favour of the body of the work, on fossils. (Lyell, 1881B: 8).

Buckland, of course, continued to give the regular series of Mineralogy and Geology Lectures *in accordance with the terms of his Readership* and these invariably attracted distinguished visitors, and he frequently invited the more interested students to meet his guests, as Ruskin in particular recorded many times in both the autobiographical Praeterita and in various letters and other writings. For example:

> I was formally invited by Dr. Buckland to his house in Tom Quadrangle, Christ Church, to breakfast with some polite little green lizards; I think from Carolina, where their duty is to keep the flies off plates. (Ruskin, 1908, 21: 152-153).

Ruskin also gave a graphic description of the chaotic state of Buckland's accommodation at Christ Church in a letter to his father dated 22 April 1837:

> Lord Cole and I were talking about some fossils newly arrived from India. He remarked in the course of conversation that his friend Dr. B.'s room was cleaner and in better order than he

> remembered ever to have seen it. There was not a chair fit to sit upon, all covered with dust, broken alabaster candlesticks, withered flower-leaves, frogs cut out of serpentine, broken models of fallen temples, torn papers, old manuscripts, stuffed reptiles, deal boxes, brown paper, wool, tow and cotton, and a considerable variety of other articles. (Ruskin, 1908, 36: 14).

In the summer of 1837 the whole of the Buckland family spent an extended holiday in Normandy, leaving in mid-July (M.S. CUL Greenough Papers, letter from Buckland to Greenough, 11 July 1837). The Bucklands visited Bayeux at the beginning of August to show the children the Bayeux Tapestry, and to attend a meeting of the Société des Antiquaires de Normandie in Caen on 2 August, after which Buckland saw the geological collections of the Faculté des Sciences and some private collections. Following this there was a two-day tour of geological sites of the Caen region, guided by Eudes-Deslongchamps: "Cette visite fut pour les géologues caennais un grand événement" (Bigot, 1943: 130).

Mary Buckland was by this time pregnant again, but must have been in much better health than in some of the more recent pregnancies, because after sending the children back to Oxford at the end of August, the Bucklands continued to tour northern and western France, looking as much at architecture and archaeology as geology, until mid-October. The child, another son, was born on 21 January 1838, and was baptised Adam Sedgwick Conybeare Buckland, with Sedgwick, Conybeare and Mrs W D Conybeare as the godparents. Sedgwick, who never married, was reported to be simply delighted by "Adam Sedgwick junior". A few days after the baptism, Sedgwick wrote to his sister:

> The day following (the 21st) I went to Oxford to stand godfather to Dr Buckland's youngest son. He was christened Adam Sedgwick; so you see my name is to be perpetuated, though as yet I have no child of my own. (Clark & Hughes, 1890A: 511).

In February 1838 the long-expected evangelical response to the Bridgewater Treatise appeared, not this time from Oxford, but from William Cockburn, the irascible Dean of York, in the form of a 23-page open letter "to Professor Buckland, concerning the Origin of the World" (Cockburn, 1838). Like Nolan before him, Cockburn made the mistake of trying to argue against Buckland on the grounds of geological facts, rather than theology, producing such absurdities as a claim that volcanoes might be the result of the waters of Noah's Flood "penetrating into the recesses of the rocks [and causing] the metallic bases to explode"! (Cockburn, 1838: 15). Buckland refused to respond.

For several years Buckland had been one of the most ardent admirers of the skill and ability of Louis Agassiz in the field of fossil fish studies, and had not only been instrumental in persuading Agassiz to come to Britain for the first time in 1834, but had subsequently arranged the necessary funding to enable Agassiz to catalogue the very substantial and rich collections of fossil fish in Britain, and for the employment of Joseph Dinkel as a full-time artist to draw and paint the specimens. Up to the middle of 1837 Agassiz had worked almost exclusively as a vertebrate zoologist and palaeontologist and appeared to have taken little or no interst in fields such as geomorphology or Pleistocene studies. However, having been himself initially sceptical, Agassiz had become totally convinced by the argument of Charpentier (1835) that the explanation of the dispersal of erratic blocks in the comparatively low lands north of the Alps was due to the action of glaciers rather than old-fashioned "deluges", or distribution as iceberg dropstones in a marine submergence as advocated by Uniformitarians, such as Lyell, (see Chapter 5.2 below).

Buckland appears to have decided that it was imperative for him to travel to Neuchatel as soon as possible to persuade Agassiz of the error of his ways and the very real danger that such heterodox views presented, particularly in relation to his continued credibility in Britain, and hence the continued availability of funds for his fossil fish research (which was voted by the British Association on an annual basis). However, Buckland's teaching and other commitments meant that he could not travel to Switzerland till the summer, and in the meantime he prepared (amongst other things) two papers for the Geological Society on some important new discoveries: of new genera of fossil fish found in the Bagshot Beds during the excavation of the London to Southampton Railway (Buckland, 1838B) and of the first discovery of a large fossil dragonfly in the Stonesfield Slate (Buckland, 1838C), and both papers were presented to the Geological Society at its 6 June 1838 meeting.

At least one family matter caused considerable concern and distress at this time as well. In 1837 the two older boys, Frank and Edward, had both been sent as boarders to the Preparatory School founded by Buckland's brother, John, jointly with Thomas Arnold (the brother of John Buckland's wife) at Laleham. Arnold became Headmaster of Rugby in 1829, leaving John Buckland in sole charge of what later in the century became regarded as the pioneering model of an English Preparatory School. Although Buckland was himself quite prepared to use corporal punishment on the boys (one apocryphal story has it that within an hour of Frank's birth Buckland, aided by Edward Copleston, Bishop of Oxford, had planted a bush in the garden both to celebrate the birth and to ensure a guaranteed supply of birch twigs!) and had himself both seen and suffered great brutality during his days at Winchester, he was quite clearly both alarmed and revolted by his brother's brutality towards the boys. After one visit in 1838 he felt obliged to write a long letter remonstrating :

> against your mode of punishing children with a round ruler, which is calculated to inflict on their hands and has inflicted on Frank an injury that he will carry to the Grave. ... A portion of the joint has been crushed and the injury is irremediable. ... I feel it therefore my Duty to require from you as a condition of my boys' return again to Laleham, an assurance that they shall no more be punished by blows inflicted with a round ruler on the hand more specifically on the Right Hand. (Burgess, 1967: 16-17).

In a happier vein, at the end of June the whole family went to London for the Coronation of Queen Victoria on 28 June, and Frank Buckland described the procession in his journal, and added that the next day they went to the Surrey Zoological Gardens and met "Billy", the spotted hyaena that Buckland had borrowed in December 1822 for his experiments on hyaena damage in connection with the Kirkdale Cave discoveries, (Bompas, 1891: 7-8).

Probably by this time the summer arrangements had been agreed, at least in outline: the Bucklands were to go first to the British Association meeting at Newcastle-upon-Tyne, and then go to Holland and travel up the Rhine to attend the meeting of the Deutscher Naturforscher at Freiburg im Breisgau, where they would meet Agassiz, after which they would continue up the Rhine Valley to Neuchatel, and thence to examine the claimed "glacial" phenomena in late September or early October. Since the railway had not yet been completed between London and Newcastle, most of the British Association members from the south of England appear to have taken coastal steamers from London direct to Newcastle, but Buckland - as usual - took the opportunity to travel from house to house, friend to friend, taking in geological observations on the way. On 19 August, Mary Wordsworth wrote from Rydal:

> He [William Wordsworth] is now listening to the conversation of Proff: Sir Wm Hamilton - who has turned aside on his way to the Grand Meeting at Newcastle. Proff. Buckland passed too by way of the Lakes the other day. (Hill, 1982: 632).

The Newcastle meeting was an overwhelming success. Lyell (President of the Geological Section) reported to Leonard Horner: "Our section was crowded, from 1,000 to 1,500 persons always present" (Lyell, 1881B: 42). The highlight of the public programme appears to have been a field excursion to examine the Coal Measures on the foreshore north of the Tyne, which was attended by over 3,000 people, including very large numbers of local coal miners, during which Sedgwick gave a half-hour impromptu address on both the local geology and on the munificence of the Deity in providing such valuable and easily accessible mineral wealth. More significantly, for the first time the Association made what was essentially a political move, with a formal resolution addressed to the Government (drafted by Thomas Sopwith and Buckland) calling for the establishment of proper arrangements for the collection and preservation of mining records. In addition, as usual Buckland produced a report of an interesting new discovery to the Geological Section, this time a rich find of fossil reptile footprints in a Triassic sandstone near Liverpool (Buckland, 1839D).

By 20 September 1838 all participants, including a number of other Britons as well as the Bucklands, assembled at Freiburg for the Deutscher Naturforscher meeting, which appears to have been very much on the lines of a British Association meeting, with scientific sessions in the morning, scientific excursions in the afternoon, and lavish hospitality by night (Owen, 1894: 130-138). The Bucklands then travelled to Neuchatel with Agassiz, and in early October spent several days examining in some detail Agassiz's evidence for former glaciation first in the Jura around Neuchatel, and later across the Bernese Oberland, including detailed traverses of the Rosenlaui and Grindelwald Valleys from their respective glaciers downwards (Buckland, 1841A: 332). By the end of the visit Buckland was totally convinced of the case presented by Venetz, Charpentier and Agassiz. Perhaps even more significantly, he told Agassiz that he had been familiar for many years with many of the phenomena now attributed to glaciation, such as moraines, polished and striated surfaces, roches moutonnées, and displaced blocks, not just in the Alps: he had seen directly comparable phenomena in Scotland and Northern England. Clearly glaciation was the key to much of the "Diluvial" phenomena that Buckland had been working on for more than 20 years. He was, however, well aware of the dangers of putting forward yet another "catastrophist" explanation, bearing in mind the advancing tide of uniformitarianism. Consequently, Buckland felt that the ground would have to be very carefully prepared before even hinting at such an explanation, and he therefore urged Agassiz to return to Britain as soon as possible in order to examine for himself the localities that Buckland could recall as being comparable with those just seen in the Jura and the Alps, and also to carry out a more extensive search for glacial phenomena through Scotland and England. Agassiz appears to have agreed in principle, but in fact it was almost two years before he was able to visit the British Isles again (and then primarily to carry out further work on fossil fish), and in the meantime both the Bucklands appear to have maintained an absolute silence about what they had seen in this respect during the Swiss visit, and returned to their usual, fairly peripatetic and decidedly eccentric, lives in England, as Richard Owen's wife noted in her diary for 6 November 1838:

> A visit from Dr & Mrs Buckland and their two eldest boys, a friend, and a couple of live marmots; both the Doctor and Mrs Buckland looking better for their German tour. The Doctor sat on the sofa with the two marmots and his bag on his cap. They were all going to Drury Lane, I don't know whether the marmots are going too! (Owen, 1894: 140).

Probably one of the other major items of scientific business during the stay of several weeks with Agassiz was the checking of the translation and proofs of a Swiss edition of the Bridgewater Treatise translated into German by Agassiz, which was published at Neuchatel the following year (Buckland, 1839A).

At the Anniversary Meeting of the Geological Society on 15 February 1839, Buckland was elected President of the Society for a second two-year period: as it happened, one that was to be marked by very serious controversy within the Society that called for considerable tact and diplomacy on the part of the President if outright schism was to be avoided. Within less than two months the first such major confrontation occurred, at the meetings of 10 and 24 April concerning the geology of Devon and the nature of what was at the second of the two meetings formally termed the Devonian System, with De la Beche and Greenough on one side and Murchison and Sedgwick on the other. "The atmosphere at the Geological Society was at that state when a storm such as had never been experienced at Somerset House might at any moment have burst forth" (Geikie, 1875A: 265). By all accounts, Buckland's chairing of these two difficult meetings was entirely successful, and helped to avoid the feared split of the Society on the issue.

Two and a half years after the publication of the Bridgewater Treatise, Buckland was still being pursued by the evangelicals, as Bunsen on a visit to Britain reported to his wife on 22 April 1839:

> Buckland is persecuted by bigots for having asserted that among the fossils there may be pre-Adamic species. 'How,' say they, 'is that not direct, open infidelity? Did not death come into the world by Adam's sin? I suppose then that the lions shown to Adam were originally destined to roar throughout eternity! (Bunsen, 1868: 521).

Further religious controversy, indeed "considerable sensation" according to Frank Buckland (1858: XLV), was provoked by a major, and carefully prepared, sermon preached by Buckland in Christ Church Cathedral, and subsequently published under the title <u>An Inquiry whether the Sentence of Death pronounced at the Fall of Man included the whole Animal Creation, or was restricted to the Human Race</u> (Buckland, 1839E). In this Buckland challenged the evangelical theologians who were arguing that death amongst animals was a consequence of the punishment of Adam and Eve, and that consequently no animal would ever have died had it not been for the fall of man. Buckland disagreed strongly with this view, and argued that the "sentence of death" was restricted to the human race, and referred his listeners and readers instead to his argument in Chapter XIII of his Bridgewater Treatise that the existence of carnivores increases animal enjoyment, by eliminating disease, infirmity and possible starvation. A further incident in Oxford in

April 1839 did nothing to endear Buckland in the eyes of the local Anglican establishment. Thomas Moore recorded in his diary for 28 April an extract from a letter just received from Byng:

> If you have not already been told, you may be glad to hear that the High Church in Oxford having, as you know, acquired an enormous subscription to build a temple or monument to Cranmer, sought out, and at length as they thought found, the very spot where he was buried, and, still more fortunately, discovered his bones. The bones were sent to Professor Buckland, who, having examined them, pronounced them to be the bones of a <u>cow</u>. (Russell, 1856: 255).

On 15 May 1839 a further daughter was born, and was baptised Caroline Mary, with Mrs Thomas Vowler Short, Mrs William White, and Rev. Dr. Bull as the godparents.

In June 1839 Frank Buckland was elected a Scholar at Winchester on the nomination of his father's old schoolfriend, Dr Philip Shuttleworth, who had the right of nomination on behalf of New College, Oxford, and Frank transferred from Laleham to Winchester in July. The eldest daughter "Mit", now aged nine, continued to be taught at home, largely by her mother, but with a significant contribution from her father, who ensured that she had an admirably broad curriculum, as Frances, Baroness Bunsen, discovered on 10 June 1839:

> Then to call on Dr. Buckland, where I could hardly get up the staircase for stuffed animals and fossils. Miss Buckland, aged nine, had been helping her papa to dissect a cat that morning: Mamma tried to prevent its being told, saying it was a shame, but Dr. B. <u>would</u> tell. (Hare, 1879: 509).

On 24 June 1839, Buckland was at last elected to the Institut, having been passed over in favour of Conybeare almost a decade earlier. At the same time came news that the Académie Française had awarded a prize of 3,000 francs to Prof. Doyere for his recently published French translation of Buckland's Bridgewater Treatise with a citation that this was "la meilleure Traduction d'un ouvrage de Morale" of the past 12 months. The Académie had further resolved to place Doyere's translation of the Bridgewater Treatise "on the list of prize books to be distributed in the Colleges of France" (Anon., 1839). Buckland was clearly delighted with his election as one of only eight Corresponding Members of the Institut, and wrote a generous letter of thanks to Arago on 1 July 1839, at the same time inviting Arago to come to the British Association meeting in Birmingham later that year, staying in Oxford on the way there.

The Birmingham meeting of the Association started on 29 August, but, for the geologists, at least the opening was overshadowed by the death of William Smith in Northampton earlier in the month, while on his way to the British Association. As President of the Geological Society, Buckland felt it his responsibility to organise an appropriate memorial to Smith working closely with John Phillips, who was Smith's nephew. By 12 March 1840 Buckland and Phillips appeared to be near to agreement on the form of the monument: a portrait bust carved by Noble for the Northampton Parish Church, and by 17 August the arrangements were virtually complete, and more than £88 was in hand for the project (M.S. Edinb. U.L. Gen 784/1/8 & 9).

Like all the British Association Local Committees of the period, that for the Birmingham meeting felt they had to provide a unique spectacle, and eventually chose to take 1,000 participants by boat along the subterranean canal of Lord Ward's Dudley Caverns into the vast chamber created in only 10 years' working of the limestone. The lighting effects alone were estimated to have cost Lord Ward many hundreds of pounds. Once the boats had reached the end of the workings, Murchison spoke first, giving a geological description of the surrounding hill proving that his voice that had "formerly been accustomed to command a regiment ... had lost nothing of its penetrating power" (Gordon, 1894: 81). He was followed by Buckland who:

> went to the gallery, placed himself on a mighty block of stone, and lectured for more than an hour, he and his numerous audience being veiled in the wreathing sulphur smoke, upon the subject already handled by Murchison, but in so original and humorous a manner that he held the attention of his listeners in a way seldom witnessed. (Gordon 1894: 81).

A German visitor recorded that Buckland continued by arguing that the abundant beds of iron ore, coal and limestone in the Birmingham area may not:

> be considered as mere accident. On the contrary, it in fact expresses the most clear design of Providence to make the inhabitants of the British Isles, by means of this gift, the most powerful and richest nation on earth....
>
> After another half-hour's stay underground we gladly sought daylight again, and, amid the singing of 'God save the Queen' from a thousand voices and the thundering crashes of blasted rocks renewed once more, boat and walkers alike left the remarkable vaults of Dudley Caverns. (Gordon, 1894: 82-83).

At the close of the meeting Sir Robert Peel, then Prime Minister, provided a special train to Drayton Manor, his country home, where there was a splendid house party for many of the leading participants at the meeting, including Vernon Harcourt, Buckland and Lyell.

Although Buckland does not appear to have given the slightest hint of his interest in, still less conversion to, the glacial theory, there is at least one piece of indirect evidence that suggests that his interest in the subject was becoming known at least in Switzerland. On 28 November 1839 Jean André De Luc wrote an exceedingly long letter in a mixture of 18th century-style Swiss French, with some English paragraphs (M.S. DRO 138M/F208). This letter does repay detailed study and translation, since in it De Luc advanced a whole series of arguments based on various Swiss observations by both himself and other scientists (particularly Alfred Gautier, Professor of Astronomy at Geneva) demonstrating the absurdity of the claims of Agassiz and Charpentier, after visiting Agassiz at Neuchatel in September 1839, and receiving a return visit in Geneva the following month.

In October 1839 while the whole family were staying with Conybeare at Axminster one of the daughters became dangerously ill with a recurrent fever, and once the crisis was over Mary Buckland with the sick daughter moved to Lyme Regis for a protracted convalescence. Immediately after chairing the meeting of the Geological Society on 18 December Buckland (presumably with the rest of the family) travelled to Lyme Regis to join Mary and the daughter for Christmas (M.S. DRO 138M/F206). Conybeare also returned to Axminster for Christmas, and consequently both were within a few miles of Axmouth when, during the night of 23-24 December much the largest documented example of mass movement in Britain (perhaps anywhere in the world at that time) started to occur. This was the Axmouth Landslip in which over the next two days a strip of the coastline more than three-quarters of a mile long by 400 feet wide moved in a rotational slip, that produced an offshore ridge of raised sea bottom more than a mile long and rising to more than 40 feet above sea level. Both the Bucklands together with Conybeare observed the landslip in some detail, and Mary Buckland made a series of detailed drawings. Conybeare sent a report, dated 31 December 1839, to Jameson for the Edinburgh New Philosophical Journal (Conybeare, 1840). A further major landslip along the coast between Axmouth and Lyme Regis occurred on 3 February 1840, and was again documented by Conybeare and both the Bucklands. From the drawings of Conybeare, Mrs Buckland and W Dawson of Exeter, a series of 10 plates were engraved for publication by John Murray, accompanied by a geological memoir and sections by Conybeare "the whole revised by Professor Buckland" at a pre-publication Subscribers' price of 18s, and a price of one guinea in the case of those failing to subscribe by 31 May 1840 (Advertising Broadsheet, DRO 138M/F298). (A substantial field of winter wheat growing in the bottom of "the Grand Chasm of the Slip" - 200 feet below its original situation - was "reaped by the Visiters [sic], and sold on the spot in handfuls for a moderate consideration" followed by "a variety of diversions" on Tuesday 25 August 1840, Handbill by Wills, printer, Axminster, DRO 138M/F349).

At the Geological Society's Anniversary, on 21 February 1840, Buckland was formally elected to serve for a second year as President, and after reading the citation for the award of the Wollaston Medal to Prof. Dumont of Liège, and the year's interest on the Wollaston Fund to James de Carle Sowerby, Buckland gave his Anniversary Address to the Society (Buckland, 1840A). (This is discussed further in Chapter 3.2 below.)

As usual, Buckland appears to have stayed up in London for a few days, visiting influential friends. Thomas Moore recorded in his diary for 23 February 1840:

> Returned in an omnibus; Hume to proceed home, and I to pay a visit to the Duke of Sussex at Kensington. Buckland was with the Duke, and I had to wait a little time. Found that Buckland had been showing and explaining to him a new invention for the taking off or copying any printing or engraving by means of

> electricity. Bank notes, for instance, can be thus copied instantly and accurately. Could hardly refrain from throwing in the pun of "flash notes" while he was describing this to me. (Russell, 1856: 271).

However, he was back in Oxford by 2 March, when he read a highly original synthesis to the Ashmolean Society on "the agency of Animalcules in the formation of limestone" (Buckland, 1840B). In this, Buckland brought together the recent work of Ehrenberg on the microscopic foraminifera in chalk, of Bowerbank on the organic origin of spicules in flints, and of recent investigations of the microscopic animals of the deep oceans. He also demonstrated thin sections of both Stonesfield slate and Derbyshire limestone, both abounding in microscopic shells, and concluded:

> We may therefore expect to discover fossil infusoria by the application of the microscope to thin slices of all siliceous and calcareous sedimentary rocks that contain any other kind of mineral or fresh-water remains. In this extension of the application of the microscope from the living to the fossil infusoria and foraminifers, we are commencing a new and important era in palaeontology, which will demonstrate a wonderful and very extensive, but by no means exclusive agency of animalcules in the formation of limestone. In the case of crystalline marbles, it is probable that if any organic remains were ever contained in them, they have been obliterated by heat. (Buckland, 1840B: 38-39).

Buckland had by no means forgotten the glacial theory, since he arranged for a written communication by Agassiz, "On the polished and striated surfaces of the rocks which form the beds of Glaciers in the Alps", to be read at the closing session of the Geological Society's season on 10 May 1840. Although ostensibly far less controversial than the 1838 papers, and primarily intended to introduce the series of splendid plates of glaciers that Agassiz was about to publish, this was very clearly the first shot of the campaign of Buckland and Agassiz to promote the glacial theory within the Geological Society (arguably the most influential geological organisation in the world at that time). Agassiz mainly described the erosional effects of glaciers, such as polished surfaces and striations caused by hard englacial particles: nevertheless he referred several times to occurrences of such polish and scratching well beyond the present glacier margins, and far higher on the valley sides than the level of the present-day ice. The annual lecture courses at Oxford were completed soon afterwards, and Buckland was free to go glacier-hunting until the start of the Geological Society's new session, announced for 4 November.

On 1 August Agassiz wrote to Buckland confirming his arrangements for the summer. He was leaving immediately to set up camp for a full three weeks on the Mer de Glace, where he intended to carry out detailed observations of the glacier itself, continuing:

> If I return safe, I shall start at the end of this month or first of Sb.[Sept.] to be with you a week after and hence to Glasgow. I hope to bring many new things from the Alps. ... I congratulate for your important discovery; you will of course show something of it at the meeting. (M.S. DRO 138M/F414).

(It is not at all clear what the "important discovery" was, but Buckland's firm belief that evidence for glaciation could be found in the British Isles must be a strong possibility. Certainly, Buckland did not present any "important discovery" to the meeting of the British Association itself.)

The travels and activities of the Bucklands and Agassiz during September and October 1840, together with a subsequent presentation of papers on the former existence of glaciers in Britain to the Geological Society in November and December of that year, are discussed in some detail in Chapter 5.2 below, so only the briefest of outlines is appropriate at this point. Buckland and his wife travelled north from Oxford by the western main road, and at least two days before their arrival in Glasgow on 18 September they had made a diversion from the Dumfries to Glasgow road via Kilmarnock to a very remote location near Crichhope Linn, where Buckland unequivocally identified a low ridge across the valley as a glacial moraine. This must have been at least five days, possibly longer, before the arrival of Agassiz in Glasgow for the British Association Meeting on 21 September, and his recognition of evidence of glaciation in the Bell's Park area of the City. Thus, Buckland's identification of the Crichhope Linn locality must rank as the first recognition of glaciation in Britain, (Boylan, 1981B; and Chapter 5.2 below).

On Tuesday 22 September Agassiz read, in French, a long paper to the Geology Section, of which an abstract appeared in the Report and Transactions under the title "On Glaciers and Boulders in Switzerland" (Agassiz, 1841A). In this address he argued strongly not only that the Alpine glaciers had previously extended far beyond their present limits, but also that there had at some time in the past been a major glaciation covering all of northern Europe and the northern parts of both Asia and America. Also, although not in the published abstract, Agassiz apparently told his audience that he intended to go directly after the meeting to the Scottish Highlands, particularly the Ben Nevis area, where he expected to find evidence of such former glaciers.

On the final day of the meeting, 23 September 1840, the Magistrate and Town Council of Glasgow gave a splendid banquet for the members of the Association, with a list of no less than 22 Toasts , including one (proposed by Lyell) to "Foreign Naturalists, and M. Agassiz". In view of his agonising over the potential role of women in the British Association before the Oxford, 1832, Meeting, there was a particular irony in (or perhaps more likely deliberate mischief behind) the allocation of Toast no. 14 to Buckland: "The Ladies who have honoured the Meeting by attending its Sections"! (Morrell & Thackray, 1981: fig. 23).

Immediately after the close of the Glasgow Meeting, the Bucklands and Agassiz travelled northwards via Loch Lomond, Loch Fyne, Loch Awe, the Bonawe and Ballachulish ferries to Fort William, seeing abundant evidence of glaciation from Inveraray northwards. After exploring the Ben Nevis area, including Glen Roy and Glen Spean, they continued north-eastwards through the Great Glen to Inverness. After a few days diversion amongst the very rich Old Red Sandstone fish collections and fossil localities of the Moray Firth area, they continued by the main road to Aberdeen. After this, Agassiz had to leave for a brief visit to Ireland, again mainly to see fossil fish collections, but incidentally recognising evidence of glaciation in Ireland, whilst the Bucklands travelled to Lyell's family home at Kinnordy, near Kirriemuir. Here Buckland was able to "convert" Lyell completely to the glacial theory by demonstrating excellent examples of various glacial phenomena all around Lyell's ancestral home, after which the Bucklands continued their journey by making an extensive tour of Upper Tayside, the Central Grampians and the Trossachs, before travelling via Stirling to Edinburgh, finding evidence of glaciation throughout the journey and all around the City of Edinburgh. They then travelled extensively in South-East Scotland and North-East England, again finding much evidence of glaciation, before returning to Oxford around the end of October. Purely in terms of distance and travelling time the Bucklands' tour of the autumn of 1840 was a remarkable feat, particularly bearing in mind the very primitive state of the roads in the Highlands at that time. (In many places the evidence of glacial striation etc was first seen on the bare rock surfaces of the unmade carriageway, and the only form of public transport available over most of the route would have been light private-hire carriages, with travel on horseback being necessary for a number of the areas and places visited.) At the time Buckland was over 56 years old, and Mary was aged 43, and had given birth to eight children, in addition to having at least two serious miscarriages.

The Geological Society's 1840-1841 session began, as planned, on 4 November, and the whole of this evening, and of the two subsequent meetings (18 November and 2 December) was taken with substantial papers on the evidence for glaciation by first Agassiz (1841B) followed by the first part of Buckland's memoir, relating to Scotland (Buckland, 1841A), a paper by Lyell on Forfarshire (1841), followed by the second part of Buckland's paper - on Northern England. The reaction to the glacial theory amongst the British geological establishment (except for Buckland and Lyell) was almost universally hostile, although this was rarely personalised. Buckland was, for example, able to host (as President) well-attended dinners of the Geological Society Club on each of the three evenings (M.S. GSL Geol. Soc. Club). Mrs Richard Owen recorded in her diary for 21 November 1840 that her husband:

> brought back with him to dinner Dr Buckland, Professor Agassiz, and Dr Mantell, and afterwards entertained themselves to their hearts content with the microscope. They made some experiments in blood globules. Dr Buckland's blood was irregular, that of Agassiz regular. Dr Mantell, who stated he had a very slow circulation, on examination proved to have blood globules of a decidedly larger size than the others. Dr Buckland was just saying with that droll look of his "Why, Mantell, you see you have a good deal of the reptile about you", when the news was brought in that the Queen was safely delivered of a little princess, so the discussion was stopped by all the gentlemen drinking health to Her Majesty. (Owen, 1894: 177).

On 19 February 1841 Buckland delivered his valedictory Anniversary Address to the Geological Society before vacating the chair in favour of Murchison (Buckland, 1841B). Again, this will be discussed further in Section 3 below, but it should be noted that the Address included a long section on "Geological Dynamics - Glacial Theory", in which Buckland both surveyed and summarised the Agassiz, Buckland and Lyell papers of the previous November and December, and in places added some further observations and comments. However, the promotion of the glacial theory in Britain received a very serious set-back when Lyell abandoned the glacial theory and reverted to the submergence theory. The Geological Society's Council Minutes record that on 5 May 1841:

> A letter was read from Mr Lyell requesting to withdraw his Memoir on the evidence of Glaciers in Scotland. Request granted. (M.S. GSL CM 1/5).

The minutes of successive Council Meetings suggest strongly that the Council was "stalling" on the question of publishing the contributions of Agassiz and Buckland. Agassiz's text was "referred" on 18 November 1840, and then "referred" again on 1 December 1841, and whilst the referees' reports on the two parts of Buckland's paper were received on 17 November 1841, the Council took no action one way or the other on the reports. Eventually, on 28 June 1842 Buckland wrote a formal letter to the Council applying to withdraw both the 1840 paper and a subsequent paper on glaciers in North Wales (Buckland, 1842A) (M.S. GSL LR 7/193) and leave was granted for this withdrawal at the Council Meeting on 16 July 1842 (M.S. GSL CM 1/5). Although by this time the glacial theory had been taken up with some enthusiasm by several of the younger geologists, including Charles Darwin

(Darwin, 1842; F Darwin, 1903: 173-174), Buckland evidently expected a rebuff from a majority of the fellow members of the Council, and hence decided that a "voluntary" withdrawal of the contentious papers was the only solution.

On 3 May 1841 Mary gave birth to her ninth child, another daughter, who appears to have been a sickly child from the very beginning, since she was baptised privately, with the single Christian name of Emily, within three or four weeks of her birth, and died on 20 December of the same year.

On 19 May 1841 Buckland read to the Geological Society a short paper on another series of distinctively original observations: "On the Agency of Land Snails in corroding and making deep Excavations in compact Limestone Rocks" (Buckland, 1842B). In October 1841 Buckland travelled extensively in North Wales with Thomas Sopwith seeking, and finding, extensive evidence of glaciation, and read a paper on this to the Geological Society on 15 December; but once again only an abstract was published in the Proceedings (Buckland, 1842A) and the full text of this was withdrawn in June 1842, as noted above. This time the reaction from the uniformitarian "establishment", led by Murchison, Buckland's successor as President of the Geological Society, was even more hostile than it had been to the papers of Agassiz, Buckland and Lyell 12 months earlier.

On 18 February 1842 Murchison used (or perhaps more accurately, abused) his privilege of surveying geological progress during the previous 12 months in his Anniversary Address to present a quite uncompromising attack on both the glacial theory and its proponents (particularly

Buckland), in a section on the glacial theory that took up the whole of the last 16 pages of the published version of the Address, ending:

> In conclusion, Gentlemen, it is gratifying to reflect, that notwithstanding the vibrations of opinion which have been caused by the introduction of glacial action among geological dynamics, the fundamental principles of our science remain entirely unaffected. Conspicuous as it may appear through the attractive descriptions of Agassiz, or the eloquence of Buckland, the glacial theory must be considered an episode only in the records we are labouring to prepare of the grand changes of the planet. (Murchison, 1842: 686-687).

Although there is no evidence that Buckland shifted his ground on the subject after the publication of the abstract of the North Wales paper (Buckland, 1842A), and after receiving increasing support in his position from, amongst many others, both Darwin and Forbes, he never again ventured into print on the subject. Instead, he turned to two quite different new areas of research, the relationship of geology and geological chemistry to agriculture, and the techniques of registering the strength of earthquakes.

Agricultural research was a particular pleasure for Buckland in the 1840s, not least because the application of science to farming represented a synthesis of so many of the varied areas of scientific interest that Buckland had indulged in for so long. In 1840 he had bought some very wet clay land at Marsh Gibbon near Oxford and over the next five years turned this into a model farm, with well-drained land and a well-built farmhouse and range of farm buildings, incorporating such innovations as slate damp-proof courses and extensive ventilation of the stables and cowshed (Gordon, 1894: 158-160). In 1842 Buckland was very impressed by the young Lyon Playfair, the Scottish protégé of Liebig, and wrote to his friend, Robert Peel, the Prime Minster, on 26 April

1842 stressing the fact that scientific agriculture and agricultural chemistry was being very neglected in England, in comparison with France and Germany, and urging Peel to appoint Playfair to carry out a series of experiments in each of the principal geological areas of the country (Reid, 1899: 77-78). Although Peel doubted if Parliament would agree to this, he later invited Playfair to join amongst others Buckland and De la Beche in one of his house parties at Drayton Manor, and subsequently Peel found a way to provide indirect financial support to Playfair and his work by appointing him to a salaried post on a royal commission, while continuing his chemical research in Manchester (Reid, 1899: 80-87). Buckland also became active in the Royal Agricultural Society, and contributed a very substantial and authoritative review of the current state of agriculture to the Quarterly Review (Buckland, 1844B - unsigned). Above all, he was particularly delighted when, in the autumn of 1842, Liebig recognised the great potential of Buckland's beloved coprolite beds as a potentially rich source of mineral phosphates for agricultural purposes (F Buckland, 1858: xliii-xliv). Within a very few years the various coprolite-rich horizons of the Triassic and Jurassic of England and Wales (and indeed of the Continent) were being very extensively worked for the manufacture of valuable agricultural fertilizers.

The interest in the measurement of earthquakes arose out of discussions at the 1842, Manchester, Meeting of the British Association, at which Buckland was appointed Chairman with Milne as Secretary of a special committee to investigate the field. Buckland threw himself into the work with great enthusiasm, reporting back to the 1843, Cork, Meeting of the Association (Buckland and Milne, 1844).

A graphic confirmation of the many reports about the utter chaos of Buckland's rooms at Christ Church emerged in 1843, when on 2 April he wrote to Henry Warburton, Murchison's successor as President of the Geological Society:

> The clearing of my dining room has led to a discovery of the long lost paper of Griffiths which was referred to Conybeare in 1829 and by him put into my hands I being then at Axminster - He was then P.G.S. and he knew not enough of Ireland to report on it. I ... [? deeply] regret this delay and must plead guilty to the crime of disorderly custody of papers and can only intreat your sympathy and that of the Council. I think the best thing that can be now done with the paper is to refer it again to Murchison or Sedgwick who have both been recently in Ireland at work on the Devonian strata which are the great point of Griffith's [sic] paper. The sections are very good and should be published.
>
> [Postscript overleaf]: Conybeare's paper has also been discovered on the Valleys of the Thames gravel and diluvial phenomena. (M.S. GSL LR7/397).

The failure of the full text and sections of the pioneering work of Griffiths on the geology of Ireland to appear has been the subject of recent discussion and conjecture (Davies, 1980), but the re-discovery of Buckland's 2 April 1843 letter throws a completely new light on this mystery. However, the fact that two substantial and much-discussed papers could be mislaid by a referee for more than 13 years suggests that the Society's arrangements for monitoring prospective publications through the various stages must have left a great deal to be desired. One is led to wonder at the same time what extraordinary circumstances led Buckland to do something as unnatural (to him) as tidy up his dining room in this way at that particular time. Buckland had been very unwell earlier in the year, as Mantell noted in his Journal for 11 March, when Buckland made "his first appearance in London since his serious indisposition" (Curwen, 1940: 167), so it seems most likely that the attack on the chaos of his rooms had taken place during this period of illness.

Vertebrate studies were by no means forgotten, and following the discovery of what Buckland supposed to be "the trackway of some fish, crawling along the bottom by means of the anterior rays of its pectoral fins" on a slab of Coal Measures Sandstone, Buckland investigated the various modes of locomotion other than swimming used by various groups of fishes, giving a paper on the biological evidence to the Ashmolean Society (Buckland, 1843A) and a geological description of the fish track, which he termed Ichthyopatolites, to the Geological Society (Buckland, 1843B). Later in the year he offered an additional course:

> of Eight Lectures on the Proofs of Unity and Design disclosed by Geology, from comparison of the extinct Forms of Animal and Vegetable Life with those now existing on the Surface of the Globe (printed broadsheet, DRO 138M/F292).

The regular courses of Mineralogy and Geology lectures were given in the spring and summer terms of 1844, although the most memorable scientific event of the year was undoubtedly the return of the British Association for the Advancement of Science to York, its original birth-place. The choice of York was somewhat controversial within the Association, which at that time had not agreed on any sort of policy as to the frequency with which it would return to particular provincial towns, but any controversy about this paled to insignificance compared with the inevitability of a further confrontation between science and religion, and perhaps even between more progressive political views and the traditional toryism of the York City Council. As noted above, the then Dean of York, Dean Cockburn, had already attacked Buckland in a very personalised manner in 1838, and had followed this up by a succession of open letters including the splendidly titled A Remonstrance upon

<u>the Dangers of Peripatetic Philosophy</u> (Cockburn, 1839).

According to oral tradition in York, related in 1972 by the late George Wilmot on the occasion of the joint meeting of the Yorkshire Philosophical and Geological Societies to mark the 150th anniversary of the discovery of Kirkdale Cave, Cockburn started his mischief some weeks before the arrival of the British Association. He convinced the diehards on the City Council of the religious and political unsuitability of prominent members of the Geological Section, and persuaded the Council to exclude all members of the Geological Section from the City's invitation list to the splendid civic reception to mark the opening of the Meeting. Cockburn must have been only too well aware that his own Archbishop, Harcourt, was a member of the Geological Section and a close personal friend of Buckland (it was at Archbishop Harcourt's house near Oxford that the notorious "heart of a king" incident had taken place), and as a consequence the City of York banned its own Archbishop from the civic reception! (The oral tradition also has it that in retaliation Harcourt invited all the leading members of the Geological Section to a most spectacular party at Bishopsthorpe Palace, his official residence, which lasted the whole length of the British Association Meeting.)

From 10 to 14 September 1844 Buckland was in Canterbury for the first annual meeting of the British Archaeological Association, in which he was playing an active part (British Archaeological Association, 1844).

Cockburn's hope of a major public confrontation with Buckland during the British Association Meeting in York at the end of the month was dashed when, on 21 September, the Bucklands' youngest child, Adam, died and was buried with the other three children in Christ Church Cathedral (M.S. DRO 138M/F886). Immediately after the funeral the whole family moved to Lyme Regis by coach "for change of air", and:

> On the lias beds of this happy hunting ground of geologists, Dr. Buckland took the children fossilising, and made them acquainted with the local celebrity Mary Anning, who, from the early age of ten, gained her livelihood and supported a widowed mother by collecting specimens on the beach. (Gordon, 1894: 113).

Despite Buckland's absence, Cockburn delivered to the Geological Section a prepared attack on both Buckland's Bridgewater Treatise and Murchison's Silurian System from the viewpoint of biblical literalism. He had a published version on sale the next day under the title The Bible Defended Against the British Association (Cockburn, 1844A) and two days later appointed himself as the preacher at the British Association service in York Minster, delivering A Sermon on the Evils of Education Without a Religious Basis (Cockburn, 1844B). He took as his theme human vanity and the dangers of academics "who lead the young in the way of science" (Cockburn, 1844A: 8) - making it perfectly clear that in this he was referring to the two Reverend Canons holding the chairs of Geology in Oxford and Cambridge respectively (i.e. Buckland and Sedgwick). Cockburn subsequently tried to draw the leading geologists and the Geological Society itself into a public debate, and pursued the absent Buckland as well, by means of correspondence, although Buckland, unlike Sedgwick, refused to rise to the bait.

In October 1844 Frank Buckland entered Christ Church as a commoner, having left Winchester the previous July. He had been unsuccessful in succeeding his father and his uncle in obtaining a Scholarship to Corpus Christi College, but after three months at Christ Church he obtained a modest scholarship as a Student of Christ Church and was formally admitted to this on 24 December 1844. At this point he moved into some student rooms in the Fell's Buildings, Christ Church, and established in them part of the family menagerie including Jacko, his monkey, an eagle, a wide range of small mammals including squirrels and dormice, together with sundry reptiles and amphibia, and completed his entourage by acquiring a young bear (Bompas, 1891: 38). (In strict conformity with the rules for undergraduates, the bear always wore academic dress while being walked in the Quad or taken out into the public streets.)

Although the rest of the family had stayed on in Lyme Regis when Frank Buckland returned to Oxford to enter Christ Church, Buckland was back in Oxford himself by 18 November 1844, when he gave a report to the Ashmolean Society on the excavation of two Saxon burials near Canterbury during the first meeting of the British Archaeological Society (text in unidentified newspaper cutting, DRO 138M/F347). The year ended with a memorable visit to stay at Drayton Manor, where Sir Robert Peel had gathered together, as he explained in a letter to Prince Albert dated 17 December 1844:

> I have some very distinguished scientific men on a visit here - Dr Buckland, Dr Lyon Playfair (the translator of Liebig), Professor Wheatstone (the inventor of the electric telegraph), Professor Owen, of the College of Surgeons, Mr George Stephenson the engineer, Mr Pusey, Mr Smith of Deanston. ...
>
> I invited yesterday all my principal tenants to meet them at dinner and acquire information, which was most kindly and liberally given them by all the philosophers, on practical points connected with vegetation, manure, the feeding of animals, draining &c. The meeting was a most interesting one. (Parker, 1899: 162).

Buckland also appears to have spent some time during the Christmas period in Hampshire, presumably tending to his Living of Stoke Charity, where he met H W Greville the diarist at The Grange, Arlesford. Greville noted "Buckland gave us a great dose of geology, not uninteresting, but too much of it." (Strachey & Fulford, 1938: 197). By a strange coincidence (in view of the events of the next few months) Buckland was in the company of Archdeacon Samuel Wilberforce, of whom Greville wrote "the latter a very quick, lively, agreeable man, who is in favour at Court".

At the end of 1844 there was certainly nothing about Buckland's interests, demeanour or reputation in Church circles to give any hint that Peel was anxious to offer Buckland high ecclesiastical preferment.

2.6 DEAN OF WESTMINSTER, 1845 - 1856

The first part of 1845 appears to have passed uneventfully for Buckland, now in his 62nd year, giving his statutory Lecture Courses at Oxford (with Frank Buckland, and occasionally a selection from his menagerie, amongst the list of registered students). In addition, he appears to have been spending more time with his family and on the practical sides of his agricultural experiments. He appears to have been completely unaware of a letter sent by Sir Robert Peel to the Queen, submitting that:

> there would be public advantage in selecting for the Deanery of Westminster a divine of irreproachable life and sufficient theological attainments, and at the same time eminent as a man of science. It strengthens the Church to have such men occasionally selected for preferment. Should this principle of selection be approved he would bring under notice Dr. Buckland, a Canon of Christ Church, and Professor of Geology at Oxford. As, however, her Majesty might wish that the Deanery should be offered to Archdeacon Wilberforce, Sir Robert Peel would most cheerfully withdraw any other claims that might interfere with his. (Parker, 1899: 417).

In the event, *the Queen chose Samuel Wilberforce for the office (confirming* Greville's opinion of Wilberforce as someone "in favour at Court"), but in fact the Royal favour towards Wilberforce, and Peel's anxiety to promote Buckland, soon resulted in the further promotion of Wilberforce to become Bishop of Oxford, thus leaving the Westminster Deanery vacant for the second time in only six months.

By the summer there was great anxiety throughout the country about two natural disasters, the return of cholera and the advance of the Potato Blight, causing the total failure of the potato crop (particularly in Ireland), and making a serious famine inevitable by the autumn or winter, at least amongst the poorer classes who at that time depended so much on potatoes as a major part of their staple diet. Buckland threw himself into investigation of both problems with considerable vigour. So far as cholera was concerned, Buckland, after gathering together many documents and publications on the disease, was convinced that the main hope lay in seeking to prevent the occurrence and spread of the disease through improved sanitation and the use of the emerging range of disinfectants, rather than rely on the treatment of the disease once it had struck (F Buckland, 1858: lxvi).

At the beginning of September 1845 Buckland travelled to Paris accompanied by Richard Owen, and on 8 September they each took their seats for the first time since their respective elections at a meeting of the Institut. One of the papers given at the Institut that day was a communication by Professor Payen on the potato disease, which had just broken out in crops all over France, and was proving even more destructive in Belgium. This paper was followed by further contributions at the Institut on 15 September, and Buckland also stayed in Paris for a special meeting of the Royal Agricultural Society of Paris called to investigate the cause and suggest remedies for the disease. On his return to England towards the end of September Buckland found that the potato crop was destroyed by the disease through many parts of England, Scotland and Ireland, and the seriousness of the situation was only too apparent by late October. In the light of what he had learned at the Paris meetings, together with extensive personal investigation and observations (including witnessing personally the potato harvest on Peel's estate at Drayton Manor), Buckland gave a full lecture to the Ashmolean Society at Oxford on 3 November 1845, outlining both the nature of the disease, in relation to arresting the spread of the disease, the selection and careful retention of undiseased seed stock for the next season, and substitute foods that could be used to alleviate the consequent famine. Buckland was himself experimenting with the use of maize flour imported from America in his attempts to provide food for the poor of Oxford, and he reported on the preparation of a nutritious potato starch jelly, stating that he ate sweetened potato jelly himself daily for breakfast. Because of its practical importance, the Ashmolean paper was immediately printed as a broadsheet and put on sale at a price of three shillings per hundred (or pro rata) by Vincent, the Oxford Bookseller, and soon afterwards the lecture, which was widely regarded as the best available study of the disease, and admirable in its practical recommendations, was published in pamphlet form (Buckland, 1845C).

The following week Buckland received a letter from Peel which began:

> Although the period has not exactly arrived for making the appointment, yet I cannot longer resist the temptation to communicate to you my intention of submitting your name to her Majesty for the Deanery of Westminster.
>
> In offering you so prominent a situation in the Church, I rejoice in the opportunity of marking my personal regard and esteem for you, and my sense of the services you have rendered to the University of Oxford, and to the great interests of science, by your unremitting and successful exertions to widen the range of scientific inquiry and knowledge, and to make them conducive to the comfort and improvement of mankind.
>
> I feel that I am adding strength to the Church by placing in an eminent position in the Church one who unites with distinguished intellectual attainments a pure and blameless character and a kind and generous heart. (Parker, 1899: 417-418).

Buckland was clearly very surprised indeed, and very doubtful about accepting. However, it was finally agreed that although on becoming Dean Buckland would have to give up his office as Canon of Christ Church, he would be allowed to retain his Readerships. In addition, the Dean and Chapter of Westminster were Patrons of the quite lucrative Living of Islip, a most attractive village just a few miles north of Oxford, and it was traditional that this Living be offered to the Dean both as a valuable supplement to his income and also an attractive country seat. After considering all of the factors, Buckland graciously accepted the Royal invitation when it was formally received.

Some years later Peel let it be known that:

> I never advised an appointment of which I was more proud, or the result of which was, in my opinion, more satisfactory, than his nomination to the Deanery of Westminster. (F Buckland, 1858: xli-xlii).

Although there is no reason to doubt that Peel meant this remark to be taken literally, he must have realised that many people would recognise this as a very obvious double entendre. The very first appointment to a Deanery that Peel had successfully solicited, while a young minister in Liverpool's administration 20 years earlier, was the appointment of an unpleasant and troublesome brother-in-law as Dean of York, largely to remove him to a safe distance from the family home at Drayton Manor. Peel's remark was certainly not lost on that brother-in-law, Dean Cockburn of York, self-appointed arch-tormentor of Dean Buckland over the previous few years!

The appointment of Buckland as Dean of Westminster at that particular time was doubly controversial. Quite apart from the constant attacks on his religious orthodoxy by the Evangelicals, and his notorious eccentricities and irreverences, during the late autumn of 1845 Buckland had become heavily embroiled in national political controversy. As the Irish potato famine became inevitable, Peel had appointed the agricultural chemist Playfair, the botanist Lindley, and Buckland as three Commissioners to investigate and report on the situation. Their report was quite unequivocal: although much could and must be done to try to minimise the spread of the disease, and to try to ensure the preservation of sufficient seed potatoes for the next season, there was nowhere near sufficient substitute food in the British Isles, and that if starvation was to be avoided, foreign grain must be imported. (Belgium, Holland, Sweden and Denmark had already adopted this solution.) Prince Albert who was taking a very close interest in the impending disaster, recorded in a confidential memorandum for the Queen that on 1 November Peel called a special meeting of the Cabinet and put the report of Buckland, Playfair and Lindley before it. Peel himself proposed that the Corn Laws be repealed immediately but was immediately opposed by all but three of the Cabinet. Peel therefore asked that his proposal be deferred for a few weeks for further consideration rather than face a defeat on a vital policy issue in Cabinet (Benson & Esher, 1907: 56-57).

Buckland's paper to the Ashmolean Society on the potato disease, given two days later, was strictly scientific and practical, although the use of substitute foodstuffs that would obviously have to be imported, such as maize meal, was referred to (Buckland, 1845C). However, less than two weeks later Buckland went to Birmingham and spoke to a very large audience about not only the scientific and practical aspects of the potato disease, but also continued with what was regarded as a highly inflammatory and impassioned plea in support of the cause of Free Trade, albeit on strictly humanitarian grounds. Greville commented in his journal on 16 November 1845:

> It has been said that Peel was not indisposed to take this opportunity of doing away with the Corn Laws .... and I lean to the belief that Peel is waiting for a case sufficiently strong to lay before his Agricultural friends, before he tells them that he must throw the ports open. There have not been wanting circumstances significant of Peel's disposition, especially a speech which Dr. Buckland made at Birmingham of a very Free Trade complexion; and he went there from Drayton, and has since been made Dean of Westminster. However, it is idle to speculate on intentions, which a short time must develop and explain. (Strachey & Fulford, 1938: 235-236).

In his briefing of 7 December 1845 for the Queen, Prince Albert recorded that:

> In the meanwhile the agitation of the Anti-Corn Law League began; in every town addresses were voted, meetings were held, the Times - barometer of public feeling - became suddenly violently Anti-Corn Law, the meetings of the Cabinet roused attention, a general panic seized on the mass of the public. Sir Robert called anew his Cabinet. In the midst of their deliberations Lord John Russell issues from Edinburgh an address to the City of London.
>
> The whole country cries out: the Corn Laws are doomed. Thereon Sir Robert declared to his Cabinet that nothing but unanimity could save the cause, and pressed for a decision. (Benson & Esher, 1907: 57).

Despite receiving the support, this time, of amongst others the Duke of Wellington, Peel found a hard core of total opposition from the major landowning interests in the Cabinet and the Party, led by the Duke of Buccleuch and Lord Stanley, and after consulting both Prince Albert and then the Queen personally, Peel offered the resignation of his government and a guarantee of his personal support for Lord John Russell, sacrificing the Party in the hope of averting the predicted disastrous famine throughout Britain and especially in Ireland. However, the vital six weeks of lost time since the completion of the report by Buckland, Playfair and Lindley meant that tragedy was inevitable even if both Houses of Parliament were willing to repeal the

Corn Laws instantly.

By then, Buckland was making arrangements for his move from Oxford, which had been his home for the past 44 years, to the Westminster Deanery (Maurice, 1885: 420). As he proceeded to fill up the ample accommodation of the Deanery with not only his large family, his books and his collections, but also most of the Christ Church menagerie (and indeed all of it when Frank visited them during the University vacations), Buckland made it clear to everyone that he had no intention of changing his ways. As the publisher, John Murray, put it in a letter to T J Torrie, dated 25 December 1845: "I have seen Buckland once since he became Dean - at the Geological Socy. - and he jokes just as usual." (M.S. Edinb. U.L. Gen 1996/7/28), and Richard Owen's wife wrote of their first visit to see the Bucklands at Westminster:

> We found the Doctor almost lost amidst heaps of boxes, packages, and lumber - the children delighted with the move. The Deanery is a dark, rambling place. R. raced about after the Dean's unwearying black legs, through great big rooms, and then out on the leads, where the Doctor said you could get a capital view of the fireworks at Vauxhall Gardens.... The Dean brought out a South American monkey, called "Jack". He looked ferociously at the strangers, and shrieked and showed his teeth; but when Mr. Liebig (Baron Liebig's son) came in, Jack jumped down into my lap and settled down comfortably. (Owen, 1894: 282).

Frank Buckland noted that his father found a new lease of life in the challenge of the new appointment:

> After his appointment to the Deanery of Westminster, Dr. Buckland, never slothful in his younger days, redoubled the activity of his life, though advancing years might well have warned him to seek rest, both of mind and body. Rising soon after seven, he worked on incessantly till two and three o'clock the next morning, allowing himself scarcely any time for meals, and still less for recreation; and, notwithstanding his important occupations, he still found time to travel to and fro from Oxford, to lecture on his favourite science. (F Buckland, 1858: lxix).

Nevertheless, Buckland continued to attend most meetings of the Geological Society, as well as those of the Royal Agricultural Society and the Institution of Civil Engineers (of which Buckland was a very active Honorary Member , with a particular interest in sewerage and other aspects of sanitary engineering). He also revelled in the power and patronage that was attached to the office of Dean of Westminster (a uniquely powerful ecclesiastical office since Westminster Abbey has no bishop with whom ecclesiastical power would normally be shared). Exercising the rights of patronage in both ecclesiastical and educational fields must have been particularly rewarding to Buckland, since almost half a century earlier he had been very much on the other side of the fence as a relatively poor boy seeking good academic places first at Winchester and later at Oxford through the operation of the patronage system, and he carefully preserved amongst his papers the first such "recommendation" that he received after his appointment (M.S. DRO 138M/ F382).

Many had assumed that Peel's appointment of Buckland to Westminster was little more than a sinecure - in effect offering a fairly generous pension while Buckland carried on as before. However, any such thoughts were soon confounded by the vigour with which Buckland embarked upon fundamental reforms, both physical and spiritual, at Westminster. His first attack was on Westminster School, where he found both the educational standards and the accommodation in a very poor state. Shortly after Buckland's appointment Williamson retired as Headmaster after more than 18 years in the post. Under a decidedly odd arrangement, although the School was primarily the responsibility of the Dean and Chapter of Westminster, the appointment of the Head was at that time at the absolute discretion of the Dean of Christ Church, Oxford. Fortunately, Buckland had been a close personal friend of Dean Gaisford for many years, and was still regularly in Oxford and hence was able to influence Gaisford's choice. Both agreed that Henry George Liddell (himself later Dean of Christ Church and the father of Lewis Carroll's Alice) should be asked to take up the challenge of restoring Westminster School to the first rank of the country's public schools. Buckland made it his business to be in Oxford the day that Gaisford asked Liddell to accept the appointment, and, as Liddell later wrote:

> I met Buckland by appointment, and walked three times round the meadow with him, discussing the whole subject. He told me freely all that it was intended to do, and all that I might expect from the Chapter. He said they were going to make a thorough reform of the whole management of the institution; (Thompson, 1899: 63).

Buckland and the Chapter gave Liddell the freedom he needed to make drastic changes in the curriculum and teaching methods, and offered him unfailing support where required, while Buckland concentrated on the appalling physical condition of the School premises, starting first with the basic housekeeping (Buckland told Stanley in January 1846 that he had found a situation in which "counterpanes in the dormitory not washed for 11 years, school not cleaned since Queen Elizabeth died" - Thompson, 1899: 88), and then progressing, with the aid of a public appeal for funds, to an extensive building programme, including the construction of a Sanitorium , although, according to Liddell's biographer the new buildings were:

> hideous and gloomy beyond words ... Buckland had no aesthetic sensibilities, and was fond of corrugated iron. (Thompson, 1899: 92).

Buckland also found the sanitary conditions in the School and throughout the Abbey Close appalling, and a source of recurrent serious infections, including cholera and typhoid, and personally designed a sewerage system for the whole area which was eventually, after much delay, carried out by the local Sanitary Authority.

The radical reforms of Westminster School by Buckland and Liddell were widely welcomed, and indeed extensively copied by other public schools, but Buckland's equally bold changes of both the fabric and the liturgy of the Abbey were extremely controversial. The Choir was almost completely gutted, and the floor level was lowered to that of the Nave and the 18th century pews were replaced by Gothic reproductions. The Choir Screen was replaced at the same time, necessitating the splitting of the organ, and the whole effect of the structural changes seemed decidedly Tractarian. Buckland's extensive reforms of the liturgy, again with a decidedly High Church outlook, were also viewed with grave disquiet by his evangelical critics. For example, on 9 June 1847 he persuaded the Chapter to introduce a weekly Celebration of Holy Communion (compared with only two or three Communion services per year), and on 29 June, contrary to a long tradition of near-secret consecrations of bishops for the Anglican Communion overseas, Buckland organised a highly controversial public consecration of four bishops, destined for Cape Town, New South Wales, Melbourne and Adelaide respectively in the presence of a vast congregation, and during which 760 persons communicated (Perkins, 1952). In his definitive Alcuin Club study of the history of the fabric and liturgy of Westminster Abbey, Perkins (1952: 156-157) wrote:

> Just over a century has passed since Buckland was installed, years crowded with activity and manifold developments. His decanate will always be recognised as the starting-point of the forward movement.

Also in June 1847, the British Association returned for a second time to Oxford, but the enthusiasm for the "Advancement of Science" that had been widespread a quarter of a century earlier at the 1832 Meeting had clearly faded out. Lyell wrote to his father:

> Out of twenty-four heads of houses, only four at Oxford to receive the Association! But it will go off the better by the absence of the lukewarm or the hostile. (Lyell, 1881B: 131).

The Bucklands returned to Oxford for the meeting, staying at Christ Church as guests of Dean Gaisford. Buckland revived his traditional splendid breakfast parties, and Mrs Richard Owen noted in her diary for 25 June:

> The Buckland breakfast. Frank's bear (Tiglath-Pileser) who resides on the premises, was an honoured guest, and was in cap and gown. (Owen, 1894: 298-299).

Buckland was a Vice-President and the Meeting was attended by Prince Albert who was also a guest at one of Buckland's gatherings. There was a move during the Meeting to petition the Government to build a new University Museum to accommodate the scientific collections (which the promoters wished to call the "Bucklandian Museum" in his honour, although he may not have been aware of this), but he had lost all faith in Oxford as a scientific institution and refused (see Chapter 3.1 below).

Despite the implied promise of the Living of Islip at the time of his appointment, Buckland found it extremely difficult to persuade the Curate, the Rev. H Walker, to leave the Rectory so that the Bucklands could move in, as is clear from a letter from Wilberforce, Bishop of Oxford, to Walker dated 24 January 1848 (Pugh, 1970: 96). Buckland continued to attend most meetings of the leading scientific societies with which he was involved, particularly the Geological Society, although his behaviour could be as eccentric as ever, as Mantell recorded with some disgust about the occasion on which he read a paper on the Moa bones from New Zealand on 2 February 1848:

> The Dean of Westminster unfortunately indulged more than usual in buffoonery, and completely marred the discussion, which consequently was utterly unworthy the subject. (Curwen, 1940: 219).

Mantell appears to have been so incensed by Buckland's behaviour that he stayed away from the Geological Society Anniversary a fortnight later, when De la Beche, as President, awarded the Wollaston Medal to Buckland, in recognition of his long and distinguished career in geology. Then as now the Society's rules excluded all serving Officers and Councillors of the Society from nomination for any medal or award, and as a consequence Buckland had been debarred from consideration for any Society honour more or less continuously until the 1847-48 season. Buckland was clearly greatly moved by the award of geology's highest honour, and replied at some length stressing the utilitarian value of geology in practical terms, and its use in demonstrating the benevolence of the Deity:

> Geological knowledge, i.e. the knowledge of the rich ingredients with which God has stored the earth beforehand, when He created it for the then future uses and comfort of man, must fill the mind of every one who acquires this knowledge with feelings of the highest admiration, the deepest gratitude, and the most profound humility. The more our knowledge increases of the infinity of the wisdom and goodness of the Creator, greater and greater becomes the consciousness of our own comparative ignorance and insignificance. (Buckland, 1848A: xx).

By March 1848 news of the revolution in France led to serious fears that the growing Chartist movement might sweep Britain along in what appeared to be a European-wide tide of insurrection and revolution, and indeed after a Chartist meeting in central London on 10 April, a large mob seized Westminster Abbey for a time, causing Buckland great concern and distress (Gordon, 1894: 245). However, things were calmer by Easter Day, 23 April, when Buckland was the preacher at a special service in the Abbey to mark the completion of the internal reconstruction. Buckland spent much of the sermon drawing out the practical lessons to be learned by Britain from the current turmoil on the Continent, and indeed in the streets of London, taking a quite liberal stance, saying:

> The present out-breaks in the world are not against religion, but are political; arising from the too long delayed concession of government to the advancing intelligence and education of the masses of mankind. (Buckland, 1848B: 10).

The sermon was widely praised, and was promptly published by John Murray, together with a long appendix setting out the details of the reconstruction work, and including a short piece on the early history of the Abbey (Buckland, 1848B: 20-25).

The following month, Frank Buckland took his B.A. degree, and immediately moved to London to live in the Deanery, accompanied by his very substantial menagerie, and without delay began to study medicine at St. George's Hospital (Bompas, 1891: 61). Meanwhile, Buckland was proudly presiding over the newly-renovated Abbey, carrying a large feather duster which he used with great ceremony, and which became almost as much of a trade-mark as his famous blue canvas specimen bag. In addition to his official duties, and a still hectic social life, Buckland retained his Oxford Chair and continued to give the two prescribed lecture courses in Mineralogy and Geology each year.

In early 1849 Buckland's long-standing interests in fossil coprolites and in agricultural chemistry were brought to the aid of his newer interest in sanitary engineering in a quite novel way, and this work resulted in a highly original paper to the Royal Agricultural Society under the title "On the Causes of the general Presence of Phosphates in the Strata of the Earth, and in all fertile Soils with Observations on Pseudo-Coprolites, and on the possibility of converting the Contents of Sewers and Cesspools into Manure" (Buckland, 1849A).

During 1849, however, there were the first signs of a mental decline. For example, in January 1849 Buckland announced in the press without any consultation or invitation that he was to lecture to the Royal Institution, and in order to save embarrassment Faraday felt obliged to allow him to give the already announced lecture. More seriously still, Buckland went into a quite inexplicable and protracted rage when, at the end of August 1849, he learned that Liddell had postponed the start of the *autumn term at Westminster School, without* consulting Buckland who was staying with the Duke of Bedford at Woburn at the time, because of the seriousness of the cholera epidemic in central London (Thompson, 1899: 118-120). On his return to London Buckland himself contracted cholera, and on 12 September sent for Mantell (a qualified surgeon and physician, as well as a leading geologist). However, on Mantell's second visit of the day, in the afternoon, Buckland was feeling better and despite Mantell's protests announced that he was leaving the next morning for the British Association Meeting in Birmingham (Curwen, 1940: 240).

Buckland survived, and after the British Association travelled to Taunton, where he was the guest of honour at the first Annual General Meeting of the Somerset Archaeological and Natural History Society, which was chaired by W C Trevelyan, an old friend of Buckland's. Buckland extemporised at length on the geology of Somerset and of his own studies of the County dating back almost half a century, including much autobiographical detail, particularly about his first attempts at geological mapping in the Mendips, commenting on the mineral wealth of the County, the relationship between geology and agriculture, the "monsters of the lias" and even the geology of the principal churches and other buildings of the County. He concluded what proved to be his last scientific address with a robust rejection of any conflict between geology and theology, and concluded:

> by asserting that geology led them to see in the relics of bye-gone ages the works of an All-wise, Omniscient, Omnipresent, All-great, All-powerful God, who has created all things,and for whose pleasure they are, and were created. (Buckland, 1851).

On 18 October 1849 Buckland published a Broadsheet announcing the start of his geological lectures:

> The Reader *in Geology will begin a Course of Lectures at the* Clarendon on Tuesday next, at One o'Clock, on the very high Antiquity of the Earth; demonstrating by Evidences in the Museum the reality of the facts cited in Two important recent publications; viz., The Rev. G. Gray, on "The Earth's Antiquity," shewing the Consistency of its very high Antiquity with the Bible Chronology; and Hugh Miller's "Footsteps of Creation," shewing the Fallacies of the Doctrine of Development maintained by the anonymous Author of the "Vestiges of Creation." (Broadsheet, DRO 138M/F294).

However, even at the age of sixty-five, Buckland continued his restless travels, checking on the latest discoveries. For example, in between a Saturday morning and Tuesday lectures, on Monday 31 October he appeared unexpectedly at Mantell's house in London, and Mantell noted in his diary: "The Dean of Westminster ran in on Monday, in a terrible hurry, and looked over some of my large bones etc." (Curwen, 1940: 244).

By November, the cholera epidemic appeared to be waning, although not yet over, so it was decided to offer a national Day of Thanksgiving to God for the Removal of the Cholera, with the centre-piece being a thanksgiving service in Westminster Abbey. Buckland chose to preach the sermon himself, taking as his text "Wash and be Clean", making it clear that the ultimate victory over cholera depended far more on the efforts of his fellow members of the Institution of Civil Engineers in providing pure water supplies and adequate sewerage arrangements for large towns, than on any Divine intervention. Again the evangelical wing of the Church was scandalised, but Buckland's sermon proved to be a great success in its printed version (Buckland, 1849B). His old friend, P B Duncan, received a copy (or at least a fairly detailed summary) by 24 November, and was prompted to run off a couple of stanzas of humorous verse on the subject:

> Dear Dean
> What says the Dean, what says the Dean.
> Wash & be Clean, wash & be Clean.
> Cleanse evry drain
> Or your drugs will be vain
> And Cholera with Influenza his daughter
> Will return & commit great slaughter
> (M.S. DRO 138M/F364).

Frank Buckland returned from a Continental tour in time to spend Christmas 1849 at the Deanery with the rest of the family, and was very alarmed at his father's condition:

> I saw for the first time symptoms of the tottering of his mental powers; he complained that he could not get through his work, and that his papers were in confusion. (F Buckland, 1858: lxix).

A post-mortem investigation after his death showed a severe osteomyelitic (or possibly, less likely, tubercular) condition affecting the axis and atlas vertebrae, and the base of the skull around the foramen magnum, whilst the brain itself appeared to be completely normal (F Buckland, 1858: lxix). Within weeks of the first obvious symptoms of the collapse of his mental facilities appearing during the Christmas 1849 period, Buckland's mental health deteriorated very rapidly indeed. By 4 February 1850 Richard Owen wrote to his sister: "I went to see the poor Dean of Westminster who's health, I fear, is breaking." (Owen, 1894: 352), and the same month Mantell recorded in his diary Buckland's absence from the Geological Society Anniversary and commented that "the distressing cause ... was to me a source of deep regret" (Curwen, 1940: 250). In his Royal Society obituary, John Phillips summed up the tragic final years:

> that apparently indefatigable mind ceased from its labours, and only the form of Buckland survived till the 14th of August, 1856. (Phillips, 1857: 268).

Much of the final years was spent at Islip, and it was there that Buckland had chosen his own burial place, soon after his appointment as Dean of Westminster 10 years earlier. It was only when the grave-digger came to excavate the reserved plot that Buckland's final geological jest was revealed, since the chosen spot was (as he must have known) in an outcrop of solid Jurassic limestone just a few inches below the ground. In the end explosives had to be used to excavate the grave, inevitably reminding all those at the funeral of Richard Whatley's "Elegy Intended for Professor Buckland" written on 1 December 1820:

> Where shall we our great Professor inter,
> That in peace may rest his bones?
> If we hew him a rocky sepulchre,
> He'll rise and break the stones,
> And examine each stratum that lies around,
> For he's quite in his element underground.
> (Gordon, 1894: 42).

3. SOME SCIENTIFIC INSTITUTIONS

3.1. UNIVERSITY OF OXFORD

It could very well be argued that even at the end of Buckland's life the University of Oxford had little claim to be listed as a scientific institution, but the general neglect of science was far worse, indeed institutionalised in the university's teaching and examination structure, when Buckland first went up to Oxford in 1801. William Tuckwell, who entered the University more than thirty years after Buckland, and who was one of the first historical commentators on science in 19th century Oxford headed the first of two chapters of his Reminiscences "Pre-Scientific Science", and began by saying:

> Prescientific unquestionably: in the Thirties the Oxford mind was inscient; its attitude first contemptuous, then hostile, towards the science that, invita Minerva, was hatching in its midst; a strange, new, many-headed, assertive thing, claiming absurdly to take rank with monopolist Humanities of Donland, not altogether without concealed intent to challenge and molest the ancient, solitary reign of its theology. (Tuckwell, 1901: 31).

When Buckland formally matriculated on 14 May 1801 he entered an institution that regarded itself as essentially a private Anglican body, completely independent of all outside controls or pressures, with the primary purpose of promoting the study of religion and the preparation of young men for entry to the Church of England ministry. Its membership was predominately rural in origin (whether from a modestly provided clerical family background or from one of the great country houses) and there was a strong southern and south-western bias in geographical terms. As early as 1772 the House of Commons had been seriously concerned about both Oxford and Cambridge in terms of the narrowness of their education and their exclusiveness in denominational terms. The internal Statutes of both were still governed by the provisions of Canon 36 of the Church of England dating from 1604 which required all members of any University or similar institution to take the 16th century Oath of Supremacy acknowledging the Sovereign as the Head of the Church, and make a formal subscription to the 39 Articles. Since Jews, Roman Catholics and Nonconformists (including the increasingly influential Unitarians and Quakers) could not take the Oath or subscribe to the 39 Articles, they were in effect debarred from University studies in England, and were forced to seek higher education either in Scotland or on the Continent.

In 1801 Oxford continued to apply the "Religious Tests" (as they were known) as a condition of Matriculation, i.e. initial entry to the University as an undergraduate, perhaps at the age of only fourteen or fifteen years, and this emphasized the religious exclusiveness of the University. (By this time Cambridge had liberalised its Statutes, and applied the "Religious Tests" as a condition of graduation, not of entry to the University, with the result that a small number of non-Anglicans had begun to enter Cambridge as full-time students, even though they were not permitted to take their degree at the end of their period of study). (Ward & Heywood, 1851: lx-lxii.)

Many aspects of the everyday life of members of the University were closely regulated by elaborate Statutes. For example, all were expected to wear the appropriate academic dress according to patterns: "engraved on brass, and lodged in the chest of the Convocation house" (Statute: Scholastic Dress and Costume, 1769). In addition to seven specified patterns and styles of academic gown related to the most senior degree held by the wearer, the Statute on Scholastic Dress also specified five different grades of student dress divided according to social status, with special patterns for sons of barons, baronets, "commoners of a superior order" and so on. In addition every member of the University "of whatever degree" was required to wear "in private as well as public dress" the then current form of clerical collar. Moreover the University re-affirmed the 1769 dress regulations in 1819, laying down a penalty of suspension for a whole term for each act of non-compliance (Ward & Heywood, 1851: 113).

The all-pervading clericalism of Oxford ran through most of the other Statutes. For example, all Heads of Colleges were required to take their turn (on average about once per year) in preaching at the weekly University service in St Mary's, and on his arrival at Oxford Buckland, as a Scholar, would have discovered that not only was he required to attend all of the weekly University services but was required to do so "from the beginning to the end, with true reverence and attention" or face a fine of 3s.4d. for each offence (Statutes of 1801). Moreover, under the same provisions, any member of the University of any rank who attended any sermon or religious service at any place not under the Church of England Episcopal authority was fined 6s.8d. for the first offence, 13s.4d. plus a "serious caution" by the Vice-Chancellor and Heads of Houses at their ordinary meeting, for a second offence, and a third offence resulted in "expulsion for ever". Quite apart from anything else, the authors of the Statutes clearly did not admit the possibility of members of the University wishing to worship in any part of the United Kingdom outside the jurisdiction of the Church of England, let alone on the Continent.

The new Statutes of 1800-1801 were not wholly obscurantist and dogmatic in the religious sense: they also introduced extensive reforms in relation to undergraduate studies. Under these it was now necessary for both students to study and tutors to teach and supervise in preparation for formal examinations, none of which had been compulsory (or even a notable feature of student life in at least some Colleges) at the end of the 18th century. However, even under the new regulations the studies were very narrowly drawn, with the compulsory subjects being the Gospels in Greek, Doctrinal Articles, Litterae Humaniores ("Lit. Hum.")i.e. Classics including both Greek and Latin compositions and literature, ancient history, rhetoric, moral philosophy and logic. In addition studies in mathematical sciences (largely Euclidian geometry at undergraduate level) and physics (entirely theoretical) were optional additional subjects of study.

Taking his Bachelor of Arts degree in December 1804, Buckland was amongst the first undergraduates to be examined under the formalised structure laid down in the Statutes of 1803. Under these the examination was entirely oral and in public, before a small board of examiners drawn from the Professors and the Heads and more senior Fellows of the Colleges, on an annual rota basis. Buckland appears to have studied across the whole field of the undergraduate syllabus (such as it was), although in the examination itself the only compulsory areas to be offered were the Greek Gospels, Doctrine, and a minimum of three Greek and Roman writers within the "Lit. Hum." because, as the regulations provided, "we intend nothing harsh" (Ward & Heywood, 1851: 63). However the examiners were especially required to assess the examinee's "powers in delivering the thoughts of his mind in Latin", and the Statute insisted:

> In preference, therefore, to all other subjects, the elements of religion are to claim first place. And the examiners are to keep in mind and religiously observe this construction of their oath, that a defect on that head cannot be compensated by any other merits of the candidates, by they what they may: so that any person that does not satisfy the examiners on this most momentous subject is to obtain no testimonial whatsoever. (1803 Statutes - Ward & Heywood, 1851: 62).

In practice, despite the claimed concern with "delivering the thoughts of his mind", both the teaching and the examination depended very much on detailed learning by rote, especially so after formal examinations were at last introduced, and with only limited tuition available in the critical areas it was hardly surprising that a conscientious undergraduate hoping to take a degree had little time for studies or interests outside the narrow confines of the prescribed syllabus. The pressures were especially great on those funded through scholarships, where continued funding usually depended on satisfactory progress reports, and whilst students were encouraged to take as wide a range of courses as practicable, there was inevitably a strong temptation to drop any subject outside the very narrow compulsory area if it was found uninteresting or difficult. Buckland's younger brother John quickly dropped Euclid, i.e. mathematics, although he did start to attend lectures in Logic instead (M.S. DRO 138M/F42).

The strong emphasis on religious observance was reinforced by the graduation ceremony in which the Statutes required the graduand to take the Oath of the King's Supremacy and kiss the Gospel, and then take the Oath of Allegiance and kiss the Book for a second time, (Ward & Heywood, 1851: 95). After graduation the social divisions were, if anything, strengthened by the Statutes. As undergraduates only the cut of the gown (and the student's financial provision and perhaps accommodation) distinguished students from one social stratum from another. However the Statutes provided that whilst the minimum period of residence after Matriculation before progressing to the status of a Scholar was four years, this qualification period was reduced to three years in the case of the sons of Barons and the eldest sons (only) of Baronets and Knights, and in the case of sons of Barons (or higher grades of Peer) even this three year period could be reduced to "a shorter period of time, if the Chancellor sees fit" (Ward & Heywood, 1851: 76).

In academic terms the life of a Scholar was transformed compared with that before graduation. No formal rules (or even areas) of study were laid down, and the Scholar was entirely free to choose fields of study or to attend lecture courses in any area that the University offered, without any restriction other than the ability to pay the prescribed fees in the case of formal lecture courses. Under the Statutues, except for a very limited number of University sermons and endowed Lectures (almost entirely on religious themes), those wishing to attend the courses of lectures at the various Professors, Readers, or Lecturers were required to pay the prescribed fees (usually 4 guineas or 2 guineas) direct to the lecturer concerned. In return, under the Statutes the advertised lecture had to be given on a particular day providing not less than three members of the University were present at the official starting time.

I consider that the organisation of the University's teaching and examination, and the prevailing academic atmosphere, is of great importance not only in assessing Buckland's own development, but in terms of his own work as a university teacher after he was appointed to his first Readership. Although the University insisted from time to time when under attack that its purpose was the provision of a broad and general education for men of all classes (including those with only very limited means through the well-established scholarship and patronage system), and to prepare its graduates for all walks of life, in practice, in the early 19th century particularly, its whole structure was _de facto_ that of an Anglican seminary, in which the highest priority was the production of able academics to fill the future needs of the University itself. The production of a reasonably literate, although not particularly imaginative, clergy was a second priority, and all other roles of the University were a very poor third. Although in many ways Buckland rebelled against the Oxford ethos both as a student, and subsequently through his professorial life with his decidedly unfashionable (in Oxford terms) emphasis on observational and experimental science, in practice he had little option but to go along with the system to a considerable extent despite its disadvantages (for example, the almost total absence of undergraduates from science courses because of the rigid and narrow nature of the examination requirements).

On the other hand, because of the unashamed clericalism of the Oxford system the role of, and interest in, science in early 19th century Oxford has almost certainly been understated in recent years. The College Fellows were almost entirely free agents with no specific duties or obligations, and with few if any pressures or restrictions in relation to their fields of study or research except for the (perhaps very influential in many cases) opinions of other members of the College, particularly the Head and more senior Fellows. The direct teaching workload of professors was minimal in terms of time, and in most cases it would have been possible under the Statutes to meet their entire annual teaching requirements in six weeks (at the rate of 4 one-hour lectures per week), and again administrative or preaching commitment permitting, the whole of the remainder of the year could be spent in research in absolutely any field of study (or indeed in idleness or comfortable living). The University had had some Chairs in science from the 17th century onwards, and in the first decade of the 19th century a significant number of both the Readers and College Fellows were well aware of, and very interested in, the most advanced areas of contemporary science, including the newly emerging science of geology. Amongst the professors these included the Regius Professor of Medicine, Christopher Pegge who, despite his own entirely classical education, became a distinguished anatomist, and who demonstrated anatomy by means of dissection of both human and animal specimens. (From around 1820 the young Mary Morland began to spend a considerable proportion of her time living in Oxford with the Pegge family, and her great skill in both anatomical drawing and dissection probably owed a great deal to Pegge.) Pegge was elected F.R.S. in 1795 and was knighted in 1799, two years before he was appointed to the regius chair of "Physic", which he held until his death in 1822 at the age of fifty seven. Although conscientious in carrying out the duties of his Chair, Pegge very soon extended not only his personal field of interest, but also his teaching programme into geology and mineralogy. There appears to have been little or no modern research on Pegge's work, but there is some evidence to suggest that by 1800 or 1801 at the latest he was already taking a very active interest in geology personally, and was arranging informal gatherings in Oxford of geologically-inclined men both from within the University and visitors from outside (Edmonds, 1979:48,note 16). Pegge's reputation as a geologist was certainly known outside of Oxford, because the entirely London-based founder members of the Geological Society included him in their first list of Honorary Members in 1807.

In the same year that Buckland went up to Oxford, 1801, John Kidd, a former student of Christ Church returned to Oxford after four years of study at Guy's Hospital, London. His first University appointment was as Reader in Chemistry, and two years later, in 1803, he became the first Aldrichian Professor of Chemistry, holding the office until 1832. (In 1822 he succeeded Pegge as Regius Professor of Physic, holding this chair until his death in 1851.) He too became drawn into mineralogy and geology, and was soon including mineralogical lectures in his chemistry course, and published an Outline of Mineralogy, and was granted the title of Reader in Mineralogy (although this did not carry a university stipend, but simply the right to charge a two guineas per student fee). After taking his B.A. Buckland was a student of Kidd for both his mineralogy and chemistry courses.

Kidd was also elected Honorary Member of the new Geological Society in its initial list of 1807. A third member of Pegge's geological circle, and a close friend of Buckland, was John Josias Conybeare, the elder brother of William Conybeare, who was at the time of the foundation of the Geological Society the newly appointed Professor in the decidedly un-geological discipline of Anglo-Saxon, from which he transferred to become Professor of Poetry in 1812.

By the time Buckland took his M.A. in 1808, John Conybeare had been joined in Christ Church by his brother William, and there were several others in Oxford who were to make their mark in various areas of academic and public life, who were very interested in geology, including William James of Oriel College and Philip Serle of Trinity College, both elected members of the Geological Society in 1812, William Hony, Fellow of Exeter College, elected to the Geological Society a few months after Buckland in 1813, John MacBride, Fellow of Exeter College and James Tyler of Oriel College, both elected members of the Geological Society in 1814 and John Shute Duncan, Fellow of New College, elected to the Geological Society in 1815. In addition to those who carried their interest in geology forward to the (quite extensive) membership of the Geological Society during the next decade, there seems to have been a number of others who took an intelligent interest in geology, attending both lectures and informal discussions during the first decade of the 19th century, including, for example, Edward Copleston and Philip Duncan. (Hugh Torrens has seen a four page manuscript note on geologists in Oxford at the beginning of the 19th century, probably by P.B. Duncan, but this appears to have been misplaced, it is to be hoped only temporarily, in the very large amount of uncatalogued manuscript material referred to as the O.U.M. "Buckland Papers" although other material appears to be included. Hugh Torrens (pers. comm.) considers that these notes confirm my view based on indirect analysis, that there was far more geological activity in Oxford at the beginning of the 19th century than has usually been admitted in histories of science.)

There is no doubt, however, that it was Buckland who both formalised and promoted the status of geology in Oxford. In 1813 Kidd gave up his unpaid Geological Readership specifically in order to create a place for Buckland since, as he explained at the end of the Preface already quoted (Kidd 1815: viii) it would have been an "injustice to the University" not to have allowed Buckland, by then the acknowledged leader of geology in Oxford, the Office appropriate to that status. At the time Oxford was very sparing indeed with the title "Professor" preferring that of "Reader" for the majority of University offices, although Oxford Readers were normally referred to as Professor in London and the country at large, following Scottish and Continental practice. Kidd's appointment as Reader in Mineralogy was somewhat anomalous in not being a formal office under the then current Statutes (those of 1808), not least because the office was in essence an honorary one, carrying no University or Regius Stipend. In the absence of any specific regulations to that particular chair it seems reasonable to suppose Kidd, and subsequently Buckland, followed the Statutes applying to comparable appointments. For example, under the 1808 Statutes, the Charles Viner Reader in Natural Philosophy was required to give annually a series of 24 lectures "at fewest on 24 different days in full term, so separated by convenient intervals that no more than 4 lectures be delivered each week." The Reader was required to give (at his own expense) at least fourteen days public notice before the start of each series. Failure to comply with any of the provisions of the Statutes resulted in the forfeiture of the whole of the stipend for the year's appointment. (Ward & Haywood, 1815: 99). Certainly in the case of Regius Chairs, and probably in the case of University appointments as well, the Reader's Stipend was paid only after the prescribed number of lectures had been given, and a certificate had to be submitted listing the dates of the lectures. On the other hand the students' fees were payable direct to the lecturer at the beginning of each lecture course, although the level of fees were regulated by the University. In Buckland's case each student paid two guineas for one academic year's course of Mineralogy lectures, and when a Geology course was added, the fee was fixed at two guineas for either Mineralogy or Geology, or three guineas for both subjects in the same academic year. Since, however, the great majority of undergraduates rarely registered for courses outside the fields of the still very narrow examination requirements, lecture series in non-examination fields such as science, or indeed John Conybeare's Anglo-Saxon or Pegge's Anatomy, were largely patronised by the relatively small proportion of the University who were undertaking post graduate studies, or who were, perhaps, Fellows. Consequently, with such low student fees, Buckland's appointment as Reader in Mineralogy, although very welcome in terms of status, did not mean very much in financial terms. Having had a sound grounding in the patronage system of the time, Buckland therefore sought the support of the Prince Regent, and was as a result granted a £100 per year Stipend to which, of course, he was able to add the £200 College

Fellowship (plus free accommodation and meals) and whatever he could raise in student fees.

Student registrations for a lecture course depended largely on a combination of three factors: its relevance to examination requirements, the perceived interest and importance of the subject, and the ability of the lecturer. On the first of these there was little that Buckland could do. Even though the new Examinations Statute of 1809 had nominally split the B.A. degree to give a choice between "Lit. Hum." or "Mathematical and Physical Sciences", and introduced classified degrees, in practice very little changed. The Statute repeated the 1803 provisions on the overriding need for the students to satisfy the examiners in the "most momentous subject" of religion, and indeed with very minor amendments of the wording this provision was carried forward into the new Examinations Statutes of 1825. Since Mineralogy and Geology were regarded as decidedly marginal to the question of the "elements of religion", and was not regarded as falling within either the mathematical or physical sciences, examination pressure was of no help at all to Buckland in terms of filling his lecture room. He therefore concentrated on the second and third possibilities, never missing an opportunity to stress the great importance of Geology in both intellectual and utilitarian terms, and, above all, developing and promoting his personal reputation as a brilliant and entertaining lecturer.

There appear to be surprisingly few details, published or unpublished, about Buckland's earliest courses of lectures, although it is clear that from the very beginning he took a very broad view of the title

"Mineralogy", including general geology as well. The earliest surviving public announcement, dated 29 April 1814 stated:

> THE READER IN MINERALOGY will begin his Course of Lectures on the Structure of the Earth on Monday May the 9th, at the Museum at Two o'Clock. The lectures will be delivered three times a Week. (Broadsheet, O.U.M., Buckland Papers).

At an early date, if not from the very beginning, the elements of palaeontology were also included, and there was a marked emphasis on practical work. During April 1814 in preparation for the May course (which in fact started on Tuesday the 10th rather than the 9th as originally advertised) he enlisted the help of Philip Serle in sorting out the geological collections in the Ashmolean Museum in preparation for their use in teaching, (Gordon, 1894: 14-15). Another innovation was the preparation of large-scale sketch maps and diagrams, often coloured, to illustrate the lectures. (A very large quantity of these still survive in the Oxford University Museum, and the various items are very revealing in terms of Buckland's teaching methods (see also the identifications of teaching aids by Boylan (1971) and Edmonds & Douglas (1976), and Murchison's description of Buckland's lecture room in Appendix 1.3).

As was to be expected the majority of the students registering for the course of the Reader in Mineralogy were graduates (including several who were senior Fellows, but despite this restricted potential audience Buckland regularly attracted between thirty and sixty students in each of the years 1814 to 1818 inclusive, and it seems clear that in addition there were usually several non-paying guests at each lecture, frequently very senior members of the University, or prominent public figures visiting Oxford who attended the lectures either out of curiosity because of Buckland's growing reputation or in response to a pressing invitation from Buckland himself anxious to show off his wares (see, for example, Edmonds and Douglas, 1976).

One of the comparatively few undergraduates to register during this period was the young Charles Lyell but even he did not register for so esoteric (and useless, in examination terms) a subject as mineralogy immediately. Going up to Oxford in January 1816 his first year's study concentrated on classics, including Herodotus, and his more scientific studies concentrated on Logic and Books 1-4 of Euclid. Lyell almost certainly met or at least knew of Buckland during his first year since although he was at Exeter College he had a friend at Corpus Christi College where Buckland was a Fellow, and after reading Robert Bakewell's Introduction to Geology during the Christmas vacation of 1816, Lyell enrolled for Buckland's Mineralogy course on 13 May 1817, (Wilson, 1972: 35-42). At the time Lyell was still less than half way through his second year, and the enthusiasm with which he threw himself into the new subject caused Lyell's father some concern, and he wrote to Dawson Turner: "Buckland's Mineralogical lectures are engaging him heart and soul at present."(Wilson, 1972:44).

By this time too Buckland was very active in the Geological Society, as were some of his former Oxford geological friends and associates several of whom had by then left Oxford, so Buckland developed a tradition that lasted many years under which as soon as the Geological Society's programme ended (usually towards the end of May) an informal Society gathering was held for up to a week in Oxford, usually during the first half of June. (From the early 1820s Sedgwick began to arrange a similar informal gathering of geologically inclined friends in Cambridge immediately after the Oxford gathering at which those with geological interests from both Oxford and Cambridge met up for several days of not too serious discussions and a good deal more eating and drinking, in the company of leading geologists from London, such as Greenough, and from "the country".) Lyell had shown sufficient interest and promise during his first course of Buckland's lectures that he was invited by Buckland to meet a number of the leading geologists of the day during the June 1817 geological gathering in Oxford. Several of the young undergraduate's life-long geological friendships seemed to have dated from that week, and less than two years later he was elected a Member of the Geological Society as soon as he graduated.

Despite later differences in matters of geological philosophy, there is no doubt at all that Buckland's most successful and famous student not only received a very broad geological education with a strong emphasis on both practical field work and on continental geology (drawing in particular on Buckland's extended tour of 1816), but also retained a very warm and genuine admiration for Buckland, despite the latter's undoubted faults, for the rest of his life. When, in 1827 Lyell wrote a long and wide-ranging contribution for the Quarterly Review on "The State of the Universities", which was overall devastatingly critical of the Oxford and Cambridge systems, the great success of the geological courses of Buckland, and of Sedgwick at Cambridge, was emphasised, and he suggested that there would be even greater support if such subjects could be brought within a far more broadly based, and less narrowly religious, examination structure:

> The efficacy of the present system, therefore, in so far as it depends on the stimulus supplied by the public examinations, is inseparably connected with the imperfect cultivation of all sciences that cannot lead to academic distinction. (Lyell, 1827: 260).

(There are a number of hints in the surviving correspondence of the period immediately before the Review that Lyell consulted Buckland on at least one earlier draft, and that as a result some of Lyell's more personalised attacks on his former University were amended, with the apparently paradoxical result that the indictment of the Oxford system as a whole was strengthened rather than weakened, and that although Buckland clearly found Lyell's attack somewhat distressing since he had by then already given well over half his life to Oxford, he accepted that Lyell's strictures were still as valid then as they had been when Lyell first entered his mineralogy class ten years earlier.)

By 1818 Buckland felt that the time was ripe for further advancement, for both personal and financial reasons. His 1818 course attracted more interest than ever, particularly amongst the more senior members of the University, and even his irascible Uncle John Buckland, a strict classicist, had attended one of his lectures, and had been very impressed although apparently baffled by the subject matter as Buckland explained to his father in May 1818 (MS DRO138M/F24). On the financial side, he found that his post was perhaps the most onerous in the University if carried out conscientiously. Quite apart from the high costs of the considerable amounts of foreign literature that was needed to keep up with current advances, he had to pay personally for any maps, diagrams or additional teaching specimens that might be required, and travelling expenses for fieldwork and research (including the regular participation in the Geological Society's meetings) added up to an annual sum that was almost certainly considerably higher than his total income (of perhaps £180 including students fees) from his Readership. Although no detailed accounts or other financial information appear to have survived, (it appears that only his scientific papers and correspondence were preserved by the family when he died), it seems very likely that most of his College Fellowship stipends of £200 per year was by 1818 being used to subsidise his research and teaching as well. There was, obviously, a very marked contrast between Buckland's position and that of, for example, his friend John Conybeare, Professor of Poetry who had not only very few teaching expenses to meet out of his (much larger) Stipend, but also a far better chance of recruiting large numbers of paying students because of the inherent bias in the examination system.

Buckland therefore determined to petition the Prince Regent via the University authorities and the Prime Minister (Lord Liverpool) asking for the establishment of a second Regius chair, this time in Geology. My own work on the very interesting manner in which Buckland went about this has been overtaken by an excellent, very substantial and detailed, paper specifically on the founding of the Oxford Readership in Geology, 1818, by the late James Edmonds (1979), and since my own findings and interpretations are the same as those of Edmonds only the briefest note is necessary at this point. Following the great success of his April-May 1818 course of Mineralogy lectures (which in fact covered most of geology as well) Buckland consulted his uncle and a number of his friends about the way in which he should proceed.

By the end of October he was able to report to his Uncle that a formal Memorial (i.e. draft Petition addressed to the Prince Regent) had been supported by the Hebdomadal Board of the University (i.e. the weekly meeting of the Heads of Houses under the Vice-Chancellor), and that the Board had agreed to put the position on the agenda for its next weekly meeting (MS DRO 138M/F23). Buckland's original claim was for appointment as Reader in Geology and as Curator of the University's geological collections, both offices to be held in addition to the Mineralogy Readership, and with a Stipend of £100 attached to each of the three offices, giving £300 in all.

At the meeting of the Hebdomadal Board a week later, 2 November, a more modest proposal was agreed. The Vice-Chancellor was asked to seek the assistance of the Chancellor, Lord Grenville, in obtaining Lord Liverpool's support for a £100 per year Stipend to be added to an office of Reader in Geology (only). Immediately after this, apparently in an attempt to force the issue, the Vice-Chancellor (Frodsham Hodson, Principal of Brasenose College) formally appointed Buckland as Reader in Geology (although on an unpaid basis, as had been the case with his original appointment as Reader in Mineralogy five years earlier).

Buckland amended his Memorial in accordance with the decision of the Hebdomadal Board, and included a reference to his new appointments, and this petition accompanied by copies of the appropriate minutes and of his letter appointing Buckland Reader in Geology, were all forwarded to Grenville on 9 November, who in turn sent them forward to Lord Liverpool with a strong personal recommendation, stressing:

> The advantages of this particular science as forming one essential link in the great chain of Natural History need not I am sure be insisted on: and I think it probable that the name of Mr. Buckland is not unknown to Your Lordship as that of a Person who in pursuit of that Study has already done much credit to the University and to his Country, and contributed largely to the rapid advance which has of late years been made in this branch of knowledge. And I trust that on these grounds I shall be excused for venturing to express my entire conviction that both with a view to the general progress to Science, and as a well-meritted encouragement to a very distinguished individual, H.R.H.'s bounty could not be better bestowed than by a compliance with this application from Mr. Buckland, seconded as it is by a strong recommendation and the earnest wishes of the whole University. (M.S. P.R.O.: TI/1771 - 1818 (23516).

The Memorial itself is interesting on several accounts (one of them being that the copies in the Public Record Office and the Devon Record Office are just about the only autograph manuscripts of Buckland that are entirely legible, demonstrating that he had an excellent calligraphic hand which he chose not to use!). Particularly pertinent are his references to the way in which his existing Readership had developed:

> That the Reader in Mineralogy in his Execution of this Office had found it necessary to extend his Lectures beyond the Elements of Mineralogy into Geology as constituting the higher and more important Department of his subject, and that his Lectures have uniformly been attended, and (as he has reason to believe) approved by Persons of the highest Rank and Consideration in the university. That in doing this he has found his Salary of 100£ per annum wholly inadequate to the Quantity of Time Labour and very great Expence [sic] which are necessary to the pursuit of these united Sciences, as extensive travelling is, and always will be indispensable to the acquirement of that knowledge which is essential to a Lecturer in Geology. That it is impossible to treat adequately in a single Course of Lectures the United Branches of Mineralogy and Geology ... M.S. DRO 138M/F43),

Although relations between Grenville and Liverpool were politically strained, the Prime Minister must have dealt with the matter immediately since Liverpool's reply informing Grenville that the Prince Regent had approved the proposal and had fixed a Stipend of £100 for the additional Readership, was dated 20 November 1818, only five days after Grenville had forwarded the proposal. Although obviously pleased with the decision as such, Buckland was very dissatisfied with the level of the Stipend fixed, and on 27 November 1818 he wrote a long letter to the Secretary to the Treasurer setting out his reasons why the additional £100 Stipend was inadequate, drawing attention to both his de facto position as Curator of the geological collections in relation to which:

> he alone will be a competent expositor, he is and will be perpetually called upon by Men of Science, foreign and domestic, who visit Oxford to shew and explain to them the contents of the collection .... In the case of foreigners it is due to the dignity of the University and of the Country that hospitality should be shown to them, and men of Science in the place invited to meet them, and this is not the least expensive of the duties that devolve on the Reader in Geology. His foreign connections arising from the nature of his pursuits will still further increase the number of his foreign visitors. His official correspondence will also be a source of perpetual demand on his time and money. He must not only travel himself but be in communication with other travellers and professors at home and in foreign countries (seeing that the whole World is the subject matter of his Science). (M.S. B.L.Add. M.S. 58995 - 68/69).

In the letter to the Treasury he also referred to the cost of "the purchasing of specimens to send abroad and receiving others in exchange", and insisted that his own expenses "on the carriage of letters, parcels, specimens and official exercises of hospitality" alone were already exceeding the value of his Mineralogy Readership, and that in addition his travelling expenses alone over the previous eight years had averaged £200 per year. However, despite the letter, and both an urgent visit to London to attempt to see the Secretary to the Treasury personally (in which he was unsuccessful), and the intercession of Robert Peel junior on his behalf, the Treasury was not prepared to re-open the issue, nor apparently was the University willing to meet Buckland's travelling and other exceptional expenses, although some bequest funds were eventually made available to assist with his museum responsibilities.

Perhaps the most important thing to emerge from these recent studies of the origin of the Geology chair at Oxford is the extent to which this was, in effect, a personal chair for Buckland. At the time it was common knowledge that Buckland had actively lobbied for the establishment of a second Readership, and that he confidently expected to be appointed to any such chair if it was established. On the other hand, he himself feigned modesty on his prospects of being appointed, and it is only with a detailed examination of the original documents that the true nature of the approach to the Crown becomes clear. The action of the Vice-Chancellor in appointing Buckland to an unpaid new Readership in Geology is another very interesting newly emerged factor, and it seems most likely that Hodson acted in this with the tacit approval of the Hebdomadal Board, in order to force the issue.

As noted above, Buckland began work immediately on an inaugural lecture emphasising the conformity of geology with religion as well as the utility of the subject. In fact, there was no obligation on a Reader, even one appointed to a newly-created office, to present a formal Inaugural Lecture in this way, and traditionally only certain designated professorial posts had carried with them an explicit or traditional obligation to present an inaugural address, Buckland's decision to arrange, advertise and publish such a lecture is yet another indication of the strategy that he was following in promoting the interests of geology (and indeed himself) within the University and to a wider public.

Certainly he was very successful in drawing attention both to the new science and to himself. He had a capacity audience at the Inaugural Lecture when it was given on 15 May 1819 under the title "Vindiciae Geologicae [A Vindication of geology]; or the Connection of Geology with Religion Explained". (The content of this has been discussed previously in Chapter 2.4 above.) The registration fee payable by each student was two guineas for a single course, or an additional one guinea for those who had already paid a two guinea fee for the Mineralogy course in the same academic year, and thirty eight members of the University registered for the first geology course that followed on immediately after the Inaugural Lecture, including the Chancellor himself, Lord Grenville, the President of St. John's College and the Junior Proctor.

Reconstructing and analysing the changing content of Buckland's lecture courses over the years would certainly be an interesting, and potentially valuable field for a future major research study. Very large amounts of manuscript material that have collectively been known as the "Buckland Lecture Notes" were donated to the Oxford University Museum by Frank Buckland, and are still preserved there. However, the designation "Lecture Notes" appears to be a serious over-simplification, and much of whatever archival integrity the papers had at the time of Buckland's death has been lost in successive use and re-sorting. Even today this important resource remains uncatalogued, although it had been widely hoped that this work would be carried out as part of Dr. Rupke's recent research fellowship on Buckland. In some cases Buckland prepared a fairly detailed outline of a particular lecture for either the Mineralogy or Geology course, and in such cases the years in which the particular lecture was given were recorded by Buckland at the head of the manuscript. Even so, the majority of the notes (other than quotations transcribed into them) consist of little more than aides memoires or "prompts" (in the theatrical sense) to remind Buckland of important topics on which he would then extemporise. In the case of other subjects, the so called Lecture Notes consist of little more than a paper folder within which Buckland gathered together a variety of notes relating to the subject in question, including, for example, letters received describing relevant observations, handwritten copies of quotations, and relevant newspaper cuttings.

Buckland's extensive use of maps, diagrams, specimens and structural models in the course of his teaching is very well demonstrated by the two surviving lithographs of Buckland lecturing, described in detail in Boylan, 1971, (see Fig.1), and Edmonds & Douglas, 1976: in both cases many of the items displayed in the lecture room have been identified, and in the case of the larger print Edmonds and Douglas have confidently identified most of the 29 men portrayed as members of his audience at the 1823 lecture that was drawn by the artist Nathanial Whittock. These included at least six Full Professors, five Heads of Colleges and the Bishop of Oxford, in addition to prominent geologists such as the two Conybeares and both the Duncans. Even allowing for some artistic licence (all may not necessarily have attended a lecture on the same day)

Buckland's audience was a most impressive one.

A much clearer picture of Buckland's Oxford lectures can be gained from a careful study of some student notes, taken down apparently verbatim in the case of some of Buckland's more memorable bon mots or more provocative or outrageous remarks. The earliest surviving set I have been able to trace is that of the young Newman who attended both the Mineralogy and Geology lecture courses in successive terms in 1821. However he only wrote up and preserved the mineralogy notes, regarding Buckland's geology as being too speculative and theoretical. Newman's notes are preserved in the Birmingham Oratory, and are very revealing in terms not only of the content of Buckland's mineralogy teaching (it was in fact fairly formal and clearly owed a great deal to that of Kidd, judging by the latter's valedictory publication (Kidd, 1815), and also in relation to Buckland's lecturing style. Newman's notes have been transcribed and are reproduced as Appendix 1.1 below.

From the 1820s a detailed note on one Geological lecture, together with one of Buckland's famous field trips to examine the Jurassic of Shotover Hill, was made by Murchison during his first stay with the Bucklands in Oxford, and this survives in the Murchison Papers in the Geological Society. A transcript of these notes is reproduced below as Appendix 1.2.

However, much the most complete record of Buckland's Oxford teaching is in the notebooks of J.E. Jackson who attended the whole of the Mineralogy course together with a truncated Geology course (reduced to half its normal length because of the British Association meeting) in 1832. The originals are in the Geological Museum Archives (British Geological Survey) and these too have been transcribed and are reproduced as Appendix 1.3 below. A comparison between the Newman notes of 1821 and those of Jackson eleven years later shows that the broad outline of Buckland's Mineralogy course had not changed over the period, and indeed some particularly telling points (or jokes) appear in both sets of notes. On the other hand, the Geology course appears to have had much new material in it, for example the section on Coprolites, and a considerable number of references to recent discoveries and controversies. Jackson also included a number of other notes and remarks of Buckland in the back of one of his notebooks, together with transcripts of notes that he had made about some of Buckland's unprinted comments and banter during the Megatherium lecture to the British Assocation.

One other completely unexpected value of Jackson's notes was that thanks to Jackson's careful phonetic transcription of proper names and other words with which he was unfamiliar, it is possible to demonstrate that Buckland had retained a marked West Country accent. This revelation was not in itself unexpected: it was once suggested that the young Charles Lyell, a Scot by birth but brought up largely in the New Forest, probably needed an interpreter when he first entered Exeter College, so strong were the prevailing Devonshire and Cornish accents of most of the residents from senior Fellows downwards, and a Devon accent would certainly not have been socially unacceptable in Buckland. However, so far as I am aware, whilst Buckland was certainly criticised for "coarse speech" in another sense, there appears to have been no written evidence for his possession of a Devon accent, and Jackson's phonetic mis-spelling of names such as "Beaumont" provides clear evidence of Buckland's manner of speech.

The changing emphasis of the subject matter of Buckland's lecture courses can also be discerned from the broadsheets that he was required to publish advertising the start of each course and from other direct or indirect publicity for them. For example, in 1822 he emphasized his discoveries at Kirkdale, reversing the order so that the Geology lecture course was given first in the winter term, while the issue was particularly topical because of his Royal Society papers, as noted above. In 1823 he announced the start of:

> "his Course of Lectures on the Composition and Structure of the Earth, the Physical Revolutions that have affected its Surface and the Changes in Animal and Vegetable nature that have attended them" (Broadsheet, 3 February 1823).

In that year he attracted 52 students, of whom only 19 were undergraduates, and who were *rewarded by a special lecture in February* on his recent discovery of the "Red Lady of Paviland". The following year, he capitalized on the tremendous success of the Reliquiae Diluvianae, and immediately after the long delayed publication of the Bridgewater Treatise he offered:

> a Course of Eight Lectures demonstrating the principal Organic Remains of a former World, which are figured and referred to in his Bridgewater Treatise (Broadsheet, 7 November 1836).

By 1843 Buckland had reverted to the summer term for his Geology course, offering:

> his Course of Lectures on the Composition, Structure, and Physical Revolution of the Earth, and the Changes in the Animal and Vegetable Nature that have attended them,... Members of the University have free admission to the Collections in Geology

and Mineralogy,..(Broadsheet, 6 May 1843).

The same year he offered a further course of eight lectures:

> on the Proofs of Unity and Design disclosed by Geology, from comparison of the extinct Forms of Animal and Vegetable Life with those now existing on the Surface of the Globe (Broadsheet, 20 October 1843).

(The two autumn courses of only eight lectures appear to have been supplementary ones over and above those required by his Stipend as Reader in Geology, and presumably an additional fee would have been payable for these). The advertised subject matter of the courses continued to be varied from year to year, with topical subjects being included, as for example in each of the last two years that Buckland was well enough to carry out his teaching duties:(DRO 138M/F291/293).

> his Course of Lectures on the Architecture and Physical Structure of the Earth, on the manifold Changes that have affected its interior and surface, adapting it for the habitation of the Human Race, and on the Remains of successive extinct races of Animals and Vegetables which preceded the Creation of existing species and of Man (Broadsheet, 18 October 1848).

The final Broadsheet was that of 18 October 1849 already quoted in full in Chapter 2.6 above, with its denunciation of the "Fallacies of the Doctrine of Development" in Chambers' (anonymous) Vestiges of Creation.

In the early 1820s Buckland appears to have had ambitions for further advancement within the Oxford system, and in February 1823 offered himself as a candidate for the prestigious office of President of Corpus Christi College, of which he had been a member for over twenty years, but was not elected. His eventual advancement within Oxford came not from the University as such, but from the Crown with his appointment as Canon Residentiary of Christ Church Cathedral, (apparently on the recommendation of Robert Peel, and presumably with at least the acquiescence of Edward Legge, the Bishop of Oxford). Of course, Buckland continued to play an active part in the life of Oxford over and above his teaching duties and his responsibilities for the Museum, and the more traditional senior Dons found that under the Statutes that they so stoutly defended, they now had no option but to listen to the eccentric geologist at least once a year or so when it was Buckland's turn as a Canon to preach at the weekly University service at St. Mary's where Newman was now the Incumbent.

The continued success of Buckland's lectures, coupled with the rapidly growing collections that he used very actively in his teaching, led the University to provide a far larger space, consisting of the western end of the first and second floors of the Clarendon Building, providing, in the words of a contemporary commentator:

> ample space for the exhibition of these interesting and in many respects unique collections. Their most remarkable contents fossil bones and other organic remains of a former world.... the convenient space and handsome provision now made by the University for the exhibition of specimens, combined with the advancement of science, must operate as a strong motive to the continual addition of similar benefactions. (Ingram, 1837: 15-16).

In fact the new museum and teaching accommodation was rushed into use by the University in time for the start of the British Association visit in June 1832. Just before the meeting Baden Powell gave a much publicised and debated public lecture on "The Present State and Future Prospects of Mathematical and Physical Studies in the University of Oxford", (Powell, 1832) in which he argued for the introduction of experimental science and of mathematics as compulsory examination subjects.

The new accommodation and the polite, perhaps even moderately enthusiastic, reception that Oxford gave to the British Association,, including the unprecedented award of Honorary Degrees to four "notorious" dissenters (John Dalton, a Quaker, David Brewster and

Robert Brown, both Presbyterians and Michael Faraday, a Sandemanian) appear to have given Buckland some hope that there would be a genuine "Advancement of Science" within the University. During the late 1820s and early 1830s he had increasingly found himself torn between his personal progressive "Peelite" Tory political and social views and the pressure on him from most of the University establishment to act in what was claimed to be the interests of Oxford. For example, in 1829 Mary Buckland, an independently minded evangelical Anglican, appears to have disapproved when Buckland withheld his support from the Catholic Emancipation Bill,(Lyell 1881A: 250-251). Consequently, in 1834-1835, although Buckland was apparently strongly in favour of the sentiments of Lord Radnor's Bill for University reform, and in particular as a first step the abolition of the religious "Tests", he finally gave in and joined all his fellow Canons in signing the petition against the Bill for the sake of unanimity, (although in Buckland's case the support for the petition appears to have been largely if not wholely confined to its objection to parliamentary interference with the independence of the University: Hampden,1834).

If Buckland felt that this kind of "trimming" would make himself, geology and the whole of science more acceptable to Oxford he was sadly mistaken. For example, although everywhere else in the World he was honoured with the title "Professor",from the early 1820s onwards, even the 1839 New Statutes of the Lecturers headed the first Chapter relating to Buckland: "Of the Lecturer in Mineralogy", although the text did provide that: "The reader in mineralogy [sic] is to expound this matter in one series of lectures every year", and whilst the next chapter was at least headed "Of the Reader in Geology", again the title was given with lower case initial letters in the text, which provided that he was "to explain the subject of that science in one course of lectures every year." (Ward and Haywood, 1851:241). Only with the University's formal evidence to the House of Commons in 1846 was Buckland listed by the University as a Professor, although it was made clear that despite this his official title was still only that of "Reader". (By this time the only other designated Professor, according to the Return to the House of Commons, who was not honoured with that title, was - significantly - Deane Walker, "Reader in Experimental Philosophy".) (Ward and Haywood, 1851:353-357).

Nor was there any liberalising of Statutes in relation to religious observance. Indeed, the 1839 New Statutes of the Lecturers specifically provided that no Lecturer was permitted to:

> Teach or dogmatically assert any thing in any measure opposed to the Catholic faith or to good morals. But on the contrary... whenever a favourable occasion presents itself... is to exalt his hearers to embrace and uphold sound doctrine, and to live reputably and religiously. (Ward and Heywood, 1851:244).

With his patron, Lord Grenville, dead no-one was prepared to do anything about the Stipend attached to the two Readerships: both remained unchanged at £100 per year up to and including the last year in which Buckland was able to give the prescribed courses, 1849, by which time the Mineralogy Stipend had been unchanged for thirty six years, and that for Geology for thirty one years. Also, from the high point of the 1820s Buckland's student numbers declined quite markedly, so that at the time of the House of Commons enquiry the University reported that the total number of registered (paying) students over the previous five years (i.e. 1841 - 1845 inclusive) had been only 107 or an average of just over 20 per year. These numbers were still better than those of Daubeny, who averaged only 16 students per year as Reader for his Chemistry course and only 6 per year for Botany, and was of the same order as that of the Regius Professor of Modern History (which by then had the very considerable advantage of being an optional examination subject). It must have been particularly galling to Buckland that Pusey, as Regius Professor of Hebrew, had between 5 and 10 students per year over the same five year period for a total remuneration of £1200 per year, (Ward and Heywood, 1851: 353-357). There is little doubt that Peel's wish to appoint Buckland to high ecclesiastical office, first to the Oxford canonry, and in 1845 to the Westminster Deanery, was at least in part to give Buckland the financial recompense and security that he was denied by the University. The fall in student numbers (with its corresponding effect on the income from his lecture courses) may in part have been due to a diminution in Buckland's charisma and flamboyance, but was even more a reflection of the almost total lack of interest in scientific matters amongst the great majority of members of the University, especially postgraduate students and Fellows who had provided the majority of Buckland's audience in the heyday of the 1820s. Although I am suspicious of the ambitious claims made on behalf of Cambridge by both its 19th century and more recent apologists (e.g. Cannon, 1978: 29-71), doubt whatsoever that the far more liberal atmosphere of Cambridge in the 1830s and 1840s (and indeed of the new foundations such as University College and King's College, London), must have placed Oxford at a serious disadvantage in terms of the recruitment and retention of young men with any kind of interest in the sciences.

Although there is no evidence that Buckland's final illness was anything other than physically induced, after his move to Westminster he clearly became more and more depressed (in the emotional if not the medical sense) by the state of Oxford during his frequent return visits (both to lecture and from 1847 during his extended periods of residence at Islip). His beloved geological collections rapidly degenerated into almost total chaos, and by the time of his death were a scientific scandal and a course for bitter public criticism of the University (which eventually shamed the University into providing the present Museum in Parks Road (completed in 1860) as the first part of a new Science Campus).

The initial moves that originally led to the building of the University Museum were made during the return visit of the British Association to Oxford in 1847. Daubeny and Henry Acland tried to enlist Buckland's support for the project but he refused saying:

> "Some years ago I was sanguine, as you are now, to the possibility of Natural History making some progress in Oxford, but I have long come to the conclusion that it is utterly hopeless. The idle part of the young men will do nothing, and the studious portion will throw their attention into the channel of honours and profits which can alone be gained by the staple subjects of examination for degrees and fellowships. (M.S. RSL: 1561a).

Buckland had been a member of Oxford University for very nearly half a century by this date, but in his view the institution, always an intimate and relatively closed society, had finally turned completely in on itself. All efforts of reform of its educational objectives and systems were rejected, as were any attempts at outside "interference", while the University seemed hell-bent on tearing itself apart as a result of factionalism within the Anglican community, particularly the conflicts between those who wanted to continue living, in Oxford, the life of a comfortably off, moderately intellectual, country parson, and the aestheticism and reforming zeal of the Tractarians.

Thirty years ago, F Sherwood Taylor in his paper "The Teaching of Science at Oxford in the Nineteenth Century" (Taylor, 1952), traced the chequered history of Oxford science throughout Buckland's period and beyond, and commented:

> From 1813 to 1848 William Buckland had been the most effective agent in the promotion of scientific studies in the University. (Taylor, 1952: 83).

In reality, this was faint praise (although Taylor's evaluation was a genuine one, without irony, and he clearly held Buckland and his work in high regard). Oxford had few men of scientific distinction, and was even less successful than Cambridge in retaining the few scientifically-inclined graduates that it produced, despite a much more liberal celibacy rule. In most cases, College rules required Fellows to resign on marriage, although from the late 18th century exceptions were made by Oxford colleges in the case of fellowships that were difficult to fill. For example, Corpus Christi College allowed the appointment of unordained married men as Medical Fellows, and others made exceptions for Legal Fellows, again because of their scarcity.

Also, Oxford, unlike Cambridge, permitted Professors to marry, although they usually had to give up their lucrative College appointments. A J Engel's recently published book <u>From Clergyman to Don. The Rise of</u>

the Academic Profession in Nineteenth-Century Oxford (Engel, 1983), based on his 1975 Princeton Ph.D. of the same title, is very revealing on the professionalising of academic life in Oxford through the 19th century, and is extremely relevant to an understanding of the development of both science teaching and scientific research in the University during Buckland's time.

Certainly, Buckland had successfully established the Readership in Geology and had built up for the (largely uncaring and unknowing) University magnificent collections in both geology and comparative anatomy. However, even the most ardent apologist for 19th century Oxford science, such as William Sollas, one of Buckland's successors in the geology and mineralogy chair, and one of his most fervent admirers, dealt almost exclusively with Buckland's private research work, carried out mainly far away from Oxford, in his chapter entitled "The Influence of Oxford on the History of Geology" (Sollas, 1905: 219-256). In reality Buckland suffered in Oxford the classic fate of the prophet in his own land, and found his scientific satisfaction and rewards elsewhere, most notably in the Geological Society, and his esteem just about everywhere else in the scientific world other than Oxford.

His teaching methods were very unconventional and innovative in terms of contemporary English (and indeed most Scottish and Continental) universities. Quite apart from the theatricality of the actual lectures themselves, the continuous and imaginative use of teaching aids such as maps, diagrams and specimens was an important landmark on the road from the abstract "theory of the earth" view of geology to the vision of geology as a practical and useful science, based on structured observation, the testing of hypotheses and experimentation. It is true that Werner used to pass mineral and rock specimens around his classroom in the way that Newman and Jackson (Appendices 1.1 and 1.3) describe, but in Buckland's case, such lectures in the classroom or museum were supplemented as an essential element of his teaching, by equally well-planned teaching in the field, which in fact set a pattern that is still regarded as an essential element of undergraduate teaching not only in geology, but also in other observational sciences, at the present day.

At first these teaching excursions were confined to places within walking or riding distance of the Oxford lecture room, but with the opening of the Great Western Railway route through Oxford, places as distant as Bath and Bristol were brought into the field teaching programme (despite Buckland's aversion to rail travel). On these railway journeys, Buckland gave a running commentary on the geology and scenery of the country through which the group was travelling, especially on the geological evidence exposed in the freshly excavated railway cuttings.

Buckland's innovations in both the arrangement and educational use of geological museums were also notable. He emphasised systematic collecting, international comparative material, hence his appeal in the early issue of Silliman's new American Journal of Science (Buckland, 1821B), and the proper recording and labelling of specimens. Many hundreds of items still surviving in the Oxford University Museum (despite the appalling neglect of the mid-19th century) bear clear identifications and locations written on the specimen itself by Buckland, or in his wife's far clearer, but still very distinctive hand. But above all it was his imaginative use of the museum collections as an integral part of the teaching not only of mineralogy (as, for example, Werner was doing by the end of the 18th century), but also of general geology and palaeontology. His educational views were also very much to the fore in both the establishment and the early organisation of the Geological Museum.

His own experience in the first decade of the century of extended periods of geological mapping in the field in his own student days (see Chapter 2.2 above), convinced Buckland of the immense value of mapping projects as an aid to the learning of geology. He certainly initiated both Lyell and Murchison in the techniques of geological mapping, and most probably De la Beche also (although there seems to be no direct evidence on this point). Murchison's extraordinary feats of mapping first in Wales and the Welsh Borders, and then over the vast European part of the Russian Empire, would have been reward enough for any teacher, without the work of Lyell, or that of De la Beche and Murchison again as successively the first and second heads of the Geological Survey.

There is also a clear parallel between Buckland's very "progressive" views (in the modern educational sense) on the education of his own children (boys and girls equally), and his approach to university teaching in geology. Almost from the time that each child began to walk he took time off each day that he was in Oxford or with the family on holiday to teach them by means of practical experience and careful observation in many fields of science, particularly natural history, with special emphasis on careful observation, experiment (including dissection as soon as they were old enough to understand the safe use of knives and other instruments), and logical deduction (see Chapter 3.4 above, and the many reminiscences of his children in F Buckland, 1857 and 1858; Gordon, 1894; and Bompas, 1891).

Probably extremely few present-day teachers of geology, and none of their students, realise that most of the traditional British approaches to the successful teaching of geology in the classroom, the laboratory and in the field, even down to the belief in the value of individual mapping projects as a key part of the learning process for the advanced student, which are still used successfully today in Britain and many other parts of the world, owe their origin to the first holder of a Geology Chair in England, William Buckland.

Overall, Buckland's contribution as one of the outstanding teachers of science (in any subject) that Oxford has ever known is undeniable, and perhaps that should be honour enough for someone who made a profession of University teaching. I think it is by no means fanciful to read a strongly autobiographical element in the last paragraph of Buckland's warm tribute to the lately deceased fellow vertebrate palaeontologist and Quaternary specialist, Professor Blumenbach, in Buckland's last Anniversary Address to the Geological Society of London:

> Blumenbach seemed born for the express functions of a Professor; from morning till night, his academic duties were his daily occupation and delight; and the works of his leisure hours are a register of the progress of discovery in many branches of natural science during half a century in which he flourished. As a lecturer his style was familiar, playful, and not unfrequently jocose, always animated and sometimes eloquent, leaving a clear understanding and deep remembrance of the matter he wished to impress upon his hearers; he was the personal friend, as well as the preceptor of all his pupils, of whom great multitudes have expressed their gratitude in dedications of their works to the teacher from whom they derived the rudiments of their knowledge. (Buckland, 1841B: 536).

3.2 THE GEOLOGICAL SOCIETY OF LONDON

In the late 18th century there was a growing interest in London in scientific matters, particularly the emerging science of geology, and a number of practically-orientated but mainly short-lived groups and societies came into existence, most notably the Askesian Society formed in 1796 (Inkster, 1977), and the closely associated British Mineralogical Society formed (at a meeting held in the Askesian Society's room) in 1799, (Weindling, 1979 & 1983). The two societies merged in January 1804, perhaps in part as a result of the great success of the Royal Institution (founded in 1799 and incorporated in 1800) which was able to offer a far more attractive programme of scientific demonstrations and public experiments than the Askesian Society was able to provide for its members. The Royal Institution was also establishing a reputation in the geological sciences and by 1804 already had a geological museum of more than 3,000 specimens, largely as a result of the encouragement of Humphry Davy, who from 1805 began to offer lecture courses on geology in addition to his established and very popular chemistry lectures, (see the recent study of the "R.I." by Berman, 1978).

There were, however, doubts about the seriousness of the Royal Institution, with its fashionable somewhat dilettante following, amongst those with a more serious interest in geology and mineralogy. Thirteen London-based gentlemen agreed to form what was intended to be "a little talking Geological Dinner Club" (Woodward, 1907: 10) and on 13 November 1807, eleven of the thirteen dined in the old Freemasons' Tavern in Covent Garden, and formally resolved to inaugurate the dining club as simply the "Geological Society" (not yet "of London"). Several professions were covered by the founding members, who included four medical men (William Babington, James Franck, James Laird, and James Parkinson), four chemists (Arthur Aikin, William Allen, Humphry Davy, and William Hasledine Pepys), two printers and booksellers (the brothers William and Richard Phillips), and three gentlemen of independent means (the French Count Jacques-Louis de Bournon, who usually anglicised his name to James Lewis, George Bellas Greenough and Richard Knight). Of these, although several, perhaps a majority, were able mineralogists and/or geologists, only one had received any formal education in geology: Greenough had studied mineralogy under Werner at Freiberg. So far as other affiliations were concerned, only two of the thirteen were Fellows of the Royal Society (Davy and Greenough), whilst four were Quakers (Allen, Pepys and the Phillips brothers), and Aikin had been a Unitarian minister.

The Minutes of the first meeting held on 13 November 1807 record that it was:

> Resolved:
> That there be *forthwith instituted* a *Geological* Society, for the purpose of making geologists acquainted with each other, of stimulating their zeal, of inducing them to adopt one nomenclature, of facilitating the communication of new facts, and of ascertaining what is known in their science, and what yet remains to be discovered. (M.S. GSL: OM 1/1).

After defining the thirteen inaugural members, the Minutes continued:

> That henceforth members be chosen by ballot. Any person desirous of becoming a member, having communicated his wish through the secretary to the Society, without being proposed or recommended in any other manner, shall be balloted for at the next meeting. The election to be unanimous.
>
> That no person resident in London attend more than two meetings of the Society without becoming a member.
>
> That each member shall be at liberty to introduce a visitor, under the preceding regulation.

> That the Society dine together at the Freemasons' Tavern, on the first Friday of every month, from November to June inclusive, at 15s. per head, visitors to pay as members. Dinner to be on the table at 5 o'clock precisely. Fine for non-attendance, 10s. 6d. Any member may avoid this fine by sending notice to the secretary of his intention to be absent, three days before the meeting....
>
> That a book be provided for recording the minutes of the Society, and for the insertion, by members or visitors, of any geological intelligence that may be presented. Every communication must be signed by the person who makes it. (M.S. GSL OM 1/1).

The origins and early development of the Society have been covered in considerable detail by Horace B Woodward in the official centenary history of the Society (Woodward, 1907) as well as by more recent historians of geology. Paul Weindling (1979 & 1983) has recently worked on the antecedents of the Society, and the study by Martin Rudwick (1963) was particularly important, emphasising the Society's own perception of its role in the promotion of co-operative geological research:

> Both on account of the intrinsic value of such information, as laying the foundation of a general geological map of the British territory, and on account of the material assistance which it may afford to future inquirers. (Geological Society, 1811: viii).

In emphasising this Baconian view of its role, very reminiscent of the chart plotted for the Royal Society by its 17th century founders, from which it had long since strayed, the founders of the Geological Society were clearly anxious to escape from the largely sterile arguments about "theories of the earth" that had from time to time racked and even split 18th century societies both on the Continent and in Britain, and which were still stifling geological progress in, for example, Edinburgh at the time of the Geological Society's foundation. The Preface to the Society's first volume of Transactions, dated 25 June 1811, emphasised this point:

> In the present imperfect state of this science, it cannot be supposed that the Society should attempt to decide upon the merits of the different theories of the earth that have been proposed. (Geological Society, 1811: viii).

In practice, although theoretical speculation was very much frowned upon, most if not all of the founder members were convinced Wernerians, led by Greenough, the first Chairman (re-designated President at the next meeting, and serving until 1813, with a second term as President from 1833 to 1835).

At the second meeting, held on Friday 4 December 1807, Charles Greville was elected Patron of the Society, and a long list of prominent figures in various areas of science living outside London, were elected Honorary Members of the Society. The 42 prospective honorary members in fact outnumbered the London members by a ratio of more than three to one, but this ruse had the desired effect, so that within less than a month of the initial dinner at the Freemasons' Tavern the Geological Society could claim as members almost all the prominent geologists and mineralogists in the British Isles, and many other distinguished scientists together with others prominent in public life. The Honorary Members included the Professors John Playfair and Robert Jameson in Edinburgh, Professors John Conybeare and John Kidd of Oxford, and the Woodwardian Professor, John Hailstone, of Cambridge.

The following year the ballotting arrangements were relaxed so that a majority of only two-thirds was required for the election of ordinary members, and a simple majority for honorary members (compared with the previous requirement for a unanimous vote). In addition, the membership was further extended by offering honorary membership to "any foreigner ... who has previously intimated a wish to correspond with this Society"(Minutes of meeting of 1 April, 1808: M.S. GSL OM 1/1).

By the beginning of 1809 the Society had built up a significant cabinet of specimens, and had decided to rent its own accommodation, and some space in Garden Court, The Temple, were taken on behalf of the Society. This move caused the first serious rift with the Royal Society. The President of the Royal Society, Sir Joseph Banks, had applied for ordinary membership of the Geological Society in January 1808, apparently confident in the knowledge that it was to be no more than a scientific dining club, but resigned in February 1809 because he regarded the Society's move to acquire its own accommodation, however modest, as a direct challenge to the Royal Society. In an attempt to mediate, the Patron, Greville, put forward a plan for merging the Geological Society with the Royal Society but as an "Assistant Society" empowered to admit subscribing members, not Fellows of the Royal Society, as "Assistant Members". At the 3 March 1809 meeting of the Society, the resignation of Banks and the proposal of Greville were received. It was agreed that Greville's proposal should be printed and submitted to a special general meeting of the Society but the outcome of the special meeting appeared to be a foregone conclusion, since the Society accepted the resignation of Banks "with deep regret" but asserting that "they are not conscious of having deviated from the principles which they entertained at their first establishment" (M.S. GSL OM 1/1).

The following week the special general meeting decisively rejected Greville's proposal for merging with the Royal Society as an "Assistant Society", declaring:

> That any proposition tending to render this Society dependent upon, or subservient to, any other Society does not correspond with the conception this meeting entertains of the original principles upon which the Geological Society was founded. (M.S. GSL OM 1/1).

Three more Fellows, Greville, Davy and Sir James Hall, immediately resigned their memberships of the Society. (Davy re-joined in 1815 only to resign a second time over the issue of the Society's application for a Royal Charter in 1824 - see below.) Despite this apparent split with the leadership of the Royal Society, the new Society does not appear to have lost any other members, and when first a board of permanent Trustees and then a Council were elected by the Geological Society in April and June 1810 respectively, four out of the seven Trustees and nine out of the 21 members of the Council were Fellows of the Royal Society as well. By this time, too, the Society had joined with the Medical and Chirurgical Society to take a complete house at 3 Lincoln's Inn Fields, with the Geological Society occupying the whole of the second floor for its growing collections of geological materials and maps together with its library, with shared meeting rooms on the first floor, and all but one room (used by the Medical Society) on the ground floor as residential accommodation for a joint clerk appointed by the two Societies (report of Committee of Trustees, 6 April 1810: M.S. GSL OM 1/1). At this time the insurance value of the Society's property had reached £400 and the annual subscription was four guineas.

The driving force behind the scientific work and development of the new Society was undoubtedly its President, Greenough, who was only 29 years old when the Society was founded in 1807 (the year in which

Greenough was also returned to Parliament as Member for the Borough of Gatton in North Surrey - a "rotten borough" with an 1831 population of only 145). He was anxious to set the new Society on a path of practical co-operative research into the mineralogy and geology of the British Isles, leading to the production of a definitive geological map of England and Wales, supported by scientifically collected and properly identified and recorded mineralogical and geological collections in the care of the Society itself (in contrast with the "cabinet of curiosities" standard of the small number of public collections then in existence, most notably that of the British Museum).

Buckland must certainly have learned of the new Society, its rapid expansion (with the 200th member - William Conybeare - being nominated on 19 April 1811), and its ambitious plans for practical geological work, and was very much attracted to the Society and its leading members, notably Greenough. He first attended a meeting of the Society at Lincoln's Inn Fields on 3 May 1811, and began almost immediately to supply notes of geological observations to the Society during his extended geological tour of England, Scotland and Ireland during the summer of 1811 (see Chapter 2.3 above), and the following year he made his first donation of specimens to the Society (Geological Society, 1814: 543). However, at this stage he did not join the Society, although he would certainly have been more than eligible: presumably his straitened financial circumstances was the cause of the delay in seeking nomination. At the time he was still living on his Corpus Christi studentship, eked out by some modest fees from private coaching and occasional preaching engagements, so the four guineas per year subscription to the Society, coupled with the far greater (on an annual basis) cost of travelling regularly to London for the fortnightly meetings of the Society, was probably beyond his means. News of Kidd's impending resignation from the Readership in Mineralogy and the near-certainty that Buckland would be appointed to the office as Kidd himself recommended, changed the financial outlook very considerably, and a nomination paper, signed by Greenough, James Laird and Leonard Horner (respectively the President and the first and second holders of the office of Secretary) was deposited on 19 February 1813, and Buckland was duly elected as Member No. 241 in the non-resident class, at the ordinary meeting held on 19 March 1813.

From then on Buckland was one of the most frequent contributors to the Society's geological collections, and also became more and more involved in detailed mapping for the Society's projected large-scale map of Britain, carrying out important work in many parts of the British Isles, notably in Northern Ireland (with William Conybeare) and in his excellent mapping of the Cross Fell Inlier, Cumbria (see Chapter 2.3 above). Another major project was the compilation of a detailed table of stratigraphical correlations *not only for the British Isles, but also* comparing the British strata with those of the Continent of Europe for the benefit of Geological Society members and others carrying out geological work both in Britain and abroad, and several versions of this were produced, as discussed in Chapter 2.3 above. In this, Buckland appears to have gone against Greenough, who believed that at least at that stage British geology should be looked at in total isolation without any theoretical or speculative attempts at correlations with Continental localities.

Whilst Buckland loved Oxford as a place to live and work in, for more than 40 years he regarded the Geological Society as his intellectual home and club. Although no-one appears to have seen the journal of Mary Buckland since Mrs Gordon wrote her biography in 1894, Buckland's movements can be reconstructed to a very considerable extent from the letters to and from a very wide range of correspondents and from the recorded comments of other Fellows of the Society. It is clear that Buckland only rarely missed a fortnightly meeting of the Geological Society, despite the fact that each meeting involved 10-12 hours of travelling time by coach or on horseback together with an overnight stay in London. In the valuable series of studies on "The Cambridge Network" in early 19th century English science, Cannon (e.g. 1978: 29-71) under-estimates, in my view, the role of the Metropolis and the growing number and size of national scientific bodies based in London, and only resolves the dilemma by making Cambridge a sort of "honorary suburb" of the Metropolis (or perhaps vice versa!). Certainly it was in London (and later in a succession of unlikely provincial commercial and industrial towns visited by the British Association) that Buckland came into contact on a regular basis with the other leading geological figures of his day, drawing from them stimulation and support, and offering inspiration and practical help in return.

Unlike most of the other prominent geologists in the Society, Buckland did not serve on the Council prior to his election direct to the office of Vice President in 1818, but this may well have been because he was a "non-resident" member (i.e. he was not living in London), and hence would have great difficulty in participating fully in the practical work of the Committees of the Council which were primarily concerned with different aspects of the operation of the Society's Rooms or its

Transactions (which were published in London by William Phillips as a privately-financed venture).

Buckland was an early supporter of the Transactions, and continued to contribute the results of his important research to the Society throughout his life, although during the 1830s and 1840s he also offered a considerable number of more minor papers to the British Association and the Ashmolean Society of Oxford. In fact, only two major geological papers were offered elsewhere. The first was Buckland's 1822 paper on Kirkdale Cave which was "captured" by Davy for the Royal Society's Philosophical Transactions on the award of the Society's Copley Medal, but even there Buckland had given a private account of his discoveries and conclusions to his friends at the Geological Society before he gave the formal paper to the Royal Society. The second was his analysis and interpretation of the morphology of the Megatherium, which was given initially as his rumbustious Saturday evening lecture to the Oxford Meeting of the British Association in 1832, and which finally appeared as a chapter of the Bridgewater *Treatise in 1836.*

Buckland's greatest opportunity for service to the Geological Society came in 1824 when he was elected President (in effect for a two-year period but subject to annual election). The Council and other senior members of the Society had already discussed the possibility of petitioning the Crown through the Privy Council for a Royal Charter of Incorporation for the Society, and few if any of the active geologists in the Society would have been a more suitable choice to serve as President during such a complicated manoeuvre, bearing in mind not only Buckland's high popular standing at the time in the wake of the success of the Reliquiae Diluvianae, but also his past success in persuading the Crown first to add a stipend to the Readership in Mineralogy in 1813, and then to endow a completely new chair of geology in 1818. His friendship with the young Robert Peel, recently appointed Home Secretary in Liverpool's government, could also be called upon if necessary.

Almost immediately upon taking the chair, it became clear to Buckland that there was a serious danger of a confrontation with the Royal Society almost identical to that of 1809 because of the Royal Charter proposal. Indeed, on this occasion the potential danger was considerably greater in that whilst in 1809 the worst that the Royal Society could do was urge its Fellows to resign from the Geological Society, the Royal Society could on this occasion take legal steps to try to block the Geological Society's application by means of petitions to the Crown objecting to the granting of a Charter. At the very least such a move would have greatly added to the Geological Society's expenses (at a time when it was struggling financially under the very heavy burden of its publications programme, having recently taken over the financing of the Transactions from William Phillips); at worst the Society could spend a considerable amount on legal and other fees and expenses and yet come away from the Privy Council empty-handed. There was no doubt that then (as indeed, now) the granting of a Royal Charter to a learned or professional body not only has practical benefits in terms of giving the organisation a legal corporate status, simplifying the purchase and holding of property and investments, but also adds greatly to the prestige of the organisation and the science, profession or other field that it represents, as a kind of Royal seal of approval. On the other hand, should the Crown reject an application for a Charter for any reason (and the reasons for refusal are never stated), then the reputation of the society or other organisation could very well be seriously damaged.

Despite the risks, it was felt by the Council that the status that the Society had already achieved in less than 17 years, coupled with the scientific and economic importance of geology and its comparative neglect at an official level in Britain compared with many continental countries, justified the idea being put before the members of the Society. It was therefore virtually essential that the Royal Society should be persuaded at least to acquiesce, if not positively support, the Geological Society's proposed move.

At the 23 April 1824 meeting of the Council Buckland as President, the two Secretaries (Lyell and Philip Webb), the Treasurer (John Taylor) and five other members were appointed a Special Committee to prepare the draft of a petition to the Crown for the granting of a Royal Charter "& of taking other measures which may be requisite in furtherance of the same" (M.S. GSL CM 1/1). The following week, on 1 May 1824, a special meeting of the Council was held at which the question of the Royal Society's possible attitude to the Charter Petition was discussed and it was resolved:

> That Mr. Warburton, as a Member of the Council of the Royal Society, be requested to state to the meeting of that Council, on Thursday next, that he has been desired by some Members of the Geological Society, to make it known to the Council of the Royal Society, that an application was about to be made to his Majesty's Government for a Charter of Incorporation for the Geological Society. (M.S. GSL CM 1/1: 324-325).

On 7 May Buckland chaired a further meeting of the Council at which it was agreed to call a special general meeting of the Society on 21 May, to be held after the ordinary meeting announced for that evening, "for the purpose of discussing the propriety of applying to the Government for a Charter of Incorporation", and it was also agreed that John Vandercom, a prominent London lawyer with experience in the field, and a member of the Society, should be added to the Special Committee. (M.S. GSL CM 1/1: 325-326).

There was a further discussion at the meeting of the Council held on 21 May immediately before the special general meeting. It was agreed to report that the legal expenses involved in petitioning for and obtaining a Charter would amount to about £300, or almost half of the Society's cash at the bank, but in addition it had investments totalling almost £380. Nevertheless the Council considered that such a large expenditure was justified "having deliberated respecting the advantages which the Society may derive from obtaining a Charter". The Council also received the good news that Davy, President of the Royal Society, had himself raised the matter of the Geological Society's intentions at the Royal Society's Council meeting and had "expressed his opinion of the propriety of such an application." (M.S. GSL CM 1/1: 327). The well-attended special general meeting later that evening was enthusiastic about the proposal and empowered the Council to proceed.

The first draft of the proposed Charter was considered by the Council on 18 June, and it was agreed that this should be printed and despatched to all members prior to a further special general meeting called for Friday 2 July 1824, at which it was approved. Everything seemed to be progressing well, if slowly, when at the first meeting of the Council of the winter session, on 19 November 1824 Lyell, as Secretary, reported that Humphry Davy "had tendered his resignation as a Member of the Society" despite his apparent support the previous May. The Council was by this time in no mood for compromise, and simply requested the Secretary "to inform him that the Council accepted his resignation, his arrears having been paid." (M.S. GSL CM 1/1: 334).

By the 18 March 1825 meeting of the Council Warburton was at last able to report progress with the Charter application: accompanied by Vandercom he had called on the Attorney General personally, and had been assured that the draft Charter was quite acceptable. At the Privy Council meeting held on 23 April 1825 the Charter was formally approved and sealed. Under the terms of the Charter Buckland, Arthur Aikin, John Bostock, Greenough and Warburton were appointed the first Fellows of the newly incorporated Society. The Charter also provided for the transitional arrangements under which three of the designated Fellows would form a quorum for the purposes of electing members of the predecessor body and others worthy of membership as Fellows or Foreign Members of the incorporated Geological Society of London. Under the Charter Buckland was appointed the first President to serve until the third Friday in February 1826.

In accordance with the terms of the Charter, Buckland, Warburton and Greenough held the first meeting of the Geological Society of London, and appointed as Fellows of the new Society the 19 members of the Council of the Geological Society who had not been specifically named in the Charter, and appointed from these three Secretaries (Lyell, Scrope and Webster), a Foreign Secretary (Heuland) and a Treasurer (John Taylor). It is also reported that:

> The Council of the Geological Society reported to the Council of the Geological Society of London, that they had paid Mr. Vandercom his bill for expences attending the Charter amounting to £385.14.6. (M.S. GSL CM 1/2: 8-9).

The following day Buckland presided at the second meeting of the Geological Society of London at which a further 19 Fellows were elected from the membership of the former body. At a further meeting held on 20 May (with Warburton in the Chair although Buckland was listed as attending), Vandercom's report was received saying that he had the sealed copy of the Charter and suggested making a formal presentation of it to the Council. He explained that the cost previously notified was entirely made up of fees paid by him on behalf of the Society and that he had made no charge whatsoever "beyond the money out of pocket" as "the only sort of service in my power to render". He also congratulated the Council:

> that our Society, in point of authority, now stands upon a par with the highest Society in the Kingdom; and it is my sincere hope and expectation, in point of general utility it will not be deemed inferior to any. (M.S. GSL CM 1/2: 11).

The meeting then proceeded formally to elect as Foreign Members 48 distinguished foreign scientists who had been Foreign Members of the predecessor society, and a further 302 ordinary Fellows (taking care to ensure that no-one whose contributions to the predecessor Society were more than two years in arrear was elected a Fellow of the chartered Society).

Vandercom's offer of a formal presentation was accepted and this was held on 3 June 1825 in the presence of the Charter Fellows and eight Fellows who had been members of the Council of the predecessor Society at the time of the Charter. After the formal proceedings Buckland presided at the dinner in honour of the occasion held, appropriately, in the Freemasons' Tavern, where the inaugural meeting of the Society had been held, over dinner, in November 1807. Two of those present had been at the inaugural dinner: Greenough and Aikin, although it had proved impossible to effect a reconciliaton with the most distinguished of all the founder members, Sir Humphry Davy P.R.S.

In terms of advancing the status of the Society, both at home and overseas, Buckland's first presidency was an unqualified success. However, the rapid increase in the membership of the Society, coupled with its successive moves to larger and larger accommodation in order to facilitate this, had meant that the Society had lost a great deal of the intimacy and informality that was still present when Buckland was first elected to membership in 1813. In order to try to regain the original spirit and atmosphere, during his presidency Buckland launched an exclusive dining club restricted to 40 members of the Society that would eat together on the days of the Society's meetings. The first meeting was held on 5 November 1824, at which 30 of the 40 places were filled, with the founder members including, in addition to Buckland as President, Aikin, Henry Colebrooke, Fitton, Greenough, Lyell, Charles Stokes, Henry Warburton and the lawyers Daniel Moore and Joseph Vandercom. The most important test for prospective members, apart from an intelligent interest in geology and keen support for the Society, seems to have been the ability to entertain fellow members through good conversation and to enjoy the proceedings of the Club. The spirit of the Club is best exemplified by its choice of one of the most fashionable eating houses in London, the Thatched House Tavern, St. James's Street, as its meeting place (even though the Society was by now meeting more than a mile away in Bedford Street, Covent Garden), and by the well-known series of wagers on the prospects of survival of some toads that had been sealed up in cavities in rocks, laid at the second meeting of the Club on 19 November 1824. (Buckland won his bet, at odds of two bottles of champagne to one, against Warburton that at least one toad would be alive at the end of one year, and after further experiments offered a paper on his results to Jameson for his Journal, which was widely reprinted and translated: Buckland, 1832.)

When Buckland handed over the presidency at the end of his two years of office in February 1826 to the first elected President and Council of the new Chartered Society, he did so in the knowledge that despite the very substantial expense and the considerable effort that had been expended on both formal submissions and behind-the-scenes lobbying (in which Buckland himself had excelled), the public standing of the Society had never been higher. Indeed, with the rapid formation of other scientific and learned societies from the late 1820s onwards, many of which rapidly followed the trail to Chartered status blazed by the Geological Society, the period of Buckland's first presidency and the half-dozen or so years that followed it marked the zenith of the Society's influence. Certainly, the Geological Society was one of the few scientific organisations singled out for modest praise by Charles Babbage (a frequent guest at Society meetings) in his notorious contribution to the "Decline of Science" debate. He had special praise for one of Buckland's most important innovations during his first presidency, that of having a free and open debate on the subjects of the papers read (or indeed any other geological topic) at the end of each meeting of the Society:

> It [the Geological Society of London] possesses all the freshness, the vigour, and the ardour of youth in the pursuit of a youthful science, and has succeeded in a most difficult experiment, that of having an oral discussion on the subject of each paper read at its meetings. To say of these discussions that they are very entertaining is the least part of the praise which is due to them. They are generally very instructive. (Babbage, 1830: 45).

Regrettably, the tradition under which the retiring President presented an Anniversary Address to each Annual General Meeting reviewing not only the progress of the Society, but also the advances in geology over the preceding year, was not established until the end of Fitton's first year of office in February 1828, so there is no direct evidence from such a source of Buckland's own reflections on his two years of office as President. However, Buckland's justifiable pride in respect of his work for the Society during his first presidency is clear from his remarks in his first Anniversary Address during his second presidency:

> More than a quarter of a century has now elapsed since I became a Member of this Society; and fifteen years have passed since I was placed, by your kindness, in the honourable position of filling this Chair, at that important period of our history when we received the national recognition of a Royal Charter. I shall never cease to consider it one of the brightest rewards of my labours in geology, that my name is enrolled in that charter, as the first President of the Society in its corporate capacity. (Buckland, 1840A: 211).

From 1826 Buckland continued to play a very active role in the Society and the Club, not only as a regular editorial referee and an active member of the Council during most years, but also as a welcome contributor of scientific papers and to the informal discussion that concluded each meeting and the dinners of the Geological Society Club. As noted above, his frequent visits to London for meetings of the Society (which met through the "Town Season" of November to May or early June) involved much travelling to and from Oxford, often through very adverse weather conditions which inevitably affected the state of the roads, and even longer journeys were involved for his attendance at the fortnightly meetings of the Society when, for example, he needed to journey from London to his parish in Hampshire to take the weekend services, before travelling back to Oxford on the Sunday night or Monday, or when the family were resident on the Devon or Dorset coasts for extended periods. It is clear from many letters from and to Buckland that while in London he frequently made the Salopian Coffee House his base for perhaps two or three days at a time. Despite its name, this was a noted tavern offering particularly good food and wine, and its Charing Cross location was particularly convenient for not only the Society's Rooms (first in Bedford Street and later at Somerset House), but also for the coach transport network, whilst the proprietor could always be relied upon to accommodate one of Buckland's celebrated breakfast parties at short notice if necessary.

By the early 1830s the inner circle of the Society felt that despite the substantial membership (by then well in excess of 500), there was a distinct shortage of talent suitable and willing to undertake the onerous burdens of high office in the Society, particularly the presidency. Greenough, the founder President, had served from 1807 until the rules were changed, largely at his instigation, in 1813 to provide that in future no President should serve for more than two consecutive years. However, after John MacCulloch finished his two years as President in 1818, Greenough had been pressed back into the Chair for a second time. By the autumn of 1832 Murchison was aproaching the end of his two years as President, but the obvious successor, Lyell, was unwilling to accept nomination. Murchison therefore canvassed Buckland's views on the problem, and he replied on 12 November 1832:

> I confess I know not where to look (Lyell declining) except to the ancient stock recommencing [sic] with Daubeny. thus the great Pythagorean Year. I confess I tremble for fear of strange eccentricities & aberrations but if we adopt your suggestion we must muster in the Council with antagonising forces. If we return to the old firm I think it undoubtedly our duty to look first to Greenough & I have little doubt he will be pleased with the compliment & go through Office with good honour. (M.S. DRO 138M/F239).

Greenough accepted and served for a third term (unique in the history of the Society), from 1833 to 1835, after which Lyell was persuaded to take the Chair for the 1835-1837 period. From various veiled hints in correspondence and notes, it seems that the Council again faced a crisis over the presidency at the end of 1836 and that Buckland's name was put forward but was thought to be unacceptable (presumably because of the strongly religious tone of the opening and closing chapters of the Bridgewater Treatise) and the Cambridge mathematician, William Whewell, became the President for the period 1837 to 1839. Despite this, the Society turned once again to its Charter President at the end of Whewell's term, and Buckland was formally elected President for a second period of office in February 1839. He was clearly delighted at the honour since only Greenough, the founder President of the original Society, had ever been recalled to the Chair. Indeed, only three subsequent Presidents in the history of the Society have been elected for a second term, Lyell (1835-1837 and 1849-1851), Horner (1845-1847 and 1860-1862), and William J Hamilton (1854-1856 and 1864-1866): neither Sedgwick nor Murchison, the two giants of the Society in the second and third quarters of the 19th century, were honoured in this way.

The first year of Buckland's second presidency, 1839-1840, was "one of steady and salutary progression" (Buckland, 1840A: 210) with a net increase of 26 in the number of Fellows, bringing the total to 768. Buckland's review of the year in his Anniversary Address to the Society given on 21 February 1840 is very revealing in terms of the sequence of the various sections of the Address, which occupied 57 printed pages in the Proceedings. After an initial two pages on the Society itself, he devoted a total of 12½ pages to issues relating to the organisation and utility of geology, together with geological mapping, before proceeding to the by then traditional review of the major papers presented to the Society itself during his year of office. At least four of the newly established ventures that he mentioned with great enthusiasm were projects that he had himself been closely involved with through judicious lobbying.

The first of these was the Museum of Oeconomic Geology established (after much political pressure) by the Department of Woods, Forests and Public Works: "for the express object of exhibiting the practical application of geology to the useful purposes of life" (Buckland, 1840A: 212). Buckland's growing interest in the application of geology to agricultural improvements at the time (he had already established his experimental farm by this date) was also well represented in his Address, with further praise for the Government's decision to establish a department of agricultural geology in the Museum of Oeconomic Geology exhibiting:

> the relations of geology to agriculture, in so far as a knowledge of the materials composing the sub-strata may afford extensive means of permanent improvement to the surface. (Buckland, 1840A: 213).

The new agriculture department in the Museum was also to have full facilities for the chemical analysis of soils and their source rocks. Buckland also praised the English Agricultural Society for the decision taken during its July 1839 meeting (held, probably significantly in this respect, in Oxford), to establish a Geological Committee.

Buckland was also able to report a satisfactory response from the Government in response to the lobbying by the British Association (of which Sopwith and Buckland had been the leading proponents) for the establishment of a national archive of mining records, which the Government had decided should also be located in the new Geological Museum. Buckland also commented on the completion of the work of the Royal Commission appointed to inquire into the character of the various building stones available in Britain, with a view to advising on suitable materials for the new Houses of Parliament, and in which both Buckland and William Smith had played leading parts.

Progress in geological education was also discussed at some length, with high praise for the development of a new course in civil and mining engineering in the University of Durham (which Buckland saw as having similar advantages to the great Saxon School of Mines at Freiberg because of its proximity to both the local coalfield and the lead-mining region of Weardale; Buckland, 1840A: 217). There was also warm encouragement for new courses in both University and King's Colleges, London University, and for the newly established School of Mines in Cornwall (a private institution financed by Buckland's old friend, Sir Charles Lemon).

A further section was devoted to the horrifying statistics gathered by the Polytechnic Society of Cornwall on the state of health of Cornish miners, whose general health and life expectancy were far worse than those of the agricultural labourers of the county or of miners working elsewhere in the country in the coal industry, with its better ventilation and greater use of machinery. Stressing once again the utilitarian potential of the Society, Buckland added:

> The attention of this Society is strenuously directed to the discovery of remedies for these tremendous evils, which affect no fewer than a population of 28,000 persons; (Buckland, 1840A: 219).

Yet another full section was given over to comments on the recent development of local museums, encouraged by the Geological Section of the British Association during its 1839, Birmingham, meeting, noting that:

> Another circumstance which marks the progressive advancement of public feeling as to the value of geology, is the increasing disposition to form local museums in our provincial towns. (Buckland, 1840A: 219).

Other successes recorded included the British Museum's purchase of the Hawkins collection of fossil reptiles from the Lias, following the purchase of Mantell's collection of Wealden reptile fossils the previous year, and Buckland paid a special tribute to the recently ennobled Lord Monteagle, who as Chancellor of the Exchequer Thomas Spring-Rice, had responded to the Society's representations and provided government funds for the purchase of these highly important British collections. The importance of geological mapping was stressed, and the Anniversary Address included separate sections on the first Ordnance Survey geological map, that of Cornwall and Devon by De la Beche, the new edition of Greenough's Geological Map of England, Griffith's Geological Map of Ireland and Von Dechen's single-sheet geological map of France, Germany and England, and parts of the surrounding countries. In each case Buckland once again stressed the "statistical and political importance" (Buckland, 1840A: 222) of such maps.

Turning to the more traditional areas of an Anniversary Address, Buckland then summarised the important work presented to the Society during the previous year on the geology of Devon, including the acceptance by Sedgwick and Murchison of the separation of much of the deposits of North and South Devon from the Silurian below and the Carboniferous above, and designated both these deposits and the Old Red Sandstone as a new Devonian System. Another seminal paper presented during the year, and discussed at some length by Buckland in the Address, was that of Lyell "On the Boulder Formation or drift and associated freshwater deposits composing the mud cliffs of eastern Norfolk" (Lyell, 1840), which Buckland felt was "full of elaborate detail of facts, and of ingenious speculations" (Buckland, 1840A: 234). In fact, Buckland summarised very fairly and impartially Lyell's view that the stratified drift and till had been produced by drifting ice during a period of submergence but elsewhere in the Address, in his obituary notice of the Norwegian geologist, Jens Esmark, he drew special attention to the latter's evidence (Esmark, 1826):

> to show that the greater part of Norway has, at some period, been covered with ice, and that the granite blocks, so abundant in that country, have been brought to their present place by glaciers. (Buckland, 1840A: 261).

One of the other obituaries of deceased Fellows and Foreign Members with which Anniversary Addresses traditionally concluded, was of Davies Gilbert, a founder member of the Geological Society, who as President of the Royal Society from 1827 to 1830 had been responsible for executing the Bridgewater Will, and who had been responsible for selecting Buckland as a Bridgewater author. However, the major obituary was that of William Smith who had died the previous summer in Northampton while on his way to the British Association meeting in Birmingham. Buckland recorded his personal indebtedness to Smith's unravelling of Secondary stratigraphy by 1799, although in an unpublished form:

> He had also arranged his collections of rocks and their organic remains in the order of succession and continuity of the several strata; but neglected to appropriate to himself the merit of these discoveries by immediate publication, he liberally imparted a knowledge of each, as it gradually arose, to his private friends, through whose oral communications they obtained such general currency, that their real author was frequently lost sight of or unknown. I was myself indebted to Mr. Smith, though at that time a stranger to me, for my first knowledge of the order of succession of the oolitic series. This I derived from information imparted to me by the late Rev. B. Richardson of Farley Castle, who had himself acquired it from Mr. Smith. (Buckland, 1840A: 251).

Buckland, as President, also took charge of the public appeal for subscriptions towards the cost of providing a suitable monument for the "Father of English Geology", which raised almost £90 and which was used to commission a marble portrait bust of Smith from the sculptor, Matthew Noble, for erection in the church at Northampton, and from which at least two plaster casts were taken (M.S. Edinb. U.L. Gen 784/1/8-9).

The final session of the 1839-1840 session of the Geological Society was on 10 May 1840, and for this Buckland had persuaded Agassiz to submit a written paper summarising his evidence for his glacial theory: "On the polished and striated surfaces of the rocks which form the beds of Glaciers in the Alps" (Agassiz, 1841A). Agassiz, a very popular Foreign Member of the Society, was not present to deliver the paper in person, and the contribution appears to have aroused little interest or discussion, and was followed by four very miscellaneous short contributions, at the end of which, as the Proceedings noted, "This being the last Meeting of the Session, the Society adjourned at the close of the evening's business to Wednesday, November 4th."

During the summer and autumn break, Buckland, Agassiz and Lyell developed the Glacial Theory and applied it to the British Isles, and the whole of the first three meetings of the Society in its 1840-1841 session, on 4 and 18 November, and 2 December were given up to the reading of their three highly contentious, and much disputed papers. The presentations of these three evenings, together with the reaction to them, are discussed in detail in Chapter 5.2, The Glacial Theory, below.

Buckland's own review of the year's work of the Society in his Anniversary Address given on 19 February 1841 (Buckland, 1841B) this time occupied 71 pages of the Proceedings. Once again acknowledgements of the support for geology of the Government were given high priority, with special reference to the Department of Woods and Forests and the Board of Ordnance, and the contributions to the development of geology made by the British Museum, the British Association and the Institution of Civil Engineers were all referred to, stressing that:

> in these cooperations we recognize an increasing feeling and general acknowledgement, not only of the scientific importance, but also of the pecuniary value and statistical utility of geological investigations; in directing the researches of industry to those points where they may be profitably applied, and in preventing such wasteful expenditures of capital, as, under ignorance of the internal structure of the earth, and the peculiar productions of each geological formation, we have, in times past, seen thrown away in ruinous searches after coal, where the slightest knowledge of geology would have given certain information that no coal could possibly be found. Never more shall we witness a recurrence of such unpardonable waste of public money as that which is said to have been lavished in sending lime from Plymouth to build the fortress of Gibraltar on a rock, itself exclusively composed of limestone. (Buckland, 1841B: 470).

The progress of the Museum of Oeconomic Geology and of the Geological Survey were both singled out for special praise, as was the joint initiative of the British Association and the Institution of Civil Engineers to make representations to the Government on:

> the expediency of having accurate descriptions and drawings taken, at the public expense, of the geological features exhibited in the cuttings and excavations of railroads throughout the kingdom; these are now easily accessible, whilst the railways are in process of formation, and an accurate knowledge of them may be of great scientific as well as commercial importance in future times, when the sections now laid open are covered up. (Buckland, 1841B: 474).

Buckland continued by stressing the utilitarian value of the dissected wooden models of geological features prepared by Thomas Sopwith (the Commissioners of Woods and Forests had already commissioned Sopwith to make a large-scale three-dimensional model of the Forest of Dean Coalfield), and suggested that in addition to enabling the less sophisticated to understand geological structures more clearly, such models could have a practical application in terms of estimating the quantity of coal remaining "for future consumption". Another potentially important new technique that Buckland had been quick to take up was the experimental work of Captain Ibbetson in photo-lithography of fossil images.

Turning to geology proper, Buckland first reviewed considerable progress in structural geology, particularly in relation to south-eastern England, including the "valleys of elevation" first discussed in structural terms by Buckland in the 1820s (Buckland, 1825C & 1829A). Another major section with the interesting heading of "Positive Geology" demonstrated the great progress that had been made in just one year in the recognition and separation of the Silurian and Devonian Systems over many parts of continental Europe, illustrated with many detailed examples and showing very clearly that Buckland was still the Society's unparalleled master of careful analysis and lucid synthesis of masses of geological facts. He followed this with an equally lucid examination of the various theories of the origin of coal and good summaries of progress in many areas of both vertebrate and invertebrate palaeontology.

Clearly the controversy over the Glacial Theory needed to be reviewed as well, and Buckland's opening paragraph of his section on "Geological Dynamics - Glacial Theory", began uncompromisingly:

> During the last year M. Agassiz has introduced a new and powerful machinery into the Dynamics of Geology, by asserting the claims of ice to be admitted to the list of locomotive forces that have operated largely not only in forming morains (i.e. mounds and ridges of gravel and clay intermixed with large fragments of rocks) on the flanks and at the lower extremity of existing glaciers, but also in transporting erratic blocks with the detritus of morains to distant regions, and re-arranging them by the force of floods that originated in the melting of ice and snow. (Buckland, 1841B: 509).

Buckland had certainly consulted Agassiz (who had returned to Switzerland) about his forthcoming Anniversary Address, and on 23 January 1841 Agassiz wrote a further long letter to Buckland about points of emphasis, as well as his progress on fossil fish studies *(M.S. DRO 138M/F408).* This part of the Anniversary Address is discussed further in Chapter 5.2 below.

The long obituary section included the agriculturally-minded Duke of Bedford, a long and warm appreciation of one of the Continental pioneers of vertebrate palaeontology, Blumenbach, and the original discoverer of the Kirkdale Cave fauna, and later a pioneer of the Quaternary mammals of Ilford, John Gibson, of whom Buckland said:

> In his death we have to deplore the loss of an acute and zealous discoverer and promoter of Palaeontology; and it has become the bounden duty of all the cultivators of this science, and more particularly of myself, to record our sense of the judicious sagacity and liberality of Mr. Gibson, but for whom the catacombs of Kirkdale might never have been heard of, and their records of our Yorkshire Hyaenopolis might have perished without finding an interpreter. (Buckland, 1841B: 525).

Buckland's final duty in closing his last Anniversary Address was to welcome Murchison as his successor in the Chair, but before doing so he addressed a final word to the Society as a whole:

> Gentlemen, I have now arrived at the close of my official functions in this Chair, the duties of which have been to me, during the last two years, a continual source of unmingled satisfaction. I have witnessed with delight the unanimity and energy which mark the course of your proceedings, and tend still further to exalt the high position as a science to which Geology is now advanced. It would indeed be painful to me, could I feel that, in quitting the Chair, in which your kindness has for the second time required my services, my connection with the Society would in any way be loosened, or my exertions to promote its interests in the least degree abated. (Buckland, 1841B: 540).

However, the deepening split within the Society over the Glacial Theory (discussed further in Chapter 5.2 below) culminated in an extraordinary attack in the next Anniversary Address by Murchison (1842) on his immediate predecessor, which occupied 16 pages of the printed Address. Even without this, however, Buckland's undisguised attempts to press the economic and utilitarian aspects of geology, and to emphasise constantly to Government both the value and the financial needs of geology, aroused little response in the inner caucus of the Society, the majority of whom were primarily interested in "pure" science, and were financially at least comfortably provided for, if not wealthy by the standards of the day. Even Murchison, who was always willing to petition or lobby Government or politicians on behalf of science in the name of the British Association (or in his own interest in the case of the funding of his highly ambitious project for the mapping of the Russian Empire), seems to have felt that such activities were undignified and unbefitting in the case of the Geological Society. Even more important, perhaps, the Society itself was no longer the organisation that Buckland had joined in 1813, nor even the newly-Chartered society of his first presidency. After Buckland only two of the veterans of the first decade of the Society were to be elected President - Warburton (1843-45) and Leonard Horner (1845-1847 and 1860-1862). In the year of publication of his incisive History of the Inductive Sciences, William Whewell, Buckland's immediate predecessor, had recognised the changes current or in prospect in the Society in his final Anniversary Address:

> I confess, indeed, for my own part, I do not look to see the exertions of the present race of geologists surpassed by any who may succeed them. The great geological theorizers of the past belong to the Fabulous Period of the science; but I consider the eminent men by whom I am surrounded as the Heroic Age of geology. They have slain its monsters, and cleared its wildernesses, and founded here and there a great metropolis, the queen of future empires. They have exerted combinations of talents which we cannot hope to see often again exhibited, especially when the condition of the science which produced them is changed. I consider that it is now the destiny of geology to pass from the heroic to the Historical Period. She can no longer look for supernatural successes, but she is entering upon a career, I trust a long and prosperous one, in which she must carry her vigilance into every province of her territory, and extend her dominion over the earth, till it becomes, far more truly than any before, an universal empire. (Whewell, 1839: 96).

Although Whewell ended his Address by the declaration that:"I resign my office into abler hands" (Whewell, 1839: 98), there can be little doubt that within the classification that he had just presented he placed Buckland as one of the supreme exemplars of the "eminent men" of the "Heroic Age" of geology, rather than new breed of geologists of his predicted "Historical Period".

Buckland continued to serve as a member of the Council of the Society: at the completion of his presidency in 1841 he had been on the Council in one capacity or another for a total of 21 years out of the previous 23 years, with just two single year breaks (1820-1821, and 1827-1828). In one respect his unbroken membership of the Council from 1827 onwards created a problem for the Society, since it was almost universally accepted that Buckland ought to be honoured by the Society, but then (as now) the rules relating to Awards debarred serving members of the Council from consideration. In 1847 one of Buckland's oldest geological friends, Leonard Horner, was due to be succeeded as President by his earliest geological protégé, De la Beche, and although there is no evidence that Buckland had the slightest idea what was being planned, the two of them left Buckland off the list of nominations for the 1847-1848 Council. Now that he was no longer excluded from consideration, there seems to have been little argument that Buckland should be the recipient of the 1848 Wollaston Medal, the Society's highest award, and indeed the most prestigious award of its kind in the whole of the geological world.

The Medal was presented to Buckland by De la Beche at the Annual General Meeting of the Society held in Somerset House on 18 February 1848, preceded by a very affectionate address:

> Dr. Buckland, - The Geological Society has awarded you its Wollaston Palladium Medal for the important services you have rendered to Geology during a long series of years, by your labours in the field, and by your numerous and valuable writings; for your exertions to promote the study of geology in the University of Oxford; and especially for the zeal and energy with which, in its earlier day, you laboured to advance the objects of this Society, a zeal and energy which has remained unabated to the present time. To attempt an enumeration of your many geological works before the geologists I now see assembled in this room, would be a poor compliment to those to whom they are so familiar, and who have employed them so frequently to aid them in their labours. Your works will remain lasting memorials of your power to observe, and your ability to describe and render clear to others those discoveries and researches, which have so materially advanced that science for which we are here associated. (De la Beche, 1848: xvii).

Those present recorded that Buckland was deeply moved by the simple ceremony, and his own address in reply was recorded and printed. In this he referred to his past work and previous honours, notably the receipt of the Copley Medal of the Royal Society for his work at Kirkdale, and the recent award of an honorary degree of Doctor of Philosophy of the University of Prague as one of only 22 "of the most distinguished cultivators of science and literature" in the world to mark the University's 500th anniversary. Interestingly, out of the many dozens of major geological studies that he had carried out, the one that he chose to mention specifically in his reply was his earliest work on the mapping of the Mendips (a subject he was to refer to in his last geological address - to the Somerset Archaeological and Natural History Society in September 1849). However, Buckland was above all moved by the breadth and distinction of the Geological Society Council that had elected him to the ranks of the Wollaston Medallists, including as well as De la Beche and Horner, Lyell, Murchison and Sedgwick, Greenough and Hamilton, Mantell and Owen, the explorers Godwin-Austen and Sabine and the palaeontologists William Hopkins, Robert Hutton and Daniel Sharpe. In his reply Buckland referred specifically to this galaxy of geological talent:

> Many individuals of that Council who have concurred in awarding to me this Medal, have acquired to themselves, not only an European, but a Mundane reputation, not only as citizens, but as instructors and benefactors of the world. Many of their names are as familiar on the banks of the Ganges and of the Ohio as on those of our own Thames. The scientific discoverers of the world are now closely united as one brotherhood in one great family of the human race, and the literature of science which records the physical discoveries of our time will continue indestructible by the burning of another Alexandrine library, and so long as science shall be regarded by any nation upon earth, were all Europe and Africa again submerged between the oceans from which they have been elevated by the force of subterranean fires, our literature would survive in the libraries of Asia and America. It is highly gratifying to feel that whatever real additions we may have made to man's positive knowledge of the works of God, will be indelibly preserved and imparted to all our successors of the human family in all countries and in all generations yet to come, and we trust, for their moral as well as intellectual and social and physical advantage. (Buckland, 1849A: xx).

After his death, Buckland was not particularly well served by the Society, so far as his official obituary was concerned. Because of the untimely accidental death of the President-elect, Daniel Sharpe, General Portlock became President for 1856-1858, and was responsible for remembering Buckland in his first Anniversary Address. This was presented in warm terms, beginning:

> I feel that I am obliged to review the history of our science for the last fifty years, as the first name on the melancholy list of illustrious men who have passed away from the halls of science is that of one of a band of intellectual giants who early in the present century seemed formed especially for the great work of laying the foundations of a new science; whilst the second is that of our late President, who was, as it were, the personification of a new school of men of vigorous minds, who, taking their stand on the foundation laid by their predecessors, are fitted, by their accurate knowledge and by their penetrating and liberal spirit, to complete the structure by enlarging its basis and filling up its details. (Portlock, 1857: xxvi).

However, Portlock had had little direct experience of Buckland's work, and the obituaries of John Phillips (1857) for the Royal Society and Murchison (1857) in his Presidential address to the Royal Geographical Society are more valuable because each was based on close personal experience. None, however, addressed themselves directly to one of the most interesting questions about Buckland's work for the Geological Society - the extent to which he was personally responsible for the successful reconstruction of the Society leading to and following the granting of the Royal Charter. Certainly, Buckland would undoubtedly have become President sometime in the 1820s. However, there seems little doubt that he was chosen as President in 1824 at least partly because of his established reputation as a successful political lobbyist on behalf of geology, as evidenced by his own advancement within Oxford. Of course, Henry Warburton and the volunteer lawyer, John Vandercom, were responsible for the legal work, but there seems little doubt that

Buckland's influence, particularly his growing friendship with Robert Peel and support from George IV, was also of considerable importance. The Society would probably have been granted Royal recognition in due course without Buckland, but at the very least his presidency smoothed the way (and minimised the potential damage of the split with leading members of the Royal Society over the issue of the Charter).

Perhaps Buckland's most significant (but at that time very controversial) long-term Geological Society innovation, for which he was personally responsible, was the introduction of open debates on both the papers presented, or any other topical geological subject, at the end of each Society meeting. Again, this practice is regarded as a matter of course by most scientific societies around the world, but was in fact pioneered amongst the national scientific societies by the Geological Society under Buckland. One of the rules of the Society was that in order to ensure free and uninhibited exchange of views in a friendly and "non-party" atmosphere, there should be no reporting of these informal debates, so there are few records of how they were conducted. However, the flavour of these discussions can be judged from correspondence and diaries, particularly those of Charles Lyell (e.g. Lyell, 1881A) and Gideon Mantell (Curwen, 1940). By a strange coincidence the most celebrated and most fully recorded during the period was the full-blooded attack on Buckland himself over the Glacial Theory in November and December, 1840 (see Woodward, 1883 & 1907, and Chapter 5.2 below).

Possibly this innovation was suggested by the successful discussions that Buckland had with his Oxford students after each of his statutory lectures. These discussions (and the kind of dialogue with students in the course of the lecture that was described by Henry Acland, and quoted in Chapter 2.3 above), were a great pleasure to Buckland, and must have been of mutual benefit in stimulating new ideas and challenging old ones. Certainly, they were far more than a "chore" or added burden which he carried out merely to comply with the University Statutes relating to lecturers, which provided that each professor and lecturer was required to stay behind in the lecture room at the end of each lecture and make himself available to the students.

Another obvious parallel for this development was the informal discussions that took place over the dinner (or breakfast, in Buckland's case!) table whenever Society members and other geologists gathered outside the Society's meeting room. Whatever the origin of this inspiration, there can be no doubt that Buckland's introduction of full and uninhibited discussion at Geological Society meetings was a significant, albeit minor, step in the Society's development, that was quickly taken up by the growing number of learned societies that looked to the Geological Society as their model.

3.3 THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE*

From its earliest days the British Association for the Advancement of Science has had almost a surfeit of historians (by no means all of them impartial), in marked contrast with the other two institutions chosen for special study in relation to Buckland. (Even in the case of the Geological Society, which has certainly been better served than the early days of Oxford geology, recent work has concentrated on the Society's foundation, as in the very important review of Rudwick (1963) rather than on its development during Buckland's period.) Of the more substantial historical studies of the British Association, that of Howarth, its long-serving Secretary, The British Association for the Advancement of Science: A Retrospect, 1831-1921 (Howarth, 1922) and an updated second edition for the Centenary in 1931, was for many years regarded as the definitive synthesis, although the book can justifiably be criticised for allowing the needs of science, and the perceived role of the British Association, in the early 1920s, to colour the view of the Association's role in the 19th century.

In the 1960s Derek Orange and Jack Morrell both began to explore the reality of the myths and legends about the origins of the British Association and this work resulted in a number of important papers examining the nature and motivation of the founders and early members of the Association (Orange, 1971, 1972, 1973 & 1975; Morrell, 1971).

---

* NOTE: A somewhat abridged version of this chapter was read to the York, July 1981, Symposium of the British Society for the History of Science on the history of the British Association.

Throughout the 1970s Morrell worked with Arnold Thackray on both the scientific and social contexts of the British Association and its early members, concentrating on the period up to 1844, and this work culminated in the massive and definitive study Gentlemen of Science published to coincide with the British Association's sesquicentenary celebrations (Morrell & Thackray, 1981). In the same year an important series of review papers, covering the whole 150 years of the Association's history, were edited by Roy MacLeod and Peter Collins (1981) under the title The Parliament of Science. Several of these papers are particularly relevant to the present study, including that of Derek Orange (1981) on the history of the first twenty years of the British Association, Richard Yeo (1981) on the image of science as perceived through the Association in the 19th century, Bill Brock (1981) on the relationship between the Association and professional science, Philip Lowe (1981) on what might be termed the non-specialist "receivers" of the British Association as it wound its way around the country year by year, and Roy MacLeod's own contributions, a study of the historiography of the British Association (MacLeod, 1981A), and a general introductory essay "On the Advancement of Science" (MacLeod, 1981B).

It was almost inevitable that Buckland would assume a leading role in the early development of the British Association. He had very close links with the Yorkshire Philosophical Society, and in particular with the most prominent members who actually issued the original formal invitations to the inaugural meeting in York in September 1831, especially William Vernon Harcourt. As Orange (1973: 7-13) has demonstrated, the Yorkshire Philosophical Society itself had been founded at the end of 1822 largely as a result of local pressure to form a society and museum to ensure that the fossil mammal material from Kirkdale Cave, the scene of Buckland's spectacular triumph, would remain in York. As a result, Buckland was one of the earliest Honorary Members of the new Society and assisted it in many ways during its formative years.

Quite apart from the York connection, however, Buckland was deeply concerned about the development of public, popular and governmental involvement in science. By the late 1820s Buckland had close links with most parts of the Continent, as a result of his extensive travels. (Certainly, amongst the leading British geologists of his day, Buckland had travelled wider and more extensively on the Continent than anyone else. Not until the time of Murchison's mapping of Russia at the end of the 1830s, and Lyell's visit to North America in 1841, was Buckland overtaken by any fellow leader of British geology in terms of either the mileage covered, or the number of personal contacts established and maintained.) From both his personal contacts and observations, and his subsequent careful monitoring of developments on the Continent, Buckland became convinced that Britain faced a serious threat in terms of its influence on the world stage, both politically and economically, from the nation's continued gross neglect of science and technology throughout the ruling class, and particularly at governmental level.

In many places on the Continent, particularly in France, but also through such areas as the important mining districts of Lower Saxony and Bohemia, the State was everywhere involved in financing on a large scale both scientific and technical education and research in such areas as mineralogy, geology and mining technology. Moreover, Buckland had seen clear evidence of the great value in terms of both productivity and safety of close governmental supervision and control of such activities as coal and metalliferous ore mining. In contrast with this, Buckland was only too well aware not only of the miniscule level of government support for science and technology in Britain, but also of the near-anarchy prevailing in most of the British mining districts, in which through ignorance both lives and easily recoverable rich reserves were sacrificed with equal abandon, (see for example Buckland's strictures in his Anniversary Address to the Geological Society, Buckland, 1840A), whilst untrained and ignorant charlatans charged landowners and investors vast sums for worthless schemes. As Newman had noted in his record of Buckland's first Mineralogy Course lecture of 1821 (see Appendix 1.1), Buckland had told his audience consisting largely of ordained Dons and prospective ordination candidates, that under the Continental system men like them would have been working as superintendents of mines rather than "as with us block up the entrances or the inside of the church"! Curiously, Buckland seems to have seen no inconsistency between his respectable Tory political views (including his confident belief that the Deity had deliberately provided Britain with unparalleled natural mineral wealth in order to allow it to take the first place amongst nations, or indeed his own seeking after the comforts enjoyed by the leisured rural nobility and squirarchy), and a fervent desire to see an almost Marxist degree of state control over, and financial intervention in, areas such as mineral exploration and exploitation, or scientific and technical education, under which individual rights would be subjugated to the general good of society as a whole.

By the late 1820s (if not sooner) Buckland realised that Oxford was not going to be reformed from within, and probably felt that unless it reformed itself in response to friendly external influence and stimulus, some future Parliament dominated by radicals (a prospect that came closer and closer as the pressure for Reform became unmanageable), seemed bound to intervene in the way that had been threatened on more than one occasion from the mid-1770s onwards. During his first presidency, Buckland had seen the newly-chartered Geological Society of London as a potential force for influencing the opinions of the national policy-makers, and a number of politically influential figures were brought into membership, although on the negative side of the equation only six out of more than fifty Honorary Members of the predecessor Society agreed to accept (paying) Fellowship of the Chartered Society in 1825. Many more political and other influential figures continued to attend meetings of the Society as guests of individual Fellows (Buckland himself frequently introduced both scientific and non-scientific guests). However, the great majority of Fellows seemed to have felt that the Society should confine itself to a role that was largely scientific and social, and certainly did not consider that it should concern itself officially in the kind of lobbying for and promotion of geology with government, the universities or the general public. The Society's public face was largely confined to the offering for sale of its Transactions and Proceedings, and any form of public circulation of the Society's discussions of any paper was most strongly disapproved of, as the Editor of the newly-established (and short-lived) monthly journal The Geologist discovered as late as 1842 (Woodward, 1907: 145-146).

Consequently, although Buckland was not involved in what Orange (1972: 154) has aptly termed the "pre-history of the British Association", he certainly had a great deal of sympathy with much of the concern at the perceived decline of British science, particularly those of Charles Babbage in his book Reflexions on the Decline of Science in England and on some of its Causes (Babbage, 1830), and David Brewster's long and favourable review of Babbage's book (Brewster, 1830). He presumably first learned of the idea of a provincial meeting of what were variously described as "cultivators of science" or "Friends of Science" to be held annually in a different town along the lines of the Deutscher Naturforscher Versammlung, established in 1822, in the April 1831 issue of the Edinburgh Journal of Science that Brewster edited (Brewster, 1831), although subsequently considerable efforts were made by the local organisers to appear to distance themselves somewhat from Brewster, who was at the time hardly the most popular scientist in Britain because of the tone of his review of Babbage's book. The "London Circular" (Morrell & Thackray, 1981: fig. 18), dated 25 May 1831 was an open invitation to "a General Meeting of friends of Science" and was unsigned, although it was in fact written and published by Murchison, whilst care was taken to ensure that the "York Circulars" were issued in the name of the Yorkshire Philosophical Society. However, most of the academics who saw themselves as the victims of the criticisms of Babbage and Brewster saw through these very transparent ruses, and the great majority stayed away. The reaction of Whewell, recorded in a letter to Forbes dated 14 July 1831, was typical:

> I am afraid I shall not meet you at York. Even if other circumstances allowed me, I should feel no great wish to rally round Dr. Brewster's standard after he has thought it necessary to promulgate so bad an opinion of us, who happen to be Professors in Universities. (Todhunter, 1876 (2): 122).

However, three Oxford professors, Buckland, Charles Daubeny and Baden Powell, felt that the new venture deserved their support.

In the event, a serious illness in the family prevented Buckland from attending the meeting at the end of September 1831, and Powell was also an unwilling absentee, so the Oxford interest at the inaugural meeting of the British Association for the Advancement of Science was represented solely by Daubeny, who had no difficulty in persuading the newly-formed Association to agree to hold its first full working meeting in Oxford. The absent Buckland was elected first a Member of the new Association's Sub-Committee for Geology and Geography, and at the close of the York meeting was designated President-Elect for the 1832 meeting, with Daubeny and Powell as the Local Secretaries responsible with Buckland for organising the Oxford meeting. There can be no doubt that Buckland had indicated in advance to Daubeny (and probably to Vernon Harcourt and Murchison as well) that he was willing to participate in the work of the Association in this way. It is inconceivable that a newly-formed organisation that had already gone through one crisis because of Brewster's premature announcement would risk the possibly fatal blow to its credibility of announcing as the next year's President someone who might reject the honour. I believe that the hand of Buckland can also be seen in the decision to hold the 1832 meeting in mid-June. Admittedly, the original hope had been that the York, 1831, meeting would be held in July rather than September, and that future meetings would be held in either July or August, but the period in fact chosen for the Oxford meeting coincided precisely with the traditional informal "geological week" when the most prominent members of the Geological Society, and others with geological interests, used to have their annual week's residence in Oxford. In choosing three Oxford professors as the local team for its second meeting, the new Association had greatly increased its chances of achieving academic support, and hence respectability, and by choosing the week of the traditional geological gathering in Oxford that Buckland had organised each year since succeeding Kidd in the Mineralogy Readership (and which apparently could be traced back to Pegge, see Chapter 3.1 above), there was every reason to think that Buckland would be able to deliver many geological "stars", if nothing else.

The Oxford, June 1832, meeting was the first full "scientific" (as opposed to administrative) meeting of the British Association, and although Daubeny and Powell were responsible for the highly successful practical arrangements and the administration, Buckland was closely involved in both the general shape of the meeting and the detailed local organisation in several capacities, as the President-Elect, as a local organiser, and as a prominent member of the University. It is therefore worth looking at the Oxford programme and other arrangements in some detail, not least because they set patterns which for good or ill subsequent British Association meetings tended to follow.

The first major (and perhaps surprising) success of the three local organisers was that the British Association in fact received the fullest possible support of the University authorities, and of a substantial majority of Heads of Houses, together with Lord Grenville, Chancellor of the University and Buckland's old patron. The meeting opened officially on Monday, 18 June 1832, with administrative business including the election of candidates in the Clarendon Building, where a reception was held the same evening. Entertainment and refreshments had been liberally provided, the considerable cost of refreshments at each Evening Meeting in the Clarendon being met by those British Association members who lived in Oxford. New College gave a full dinner one evening, and the Vice-Chancellor gave a public breakfast on the Wednesday in Exeter College. Although the estimated 600 participants were charged five shillings a head for "Ordinaries", these meals were also subsidised by donations in kind. For example, both the Archbishop of York (Harcourt) and the Duke of Buckingham, F.G.S., made substantial contributions in the form of gifts of venison!

Formal business opened at 1 p.m. on the Tuesday (19 June) in the Sheldonian, with a brief speech from Viscount Milton, President of the Yorkshire Philosophical Society, who had presided at the York meeting the previous September. In this Milton expressed the view that it was:

> unnecessary even to endeavour to press the importance of Associations, which have for their object *to extend the bounds* of human knowledge, and to give man a larger empire over nature. (Milton, 1833).

Buckland then took the chair and addressed the meeting, and after thanking Milton referred to the stated objects of the Oxford Meeting (and the Association) as defined by Vernon Harcourt and circulated, emphasising his total commitment to the Association and its aims, continuing:

> If any argument were necessary to justify the attempt now being made to stimulate and combine the energies of science; if a doubt has existed on [sic] any man's mind as to the probability of its success, - I would only ask him to look round upon the present audience, and observe with how many and what manner of persons this Theatre is filled. Such an attendance leaves no room to fear that the Meeting should fail of its intended objects. Your presence, Gentlemen, adds an indisputable sanction to the proceedings of last year, and fulfils the warmest hopes which the promoters of the Association had indulged. (Buckland, 1833B: 97).

Buckland also emphasised the degree of enthusiastic support from the Chancellor, Lord Grenville, whose response to Buckland's informing him of the proposal to hold the meeting in Oxford: "was pleased instantly to reply, that it was his ardent desire to be enrolled among its Members" (Buckland, 1833B: 97).

Buckland continued by explaining the purpose of the timetable and programme that had been arranged. Four Committees had been formed the previous year (Mathematics and General Physics, Chemistry and Mineralogy, Geology and Geography, and Natural History and Physiology), and closed meetings of the designated members of each Committee were to be held each day from 10 a.m. to 11 a.m., after which there would be "Sectional Meetings" of the whole body for two hours from 11 a.m. at which the Secretary of each Committee would in turn read submitted papers "before such Members of the Association as choose to assemble in any of the rooms" (Buckland, 1833B: 98). At 1 p.m. the Association was to adjourn to the Sheldonian Theatre to listen to a series of commissioned "Reports on the State and progress of different sciences" (Buckland, 1833B: 98). Finally, each evening after supper, at 9 p.m., Sectional Meetings for the reading of papers was to be resumed, except on the Thursday and Saturday evenings for which general lectures had been arranged "on the late discoveries in Magnetism, and on Chemical and Geological subjects" (Buckland, 1833B: 98). Buckland ended his opening address by summarising the purpose of the meeting:

> Thus, Gentlemen, we hope to conduct the multifarious business of the Meeting, so as to accomplish three objects: first, to lay before the whole assembly the general views of the condition of science, to which it is desirable to invite the attention of all; secondly, to enable every one to listen to, and to join in, those scientific details in which he may be more particularly interested; and thirdly, to give instruction of a more popular nature, to a more miscellaneous audience. On Thursday morning, the University

> of Oxford will avail itself of the present opportunity to express the deep respect which it entertains for the improvers of science, by conferring on four Members of the Association, of preeminent celebrity in different branches of Philosophy, the highest distinction which it has the power to bestow; and when the ceremonial is concluded, in the afternoon of the same day, I would beg leave to offer to any of the Members who will do me the honour of accompanying me on an equestrian excursion, such familiar illustrations of Geology as the country round Oxford is able to afford. (Buckland, 1833B: 98).

Two other aspects of the programme are worthy of special mention. First, on the Wednesday afternoon, with the consent of the Meeting and at Buckland's request, Murchison, as President of the Geological Society, presented the Society's highest award, the first Wollaston Medal, to William Smith "as a testimony of respect to the acknowledged 'Father of English Geology'." Smith was an Oxfordshire-born man of humble origins, two facts that were particularly significant in terms of both the location of the presentation and the determination of the Association to break through into a far wider spectrum of society than had been achieved by any of the Universities or London scientific societies.

The second particularly significant event in terms of the recognition of the British Association and, indeed, of science in Oxford, was a special Degree Congregation in the Sheldonian on the Thursday morning at which Oxford conferred honorary D.C.L. degrees on four of the most prominent British Association members present - Sir David Brewster, Robert Brown, John Dalton and Michael Faraday. The great significance of these honorary degrees in terms of the current climate within Oxford has already been discussed in Chapter 3.1 above, and it is particularly interesting to note that the names of the four honorary graduands were a closely guarded secret even from the Public Orator (who was responsible for preparing suitable citations in Latin) until the Wednesday evening.

Presumably this not only heightened the suspense and drama of the occasion as the names were announced by the Public Orator during the graduation ceremony itself, but also minimised the risk of protest by the traditionalists that were bound to be horrified at the prospect of an Oxford degree going to any form of nonconformist. The inclusion of Brewster in the list was perhaps particularly surprising in view of the very harsh things that he had said about the English universities less than two years earlier. In the case of all four, their international reputations were especially stressed - all were in fact Corresponding Members of the Institut de France (see Morrell & Thackray, 1981: 390).

After the degree Congregation a "numerous assemblage" gathered for Buckland's geological expedition and lecture on the geology of Oxford. (Poor Professor Henslow had merely "a party of members", not a "numerous assemblage", on his rival botanical excursion.) In the course of the excursion, Buckland took the opportunity to address the party on a matter of growing interest to him, the potential value of geological studies to agricultural improvements, and indeed suggested that a sub-committee of the geological section might be established to investigate this subject further.

Amongst those that Buckland had persuaded to attend was Sedgwick, who was nominated as President-Elect, and Cambridge was chosen as the venue for the 1833 meeting, although not without protest from Babbage on behalf of a number of the founders of the Association about the selection of venues, and the desirability of taking the Association to the manufacturing districts. Despite his vehement opposition only eleven months earlier, Whewell had attended the Oxford meeting, and agreed to act as joint

Local Secretary for the Cambridge meeting (with Henslow), assuring the meeting that Cambridge wanted to see as many as possible from as many places as possible, and inviting both "cultivators of science" and persons interested in science.

The final session on the Saturday evening was given over to Buckland's celebrated (perhaps notorious might be a more appropriate description) lecture on the Megatherium, already referred to in some detail in the biographical study above, and discussed further in Chapter 4.1 below.

Buckland finally closed the evening, and the Oxford British Association Meeting, by saying:

> Gentlemen, the hour is come for the adjournment of this most happy Meeting. I congratulate the University of Oxford on the compliment that has been paid it by the presence of so many distinguished and illustrious strangers, who have honoured us with their company on this ever memorable occasion. I congratulate the Association on the perfect harmony which has pervaded its Meetings, and on the vast and inestimable utility which is likely to result from its operations; I congratulate the British nation that it possesses such a Society, comprehending a host of individuals not only qualified, but prompt and ready, to come forward and promote the general interests of science. Gentlemen, I congratulate each individual here present, on the enjoyment of what I consider one of the highest gratifications of which our nature is capable, - the enjoyment of that personal knowledge and familiar intercourse, with which this Meeting has afforded, with those whose kindred minds and congenial pursuits have been long familiar to us through the medium of their works; the enjoyment of being thus brought into friendly contact and brotherly association, with those whom we have long esteemed and loved and venerated from a distance; the enjoyment of being thus abled, though but for a short, yet a most delightful week, to hold sweet counsel and communion together in these our palaces of peace. Gentlemen, it is now my painful duty to announce, that the moment of separation is arrived; it is my more grateful task to remind you, that we are to re-assemble at Cambridge in the latter part of the month of June next year. (Buckland, 1833C: 109-110).

For good or ill Buckland, Daubeny and Powell had set a pattern for the organisation and programme of the British Association which was to be followed with relatively slight modifications for a generation (Morrell & Thackray, 1981: Chapter 4). Less welcome, in at least some eyes, were the precedents set by the Oxford Meeting in terms of lavish hospitality and entertainment, and the organisers of succeeding meetings vied with each other to out-do in terms of lavishness and spectacle their immediate predecessors. In 1832 Oxford offered Ducal roast venison, the coronation of the "Father of English Geology", and Buckland's Megatherium lecture, which was a piece of pure theatre. In 1833 Cambridge, unable to match Buckland's verbal fireworks, turned to those of a chemical kind for the final evening's entertainment, whilst in 1834 Edinburgh used unrecorded quantities of black powder (certainly many tons) to blow up an estimated 20,000 tons of rock in a single explosion in the Craigleith Quarry, and so on (Morrell & Thackray, 1981: 157-163).

Buckland's involvement with the British Association did not end with his Oxford Meeting Presidency. From its foundation in 1831 till his death in 1856, he served as an officer of the Association in one capacity or another in all but two years - the exceptions being 1837 and 1850. He was three times President of Section C - Geology (1836, 1839 and 1847), and was Vice-President of the Section (or its predecessor Committee III) in eight other years of the 25 including, most notably, 1840, when he introduced Louis Agassiz and his Glacial Theory to the Glasgow Meeting, prior to their joint tour to seek out evidence of glaciation in Scotland (see Chapter 5.2 below).

I have developed an on-line computer databank of the honorary officers of the British Association and its Sections and Committees during its first 25 years, 1831-1855 inclusive, and this is very revealing in terms of the distribution of power and influence within the Association during its first quarter of a century. Over this period the Association had no fewer than 2,559 annual offices (excluding Vice-Presidents-Elect - who were not involved in the management of the Association for that particular year, and who merely duplicated the subsequent year's Vice-President's list, and I have therefore not included these in the data file). The first interesting result of this analysis was that the 2,559 annual posts were held over the period by over 640 individuals, of whom 50% held office for a single year only. The majority of those holding office for only one year were prominent persons from the area of that particular year's meeting, although the list does include several better-known names, including Sir Robert Peel (Vice-President, 1849), John Ruskin (Secretary, Section C, *Geology*, 1847) and Baron Liebig (Vice-President, Section B, Chemical Science and Mineralogy, 1855).

The computer analysis does, however, confirm that a comparatively small number of individuals dominated the offices and Council of the Association during the first quarter-century of its existence. Twenty-two individuals held more than 21 yearly offices each over this period, and a total of 625 (25% of the total) between them. Two men stand out well ahead of all others - Roderick Murchison with a total of 55 annual offices, and another geologist, John Taylor (Treasurer to the Geological Society of London, and Secretary of Committee III, Geology and Geography, in 1832, and later President of Section G - Mechanical Science) with 54. Admittedly, in each case, these totals may be regarded as somewhat distorted by long periods as a Trustee in addition to other offices (23 years each), but, even with this office discounted, these two seem to have been - metaphorically speaking - everywhere within the British Association.

Place	Name	No. of Offices	Geological Connections ?
1.	W H Sykes	33	Yes
2. =	W Buckland	32	Yes
=	R I Murchison		Yes
=	W H Whewell		Yes
5.	J Taylor	31	Yes
6. =	Sir D Brewster	30	Yes
=	C Daubeny		
8.	R Hutton	29	Yes
9. =	Sir C Lemon	27	
=	G Peacock		
11. =	C C Babington	26	
=	J Heywood		
=	J Phillips		Yes
=	A Sedgwick		Yes
15.	W V Harcourt	25	Yes
16. =	G B Greenough	24	Yes
=	E Sabine		
18. =	R Owen	23	Yes
=	T R Robinson		
20. =	H T De la Beche	22	Yes
=	L Horner		Yes

FIG. 3. "LEAGUE TABLE" (ADJUSTED) OF OFFICE HOLDERS IN THE BRITISH ASSOCIATION DURING ITS FIRST TWENTY-FIVE YEARS, 1831 - 1855

Third on the list is Charles Daubeny with 41 yearly offices, including 11 years as Local Treasurer, Oxford. George Peacock's total is also boosted by 11 years' service as a Trustee, and that of Col. W H Sykes (an old collaborator of Buckland on fossil and recent hyaena dens, but who specialised in the Association in Section F, Statistics), by 2 years as the Association's Auditor. Excluding these duplicate administrative offices gives the "league table" in Figure 3.

Looking at these in terms of Sectional allegiance (and allowing for duplicate interests), it is clear that Geology/Mineralogy is far ahead of any other Section in terms of influence, with 12 geologists out of the top 20. Physics/Mathematics can claim 4, Statistics and Mechanics 3 each, and Chemistry and Zoology 2 each.

The other thing that is clear is that the majority of this inner caucus of the Association were close associates of Buckland and Murchison - *even* those whose "allegiance" was not *directly to Section C within the British* Association itself. Col. Sykes is a case in point, as is of course Whewell, who never held office in Section C, but rose to be President of the Geological Society of London.

Buckland was a frequent contributor of papers to the Association on a wide variety of subjects, including the need for a standardised scale of geological colours for mapping purposes (Buckland, 1833D), fossil footprints (1838D), the biological and chemical weathering of chalk and limestone (1839B, 1844C, 1845A), artesian wells (1847) and on natural occurrences of phosphorous in strata (1850).

Even more significantly, Buckland served as a member of what was called the "Committee of Recommendations" responsible for putting forward reaearch projects for initiation and funding by the Association, as a result of which much of the work of Agassiz on British fossil fish was financed at a total cost to the Association of £520.

However, Buckland's main contribution to the British Association after his Presidency at the 1832 Meeting was not in the narrow confines of committee work, but in his ability both as an advocate and as an orator, and someone who could and did walk freely in the corridors of liberal and progressive power without losing the oratory and sense of theatre that brought both the middle-class industrialists of the manufacturing towns to which the Association progressed, and the humble quarrymen, to gather around whenever and wherever he stopped to speak. In Buckland's mind although the fellowship of "Association" was always a great delight (hence his celebrated lavish breakfast parties during every British Association meeting), the second half of its title "Advancement of Science" was of even greater importance. In his celebrated lecture to the assembled membership of the Birmingham, 1839,Meeting inside the Dudley Caverns already referred to in Chapter 2.5 above, Buckland did not confine himself to his graphic descriptions of the geology, nor of the evidence of Design in the action of the Deity in providing the British with the mineral wealth that could make them "by means of this gift, the most powerful and richest nation on earth", but turned to the future, urging both the scientists and the Friends of Science not to neglect the practical sciences or to take for granted the common-place, such as simple iron, ending on a note of prophecy:

> Let us think, if we were deprived of this metal, what should we be from a physical view? Thousands of benefits, thousands of conveniences, which we unconsciously enjoy every hour, would be withdrawn from us; and how many indispensable necessaries it would be impossible to satisfy! Iron, then, has already become incalculably precious; its value to the human race has become, in the highest sense of the word, inestimable. Yet still it continues to open out possibilities of immeasurable importance on quite a new side. By its capability of receiving magnetism of extraordinary strength in a moment, and of losing it again in as short a time, iron becomes an inexhaustible source of power.... As the magnetic power of iron has for the last century allowed us to find our way across distant seas, so it will, perhaps at no distant period, bring together men by land and sea, bridging over vast spaces with a speed that outstrips the power of steam and vies with the swiftness of the wind. (Gordon, 1894: 83).

Of even more immediate importance than his prophecy of high-speed electrical traction for both land vehicles and ships, was the knowledge that the Prime Minister, Sir Robert Peel, was sending a special train to Birmingham at the end of the meeting to take to his home at Drayton Manor the most eminent of the "cultivators of science" attending the meeting. In less than eight years, the voice of science had, through the medium of the British Association for the Advancement of Science, emerged from the narrow confines of the largely ignorant and uncaring Universities, and from the immensely enjoyable and intellectually stimulating, but private, clubland of the leading London scientific societies, and was being heard by both the common people of the intellectually-starved provincial cities and towns, and the highest levels of national government. Buckland approved, and was immensely satisfied.

4. VERTEBRATE PALAEONTOLOGY

4.1 QUATERNARY MAMMALS

The scientific study of fossil mammals in the British Isles began with the work of Buckland in the 1820s, starting with his work on Kirkdale Cave, Yorkshire (Buckland, 1822B), and continued during 1823 with the Reliquiae Diluvianae (Buckland, 1823) and in the series of studies in preparation for the projected second volume of the Reliquiae during the mid-1820s which never appeared (Boylan, 1967).

However, British fossil mammal studies had an extended "prehistory" and "proto-history" stretching back into medieval times, but which has been little studied. The fossils of elephants were described in works as early as Hollinshed's Chronicles of 1578 (quoting a medieval monk, Roger de Coggeshall, and ascribing them to the elephants brought to Britain by Claudius), and the classic 16th to 18th century national and county histories, such as Camden's Britannia (1586), and Plot's Natural History of Oxfordshire (1677), frequently contain references to similar fossils, although their true nature was usually unrecognised.

Other species of fossil mammals were also known before 1700, with a good description of a fossil rhinoceros from Chartham near Canterbury in a very rare pamphlet of 1669, reprinted later in the Philosophical Transactions (Somner, 1701), and there was a good description of the giant Irish deer, Megaloceros giganteus in the Phil. Trans. four years earlier (Molyneaux, 1697).

By the beginning of the 19th century the organic nature of fossils was generally recognised, and fossil mammal bones, teeth and horns began to be described in the more general works on fossils. The Organic Remains of a Former World by James Parkinson (3 vols., 1811-1814) was particularly notable in this respect, and included the first published records from Britain of both hippopotamus (from Walton-on-the-Naze, Essex), and a fossil narwhal (a specimen at that time in the Leverian Museum, probably from the Essex coast).

Buckland certainly saw a number of major cave excavations in central and southern Germany during his continental tour of 1816. He was therefore presumably aware about the various theories on the origin of fossil bones in cave deposits, including the argument of John Hunter (1794) that the cave bear skeletons and other bones in Gailenreuth Cave were the remains of wild animals that had lived in the Cave over many thousands of years at some (unspecified) time in the past, which was taken up and amplified by Cuvier in the first edition of the Ossemens Fossiles (Cuvier, 1812, 4: 12-13). (See Fig. 4 for localities.)

However, Buckland does not appear to have had a special interest in the subject, since the discovery of bone caves at Oreston Cliff, Plymouth (Whidby and Home, 1817) did not draw Buckland to the locality (Boylan, 1967: 239-241). Indeed, at that time Buckland's interests appear to have been entirely in "solid" geology, as in his excellent analysis of the complexities of the Cross Fell Inlier and the Eden Valley (Buckland, 1817A).

Nevertheless, Buckland's visit to the Palaeontological Laboratory of Cuvier (with its strong emphasis on fossil mammals) during his 1816 tour

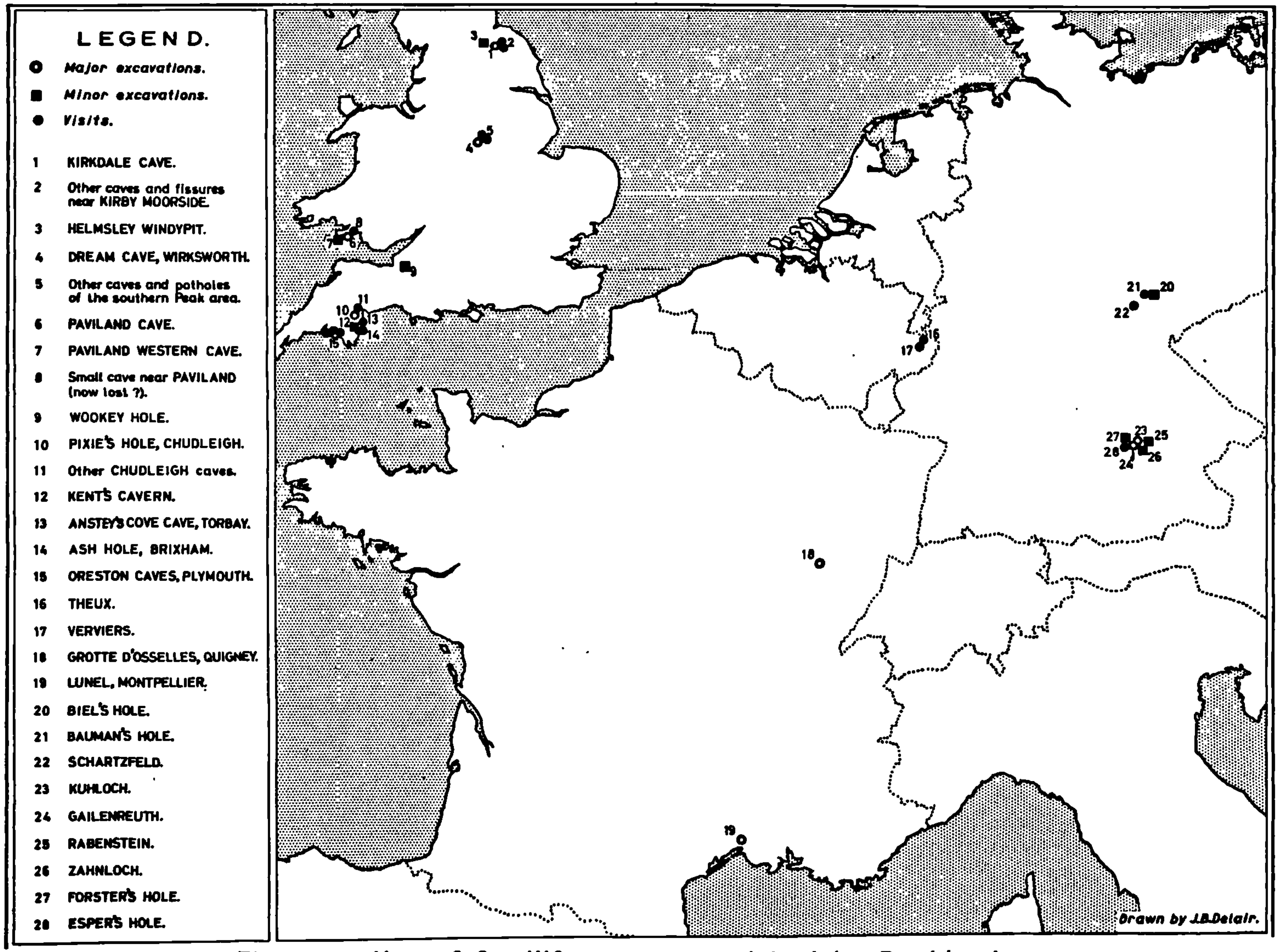


Fig. 4. Map of fossiliferous caves visited by Buckland (from Boylan, 1967)

made a lasting impression on him, as is clear from his impromptu obituary and eulogy on Cuvier given to the British Association at its Oxford Meeting in 1832:

> I cannot utter the name of Cuvier, and associate with it the term 'immortal', without being at once arrested and overwhelmed by melancholy and painful recollections of mortality. We have at this moment to deplore, in common with the whole philosophical world, the loss of the greatest naturalist and one of the greatest philosophers that have arisen in distant ages, to enlighten and improve mankind. The names of Aristotle, and Pliny, and Cuvier, will go down together through every age, in which natural history and physical sciences, in which philosophy and learning, and talent, and everything which, next to religion and morality, gives dignity and exaltation to the character of man, shall be respected upon earth. Gentlemen, I need not state to you how voluminous are the works of that exalted and most illustrious naturalist, whose recent and irreparable loss we now deplore. For nearly thirty years he has been the leader of that branch of natural philosophy which comprehends the structure and relations of all the kingdoms of animated nature. It was the genius of Cuvier that first established the perfect method after which every succeeding naturalist will model his researches; and which laid the foundation of that analytical process of investigation, of that most philosophical and accurate and uniform system of reducing every organ in every species to a fixed and certain type, which will enable his followers to extend their inquiries over the almost boundless regions of the organized world. (Buckland, 1833A: 104).

Buckland's involvement in Quaternary studies began with his work on the conformity of the biblical story of the Deluge with geological evidence for his Inaugural Lecture of 1818, the Vindiciae Geologicae (Buckland, 1820), and this work soon expanded into the major study of the superficial geology of the whole of the southern Midlands and the upper Thames Valley (Buckland, 1821D), with its relatively abundant occurrences of fossil mammals. Although this paper concentrated on the dispersal of erratics from the Lickey Hills and other centres, Buckland included "a few words on the organic remains found in the beds of diluvian [sic] gravel which we have been describing" (Buckland, 1821D: 534). In fact the "few words" extended to three quarto pages, and included brief references to fourteen localities in the Midlands and southern England that had produced remains of fossil mammals, including Thames Valley sites from Oxford and Abingdon, through London to Ilford and Brentford, and the classic King's Lawford locality near Rugby (Buckland, 1821D: 534-537). The species recognised at the various localities included the mammoth ("or northern elephant"), the "double-horned fossil Rhinoceros of Siberia", hippopotamus, horse, ox, hog "and several species of deer". He also referred to some historic finds in museum collections, and (correctly) referred the 17th century Chartham rhinoceros finds to the "Siberian rhinoceros" (i.e. Coelodonta antiquitatis, now usually known as the woolly rhinoceros) as well. One of the two skulls of woolly rhinoceros found in "diluvian" gravel at Newnham, near Rugby, Warwickshire, in 1815 (Buckland, 1821D: 535) was presented by Buckland to the Geological Society, which still has the specimen, since it was deliberately retained by the Society, because of its historic importance, when the rest of the Society's Museum was transferred to the British and Geological Museums in the early years of the 20th century.

Buckland based his identifications of mammoth and woolly rhinoceros partly on Cuvier's published descriptions and plates in his Ossemens Fossiles but also on direct experience of foreign fossil material including a rhinoceros skull from Siberia despatched from St. Petersburg by an Englishman, Mr J Prescott, via Buckland to Cuvier's Museum at the Jardin du Roi, Paris. Although very brief, Buckland's wide-ranging survey of fossil mammal finds in his 3 December 1819 lecture to the Geological Society (Buckland, 1821D) is of very special significance in British fossil mammal studies, because it marked the first unequivocal published identification of both the mammoth and the woolly rhinoceros from British localities.

Although undated and difficult to interpret at times, Buckland's (still uncatalogued) Lecture Notes throw some light on the development of his views on fossil mammals from the start of the Geological Readership lectures in 1819. Outline notes on different species, apparently dating from about 1819 or 1820, are written in ink on large sheets of paper creased to form a simple folder, into which a miscellany of cuttings, notes by Buckland on scraps of paper and the occasional descriptive letter received, were collected. Some of these folders bear the dates on which the particular lecture was given (often covering a period of 10 years or even more), and there are frequent (undated) scribbled amendments and additions.

Thus, in notes on rhinoceroses, Buckland originally listed:

> 3 existing species
> African 2 horns
> Asiatic 1 horn
> Rhinoceros of Sumatra
>
> One fossil species
> (M.S. OUM BuP. Lecture Notes)

but the "One" fossil species had subsequently been crossed out and replaced by "3", which in turn had been replaced by "5". The notes included a reference to the Phil. Trans. 1701 reprint of the Chartham, Kent, finds of the 17th century, and the folder included a newspaper cutting from the Hereford Journal reporting Sir Everard Home's paper to the Royal Society meeting of 27 February 1817 on the Oreston, Plymouth, cave finds, which included rhinoceros fossils.

Not unexpectedly, Buckland's overall position on fossil mammals around 1820, as discernable from the Lecture Notes, is decidedly Cuvierian in tone and outlook, although there is much original analysis and deduction, indicating that Buckland was certainly not slavishly regurgitating Cuvier's teachings as his own, as in one of the few dated Lecture Notes ("Diluvian Rhinoceros & Elephant" initialled "WB. Jany 9, 1820):

> The extinct double horned Rhinoceros of Siberia and the M. [mammoth] of Europe with hairy body & shaggy feet (like the White Bear) is considered by Cuvier not to have been transported thither from southern latitudes, but to have been an aboriginal native of the north ... & whether or not these species survived the waters of the last great Deluge they both appear at this time to be totally extinct as a living species over the surface of the whole Earth. This is in favour of their having become extinct at the Deluge. ... The fact of not finding their remains in the present upper surface of the Earth is however not decisive in proof that these animals have not existed since the Deluge because the remains of all animals that have lived & died since that catastrophic period for want of being entombed in some protecting cave or matrix similar to that wh. ye Diluvium [sic] gravel has afforded to ye fossil Elephant & Rhinoceros & to the various organic remains that at still more ancient periods have been committed to them. ...
>
> Hair no Proof of Climate - long wool on Dromedary, long mane on lion, bears hairy.
>
> Modern elephants & rhinoceros not migratory. (M.S. OUM Lecture Notes).

However, by the beginning of 1822, Buckland was about to establish an international scientific reputation through his novel interpretation of the results of his investigations of Kirkdale Cave, near Kirby Moorside, North Yorkshire.

This small cave, by the side of the Hodge Beck, and about 200 yards from the well-known Anglo-Saxon Minster church of St. Gregory, Kirkdale, was first broken into by quarrymen working the local Corallian Limestone, in June 1821. The cave entrance was apparently sealed by mud and stones, but had been quarried away by the time the first scientifically-inclined observer visited the scene (the London surgeon, John Gibson, who was attracted to the cave by finds of bones and teeth mixed with the limestone that was being used to repair the local roads).

Gibson was followed by William Salmond of York, and the Edinburgh-trained nonconformist minister, Dr George Young of Whitby, together with the artist John Bird, Young's collaborator in his projected "Geological Survey of the Yorkshire Coast" (Young & Bird, 1822). All of these were involved in the scramble for fossils that followed. Gibson soon shared his finds between the British Museum, the Royal College of Surgeons, and the Geological Society (Buckland, 1823: 14n). The largest collection, that of Salmond, became one of the founding collections of the Yorkshire Museum, York, and Young's (much smaller) collection similarly found an honoured place in the Whitby Museum when this was established.

The first published scientific accounts of the Cave and the fossil bones and teeth were those of Young, in letters to Jameson read to the Wernerian Natural History Society of Edinburgh on 15 and 19 December, 1821 (Anon., 1823) followed by a full paper to the same Society (Young, 1822), and a hastily added section on Kirkdale, accompanied by an additional coloured lithograph by Bird, in the first edition of the Geological Survey of the Yorkshire Coast published in February 1822 (Young & Bird, 1822).

Young's interpretation of the finds was one of strict Biblical literalism. In his view the fossils, together with the mud in which they occurred, were the result of the Universal Deluge of the story of Noah, in which animals now surviving only in tropical regions, such as elephants, hyaena, rhinoceros and "an unknown animal, possibly hippopotamus", had all been drowned, with their remains being broken up into small fragments as they were swept northwards by the force of the Deluge, until they came to rest in Yorkshire as the waters of the flood subsided.

Buckland was not immediately attracted to the Cave, but in November 1821 he received a report on the Kirkdale discovery from Shute Barrington, Bishop of Durham, who owned part of the land under which the cave was situated. Barrington had supported Buckland's efforts to establish geology within Oxford University. In response, Buckland dedicated the Reliquiae Diluvianae to Barrington, stating that the Kirkdale investigation "was begun in obedience to your Lordship's immediate advice" (Buckland, 1823: iii).

Buckland evidently wrote straightaway to Cuvier, outlining the news, and Pentland replied immediately in the name of Cuvier in a letter dated 24 November 1821, addressed to Buckland at Kirby Moorside, Yorkshire, urging Buckland not only to collect fossils on behalf of Cuvier, but also to try to identify the species of rhinoceros in the Cave (Sarjeant and Delair, 1980: 283).

Buckland arrived at Kirkdale towards the end of November 1821, and the development of his entirely novel theory that Kirkdale Cave had been occupied by a pack of hyaenas in "antediluvian" times (i.e. before the Universal Deluge), can be seen in his letters to his friend, Lady Mary Cole of Penrice Castle, Gower, now in the National Museum of Wales (North, 1942), and has been reconstructed in my biographical review of Buckland's cave work (Boylan, 1967), and in a much more detailed

150th anniversary study for the Yorkshire Philosophical Society, (Boylan, 1972).

In brief, Buckland recognised that the Kirkdale Cave fossil material was in a very different condition from that of the German caves with which he was very familiar, with no complete skeletons, nor any sign of a vertical opening through which the bones and teeth could have been washed by a stream or flood. By 26 November 1821, he explained to Lady Mary Cole in a letter written from Kirkdale that the floor of the cave:

> is entirely paved with Bones and Teeth of Hyaenas, many of them polished and worn by the trampling of their successive generations. With these are the bones and teeth of Elephant, Rhinoceros, Hippopotamus, Horse, Ox, Deer, Fox, and Water Rat! (North, 1942: 97).

Returning to Oxford in December with a substantial fossil collection of his own (now in the Oxford University Museum), plus much borrowed material, Buckland began to apply all of his growing skill and experience in, above all, comparative anatomy, in identifying the individual specimens and evaluating the significance of the finds. Following the practice of his mentor, Cuvier, Buckland chose to identify the various species represented by vernacular names, rather than by their latin scientific names.

Altogether, Buckland identified 18 species of mammals (plus 5 species of birds). The mammal species were:

> 6 Carnivora. - Hyaena, Tiger, Bear, Wolf, Fox, Weasel ...
> 4 Pachydermata. - Elephant, Rhinoceros, Hippopotamus, and Horse ...
> 4 Ruminantia. - Ox, and three species of Deer ...
> 4 Rodentia. - Hare, Rabbit, Water-rat, and Mouse ...
> (Buckland, 1823: 15).

Every effort has been made to trace and re-examine all genuine Kirkdale mammal fossils surviving in museum collections, and over 1,250 specimens attributed to Kirkdale Cave have been examined, re-identified and re-assessed. This major taxonomic study, which was intended both to review an intrinsically important historic site and to assess the quality of Buckland's work on the Kirkdale finds, has already been published in the course of the work on this thesis, (Boylan, 1981A) and is now reproduced in full as Appendix 2 below.

Perhaps the most remarkable finding of all in the course of this detailed taxonomic review, was that Buckland's original identifications and environmental interpretations were both extraordinarily accurate, even when tested against the accumulated knowledge of 160 years of progress in British fossil mammal studies since Buckland first worked at Kirkdale.

As the faunal revision demonstrates very clearly, even in an abridged species by species synonymy, the list of species alleged to have been found at Kirkdale greatly increased over the years, so that Buckland's original 18 species had grown by 1981 to more than 50 cited species. In fact, on the basis of all of the evidence, the taxonomic review has reduced the list of certain occurrences to 18 species - the same number as in Buckland's list, although his "Tiger" is now reidentified as cave lion ("Panthera" cf. leo) and his "Ox" as an extinct bison (Bison cf. priscus). Closer identification of the small rodents ("Mouse" in Buckland's list) is also now possible and Buckland's "three species of Deer" have been identified at species level, and four other species are recorded as "doubtful or uncertain records". The horse and rabbit remains (although correctly identified) are now considered to be modern intrusions, judging by their state of preservation (confirmed by chemical analyses in the case of the horse teeth). It is also interesting to note that the one figured specimen about which Buckland was uncertain, a ruminant "molar tooth of the lower jaw of a calf" (Buckland, 1823: pl. 8, figs. 5 & 6 - original in the Salmond Collection, Yorkshire Museum), has still not been positively identified despite extensive investigation more than a century and a half later, although in the faunal review I have (partly by comparison, but mainly by elimination) tentatively attributed this apparently unique juvenile specimen to the giant deer (Megaloceros giganteus).

Despite Cuvier's urging, Buckland did not identify the rhinoceros as the "Siberian" (woolly) rhinoceros (Coelodonta antiquitatis), nor the elephant as the mammoth (Mammuthus primigenius), even though Buckland was well aware of these two distinctive species both from fossils seen in British collections and from Cuvier's published descriptions, and had referred British finds to these two species both in his 1820 Midlands "Diluvium" paper (Buckland, 1821D) and his lecture notes of the same year. The Kirkdale rhinoceros is in fact the interglacial narrow-nosed rhinoceros Dicerorhinus hemitoechus, and the elephant is the interglacial straight-tusked elephant, Elephas antiquus, and both of these species can be readily distinguished from the "Siberian" species, even on the basis of fragmentary material surviving at Kirkdale. It is therefore very tempting to speculate that Buckland at least strongly suspected that the two Kirkdale species were distinct from those of Siberia and the British "Diluvium", as early as 1822, although these taxa were not in fact clearly identified and defined as distinct species until almost a generation later.

Buckland was, however, quite positive about one novel identification in the Cave:

> of many small balls of the solid calcareous excrement of an animal that had fed on bones, resembling the substance known in the old Materia Medica by the name of album graecum (see Plate X. fig. 6): its external form is that of a sphere, irregularly compressed, as in the faeces of sheep, and varying from half an inch to an inch and a half in diameter; its colour is yellowish white, its fracture is usually earthy and compact, resembling steatite, and sometimes granular; when compact, it is interspersed with small cellular cavities, and in some of the balls there are undigested minute fragments of the enamel of teeth. It was at first sight recognised by the keeper of the Menagerie at Exeter Change, as resembling, both in form and appearance, the faeces of the spotted or Cape hyaena, which he stated to be greedy of bones beyond all other beasts under his care. (Buckland, 1823: 20).

Wollaston carried out a chemical analysis of the fossil dung, and found calcium phosphate, calcium carbonate and very small amounts of magnesium phosphate and ammonium triphosphate, a composition that was considered to be entirely consistent with faecal matter derived from bones (Buckland, 1823: 50). Faraday confirmed this in analyses recorded in his diary for 22 April 1822 (Faraday, 1932: 65-66).

Buckland also stressed the small dimensions of the cave, including a detailed survey in his published reports, showing that although the original length of the cave (before the quarrying away of the entrance area). had been approximately 300 feet long, the cave was generally low and narrow, rarely more than 3 feet in diameter, and generally consisted of a low bedding plane cave with many constrictions. He particularly stressed that an elephant tooth had been found at the most distant point in the cave, beyond a constriction that he had carefully recorded as 2 ft 5 inches wide and only 1 ft 4 inches high. The occurrence of fossils of very large mammals in such a cave could not be explained either by their entering Kirkdale Cave alive of their own volition, nor indeed by the washing in of their dead bodies in any sort of inundation.

Buckland had also found that all of the bones were extremely fragmentary, and many bore signs of gnawing, teeth marks etc. consistent with what might be expected from hyaena damage, concluding:

> It must already be probable [sic] from the facts above described, particularly from the comminuted state and apparently gnawed condition of the bones, that the cave at Kirkdale was, during a long succession of years, inhabited as a den of hyaenas, and that they dragged into its recesses the other animal bodies whose remains are found mixed indiscriminately with their own. (Buckland, 1823: 19-20).

At this stage Buckland had no reliable observational or experimental evidence on the actual behaviour of hyaenas, let alone the kinds of damage that they produced on the remains of both other species and of other hyaenas (since the hyaena fossils bore identical damage and selective preservation to those of other species). An experiment with a menagerie hyaena was not carried out until December 1822, and field evidence was not found until 1826, when Captain Sykes found the Indian hyaena den which, in Lyell's words, the hyaenas':

> habitations, diet &c., are everything he [Buckland] could wish, and as much as could be expected had they attended regularly three courses of his lectures. (Lyell, 1881A:

In other words, Buckland had built up a most graphic interpretation and description of the behaviour of the Kirkdale hyaenas almost entirely by deduction from the fossil evidence. (This point will be discussed further in Chapter 4.4 below; see also Conybeare's caricature: Fig. 4.)

Fig. 5. Buckland entering Kirkdale Cave and finding it occupied by live hyaenas, from a caricature by William Conybeare.

Moreover, Buckland was convinced that the occupation of Kirkdale Cave by a pack of hunting hyaenas, preying on everything in the Vale of Pickering area, from elephants to water voles, which dismembered their prey (or perhaps sometimes carrion), and dragged the food back to the recesses of their living den in the cave, pre-dated the Universal Deluge. At Kirkdale Buckland relegated the Deluge to the comparatively minor role of covering the bone-strewn floor of the Cave with a layer of mud only one foot or so deep, before blocking the cave entrance with a "plug", described by the quarrymen, who had removed it long before Buckland's arrival, as "rubbish", composed of gravel and sand (Buckland, 1823: 6-7).

Buckland summarised his analysis as follows:

> but the facts developed in this charnel-house of the antediluvian forests of Yorkshire demonstrate that there was a long succession of years *in which the elephant, rhinoceros, and hippopotamus had* been the prey of the hyaenas, which, like themselves, inhabited England in the period immediately preceding the formation of the diluvial gravel; and if they inhabited this country, it follows as a corollary, that they also inhabited all those other regions of the northern hemisphere in which similar bones have been found under precisely the same circumstances, not mineralised, but simply in the state of grave bones imbedded in loam, or clay, or gravel, over great part of northern Europe, as well as North America and Siberia. The catastrophe producing this gravel appears to have been the last event that has operated generally to modify the surface of the earth, and the few local and partial changes that have succeeded it, such as the formation of deltas, terraces, tufa, torrent-gravel and peat-bogs, all conspire to show, that the period of their commencement was subsequent to that at which the diluvium was formed. (Buckland, 1823: 42-43).

Returning to Oxford, Buckland began work on an extensive account (65 printed pages) of Kirkdale Cave and his interpretation of the discovery, and this was read to the Royal Society over three successive meetings (7, 14 and 21 February, 1822), supported by 13 plates from drawings by Thomas Webster, William Clift, Mary Morland (who was commissioned to draw a selection of his finds for Cuvier), and H O'Neil, engraved by J Basire. These contained 148 figures, including some comparative material from Hutton Cave in the Mendips and from "diluvium" at Lawford, near Rugby (Buckland, 1822A). The Lawford fossils described and figured (Plate XII) were a lower jaw of hyaena, together with a radius and ulna of hyaena. These three specimens, all apparently from the same very old individual, were quite complete and bore no signs of the kinds of damage found on virtually all of the Kirkdale specimens, and Buckland drew special attention to this, arguing that:

> It should be observed, that this specimen [the lower jaw], and the humerus and ulna (Plate XIII. 1, 2), are not in the least degree mangled or *broken like those from the den at Kirkdale,* being derived probably *from one of the last hyaenas that were* drowned by *the diluvian waters, together with the other animals* whose bones *are found with them equally perfect, and free from* such marks of violence as occur on all the bones of whatever kind discovered at Kirkdale. (Buckland, 1823: 266).

Buckland's graphic lectures on this aged and frail "last hyaena" in Britain being swept up and drowned in the Deluge, became celebrated (perhaps notorious would be a more appropriate description, since his lsiteners could not decide how much of the detail Buckland himself really believed in, and how much was buffoonery). When this was coupled with his great delight at the identification of fossil hyaena dung - with its many possibilities for the exercise of Buckland's robust, indeed coarse, sense of humour, by the beginning of 1822, Buckland was presenting a very different public image from that of the serious young newly-appointed professor of just three years earlier.

There is little information on Buckland's private account of his Kirkdale investigations to members of the Geological Society, or indeed to his students and friends in Oxford, but his Royal Society paper was delivered with due seriousness, and despite the entirely novel thesis that it presented, was extremely well received, so much so that Buckland was within weeks awarded the Royal Society's Copley Medal specifically in recognition of the importance of the Kirkdale study.

He received the medal from the hands of Sir Humphry Davy, President of the Royal Society, who visited the Cave personally, guided by Buckland, in July 1822, and who became one of Buckland's strongest supporters in the ensuing scientific and religious controversy about Buckland's novel views. Indeed, this apparently insignificant small cave in a remote part of North Yorkshire became the focus of attention throughout the scientific world, and a place of scientific pilgrimage for those wishing to see for themselves the wonders of what the proud Yorkshireman, Sedgwick, dubbed (at least half-seriously) "our Yorkshire Hyaenopolis".

In the summer of 1822, *once his teaching commitments were fulfilled,* Buckland embarked on an ambitious programme of field investigations into finds of fossils in caves, both in Britain and on the Continent. The fame (or notoriety) of Kirkdale led to many dozens of reports of finds of fossil bones and teeth, and to exploratory excavations into the floor deposits of many British caves. Buckland understood very well that the one weak point in his graphic analysis of the Kirkdale phenomena was the lack of unequivocal scientific evidence about the original cave mouth, which had been completely quarried away long before his arrival. He therefore explored several likely areas himself, seeking unopened (or at least undisturbed) caves, and during his return to the Kirby Moorside area with Davy in July 1822, he opened several small caves and fissures, in the Duncombe Park area, using Davy as an unimpeachable independent witness to his observations. However, no second, undisturbed, Kirkdale was found, although the exploration of the "post-diluvial" Ryedale Windy pit fissure (Buckland, 1823A: 54-57), was:

> important, as illustrating the manner in which the bones of antediluvian animals may have been accumulated by falling into similar fissures, ... and when we consider that it is the habit of graminiverous animals to be constantly traversing the surface of the ground in every direction in pursuit of food, it is obvious that they are subject in a greater degree than those which are carnivorous to the perpetual danger of falling into any fissure or imperfectly closed chasm that may lie in their way; (Buckland, 1823A: 56).

Buckland had, by mid-1822, already recognised, and could readily distinguish, the three basic explanations for the occurrence of fossil mammal remains in caves: animal remains under natural pitfalls, of inhabited caves, and of water-lain cave deposits respectively (Buckland, 1823A: 76-80). This was a major advance in both speleology and vertebrate palaeontology (Boylan, 1967: 249).

Buckland continued to search for an undisturbed cave deposit to investigate, but with little success. When fossils were found in Paviland Cave, Gower, in December 1822, he instructed the local finders, through Miss Jane Talbot (daughter of his friend Lady Mary Cole) to close up the cave entrance until he arrived, but the deposits were already very disturbed, both by natural processes and by human interference, and in the event Buckland's ideal fossiliferous cave with a sealed entrance and no prior human interference was not found until after his death, with the excavation of Brixham Cave, Torbay, in 1858.

In the meantime Buckland turned his attention during 1822 to seven British bone caves found (and in most cases at least partly explored) by others: Hutton Cave (Banwell, Somerset), the Durdham Down Cave, Bristol, two caves near Wirksworth, Derbyshire, the Oreston, Plymouth fissures, and two Gower caves: the Crawley Rocks cave and Paviland Cave, and also carried out an extensive tour of German bone caves, including five important sites in Franconia, and all of these were described and discussed in Reliquiae Diluvianae, published at the beginning of 1823 (Buckland, 1823A).

The description of Hutton Cave, found half a century earlier, was based largely on notes prepared by Conybeare, supplemented by detailed work by Buckland on the surviving fossils in the Bristol Library collection. Fossil bones and teeth of several species, notably wild boar, elephant and a deer had been found at considerable depth in the course of quarrying in fissures for ochre, and the white bones were recorded as occurring in a small cavern in an ochreous deposit. Buckland felt that from the description of their occurrence, the mammalian fossils had either been washed in or represented animals that had fallen into the cave in antediluvian times, and that they were not the remains of animals dragged in by beasts of prey (Buckland, 1823A: 57-60).

While in Bristol to see the Hutton material Buckland had been shown fossil bone fragments from a small fissure on "Derdham" (Durdham) Down, near Clifton, by J S Miller (the Curator of the museum). Buckland considered that the material had "evidently been fractured by violence", and described one specimen:

> a fossil joint of the horse: it is the tarsus joint, in which the astragalus retains its natural position between the tibia and os calcis; these are held together by a stalagmitic cement, and were probably left in this position by some beast of prey that had gnawed off the deficient portions of the tibia and os calcis. (Buckland, 1823A: 60-61).

Turning to Derbyshire, Buckland had been told by White Watson of a 1663 find of bones and molar teeth of an elephant found in a cavity discovered while sinking a lead mine at Balleye, near Wirksworth. Of much greater interest was Dream Cave, Wirksworth, where in December 1822, lead miners broke into a large chamber containing a massive talus of earth and fragments of stone. Buckland was notified of the discovery and travelled immediately to Wirksworth to investigate. He found the greater part of the skeleton of a rhinoceros, somewhat scattered, but clearly belonging to a single individual because "there were no supernumerary bones, to indicate the presence of a second rhinoceros" (Buckland, 1823A: 63). Buckland carefully plotted the finds on a sketch and section, which was re-drawn by Webster and lithographed by George Scharf as Plate 20 of the Reliquiae Diluvianae. In addition to the rhinoceros skeleton, Buckland also recorded remains of horse, a very large ox and a medium-sized deer with palmated antlers. The needs of Oxford University were not forgotten and the landowner, a Mr Gell, donated all "these valuable specimens" to the Oxford Museum (Buckland, 1823A: 63).

Buckland had re-examined the account of, and specimens from, the two Oreston, Plymouth, fissures previously published(Home and Whidby, 1817 & 1820), and when a third fossiliferous cave was found there in the summer of 1822 Buckland travelled immediately to see it, accompanied by

Henry Warburton. However, before their arrival "fifteen large maund baskets" (Buckland, 1823A: 71) of bones, skulls, horns and teeth had been collected by Whidby, and were sent to the College of Surgeons for identification by William Clift, prior to publication by Whidby (1823). A further very large collection of over 600 specimens of bone and teeth, together with 33 specimens of osseous breccia cemented by stalagmite was made by Joseph Cottle of Bristol, and the faunal list corresponded closely to that of the other Oreston finds, and was comparable with that of Kirkdale except for an abundance of horse.

Since the identifications had already been made, Buckland concentrated on the mode of deposition, contrasting the Oreston finds with those of Kirkdale in the comparative completeness of the bones, and absence of the characteristic damage that he had attributed to the hyaena at Kirkdale:

> none of them are gnawed, many are quite perfect, and the majority of them slightly broken. (Buckland, 1823A: 72).

He continued by comparing the Oreston cave breccia and the bone deposits with those of Gibraltar:

> excepting the accident of their being less firmly cemented by stalagmitic infiltrations through their earthy matrix, (Buckland, 1823A: 73).

The only gnawing that Buckland could find were marks of:

> nibbling by the incisor and canine teeth of an animal the size of a weasel, showing distinctly the different effect of each individual tooth on the ulna of a wolf, and the tibia of a horse; (Buckland, 1823A: 73).

So far as the source of the bones were concerned, he could find no evidence that they had been collected by hyaenas but:

> appeared to us to have been washed down from above at the same time with the mud and fragments of limestone ... they were entirely without order, and not in entire skeletons; occasionally fractured, but not rolled; apparently drifted, but to a short distance from the spot in which the animals died; (Buckland, 1823A: 73).

Turning to the question of the age of the fossils, Buckland compared the state of preservation with those of Kirkdale, finding that:

> They retain less of their animal gelatin [sic] than the bones at Kirkdale, and when dry they ring if a blow is given to them, and are absorbent to the tongue. (Buckland, 1823A: 74).

From their condition, and the species represented, particularly hyaena, rhinoceros and "tiger", Buckland concluded "That they are of antediluvian origin" (Buckland, 1823A: 76).

Following the work in Plymouth, Buckland spent much of the summer of 1822 in Germany, re-visiting bone caves and collections that he had seen on previous continental tours in 1816 and 1820, meeting the leading workers in the field, and visiting a number of new localities.

In addition to including detailed reports on the German caves in the Reliquiae Diluvianae (Buckland, 1823A), he gave a substantial paper "Account of Bones discovered in Caves and Fissures in various Parts of the Continent" to the Royal Society spread over two weekly meetings on 8 and 15 May 1823. However, since most of the material had by that time been pre-published in the Reliquiae, only abstracts were published in, for example, the Annals of Philosophy (Buckland, 1823B).

Buckland reported on the caves that he had studied in the summer of 1822 and:

> found that all their characters and phenomena confirmed his former conclusions respecting them and the English caves: they all contain either diluvian mud, or diluvian sand and pebbles, covered with one coat of stalagmite only.... The caverns are in limestone rocks of different ages and formations, and all their circumstances concur to show that the bones they contain had existed in them previously to the inundation by which the mud and pebbles were introduced. (Buckland, 1823B: 466).

He had first visited two bone caves of the Magnesian Limestone of the Hartz, Scharzfeld and Bauman's Hole, after which he had examined many caves in the Jurassic limestones of Franconia, and described five of these in both the Reliquiae Diluvianae and the Royal Society paper: Forster's Hole, Rabanstein, Zahnloch, Gaitenreuth and Kühloch (see Map 1 for the localities of the main caves studied by Buckland).

Buckland satisfied himself as to the (still disputed) origin of the enormous quantities of cave bear remains in caves such as Gailenreuth and Kühloch. He was convinced that such caves had been the dens of the cave bears themselves, in which they had both been born (as evidenced by the occurrence of skeletal remains of new-born animals), and died. In the case of Kuhloch he estimated that the cave must have contained the remains of at least 2,500 bears, but pointed out that this was:

> a number which might have been supplied in 1000 years by a mortality of two and a half per annum. (Buckland, 1823B: 467).

In the fuller account (including six new plates) in the Reliquiae Diluvianae the descriptions of the individual caves was preceded by a comprehensive review of previous research and opinions, including in particular the work of Esper, Rosenmuller, Goldfuss, Hollman, Blumenbach, Leibnitz, De Luc, Soemmering and Cuvier (demonstrating, incidentally, Buckland's competence in both French and German languages, although he does not appear to have had any formal education in either).

Buckland's "General Remarks on the German Caves" (1823A: 142-147; 1823B: 468) covered in eight succinct paragraphs the implications of his observations and interpretations in terms of both the Diluvial theory (discussed in Chapter 5.1 below), and cave palaeontology.

These included a summary of Buckland's views on the original forms of the caves and fissures and the modification of these through the excavation of valleys by the diluvial waters, which also drifted in the mud and pebbles. The fossil remains were, in Buckland's view, of animals that had lived in and around the caves in antediluvian times, and that only a single covering stalagmitic crust had been found covering the fossiliferous deposits and the diluvium (clearly implying a single cycle of cave occupation or pitfall trapping, the Deluge, and post-diluvial stalagmite formation, although this is not explicitly stated). He also explained the differences from one cave to another in the proportions of teeth and bones in terms of the inferred depositional environment: pitfall deposits in fissures contained mainly the remains of larger (and clumsy) herbivores, and just a few carnivore remains, caves such as Gailenreuth contained mostly bear remains, since the cave had been a bear's den. However, none of the German caves examined at that time had the characteristics of a hyaena den, in terms of the highly disproportionate occurrence of different parts of the skeleton (with indigestible portions such as teeth and carpal and tarsal bones predominating), and the very distinctive kinds of damage and gnawing seen at Kirkdale.

Of course, one and a half centuries later, all of these views and interpretations (except for the concept of a single Deluge) are quite routine and unremarkable, but most if not all were entirely novel (and very controversial) when they were first presented as an integrated interpretation by Buckland in the 1820s.

Returning to England, Buckland continued work on his projected book on not only the cave discoveries but also an overall synthesis of Quaternary history, including the Universal Deluge. However, work on the final parts of the book was interrupted by exciting new discoveries in South Wales.

Buckland first learned of an interesting group of fossil bones and teeth from a fissure found in 1792 in a limestone quarry at Crawley Rocks, Oxwich Bay, Gower, which was preserved in the collection of Miss Jane Talbot of Penrice Castle (the daughter of Lady Mary Cole by her first marriage to T M Talbot of Penrice). Examining these at Penrice, Buckland identified elephant, rhinoceros, ox, red deer and hyaena, and was also told of previous finds in the area, including a rhinoceros femur from Port Eynon, and a large skull that Buckland surmised must have been of rhinoceros found at Crawley Rocks, but already lost by 1823.

Buckland was still most anxious to find a completely undisturbed cave containing the "antediluvian" mammal fauna, which would resolve many of the arguments about his novel interpretation of Kirkdale and the many other cave finds, all of which, however, had been opened up and disturbed before the arrival of scientific witnesses of the highest standing. He realised that the many caves and fissures of the Carboniferous limestone of the Gower, at that time still very remote and little visited, might produce the sought-for undisturbed "antediluvian" fossil mammal deposit, particularly since the area appeared to have already produced a larger number and concentration of fossiliferous caves and fissures than any comparable area of Britain up to that time. Accordingly, he impressed the importance of immediate "intelligence" in the event of the discovery of a new cave in the area on his friends and acquaintances in the area.

The hoped-for new discovery on the Gower was soon made when a local surgeon and the local curate began to excavate in Paviland Cave ("Goat Hole") and found two molars and a tusk of an elephant, which they re-buried. The cave opened to the sea with a chamber approximately 20 m. long by 6 m. wide and up to 9 m. high, rising up from just above the present sea level to about 10 m. above sea level, in steeply dipping Carboniferous limestone. It therefore did not have the sought-for sealed entrance, and it subsequently transpired that "Its existence had been long known to the farmers of the adjacent lands, as well as the fact of its containing large bones" (Buckland, 1823A: 82). However, the first visit by Jane Talbot and Lewis Dillwyn in December 1822 produced not only the fossil elephant remains found previously by the local men, but also "a large part of the skull to which it had belonged, and several baskets full of teeth and bones." (Buckland, 1823A: 83).

At the time Buckland was in Derbyshire working on the Dream Cave, Wirksworth, finds, but he immediately travelled to Penrice to supervise further work in Paviland Cave. He identified a considerable number of specimens of the by now characteristic "antediluvian" fauna: elephant, rhinoceros, horse, bear, hyaena, fox, wolf, ox and deer, together with other remains that were considered from their appearance and/or location to be intrusive and "postdiluvian", including one specimen of pig, numerous fragments of modern ox and sheep, a rat skeleton, some bird remains and "Man .... Portion of a female skeleton, clearly postdiluvian" (Buckland, 1823A: 85).

Within the cave, Buckland identified and described the cemented fossil sea beach containing many fragments of shells including Buccinum, Patella and Littorina (all of which occur in the local storm beaches at the present day), and on his section of the cave Buckland (1823A: pl. 21) showed this fossil cemented beach rising upwards from the mouth of the cave to a low limestone cliff, about one third of the way from the cave entrance and rising to a height of approximately 3 m. above the present sea level. The detailed description of this interesting feature anticipated by more than a century the defining of the "Patella Beach" of the Gower by T N George (1932). (The discovery and interpretation of the "Red Lady of Paviland" is examined in Chapter 4.2 below.)

Back in Oxford at the end of December, 1822, Buckland fitted the final piece into the fossil mammal jigsaw, with the famous experiments with a live spotted hyaena borrowed from Wombwell's travelling menagerie, in which, amongst other things, he presented the animal with the fore quarter of an ox, and the animal obliged him by providing not only identical remains to those of Kirkdale, but also a copious supply of the characteristic droppings (Buckland, 1823A: 38; 276-276; pl. 23; Boylan, 1972). (This experiment is discussed further in Chapter 4.4 below.)

The whole of the work on fossil mammals was brought together in book form in Reliquiae Diluvianae published in February 1823, and reprinted within the year, but Buckland also brought together in this his developed synthesis of the Diluvial Theory as he perceived it at that time, and this aspect is examined in more detail in Chapter 5.1 below. However, it should be noted here that the title of the book was very misleading, at least as far as the novel work on the fossil mammals was concerned, since Buckland asserted that far from being "reliquiae diluvianae" – i.e. "relics of the Flood", all of the fossil animal remains described were "antediluvian", and argued at considerable length against those, such as George Young, who considered that the Kirkdale and similar finds <u>were</u> the remains of animals destroyed in the Universal Deluge.

Despite his often vituperative critics, and some scepticism even amongst more sympathetic scientific friends, the publication of <u>Reliquiae Diluvianae</u> made Buckland internationally known with favourable reviews and abstracts through much of Europe and in North America, and the ultimate accolade in the field - high praise from Cuvier himself.

His position as the leading British authority in the field of British fossil mammal studies was unchallenged for two decades until the early 1840s, when Hugh Falconer returned from India, and Richard Owen established himself in the Museum of the Royal College of Surgeons, and Buckland remained the leading "elder statesman" in the field until his final illness, offering warm friendship and encouragement to Falconer, Owen and other members of the rising generation of vertebrate geologists.

During the 1820s in particular, Buckland was very much in demand, particularly in examining newly-discovered fossiliferous caves. In 1825 he made several visits to South Devon at the invitation of various investigators of newly-discovered cave deposits. The first person to excavate in Kent's Hole (now known as Kent's Cavern, Torquay) was the highly eccentric but brilliant gentleman scientist and antiquary, Thomas Northmore, who began excavating in 1824 and found fossil bones and teeth as soon as he broke through the stalagmite floor. Northmore later made much of the fact that Buckland had apparently previously visited Kent's Hole on two or three occasions, but had found nothing (and dismissed it in two lines in Reliquiae Diluvianae) because he had failed to break through the stalagmite (Blewitt, 1832).

Northmore wrote to Buckland from Torquay on 29 September 1824 describing the setting of the cave and referring also to Ash Hole, Brixham, continuing:

> I commenced my research after I had advanced about 140 to 160 feet within the cave, in a passage about 70 feet long. Here at the end under a sloping rock I found many bones of various sorts ... on the surface of the floor and there was no stalagmite beneath. Advancing 50, or 60 feet further, I commenced working under a stalagmitic incrustation, and soon found within inches of the crust a pretty large tooth, with 2 fangs, which I take to be a Hyaenae's; this was succeeded by several others which I will cheerfully send for your inspection.... Advancing another step I found more teeth and bones, similarly situated under stalagmite; and contiguous to a pool, a tusk, in good preservation.... (M.S. Coll. Mrs J M Eyles).

Northmore wrote again to Buckland from Cleve, Exeter, on 6 November 1824, giving Buckland permission "to make any use you please of my communications", and stating that his finds were being despatched to London for Buckland to examine, and stating that W C Trevelyan had already examined the site of his excavations in Kent's Hole, and had himself found hyaena remains there (M.S. Coll. Mrs J M Eyles). However, Northmore appears to have been largely by-passed in the subsequent excavations which commenced under the direction first of Trevelyan, and then of Father John McEnery. the local Roman Catholic priest, excavating from November 1825 with guidance (initially at least) from Buckland, who worked in the hyaena den and other deposits in the cave during extended visits in February and April-May, 1825, and later in the summer of 1825 (Buckland, 1825D; 1826). During this period Buckland also carried out excavations in other South Devon caves, including Pixies' Hole, Chudleigh and examined the excavations of Henry Lyte in Ash Hole, Brixham, and of McEnery in the Ansty's Cove Cave, Torquay (Pengelly, 1873A & B, Blewitt, 1832: 120-121, Boylan, 1967: 243-244).

Although Buckland continued to visit British cave sites, including for example an exploratory study of Bacon Hole on the Gower coast in 1831 in the company of Dillwyn (C B Stringer, pers. comm.), Buckland does not appear to have carried out cave deposit investigations personally in Britain after 1825. However, during his extended honeymoon tour of Europe in 1826 he directed excavations at two groups of caves in France. In March he assisted with excavations sponsored by the French Government at Lunel near Montpellier, demonstrating that this had been, like Kirkdale, a hyaena den, although occupied by striped hyaenas as well as the more usual spotted or cave hyaena (Buckland, 1827B). Later in the tour, in October 1826, he visited the Grotte d'Osselles (Quigney), near Besançon, which was supposed to be unfossiliferous, but which produced a substantial number of bones and teeth of fossil bears when the stalagmite floor was broken through under Buckland's direction (Buckland, 1827B).

By the time the Bucklands returned to England McEnery had made a major breakthrough in Kent's Hole. The previous year Buckland himself had discovered "the blade of a knife belonging to the Ancient Britons, made of flint, about two inches and a half long, and half an inch broad" (Buckland, 1825D). However, McEnery had now discovered Middle and Upper Palaeolithic flints in association with the characteristic "antediluvian" fossil mammal fauna underneath a thick stalagmite (see also Chapter 4.2 below), together with other important new finds including teeth of the sabre-toothed "tiger", Machairodus, although the latter was at first identified as Cuvier's Ursus cultrideus (Alexander, 1964). In March, 1827, Buckland offered generous support to the impoverished McEnery in the form of the services of artists and lithographers to prepare 18 large quarto plates of the Kent's Hole finds (including the flint implements), on the basis that the same plates would be used first in McEnery's own report on his excavation and finds, and then in a projected volume 2 of Reliquiae Diluvianae, in which Buckland intended to update the field evidence and his interpretation in the light of the further investigations at previously published sites, and of the many additional localities discovered and examined during the four to five years that had passed since the completion of the first volume (Kennard, 1945: 172-173).

McEnery began work on the text for the book and produced at least four different drafts at different dates before his death in 1840. Some of the versions must have been drafted several years after McEnery finished excavating in Kent's Hole in 1829, since Buckland's Bridgewater Treatise of 1836 is frequently cited in these. However, the work remained in the form of unfinished chapters and rough notes (now in the Torquay Natural History Society's Museum), a selection of which were used by Vivian for the first publication (McEnery, 1859), and all of which were grouped into ten "fasciculi" by Pengelly, who published them in full so far as practicable forty years after McEnery ended his work in the cave (Pengelly, 1869).

The projected second volume of the Reliquiae Diluvianae never reached the stage of even a first draft, although some impressions were taken off the lithographic stones prepared by George Scharf, and were distributed by Buckland and McEnery as loose sheets, and with the permission of Frank Buckland a small edition of large paper quarto impressions were taken from the sixteen surviving lithographic stones in 1858, for use in Vivian's edition of McEnery's Cavern Researches.

Instead of continuing with work on British sites, Buckland turned to two new areas of work in the field of fossil mammal studies: the identification and interpretation of material collected in other parts of the world by overseas travellers, and especially by official expeditions, and to his growing interest in functional morphology.

Strictly speaking, the first published study by Buckland of fossil mammals sent to him from distant parts of the world, those collected by a Mr J Crawfurd, F.G.S. , while on an official mission to Burma (Buckland, 1828C & 1829B) falls outside the scope of this study since Buckland finally decided that the material was Tertiary in date rather than Quaternary. However, the full Geological Society paper is revealing in terms of Buckland's views in the late 1820s. One of the unresolved issues at the time of the Reliquiae Diluvianae of 1823 was whether or not the "antediluvian" fauna of temperate and arctic latitudes could also be found in the tropics, as Buckland had predicted. Although the species were different (reflecting the greater age of the fauna), Buckland demonstrated that there were marked similarities between the Burmese fauna and that of the Quaternary of Europe, the main difference being that Mastodon was abundant whilst true elephants were absent, as were tigers and hyaenas (both of which, of course, were abundant in the living fauna of the Indian region). On this important point Buckland concluded:

> The same analogy which emboldened me in my first paper on the Cave of Kirkdale, to anticipate the discovery which was speedily made of hyaena's bones in the diluvium of England, arguing on the fact of their existence in the diluvium of the European continent, at the present moment encourages me also to anticipate the future discovery of the elephant, tiger and hyaena in the diluvium of Asia. I would also argue, on the same grounds, that it is highly probable that we shall hereafter find that the mastodon in our own diluvium and most recent tertiary strata. (Buckland, 1829B: 381).

Buckland had cooperated in this study with the anatomist, William Clift, who described and named the new species in Crawfurd's collection (Clift, 1829), and Buckland and Clift cooperated in a slightly revised and corrected version included in Crawfurd's Journal when this was published (Buckland, 1834B).

Crawfurd's Burmese finds were incidental to his main diplomatic mission, but Buckland also received for identification and evaluation material from official government expeditions as well. The most important of these was the material from the 1825-1828 expedition of HMS Blossom to the Pacific and Arctic Oceans under the command of Captain Frederick Beechey R.N. As a young lieutenant in the Navy Beechey had been on Franklin's Arctic expedition of 1818 in search of the North West Passage.

He was not without influence in Royal circles as the son of the artist Sir William Beechey, the official portrait painter to Queen Charlotte, and he was still only a lieutenant when he was given command of his own expedition in HMS Blossom during which he made detailed surveys of much of the coast of the Bering Sea and of the Arctic Ocean north of the Bering Straits, and made many scientific observations and collections. One of his detailed surveys was of the Kotzebue Sound area of the Alaskan coast on the Arctic Circle. On the southern side of the Sound in what he named Eschscholtz Bay (in honour of the German Arctic explorer of that name), Beechey found large quantities of fossil bones and teeth melting out of the permafrost in a cliff on the side of the Bay. Beechey clearly had Buckland in mind as the potential interpreter of this material, since he named the river entering Eschscholtz Bay near the find spot the Buckland River. (Unlike some of Beechey's names, the name Buckland River is still used today, and it has a small settlement called Buckland at the head of its estuary.)

On his return to England Beechey sought permission from the Admiralty to offer the Eschscholtz Bay material, together with the expedition's field notes, to Buckland, and this was quickly agreed. Buckland was very interested indeed but was somewhat concerned about the publication timescale envisaged by Beechey. Eventually he agreed to write up the finds. He had seen fossil mammal remains from the permafrost of Siberia at least 10 years earlier, but had never had the opportunity to undertake the primary publication of such material, nor had he seen anything from the North American side of the Bering Straits.

In his report (Buckland, 1831), he identified the elephant and rhinoceros remains as identical to those of Siberia and Europe, and compared the fauna with his "antediluvian" mammal fauna of Britain and Western Europe, and added a comprehensive survey of the other Arctic finds of fossil mammals, both in the form of frozen carcases and the more common skeletal remains. He was also concerned to explain the mechanism by which the fossil remains could have accumulated in "mud" that was frozen completely solid until it was exposed to the atmosphere by cliff erosion during the short Arctic summers, and became convinced that the only explanation for this, and for the preservation of well-preserved carcases of mammoth and woolly rhinoceros in the Arctic permafrost must be sudden climatic change:

> this northern region of the earth seems to have undergone successive changes from heat to cold, so that it is probable that the last of these changes was coincident with the extirpation of the mammoth. That this last change was sudden is shown by the preservation of the carcase in ice .... and the cause producing this change of climate may also have produced an inundation, sufficient to destroy and bury in its ruins the animals which then inhabited the surface of the earth. (Buckland, 1831: 612).

The other strand of Buckland's later work on fossil mammals was his growing conviction of the importance of functional morphology. He had, of course, already undertaken some remarkable and intuitive work in this field in his reconstruction of the characteristics of the cave hyaenas during his work on Kirkdale, but this issue became of even greater importance to Buckland as he began work on the Bridgewater Treatise, since the perfection of functional adaptation of the diversity of fossil species was central to his concept of Proofs of Design.

Buckland's first opportunity to try out this approach came during the 1832 British Association meeting in Oxford, when Buckland, as President, had the opportunity to give a public lecture on the final evening of the Meeting. Buckland chose as his subject the recently discovered "monstrous animal, the Megatherium" (Buckland, 1833: 105), an extinct Pleistocene mammal from Argentina akin to a giant sloth. A large number of well-preserved bones of this animal had recently been brought to Britain by the Consul in Buenos Aires, Woodbine Parish, and which had been discovered in a bizarre way if Buckland's story is to be believed:

> It was discovered by a peasant who, passing along the river Salado in a dry season, threw his lasso [sic] at something he saw half-covered with water, and dragged on shore the enormous pelvis of this animal; the rest of the bones, consisting of the greater part of the skeleton, with many of the claws and teeth, were obtained by turning aside the current by means of a dam. (Buckland, 1833A: 106).

The skeletal remains were produced, with the five year old Frank Buckland sitting inside the pelvis to demonstrate the likely size of the animal's foetus, whilst the luckless William Clift of the Royal College of Surgeons Museum was made to crawl through the birth canal of the pelvis, to be hailed a born-again scientist and a child of the Megatherium. It seems clear that after such clowning, coupled with much earthy language, only a very small minority of the audience had the slightest idea when, if at all, Buckland was to be taken seriously.

In fact, those who knew Buckland well enough to be able to separate fact from tomfoolery must have recognised that they were listening to the results of a remarkable and innovatory analysis of the functional adaptation of the Megatherium to an inferred environmental niche, based on a detailed analysis of the skeletal evidence.

The fossil Megatherium of the Pleistocene of South America had been known, although from less complete skeletons, for more than a decade and its affinities to the sloth had been recognised. However, as Buckland explained to his audience, these two animals:

> have been considered by Buffon and other naturalists to afford the greatest deviations from the ordinary structure of quadrupeds - deviations which they have viewed as indicating imperfection in their organization, without any compensating advantage. (Buckland, 1833A: 106).

Buckland disagreed profoundly with this interpretation and considered on the basis of a careful analysis of their functional morphology the fossil Megatherium and the living sloth:

> they afford striking illustrations of those rich and inexhaustible contrivances of nature by which the structure of every created being is precisely fitted to the state in which it was intended to live, and to the office which it was destined to perform. The peculiarities of the Sloth which render its movements so awkward and inconvenient upon the earth, are adapted with much advantage to its destined office of living upon trees and feeding upon their leaves; the peculiarities of the Megatherium are not less wisely adapted to its office of feeding upon roots. (Buckland, 1833A: 106).

The Megatherium was indeed a strangely proportioned animal, about eight feet high and up to twelve feet long, with rear quarters larger than those of an elephant, but with disproportionately small fore quarters except for hugh shovel-like fore feet armed with three claws more than a foot long.

For Buckland, the key to the interpretation of most animals lay in the teeth, since from these the likely diet could be inferred, and from that the animal's likely mode of life. In the case of the Megatherium, the teeth were, in his view, "ill adapted for the mastication of grass or flesh" but "wonderfully contrived for the crushing of roots" (Buckland, 1833A: 106). Moreover, if an animal lived on roots, it was clearly necessary for other parts of its anatomy to be adapted to the digging up of roots, hence in the case of the Megatherium the very extreme adaptation of the fore feet, with their enormous claws, to form "most powerful instruments for scraping roots out of the ground" (Buckland, 1833A: 106).

He then turned to the "enormous posterior" of the animal, and at this point his robust humour appears to have got the better of him, judging by many contemporary comments, explaining with graphic demonstrations and the odd comment about humans similarly afflicted that:

> The object of this apparently incongruous admixture of proportions , was to enable the creature to stand at ease on three legs, having the weight of its body chiefly supported by the hinder extremities, and one of its fore paws at liberty to be exercised without fatigue in the constant operation of digging roots out of the ground. (Buckland, 1833A: 106).

Buckland was less certain about the function of the armadillo-like armour, suggesting that it might have been protection against "the myriads of insects that swarm in the regions frequented by these animals, and also against beasts of prey" (Buckland, 1833A: 107) or - perhaps less seriously:

> to prevent the annoyance which this class of animals would feel, without some such protection, from the constant presence of sand and dirt with which the act of digging and scratching for their daily food would otherwise fill their skins; (Buckland, 1833A: 107).

Buckland concluded the formal lecture by affirming publicly, apparently for the first time, the theme that was to be central to the Bridgewater Treatise on which he was working:

> that this was but one of the many examples afforded by comparative anatomy of the inexhaustible richness of contrivances whereby Nature has adapted every animal to a comfortable and happy existence in that state wherein it was destined to move; ... that the researches

> of Geology tended not only to afford similar examples of contrivance, indicating the wisdom, and goodness, and care of the Creator over all his works, but afforded also to natural theology a powerful auxiliary, showing from the unity of design and unity of structure, and from the symmetry and harmony that purveyed all organic beings in the fossil world, as well as in the present, that all have derived their existence from one and the same Almighty and Everlasting Creator. (Buckland, 1833A: 107).

After the British Association meeting Buckland continued this line of research with a detailed investigation of the functional morphology and adaptation of the present-day relatives of the Megatherium, the sloths. As he had indicated in the British Association lecture, these had been dismissed by most naturalists as "imperfect" aberrations, whilst Buckland considered that their form and detailed morphology demonstrated perfect adaptation to their very unusual arboreal habitat, in the light of studies not only of their skeletons and captive animals, but also of field observations by *naturalists who had seen the animal in the wild*, such as the English zoologist William Burchell (M.S. DRO 138M/F240). He prepared a substantial paper on this for the Linnean Society, which was read on 19 March 1833 under the title "On the Adaptation of the Structure of the Sloths to their peculiar Mode of Life", and an abstract appeared the same year (Buckland, 1833E), although because of the Society's serious backlog of publications the full text did not in fact appear for four years (Buckland, 1837A).

The same principles of functional analysis of fossil remains, that Buckland had begun with his work on the hyaena and other remains of Kirkdale Cave in 1821, and which were developed to a high art in his work of the early 1830s on Megatherium and living sloths, were used in a wide-ranging survey of the whole of the Animal and Vegetable Kingdoms in the

Bridgewater Treatise (Buckland, 1836B). However, only two sections were devoted to fossil mammals out of the 31 sections in the five long chapters devoted to the Proofs of Design in the Structure of various fossil groups (vertebrates, molluscs, "articulated animals", "radiated animals" and fossil vegetables). He explained that this restriction on the coverage of fossil mammals was deliberate, and that he had chosen two extreme examples of specialised adaptation, the Tertiary proboscidian Dinotherium, and the by then familiar Megatherium (Buckland, 1836B (1): 135-136). The Megatherium section was much the longest treatment of a single species in the Bridgewater Treatise, and seems to have been Buckland's definitive and revised text of the 1832 British Association lecture, of which only a short abstract had appeared (Buckland, 1833A). The section included detailed descriptions of the osteology of the Megatherium remains, with elegantly argued discussions of individual bones demonstrating their purpose in the adaptation of the animal to its distinctive mode of life. The section was supported by two plates containing 21 drawings, all but one of them specially drawn for the book, in one case by the distinguished sculptor, Sir Francis Chantrey R.A. The age and distribution of Megatherium was still a matter of some controversy, but Buckland was able to add a footnote to the "Explanation of Plates" in volume 2 settling the matter:

> Mr. Darwin has recently discovered the Remains of Megatherium along an extent of nearly six hundred miles, in a North and South line, in the great sandy plains of the Pampas of Buenos Ayres, accompanied by the bones and Teeth of at least five other Quadrupeds. He has also found that the Bones of this Animal are so often accompanied by those of the Mastodon angustidens, as to leave no doubt that these two extinct species were contemporary. (Buckland, 1836B (2): 20).

Buckland therefore summarised the characteristics of this enormous and strange Quaternary mammal:

> Thus heavily constructed, and ponderously accoutred, it could neither run, nor leap, nor climb, nor burrow under the ground, and in all its movements must have been necessarily slow; but what need of rapid locomotion to an animal, whose occupation of digging roots for food was almost stationary? and what need of speed for flight from foes, to a creature whose giant carcase was encased in an impenetrable cuirass, and who by a single pat of his paw, or lash of his tail, could in an instant have demolished the Cougar or the Crocodile? .... His entire frame was an apparatus of colossal mechanism, adapted exactly to the work it had to do; .... Each limb, and fragment of a limb, forming co-ordinate parts of a well-adjusted and perfect whole; and through all their deviations from the form and proportions of the limbs of other quadrupeds, affording fresh proofs of the infinitely varied, and inexhaustible contrivances of Creative Wisdom. (Buckland, 1836B (1): 163-164).

Although the main purpose of the Bridgewater Treatise was to demonstrate the existence of a Deity from the perfection of Design and adaptation amongst the whole of the fossil world, and the "Consistency of Geological Discoveries with Sacred History" (the title of Chapter II), the book also included an excellent introductory review of historical geology and palaeontology including a short session on Quaternary mammals (although by this time Buckland was following the convention of Lyell and others by using "Pliocene" to cover both the "third and fourth" (i.e. Quaternary) "divisions of the Tertiary fresh-water deposits" (Buckland, 1836B (1): 92). In this review Buckland drew particular attention to the widespread occurrence of existing forms such as elephant, rhinoceros, hippopotamus and horse, "the first abundant traces of Ruminantia, e. g. Oxen and Deer", and that the numbers of both rodents and carnivores were apparently greatly increased, the latter being attributed by Buckland to the "commensurate ... increased numbers of terrestrial herbivora" (Buckland, 1836B (1): 92). He also commented on the occurrences of marine mammals including such tropical indicators as manatees, and considered that altogether:

> the tropical character of many other animals, even of the latest tertiary strata [i.e. "pre-Diluvial" Quaternary], in favour of the opinion, that the climate of Europe maintained a high, though probably a gradually decreasing temperature, even to the latest period of the tertiary formations. (Buckland, 1836B (1): 93).

Buckland also included a section in which he argued that far from being a sign of the cruelty of God, the existence of hunting bands of carnivores (such as his beloved Kirkdale hyaenas) was proof of the benevolence of God towards the rest of the animal population, since carnivores prevent overpopulation and hence starvation amongst the herbivores, as well as removing the aged, diseased or weak members of the carnivore population as well. This short Section "Aggregate of Animal Enjoyment increased, and that of Pain diminished, by the existence of Carnivorous Races" (Buckland, 1836B (1): 129-134) not only potentially had profound political implications, with its assertion that Nature "resolves each apparent case of individual evil, into an example of *subserviency to universal good.*" *(Buckland, 1836B (1):* 131-132), but quite clearly presages the mechanism of Natural Selection adopted by Buckland's close friend Charles Darwin, two decades later. In Buckland's view the evils of debility, age or starvation:

> are superseded by the establishment of a controlling Power in the carnivora; by their agency the numbers of each species are maintained in due proportion to one another - the sick, the lame, the aged, and the supernumaries, are consigned to speedy death; and while each suffering individual is soon relieved from pain, it contributes its enfeebled carcase to the support of its carnivorous benefactor, and leaves more room for the comfortable existence of the healthy survivors of its own species. The same "police of Nature," which is thus beneficial to the great family of the inhabitants of the land, is established with equal advantage among the tenants of the sea. (Buckland, 1836B (1): 132-133).

4.2 FOSSIL MAN

The outstanding discovery in Paviland Cave in December 1822 was the human skeleton, which was found less than two metres from the site of the original elephant skull discovery. The body had been buried in a shallow grave scraped in the surface of the cave deposit, and had been buried with a few shells of Littorina littoralis and between forty and fifty fragments of fossil ivory, cut and worked into cylindrical rods from 5 mm. to 15 mm. in diameter and from 25 mm. to 100 mm. in length, together with some fragments of rings cut out of ivory that could be reconstructed to a diameter of approximately 100-125 mm., and a metacarpal of a wolf worked into "a rude instrument, resembling a short skewer or chopstick" (Buckland, 1823A: 89). Equally interesting, the body had been completely covered with a red pigment at the time of burial, and this had stained the skeleton.

It should be stressed that Buckland's interpretation of Quaternary history at that time presupposed that undisputed human fossils would eventually be found with the "antediluvian" fauna, since he still equated the geological Universal Deluge with the Biblical account of Noah's Flood, even though he considered that the antediluvian timescale had been of a completely different order from that of the present era. Consequently, Buckland had no fear of the discovery of human remains in pre-diluvial deposits because this would challenge his religious beliefs, as has often been alleged, most recently in an extraordinarily virulent and personalised attack on Buckland by Raymond Dart (1956), supported by other palaeoanthropologists working on the early hominid finds in South Africa, (Boylan, 1972). In fact, Buckland was sure that fossil human remains would be found with the "antediluvian" mammal fauna. However, he was only too well aware of the large number of purported finds of "pre-Noachian" human fossils over the previous years. These had begun with the many records of giants (usually based on elephant or rhinoceros bones) from medieval times, and including the notorious Homo Diluvii Testis (Man Attesting the Flood") of the 18th century, preserved in the Teyler's Museum, Haarlem (where Buckland had seen the fossil remains), but which Cuvier had recently demonstrated to be a Miocene giant salamander. Any find of early fossil men was bound to be highly controversial and it was essential that the evidence was unambiguous.

The risks to the progress of palaeontology of publishing claims of human fossil finds that subsequently proved to be spurious was to remain a matter of serious concern for at least half a century, and was one reason for the very conservative stance taken on the issue by successive generations of scientists through most of the 19th century. Forty years later, Hugh Falconer, one of Buckland's closest followers in fossil mammal studies, writing on his (correct) exposure of Boucher de Perthes' Moulin Quignon jaw from the Somme gravels as a fake, said:

> The truth has been spoken out and I spoke it. Fancy what discredit would have been thrown on the subject had the exposé been made by the enemy - such as Soapy Sam [Samuel Wilberforce, Bishop of Oxford]! We would have been regarded as simpletons open to be practiced upon by the flimsiest imposition: and the whole subject would have been put back a quarter of a century [my emphasis]. (M.S. FPF 110; Boylan, 1979).

Buckland considered at some length all the evidence concerning the Paviland skeleton and its possible dating, as is clear from the excellent analysis of his letters relating to Paviland made by F J North (1942). Bearing in mind the scant regard of the people of the Gower for the law, Buckland first thought that the skeleton might be the remains of a murdered customs official, buried in the cave by local smugglers. However, he soon wrote from Penrice:

> the Man whom we voted an Exciseman turns out to be a Woman, whose history wd. [would] afford ample matter for a Romance to be entitled the Red Woman or Witch of Paviland - for some such personage she must have been; but for what purpose she used her ivory Rods and Rings and the shells in her pocket I have yet to learn ... (North, 1942: 108).

He even speculated that the "Red Lady" might have been antediluvian, suggesting in jest to Lady Mary Cole that perhaps she had been:

> a near connection of Adam. Perhaps Eve herself, for is it extraordinary when Adam was made of red Earth that his Rib should have had a tinge of ruddle? ... This hypothesis is so ingenious that it deserves to be true; we cannot however admit our Red Woman to have been Antediluvian, tho' I dare say that the Cambrians would readily contend that Adam was a Welch [sic] Man. (North, 1942: 110).

Finally, however, he decided that although the rods and rings must have been carved out of fossil ivory (presumed to have been derived from the fossil elephant tusk in the Cave), taking into account the "disturbed state of the diluvial earth all over the bottom of the cave" (Buckland, 1823A: 92), the date of the human bones was:

> coeval with that of the military occupation of the adjacent summits, and anterior to, or coeval with, the Roman invasion of this country. (Buckland, 1823A: 92).

The story of the Red Lady of Paviland consequently passed into the growing corpus of humorous verse about Buckland, and the physical remains into the Oxford University Museum, where, 90 years later, they were at last recognised as part of the skeleton of a young man of the Upper Palaeolithic period.

The publication of McEnery's discoveries in 1859 began a controversy about Buckland's role which is still not completely resolved. The excavations that re-commenced in Kent's Hole in about 1840 soon confirmed the correctness of McEnery's central assertion, that some of the human artefacts must be contemporaneous with the fossil mammal remains because of their location in the cave deposits (e.g. Austen, 1842; Vivian, 1848). In his unpublished manuscript McEnery stated:

> Dr. Buckland is inclined to attribute these flints to a more modern date by supposing that the anct. Britons had scooped out ovens in the stalagmite and that through them the knives got admission to the diluvium... Without stopping to dwell on the difficulty of ripping up a solid floor which notwithstanding the advantage and undermining and the exposure of its edges, still defies all our efforts, tho commanding the apparatus of the quarry I am bold to say that in no instance have I discovered evidence of breaches or ovens in the floor but one continuous plate of stalagmite diffused uniformly over the loam... (Pengelly, 1869).

Vivian appears to have started the story that Buckland was responsible for the suppression of the unacceptable views of McEnery, in his editing of the unpublished McEnery manuscripts. He further claimed that his own Geological Society paper of 1847:

> was considered so heterodox that its insertion in the Transactions was delayed until the late lamented Dr. Buckland could again visit the cavern, which he was never able to accomplish. (McEnery, 1859: 60).

Pengelly went even further and clearly referring to Buckland he claimed that:

> but for the strong hand of scientific authority Mr McEnery would have published at once his discoveries... Mr Godwin-Austen's paper, in 1840, experienced an undeserved neglect; and in 1847, the Geological Society of London, in the three lines they devoted to Mr. Vivian's paper declined to do more than to state ... the bones of various extinct animals were found in several situations. (Pengelly, 1866: 542-543).

In my review of Buckland's role in the development of cave science (Boylan, 1967: 248-249 and 250-251), I was partly convinced by these assertions. However, further detailed work has led me to change my views in recent years. As A S Kennard pointed out in his Presidential Address to the Geologists' Association: "Vivian has muddled his notes badly." (Kennard, 1945: 160 & 208-209).

To begin with, the referee for Austen's 1840 paper to the Geological Society was not Buckland, but De la Beche, who on 6 February 1841 recommended against publication not because of its heterodox opinions on the antiquity of man but because the Abstract that had by then already appeared in the Proceedings (Austen, 1841), "contains nearly the whole of the paper" and hence was not worth re-printing in the Transactions (M.S. GSL: COM/P4/2). However, Austen's claim that human artefacts:

> occur in all parts of the cave and throughout the entire thickness of the clay, and no distinction founded on condition, distribution or relative position can be observed whereby the human can be separated from the other reliquiae

was published by the Geological Society in its Transactions, and without any attempt at suppression, in Austen's 53 page "On the Geology of the South - east of Devonshire" (Austen, 1842: 444). (Incidentally, if Vivian and Pengelly were accusing Buckland personally in their claims of improper suppression, it should be noted that Buckland was not the President of the Geological Society at the time of De la Beche's adverse recommendation, but was President at the time that Austen's major paper in the Transactions (Austen, 1842) was published.)

Vivian's claims in respect of the antiquity of the traces of human occupation in Kent's Cavern were published without any difficulty in the Report of the British Association (Vivian, 1847), at a time when Buckland was still actively involved and very influential in the British Association although he had finally retired from the Council of the Geological Society. Overall, therefore, the very serious charges that Buckland deliberately suppressed evidence of the antiquity of man that he personally found unpalatable, seem unfounded, as A S Hunt argued very forcibly against what he termed in the title of his paper Buckland's "detractors" at the beginning of the century (Hunt, 1902).

Certainly, as the years passed without the discovery of evidence for the antiquity of man sufficiently strong for him to risk presenting it to a world that still, in the main, looked to the margin notes of the Bible for the timescale of human existence, Buckland became increasingly doubtful that such evidence would ever emerge. In addition to slipping towards the dangerous trap of assuming that the absence of undisputed fossil evidence that man was coeval with his "antediluvian" fauna proved that man had not been present at the time of the extinct animals, Buckland became increasingly sceptical from the late 1820s onwards about his earlier correlation of the perceived Universal Deluge of his geological observations, and the Biblical Flood. He appears to have considered that if these two were not one and the same, then there could no longer be any certainty that man had existed during or before the time of the geological Deluge, as opposed to the scriptural one, in which case there would be no evidence to find of man in antediluvian deposits.

The cave environment is much the most difficult terrestrial situation in which to carry out excavations, and it is probably fair to say that with the possible exception of McEnery's original finds under the freshly broken thick stalagmite floor at which no prominent scientist was present to serve as an independent witness, none of the evidence of the contemporaneity of man with the extinct mammals of the "antediluvian" fauna, would have provided the unarguable evidence that was needed.

Even after the Brixham Cave excavation under the direction of the Royal Society in 1858, it was several years before even progressive scientists of the standing of Lyell would accept the evidence for the antiquity of man. The angry confrontation between Falconer and Lyell following the publication of the latter's Antiquity of Man (Lyell, 1863) was largely prompted by Falconer's justifiable feeling that even after the Brixham Cave excavations of 1858 and the demonstration of the antiquity of the flint implements of the Somme and elsewhere in 1859, Lyell had withheld his support at a time when it was very much needed. Then, adding insult to injury, Lyell rushed out the (highly profitable) Antiquity of Man in which the work of the three British pioneers in the field, Falconer, Prestwich and Evans, were almost totally ignored, and Lyell appeared to claim credit for most of the innovatory interpretations in the book (Boylan, 1979; Bynum, 1984).

Although I have modified my views on some points since my first examination of Buckland's place in the development of cave science, published more than sixteen years ago, I feel that on the questions of human palaeontology and the antiquity of man, my overall assessment of that time still stands:

> Certainly Buckland rejected the growing evidence for the antiquity of man at a time when a powerful advocate was needed: on this key issue he allowed dogmatism to replace reason. His reputation in the history of science has paid dearly for this error, but I suggest that the broad back of Buckland has carried too much of the burden of what is really the failure of

a whole generation of scientists, not of Buckland alone. It must also be remembered that McEnery, Hugh Falconer, Schmerling, Godwin-Austen, Vivian, Pengelly, William Boyd Dawkins and many others all benefited directly from Buckland's teaching or writings. (Boylan, 1967: 251).

4.3 MESOZOIC REPTILES, MAMMALS AND COPROLITES

Buckland's first experience of vertebrate fossils of the Secondary Formations probably came through his well-documented contacts over a long period of time with the Anning family of Lyme Regis, Dorset, just a few miles from the family home at Axminster.

Richard Anning was a carpenter and cabinet maker who had discovered by the last decade of the 18th century (if not earlier) that there was a good profit to be made out of the collecting and sale of "natural curiosities", especially shells and fossils from the sea, foreshore and cliffs of Lyme Bay, particularly during the summer and autumn, when Lyme Regis was a fashionable watering place for both Bath and London Society. Assisted by his wife, Mary Anning, together with their children almost as soon as they were able to walk, Richard Anning collected a wide range of interesting fossils and sold them to eager collectors. The oldest son, Joseph (1796-1849), became a noted fossil collector and dealer in his own right. However, his life and work in this field has been very much oversahdowed by that of his sister, Mary junior, who was born in 1799, and who became the most celebrated professional collector of fossils of the 19th century. Despite her social class and rudimentary level of education, Mary Anning became a friend and scientific confidant of many of the leading geologists of the day, most notably the anatomist Sir Everard Home, De la Beche and Buckland, and even the King of Saxony visited Lyme Regis to call on her. On the death of Richard Anning in November 1810, the two eldest children, Joseph (aged 14) and Mary (aged 11), took over the family business. (De la Beche, 1848: xxiv-xxv; Woodward, 1901; Delair, 1968; Howe, Sharpe and Torrens, 1981: 11-12).

It is more than likely that Buckland (and presumably his father, Charles, also) knew Richard Anning, and later his remarkable children, from the many family visits to Lyme Regis during his childhood and student days. Even if this was not the case, then Buckland must have learned of the finding of a very well preserved skeleton of what was at first described as a crocodile, in the Lias between Lyme Regis and Charmouth in November 1812. The discovery of this 17 ft. long fossil was sensationalised by the press, because of the claim that it had been discovered by the 13 year old Mary Anning. In fact, Howe et al. (1981: 12) have argued convincingly that the first part of the skeleton had actually been found a year earlier by the elder brother, Joseph, who told his sister where to look; but the true story of discovery by a 15 to 16 year old youth would not have been as attractive to the press, nor as good for business, as the legend of Mary's discovery of this remarkable fossil, which the family sold for £23, and which after a period in the Bullock Museum in the Egyptian Hall, Piccadilly, was bought by the British Museum for £47.5s. at the Bullock auction in May 1819 (Howe, et al., 1981: 12).

Although Buckland's £200 per year Fellowship would not allow him to compete in that kind of market, and although there were no significant University funds available for the development of museums, Buckland became an honoured and favoured customer of Mary Anning, and acquired a considerable amount of fossil material, including less spectacular ichthyosaur fragments, Lias fish and invertebrates, from her over the next few years. His frequent visits to Lyme Regis, together with his work on the surveying of the Bristol region (jointly with Conybeare), brought Buckland into contact with both the important Bristol collector

James Johnson (c. 1764-1844 - Howe et al., 1981: 12-15) as well as Henry De la Beche, who settled in Lyme Regis in 1812 after being "cashiered" from the Military School at Great Marlow (McCartney, 1977: 2-6).

In fact, contrary to contemporary claims (and indeed most general histories of palaeontology), the 1811-1812 find of the Annings, whether by Joseph or Mary, was by no means the first discovery of ichthyosaur remains (Howe et al., 1981: 5-11), but it was the Bullock Museum specimen that first attracted wide attention, resulting in a series of papers by Sir Everard Home in the Philosophical Transactions from 1814 onwards in which he seriously misinterpreted the nature of the animal, suggesting that the (still unnamed) forms were cartilaginous fishes akin to the sharks. In 1818 he published some important material from Buckland's collection (Home, 1818), including a sternum, clavicle and a coracoid bone. The existence of these disproved conclusively Home's assertion that the ichthyosaur was some form of fish, and in the 1818 paper he changed his opinion to suggest that ichthyosaurs might be allied to lizards. There appears to be no surviving evidence of the circumstances that led Buckland to send these three very significant specimens to Home. Bearing in mind Buckland's comprehensive understanding of vertebrate osteology by the time that he returned from his 1816 continental tour (including his visit to Cuvier's Laboratory),

it seems very probable indeed that Buckland himself recognised their significance and referred them to Home on this basis. (Home was a notorious plagiarist, and even went to the extent of destroying most of John Hunter's original manuscripts in an attempt to conceal the extent of his plagiarism, as the late Jessie Dobson (1954) demonstrated in her study of William Clift.)

Since Home had still not given a scientific name to the new form, Charles Koenig proposed the name Ichthyosaurus (i.e. "fish-lizard") in the published British Museum catalogue (Koenig, 1818: 54), and this became established despite a belated attempt by Home to name the animal Proteosaurus (Home, 1819).

The detailed osteology of ichthyosaurs, together with discussions of their biological relationships, was largely resolved in two major papers to the Geological Society by De la Beche and Conybeare (1821), Conybeare (1824A) and in the third edition of the Ossemens Fossiles (Cuvier, 1825 (5) (2): 445-474). Although not a co-author, Buckland's close involvement in the research leading up to all three papers is very evident from the extensive correspondence with De la Beche now in the National Museum of Wales (McCartney, 1977: 20) and his correspondence with Cuvier's Laboratory (Sarjeant & Delair, 1980), although it appears that the only reference during this period to ichthyosaurs in a publication under Buckland's own name was a note of the discovery of ichthyosaur remains in the Bristol area, included in the very long joint paper on the South-western Coal District (Buckland and Conybeare, 1824: 302).

The whale-sized Plesiosaurus, with its characteristic long neck, was first described and named from fairly fragmentary materials distinguished from their two species of ichthyosaur, by De la Beche and Conybeare (1821). During the winter of 1822-1823 the Annings found an almost complete skeleton in the Lias of Lyme Regis, and Buckland learned of the discovery almost immediately (presumably from Mary Anning herself: certainly when she found the complete skeleton of a young plesiosaur on 21 December 1830 she turned first to Buckland for his assistance in finding a suitable purchaser: M.S. DRO 138M/F254). Buckland had little difficulty in persuading the Duke of Buckingham to buy the specimen, and after many weeks of work by a large labour force the specimen was transported by sea direct from Lyme Regis to London, where the Duke of Buckingham invited Bucklar i to investigate the new find with a view to publication (Buckland, 183 A: 203; Conybeare, 1824B: 381). In the event, Buckland asked Conybeaie to study and publish the specimen, which he did with great effect i a paper given to the Geological Society on 20 February 1824 (Conybeare, 1824B; North, 1956: 138), and Buckland also provided full details for Cuvier for the final volume of the Ossemens Fossiles, then at the final stages of publication (Sarjeant & Delair, 1980; Cuvier, 1825 (5) (2): 475-487).

E ckland included long chapters on both ichthyosaurs and plesiosaurs in hi Bridgewater Treatise (Buckland, 1836B), each of which demonstrates ve well indeed Buckland's interest in, and command of, the study of fu tional morphology. This is seen not only in the very lucid descripti of each part of the skeleton, demonstrating its function within the living animal, but also the value of each component part in the reconstruction of a living animal and its environment. The quality of this work is perhaps best demonstrated in Buckland's interpretation of the eyes of Ichthyosaurus, which was accompanied by very detailed anatomical drawings of the best preserved fossils:

> The enormous magnitude of the eye of the Ichthyosaurus ..., is amongst the most remarkable peculiarities in the structure of this animal. From the quantity of light admitted in consequence of its prodigious size, it must have possessed very great powers of vision; we have also evidence that it had both microscopic and telescopic properties. We find on the front of the orbital cavity in which this eye was lodged, a circular series of petrified thin bony plates, ranged around a central aperture, where once was placed the pupil; the form and thickness of each of these plates very much resembles that of the scale of an artichoke. ... This compound circle of bony plates does not occur in fishes; but is found in the eyes of

> many birds, as well as of Turtles, Tortoises, and Lizards; and in a lesser degree in crocodiles. (Buckland, 1836A: 173-174).

In a footnote Buckland suggested a comparison between the eye of the ichthyosaur and that of the Golden Eagle (also illustrated): "one of its uses in each case being to vary the sphere of distinct vision, in order to descry their prey at long or short distances." (Buckland, 1836A: 173). In the main text he continued by arguing that although the soft parts of the eyes "have of course entirely perished", the form of the eye could be deduced from the nature of the bony socket, showing that the eye-ball had been very large indeed ("sometimes larger than a man's head") and that the form of the eye would have not only enabled the animal to hunt during the night and at great depths within the sea, but would also enable the eye to withstand the water pressure during deep dives (Buckland, 1836A: 173-175). Buckland also turned to the nature and function of the sternum and the ribs joining it - one of the subjects that he had referred to Home 18 years earlier - and interpreted the structure of this part of the anatomy as indicating the adaptation of the animal's breathing functions to facilitate both deep diving and prolonged periods of swimming entirely under water, drawing attention to the morphological similarity of this structure to that of the duck-billed platypus of Australia, which similarly spent much of its life under water, although he did not, of course, suggest this was evidence of any kind of taxonomic relationship.

Turning to Plesiosaurus, Buckland summarised this strange animal concisely:

> To the head of a Lizard, it united the teeth of a Crocodile; a neck of enormous length, resembling the body of a Serpent: a trunk and tail having the proportions of an ordinary quadruped,

> the ribs of a Camelion, and the paddles of a Whale. Such other strange combinations of form and structure in the Plesiosaurus - a genus,the remains of which, after interment for thousands of years amidst the wreck of millions of extinct inhabitants of the ancient earth, are at length recalled to light by the researches of the Geologist, and submitted to our examination, in nearly as perfect a state as the bones and species that are now existing upon the earth. (Buckland, 1836A: 202-203).

As in the case of the Quaternary mammal from South America, Megatherium, Buckland disagreed with Cuvier, who had concluded that plesiosaurs were "anomalous and monstrous", insisting:

> we have seen in proceeding through our examination of its details, that these apparent anomalies consist only in the diversified arrangement, and varied proportion, of parts fundamentally the same as those that occur in the most perfectly formed creatures of the present world. Pursuing the analogies of construction ... we find an unbroken chain of affinities pervading the entire series of organized beings, and connecting all past and present forms of animal existence by close and harmonious ties. Even our own bodies, and some of their most important organs, are brought into close and direct comparison with those of reptiles, which, at first sight, appear the most monstrous productions of creation; and in the very hands and fingers with which we write their history, we recognize the type of the paddles of the Ichthyosaurus and Plesiosaurus.... thus, the fin of the fish becomes the paddle of the reptile Plesiosaurus and Ichthyosaurus; the same organ is converted into the wing of the Pterodactyle, the bird and the bat; it becomes the fore-foot, or paw, in quadrupeds that move upon the land, and attains its highest consummation in the arm and hand of rational man. (Buckland, 1836A: 213-214).

Although Buckland's first scientific involvement with Mesozoic vertebrates was with the aquatic ichthyosaurs of the Liassic sea, his most important scientific contribution to Jurassic osteology was in the discovery and recognition of terrestrial vertebrates. From his student days onwards Buckland had been collecting fairly consistently from the Middle Jurassic Stonesfield Slate of the Oxfordshire Cotswolds, with its exceptionally well-preserved fossils of many kinds. Sometime before the visit of Cuvier to Oxford in 1818, Buckland had begun to find (or perhaps more often acquire from the quarrymen) a series of vertebrate fossils that were quite unlike anything that had been scientifically published by that date - the remains of true, terrestrial, dinosaurs. During his Oxford visit Cuvier had been shown these fossils by Buckland, since Cuvier subsequently wrote, referring to the Stonesfield material published by Buckland (1824C) and stated: "j'en ai vu les pièces chez lui à Oxford en 1818;" (Cuvier, 1825(5)(2): 344). Not only does this statement give a terminal date for the discovery of at least some dinosaur remains by Buckland, but also the use of the word "les" (i.e. "the") in relation to the 1824 paper, seems to me to indicate that Cuvier had seen in 1818 all of Buckland's figured specimens (otherwise some other, more appropriate, word would have been used, such as "des", i.e. "some").

In fact, with the benefit of hindsight, it has become clear that dinosaur fossils had been known in Britain from the 17th century onwards, and on the Continent and in North America from at least the latter part of the 18th century, although their significance had not been recognised (Colbert, 1968: 3-5; Swinton, 1970: 21-28; Delair & Sarjeant, 1975: 6-12). (In addition to the numerous examples reviewed in these three studies, the British Museum (Natural History) has recently discovered a dinosaur limb-bone, probably of Iguanodon, in the William Smith Collection, and which was probably found in the first decade of the 19th century: this specimen was displayed by Alan Charig at the Vertebrate Palaeontology: History of Collecting and Curation symposium at the Museum in September 1982, but the specimen has not yet been published.)

Delair and Sarjeant (1975) have examined in very considerable detail the evidence relating to the priority of discovery of true dinosaurs, and in particular have re-examined the traditional view that Gideon Mantell's discovery of the Iguanodon in the early part of 1822, the inclusion of a note and figure about the new, still unnamed, discovery in his Fossils of the South Downs (Mantell, 1822: 54), and named and published in full three years later (Mantell, 1825). Delair and Sarjeant argue convincingly in favour of Buckland's priority in the discovery and recognition of dinosaurs on the basis of the respective dates of discovery, and Buckland has undisputed priority in terms of scientific publication. However, he seems to have been either exceptionally diffident, or very dilatory, over full publication of the Stonesfield material. Following his visit to Oxford, Cuvier pressed Buckland through his Irish assistant, Joseph Pentland, to either publish the dinosaur remains himself or to send them to Cuvier for publication (Sarjeant & Delair, 1980: 262), and the scientific name of Megalosaurus appears to have been agreed between Buckland and Conybeare, since the Stonesfield find was referred to in passing by the anglicised version of its name "Huge Lizard" in the Geological Society paper describing ichthyosaurs and plesiosaurs (De la Beche and Conybeare, 1821). The Following year, James Parkinson included a reference to the finds in his new book on British palaeontology:

> Megalosaurus (Megalos great, saurus a lizard). An animal apparently approaching the Monitor in its mode of dentition, and not yet described. It is found in the calcareous slate of Stonesfield.... It is hoped a description may shortly be given to the public. The animal must in some instances, have attained a length of forty feet, and stood eight feet high. (Parkinson, 1822: 298).

Further complaints about the non-appearance of Buckland's long-promised report on these important finds followed, including a further remonstrance from Cuvier via Pentland, and there may well have been an intentional double entendre in the opening words of Buckland's account when it was finally given to the Geological Society on 20 February 1824: "I am induced [my emphasis] to lay before the Geological Society the annexed representations of parts of the skeleton of an enormous fossil animal" (Buckland, 1824C: 390). The paper was entitled "Notice on the Megalosaurus or great Fossil Lizard of Stonesfield", and was accompanied by 23 drawings by Mary Morland (lithographed on to five large folded plates by Henry Perry).

Buckland began by explaining that the material collected to date consisted entirely of isolated finds except for two series of associated vertebrae (one in the Oxford Museum and the second donated to the Geological Society by Henry Warburton) and:

> must have belonged to several individuals of various ages and sizes; there are others in the Oxford Museum which are derived from a very young animal; in the same stratum with them there occur also fragments of large bones, of similar structure, which have been rolled to the state of pebbles. (Buckland, 1824C: 390).

Possibly it was the fragmentary and rolled state of much of the material that caused Buckland to delay publication, presumably in the hope of finding a more complete specimen. Nevertheless, having committed himself to print at last, he argued that: "Although the known parts of the skeleton are at present very limited, they are yet sufficient to determine the place of the animal in the zoological system." (Buckland, 1824C: 390). Buckland placed Megalosaurus in the Order of Saurians (lizards), and used present-day lizards as an analogy in attempting to estimate the size of the animal, suggesting that pro rata with present-day lizards, the bones discovered would indicate a bulk equivalent to that of an elephant, and a length of up to forty feet long, adding:

> and although we cannot safely attribute exactly the same proportions to recent and extinct species, yet we may with certainty ascribe to it a magnitude very far exceeding that of any living lacerta. Large as are the proportions of this individual, they fall very short of those which we cannot but deduce from a thigh-bone of another of the same species, which has been discovered in the ferruginous sandstone of Tilgate Forest near Cuckfield, in Sussex, and is preserved in the valuable collection of Gideon Mantell, Esq. of Lewes, together with many other bones belonging to the same species, and of the same size with those from Stonesfield. (Buckland, 1824C: 391).

The Tilgate Forest material of Mantell was, of course, that to be published by him the following year as Iguanodon. Buckland also summarised other finds of Mesozoic land reptiles, including finds from the Bath Oolite or Cornbrash and early finds of Chalk reptiles at Maastricht, Netherlands, and near Lewes and Steyning, Sussex. Of particular interest was his reference to "the bones of large cetaceous animals" in the Cornbrash at Gibraltar, east of Woodstock, associated with "the scales, teeth, and bones of a species of crocodile" (Buckland, 1824C: 392). Buckland continued to collect from this locality for the Oxford Museum and almost half a century later John Phillips used Buckland's material, together with other specimens found in 1868 at Kirtlington, in defining the (still problematical) dinosaur taxon Cetiosaurus oxoniensis (Phillips, 1871: 245-247, 291; Delair & Sarjeant, 1975: 22-25). Thus, in what was in fact a very short paper (just over six pages), Buckland had recognised three distinct taxa of dinosaur, and named one of these - Megalosaurus. As Delair and Sarjeant pointed out in their conclusion:

> Thus it is William Buckland who must be regarded as the first scientific discoverer of the enormous fossil reptiles later to be called dinosaurs. It is also evident that Buckland, unlike Cuvier and Mantell, perceived the reptilian nature of the earliest discovered bones of Cetiosaurus and might have earned further fame by being the first to describe a sauropod dinosaur - but missed that opportunity. (Delair & Sarjeant, 1975: 25).

As with Megatherium, Ichthyosaurus and Plesiosaurus, Buckland devoted a section of his Bridgewater Treatise to a lucid and detailed description of Megalosaurus and a further one to Iguanodon. In the case of Megalosaurus he paid special attention in this to the jaws and teeth, with very detailed descriptions and illustrations demonstrating that:

> From these we learn that the animal was a reptile, closely allied to some of our modern Lizards; and viewing the teeth as instruments for providing food to a carnivorous creature of enormous magnitude, they appear to have been admirably adapted to the destructive office for which they were designed. ... In the structure of these teeth, ... we find a combination of mechanical contrivances analogous to those which are adopted in the contruction of the knife, the sabre and the saw. When first protruded above the gum, ... the apex of each tooth presented a double cutting edge of serrated enamel.... like that of the two-edged point of a sabre, cutting equally on each side. As the tooth advanced in growth, it became curved backwards, in the form of a pruning knife.... The strength of the tooth was further increased by the expansion of its sides .... In a tooth thus formed for cutting along its concave edge, each movement of the jaw combined the power of the knife and the saw; whilst the apex, in making the first incision, acted like the two-edged point of a sabre. The backward curvature of the full-grown teeth, enabled them to retain, like barbs, the prey which they had penetrated. In these adaptations, we see contrivances, which human ingenuity has also adopted, in the preparation of various instruments of art. (Buckland, 1836A: 238-239).

In the 1824 Megalosaurus paper, Buckland himself recognised that:

> The other animals that are found at Stonesfield are not less extraordinary than the megalosaurus [sic] itself. Among the most remarkable are two portions of the jaw of the didelphys or opossum, being of the size of a small kangaroo rat; and belonging to a family which now exists chiefly in America, Southern Asia, and New Holland. (Buckland, 1824C: 391).

At the time nothing remotely resembling an identifiable mammalian fossil had been found anywhere in the Mesozoic, and the discovery of the jaw of a primitive mammal in the Jurassic of Stonesfield was at least as important as the identification of the Megalosaurus itself, although Buckland again appears to have played down this discovery. This specimen too had apparently been seen by Cuvier during his visit in 1818, and he had in passing suggested that it resembled the lower jaw of the present-day opossum (Owen, 1846: 30), and in the original publication, Buckland stated:

> I refer the fossil in question to this family on the authority of M. Cuvier, who has examined it; and without the highest sanction, I should have hesitated to announce such a fact, as it forms a case hitherto unique in the discoveries of geology; viz. that of the remains of a land quadruped being found in a formation subjacent to the chalk. (Buckland, 1824C: 391).

At Cuvier's request, Prévost re-examined the specimen and sent a drawing of the jaw to Paris. As a result, Cuvier added a footnote in the Ossemens Fossiles saying that the drawing confirmed his initial opinion and adding:

> Dans tout les cas, si cet animal est vraiment du chiste de Stonesfield, c'est une exception bien notable à la règle, d'ailleurs si générale, que les couches de cette ancienneté ne recèlent point de reste de mammifère.(Cuvier,1825 (5)(2):349).

The specimen was finally published in detail by William Broderip (1828) and given the name Didelphys bucklandi, and it was Richard Owen (1838 and 1841) who erected a new genus Phascolotherium to accommodate the species, since it clearly could not be accommodated in the same genus as the present-day opossum. Owen's 1838 paper was in part a reply to an attack by de Blainville, who criticised Buckland's inclusion of Didelphys bucklandi in plate 2 of the Bridgewater Treatise (Buckland, 1836B), claiming that either the mammal fossils were not from the Jurassic of Stonesfield at all, or alternatively were reptilian. The controversy is summarised very well and concisely in the 1839 Anniversary Address to the Geological Society by Whewell (1839: 86-89). Owen returned to the issue in his History of the British Fossil Mammals and Birds (Owen, 1846: 29-70), and since then neither the source nor the mammalian nature of Buckland's Stonesfield finds have been seriously challenged.

In February 1829 Buckland presented to the Geological Society a paper linking together three different discoveries, largely based, initially at least, on the collecting of Mary Anning, under the title "On the discovery of a new species of Pterodactyle; and also of the Faeces of the Ichthyosaurus; and of a black substance resembling Sepia, or Indian Ink, in the lias at Lyme Regis" (Buckland, 1829F), although two separate papers were printed in the Transactions, covering the pterodactyl (Buckland, 1835A), and coprolites (Buckland, 1835B). The (very interesting) identification of fossil ink-sacs in the cephalopod fossils of the Lias was not published in the Transactions, but instead was used as a Section of the Chapter "Proofs of Design in the Fossil Remains of Mollusks" of the Bridgewater Treatise (Buckland, 1836B: 303-310).

Fragments of gracile bones had been known from several locations in Britain, as well as on the Continent, for a number of years, but had been attributed - very tentatively - to fossil birds, as in a passing reference in Buckland's Megalosaurus paper (Buckland, 1824C: 392).

Cuvier had first described a species of the flying Mesozoic reptiles, the pterodactyls, in 1809, and by the time of the final edition of the Ossemens Fossiles he had named two species and described a third, all from the Solenhofen Limestone of Bavaria (Cuvier, 1825(5)(2): 358:383).

In his paper, Buckland stated:

> I had for some time past suspected the existence of the Pterodactyle in the lias [sic] at Lyme; partly from having heard, about twenty years ago, that in the collection of Mr. Rowe, then made at Charmouth, there was the skeleton of a fossil bird, which I never saw, but imagine may have been a Pterodactyle; and partly from having found, four years ago at Lyme [i.e. 1825], in the collection of Miss Philpots, some bones of a wing and toe, which I could refer to no other animal, and of which a drawing was then made for me. More recently, I have discovered in the cabinet of Miss Philpots a thin elongated fragment of flat bone, which appears to be the jaw of a Pterodactyle; it is set with very minute, flat, lancet-shaped teeth, bearing the character of a lacertine animal. (Buckland, 1835A: 219).

A well-preserved specimen on a slab of Lias shale, disarticulated but tolerably complete except for the skull, had been found by Mary Anning a short time previously (presumably around the end of 1828), and Buckland described this specimen in some detail, drawing particular attention to the observation made and pointed out to Buckland by William Clift and William Broderip:

> that the remaining cervical vertebrae are surrounded with small cylindrical bony tendons of the size of a thread. These run parallel to the vertebrae ... and resemble the bony tendons that run along the back of the Pygmy Musk ... and of many birds, and are familiar to us in the leg of the common Turkey: these bony tendons must have materially added to the power of the neck and head of the Pterodactyle. (Buckland, 1835A: 218).

Buckland compared the new find with the published species from the Solenhofen Slate, and decided that this was a new species, which he named <u>Pterodactylus</u> <u>macronyx</u> because of the much greater length of its claws compared with those previously described.

Buckland went on to acknowledge that in 1823 J S Miller (Curator of the Bristol Museum) had suggested that the "bird" bone fragments commonly found at Stonesfield:

> ought rather to be referred to the Pterodactyle. At that time I saw much reason to adopt his opinion with respect to many specimens; and I now, on further examination, am disposed to think they may all be referred to a flying reptile rather than a bird; ... Here then we have a new and important locality of the genus Pterodactyle, nearly in the middle region of the oolite formation, and in a place intermediate between the lias and the lithographic limestone.... Within this period are included the strata of Tilgate Forest: and it deserves inquiry whether many of the bones discovered therein, which Mr Mantell has referred to birds, may not on more careful examination prove to belong also to the Pterodactyle; and whether there be any certain evidence of the existence of fossil birds in strata more ancient than the tertiary. (Buckland, 1835A: 219-220).

Again, both Buckland's interpretation and his predictions remain substantially unchallenged one and a half centuries later, except for the extremely rare finds of the primitive bird Archaeopteryx lithographica amongst the far more abundant pterodactyl in the Solenhofen Lithographic Limestone itself.

The second part of the February 1829 paper had also had a fairly long period of gestation before Buckland threw caution to the winds and presented his thoughts to the Geological Society. From the time of his Kirkdale Cave work, Buckland had delighted in talking about his identification of fossil hyaena dung or "coprolites", and he had subsequently found abundant hyaena coprolites in both Kent's Cavern and the Cave of Lunel. Analyses by Wollaston and Faraday had demonstrated that hyaena coprolites had a characteristic chemical composition, and in December 1825 Buckland had asked Wollaston to analyse a "Bezoar stone", well known to fossil collectors at Lyme Regis, and so called "from their external resemblance to the concretions in the gall-bladder of the Bezoar goat" (Buckland, 1835B: 223). Wollaston found that the sample contained a high level of phosphate of lime, and agreed that the "bezoar" could be of faecal origin (Buckland, 1835B: 223).

Immediately after the Geological Society paper was read, Murchison appears to have persuaded William Prout to carry out a much wider range of chemical analyses on possible coprolites from the Lias not only of Lyme Regis, but also from Westbury and Aust on the Severn, and Prout's findings were entirely favourable to Buckland's hypothesis, (M.S. DRO 138M/F110; Buckland, 1829G; Buckland, 1835B: 223). However, once again Mary Anning's careful collecting and recording had been of great importance:

> The certainty of the origin I am now assigning to these Coprolites, is established by their frequent presence in the abdominal region of the numerous small skeletons of Ichthyosauri, which, together with many large skeletons of Ichthyosauri and Plesiosauri, have been found in the cliffs at Lyme, and supplied to various collectors by the skill and industry of Miss Mary Anning. I have two of these skeletons, in each of which the Coprolites are very apparent, but flattened; and Miss Anning informs me that since her attention has been directed to these bodies, she has found them within the ribs or near the pelvis of almost every perfect skeleton of Ichthyosaurus which she has discovered. (Buckland, 1835B: 224).

Buckland considered the very common "Bezoar stones" to be the coprolites of ichthyosaurs and gave them the name Ichthyosauro-coprus. He had also investigated the contents of many of these and found abundant evidence of fish scales, together with the vertebrae of fishes and small ichthyosaurs, and he figured a large coprolite containing an ichthyosaur vertebra more than an inch in diameter (Buckland, 1835B: 225 and Pl. XXIX). The characteristic spiral shape with a finely corrugated exterior was attributed by Buckland to the impressions: "which, in their plastic state, they may have received from the intestines of the living animals." (Buckland, 1855B: 225). Prout had also been asked to investigate the possibility that the jet black colour of some of the coprolites might be caused by fossil ink from the sacs of cephalopods, in view of the abundance of fossil ink sacs, and Prout found an ink-like substance very similar to that in the fossil ink sacs also submitted by Buckland. In addition to this he found that nearly half of the Lyme Regis coprolites contained other fragments that were almost certainly derived from cephalopods, confirming that these formed an important part of the diet of the ichthyosaurs (Buckland, 1835D: 226).

Turning to the Rhaetic bone bed of the Severn cliffs, Buckland was now able to re-interpret much of the accumulation of bones, teeth and spines of reptiles and fishes as comprised of faecal pellets, although the form of these was distinct from those of ichthyosaurs, and Buckland suggested that these might be coprolites of some unknown fish (Buckland, 1835B: 227-230). He continued by summarising his identification of coprolites in formations other than the Lias, including a rich occurrence at the base of the Carboniferous Limestone at Clifton near Bristol (also drawn to his attention by J S Miller), and which Buckland considered to be fish coprolites, in the middle and upper Oolites, in Dorset and at the base of Shotover Hill near Oxford, in the Wealden at Tilgate Forest, the Greensand of Wiltshire and Dorset, the Chalk of Lewes (where a coprolite had been found by Mantell actually within the body of a fossil fish), as well as near Maastricht, and also in the Tertiary of Belgium, the Isle of Sheppey, and near Aix en Provence (Buckland, 1835B: 230-235). Buckland concluded:

> Thus, in formations of all ages, from the first creation of vertebral animals to the comparatively recent period in which hyaenas accumulated album graecum in their antediluvian dens, we find that the faeces of aquatic or terrestrial carnivorous animals have been preserved. ... In all these various formations are Coprolites from records of warfare, waged by successive generations of inhabitants of our planet on one another: ... the general law of Nature which bids all to eat and be eaten in their turn, is shown to have been co-extensive with animal existence upon our globe; the Carnivora in each period of the world's history filling ther destined office, - to check excess in the progress of life, and maintain the balance of creation. (Buckland, 1835B: 235).

Buckland repeated this view of the role of carnivores in the Bridgewater Treatise, which also contained a resumé of both the original Geological Society paper on coprolites, and of further discoveries made in what can best be described as a "coprolite fever" that swept much of the geological world in the early 1830s, although in the Section title Buckland implied that the subject was the "Intestinal Structure of Ichthyosaurus and of fossil fishes" (Buckland, 1836B: 187-192), perhaps for reasons of delicacy.

Finally, towards the end of his working life, Buckland became more and more convinced of the great economic value of coprolite-rich deposits (such as those of the Rhaetic bone beds), and also viewed the occurrence of coprolites as evidence of Divine providence because of their value to man. The scatalogical bravado of the professorial coprolites presented to the 1832 Oxford lecture course (see Chapter 2.5 above and the Jackson lecture notes in Appendix 1.4), or in De la Beche's "Coprolitic Vision" (Fig. 5), (McCartney, 1977: 48-49), gave way in the mid-1840s to a very different kind of "coprolitic vision", in which the fossilised dung of long-extinct fishes and ichthyosaurs would be harnessed to provide the greatly increased agricultural production that Britain needed to avoid the risk of famine in the face of rapid urbanisation, population growth and disasters such as the potato disease. This was one of the central themes of his highly regarded and very influential Quarterly Review article on agriculture (Buckland, 1844B) and of his last major scientific paper: "On the Causes of the general Prevalence of Phosphates in the Strata of the Earth, and in all fertile soils; with observations on Pseudo-Coprolites, and on the Possibility of converting the Contents of Sewers and Cesspools into Manure". This paper was in fact offered to the Geological Society in a letter from Buckland to De la Beche, as President of the Geological

Fig. 6. "A Coprolitic Vision": Caricature of Buckland
by Henry De la Beche

Society, dated 10 March 1848 (just a month after the award of the Wollaston Medal) (M.S. NMW DLB Papers), but the Society could not, or would not, find the paper a place in its programme even as a lecture, and instead Buckland presented it the following year to both the Royal Agricultural Society and the British Association, where in each case it was, in fact, very favourably received (Buckland, 1849A, 1850).

By this time Buckland could see one innovatory area of research already producing economic benefits. On 23 May 1842, the agricultural pioneer, Sir John Bennett Lawes of Rothamsted, had been granted a patent for a process involving the treatment of coprolites with sulphuric acid to make an artificial phosphate fertiliser. Lawes opened a factory to undertake the process on a commercial scale at Deptford in 1843, and a second (and much larger) one at Barking Creek in 1857, thus founding the synthetic agricultural fertiliser industry, (Woodcroft, 1969: 330; Clarke, 1901).

The subsequent history of the coprolite industry with its "Mr. Baker, Farm and Coprolite Surveyor" at Barton, near Cambridge, and its "Coprolite Street" in the dockland area of Ipswich, (both of which would surely have appealed to Buckland's sense of humour), has been recently documented by Richard Grove (1976A & 1976B), with special reference to Cambridgeshire, but with national statistics that show that by 1860 synthetic phosphate fertiliser production had reached 30,000 tons p.a. at a value of £2 per ton, and rose to a peak of 258,000 tons (£625,000 value) in 1875, before the collapse of the industry due to the discovery and importation of new sources of phosphate, particularly in the U.S.A.

4.4 PALAEONTOLOGICAL AND ENVIRONMENTAL RECONSTRUCTIONS

Buckland undoubtedly regarded Georges Cuvier as his mentor and scientific model, even though he was never a formal student as such of Cuvier, and their personal contacts were fairly brief, and frequently largely social rather than scientific. Although for the first two decades of the 19th century Cuvier reined supreme in Europe in his well-endowed scientific powerhouse at the Muséum, and concentrated largely on the comparative osteology of both fossil and living vertebrates, his work in the laboratory or the field never became an end in itself. The giving of scientific names to new forms as some kind of trophy-hunting, or the kind of palaeontology that Huxley was to characterise graphically half a century later in his jibe against Richard Owen and his "tired homologies", had no place in Cuvier's scheme of things. Instead, all was seen as part of a more fundamental purpose and objective, the understanding of the history of the earth and - in palaeontology - the creation of a vision of a living and breathing animal.

In the Essay on the Theory of the Earth that introduced the first edition of the Ossemens Fossiles of 1812, and published in Britain by Jameson (1822), Cuvier emphasised the "High Importance of investigating the Fossil Remains of Quadrupeds" in terms of his ultimate purpose of reconstructing the history of the earth and its past environments:

> The appearance of their bones in strata, and still more of their entire carcases, clearly establishes that the bed in which they are found must have previously laid dry, or at least that dry land must have existed in its immediate neighbourhood. Their disappearance as certainly announces that this stratum must have been inundated, or that the dry land had ceased to exist in that state. It is from them, therefore, that we learn with perfect certainty the important fact of the repeated irruptions of the sea upon the land, ... and, by a careful investigation of them, we may hope to ascertain the number and the epochs of these irruptions of the sea. (Jameson, 1822: 58-59).

In June, 1832, Buckland, as President of the British Association, had an ideal opportunity to pay a public tribute to the recently deceased Cuvier, and in this summarised concisely his own view of this "recent and irreparable loss":

> For nearly thirty years he has been the leader of that branch of natural philosophy which comprehends the structure and relations of all the kingdoms of animated nature. It was the genius of Cuvier that first established the perfect method after which every succeeding naturalist will model his researches; and which laid the foundations of that analytical process of investigation, of that most philosophical and accurate and uniform system of reducing every organ in every species to a fixed and certain type, which will enable his followers to extend their inquiries over the almost boundless regions of the organised world. (Buckland, 1833A: 104).

Buckland took the precepts of his master and developed them even further in his attempts to understand personally, and graphically convey to both fellow geologists and non-scientists alike, the often strange worlds of past environments or long-extinct animals and plants of remote geological ages. Whilst in no way minimising the value and importance of Buckland's application of this approach to both invertebrate and plant fossils (most notably in the four long chapters on Proofs of Design in these forms of life in the Bridgewater Treatise - Buckland 1836B: 295-523 - which are worthy of a major thesis in their own right), nor his work on Quaternary environments (Chapters 5.1 and 5.2 below), it was Buckland's work in the field of vertebrate palaeontology that Buckland raised Cuvier's objectives and methods to a completely new level.

From a late 20th century perspective, there can be little argument that the high point of Buckland's many contributions to geology was one of his earliest: the entirely original interpretation of Kirkdale Cave as a den of a marauding pack of living hyaenas, based on meticulous observation of the nature of the cave and of its fragmentary remains. In his work at Kirkdale (see Chapters 2.4 and 4.1 above and Boylan, 1972), one and a half centuries ago, Buckland pioneered those techniques of excavation, observation, deduction and induction, coupled with observations of, and practical experiments with, present-day analogues of the fossil species present, which have at last come into their own in recent times as essential ingredients of the widespread interest in paleoecology and the "new" historical science of taphonomy - tapho = burial, nomos - law, i.e. the study of the processes by which physical evidence of living beings pass out of the biosphere and become fossils within the lithosphere. The term Taphonomy for "a new branch of palaeontology" was first proposed in an obscure Russian paper published in 1940 by I A Efremov, but serious studies in, and the practice of, the field began less than two decades ago (see, for example, Hill & Walker, 1972; Behrensmeyer, 1975; Behrensmeyer & Hill, 1980; Brain, 1981; and Shipman, 1981). Exactly 160 years after the publication of Kirkdale in the Philosophical Transactions and the award of the Copley Medal to Buckland for his innovatory work in paleoecology and what is now termed taphonomy, Tony Stuart, in discussing taphonomy and paleoecology in his major book on British Pleistocene vertebrates, felt compelled to write: "It should be pointed out, however, that taphonomic studies relevant to British vertebrate fossils, ... especially in a European context, are still in their infancy." (Stuart, 1982: 63). Even in comparatively recent times, Buckland's interpretation of the phenomena of Kirkdale Cave has been strongly challenged or even completely dismissed as some kind of religious fraud of the sort that Buckland delighted in exposing when visiting Italian cathedrals, particularly by paleoanthropologists working in southern Africa, most notably in Raymond Dart's tendentiously-titled paper "The Myth of the Bone-accumulating Hyena" (Dart, 1956). However, Buckland's interpretation has been vindicated in every respect by more recent work on living hyaenas, particularly that of Hans Kruuk (1966 and 1972) and Chris Buckland-Wright (1969), of Antony Sutcliffe (1970) on the comparison between the contents of both fossil and present-day hyaena dens, and my own detailed work on the historical background to Buckland's Kirkdale Cave investigation (Boylan, 1972).

With Conybeare and De la Beche, Buckland also put flesh and (reptilian) blood on to the skeletal remains of Jurassic vertebrate fossils. The discovery and study of coprolites and their contents was a particularly important step in this process. Setting aside the opportunities for Buckland's sense of humour, coprolites had a practical purpose in demonstrating vividly to the lay public that animals such as ichthyosaurs had once been alive, and had fed and defecated in an entirely natural way, no different from that of present-day forms of life. (The incident recorded by Jackson in the geological lecture notes - Appendix 1.4 - about the professorial "coprolites" had an underlying serious purpose, even if Buckland's primary objective was to amuse or to shock.) In scientific terms, the study of the fragmentary contents of coprolites was far more interesting and important in demonstrating the nature of the food consumed by the animal producing it. Thus, Buckland identified microscopic fragments of undigested bone and of tooth enamel in the fossil dung of the hyaenas of Kirkdale Cave and subsequently of other bone caves, whilst in the ichthyosaur coprolites of Lyme Regis or of the Bristol area he was able to identify the characteristic scales of the well-known Liassic fish Dapedium politum and fragments of cephalopods from the belemnites or ammonites of the Lias sea (Buckland, 1835B: 225-226).

His constant search for physical evidence of the biology and mode of life of the extinct forms now known only from fragmentary fossil remains, led Buckland from the late 1820s onwards into a further new area of research, that of trace fossils, particularly fossil footprints and tracks. The form of the feet of terrestrial animals, such as the Jurassic reptiles then being discovered, could be inferred from the keletal remains of the animals' feet, whilst depositional environments could be reconstructed by analogy with those of the present day, as for example in shoreline or desert deposits represented by ripple-marked sands, or desiccation-cracked muds.

As with several other new areas of scientific work, Buckland's first involvement with fossil footprints began on a decidedly theatrical note. In 1827 he received drawings and at least one cast of a strange track running across the surface of a block of fine-grained New Red Sandstone found in Dumfriesshire and sent to him by the Minister of Ruthwell, the Rev. Henry Duncan. Buckland was soon convinced that these marks were the footprints of an unknown animal walking across the still-wet surface of the ground in geological times, and pressed into service Mary Buckland to prepare some fresh pastry in a range of consistencies, together with various animals from the family menagerie at Christ Church, beginning with one of his crocodiles, and followed by three different species of tortoise (Duncan, 1831: 202-203; Gordon, 1894: 217). Buckland's reply to Duncan dated 12 December 1827 (and quoted in part in Chapter 2.5 above) explaining that the closest match to Duncan's find was the gait of a tortoise walking slightly downhill on soft sand (Duncan, 1831: 203). In his very comprehensive review of the history of British fossil footprint finds and investigations, Bill Sarjeant (1974: 269), has drawn attention to an account by John Murray III (the son of Buckland's publisher) of a memorable party at Murchison's house in London in mid-January 1828 in which the experiments were repeated in front of a substantial and select scientific audience, in which the apparently stubborn and unhelpful tortoises were found to have become stuck in the pastry:

> It was really a glorious scene to behold all the philosophers, flour-besmeared, working away with tucked-up sleeves. Their exertions, I am happy to say, were at length crowned with success; a proper consistency of paste was attained, and the animals walked over the course in a rather satisfactory manner; insomuch that many who came to scoff returned rather better disposed towards believing. (Murray, 1919: 7-8).

Duncan read his paper to the Royal Society of Edinburgh on 7 January 1828, but because of publishing delays it did not appear for over three years, so the earliest published scientific account of fossil footprints was in fact the short abstract of Duncan's text written (in French) by Buckland (1828B) for the Annales des Sciences Naturelles. Other discoveries followed, and several were referred to Buckland, including a second find by Duncan in the Dumfries area and the first Continental discovery, in Saxony. These were described in the Bridgewater Treatise (Buckland, 1836B: 258-266), and in a much fuller account to the Ashmolean Society, of which only an abstract survives (Buckland, 1836C). Later, following the discovery and publication of the first series of footprints attributable to the ichnogenus named Chirotherium Kaup (named from the first Saxony discoveries) in the Liverpool area in 1838 (Sarjeant, 1974: 284-287), Buckland gave papers on these first to the 1838 meeting of the British Association (Buckland, 1839D), and the following year to the Ashmolean Society (Buckland, 1839F), in the latter case drawing attention to the preservation of clear ripple and raindrop impressions on the New Red Sandstone surface as well, and in addition noted further recent discoveries of fossil reptile footprints in the New Red Sandstone of Cheshire, Shropshire and Warwickshire.

Other kinds of trace fossils were also of interest, particularly as indicators of the environmental conditions. In the Bridgewater Treatise section on fossil footprints, he included a note on occurrences in both the Jurassic and the Cretaceous of Oxfordshire, Sussex and Dorset of:

> perfectly perserved and petrified castings of marine worms, at the upper extremity of holes bored by them in the sand, while it was yet soft at the bottom of the water; .... The preservation of these tubes and castings shews the very quiet condition of the bottom, and the gentle action of the water, which brought the materials that covered them over, without disturbing them. (Buckland, 1836B: 260).

A few years later he described other tracks in Coal Measures sandstone as "Petrified Trackways of Ambulatory Fishes" (Buckland, 1843B).

From his earliest papers, Buckland consistently saw what we now term paleoecology as one of the main objectives of the study, and in many it was the overriding priority. The nature of the depositional environment was lucidly reconstructed and presented with admirable clarity and unchallengeable logic, whether he was dealing with the various alternative cave environments (Buckland, 1823, 1835; Boylan, 1967), the soft sand or mud of the New Red Sandstone landscape or the tranquil waters of the Lias sea in which even fossil reptile dung and the ink sacs of cepholopods were preserved, (discussed above), or in his celebrated identification and interpretation of what was known as the Dirt Bed of Portland as a fossil soil in which extinct cycads had grown (Buckland, 1829C). The estimation of paleoclimates by means of comparisons with the habitats of comparable present-day species to those occurring as fossils also became of increasing importance to Buckland from the mid-1820s onwards, as in the inference of a tropical climate in Portlandian times in view of the presence of plant forms whose only present-day analogues were tropical (Buckland, 1829C), or his inference of a very much colder past climate at the time that Eschscholtz Bay was inhabited by mammoths and woolly rhinoceros (Buckland, 1831 and Chapter 5.2 below), and also with his identification of the impressions of raindrops (Buckland, 1839F). Buckland's attempts at reconstructing the paleoecology of past environments were not seen by him purely in sterile, theoretical, terms: the imagery of the written descriptions and interpretations is frequently so intensely visual that it seems inconceivable that Buckland was not writing these without a very clear image in his own mind of his reconstructed environment. This is particularly well seen in the graphic descriptions of the hunting hyaena pack of Kirkdale Cave, already quoted in Chapters 2.4 and 4.1 above, or in, for example, his vivid description of the environment that produced the basal Lias coprolitic bone bed:

> This remarkable phaenomenon of a stratum of stone many miles in extent, and many inches in thickness, and in which sometimes one fourth part of the whole substance is made up of balls of coprolite, seems explicable only by its position in the lowest region of the great formation of the lias, a position which must for a long time have been the bottom of an ancient sea, and a receptacle of the faeces and bones of its inhabitants, the cloaca maxima, as it were, of primaeval Gloucestershire.... moreover, it seems not improbable that the cause of the death of so many animals of every age and condition, may have been the sudden influx of the mud, which has since been indurated to the state of lias and lias shale*. [Footnote] *There may also have been an influx of the butumen which is so abundant in the lias shale, or a sudden alteration of the temperature of the waters, or a chemical and fatal change in their composition. (Buckland, 1835B: 229-230).

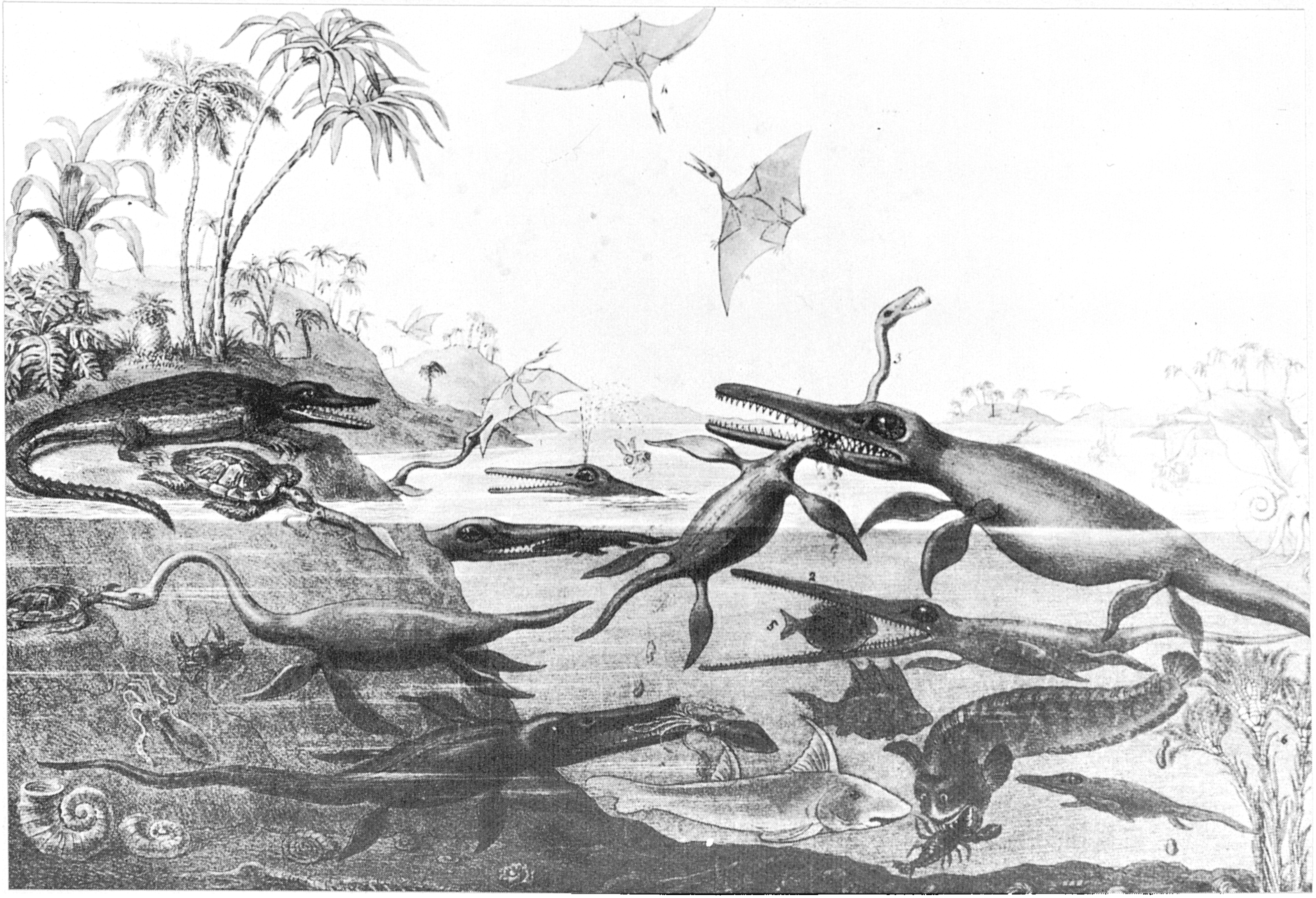
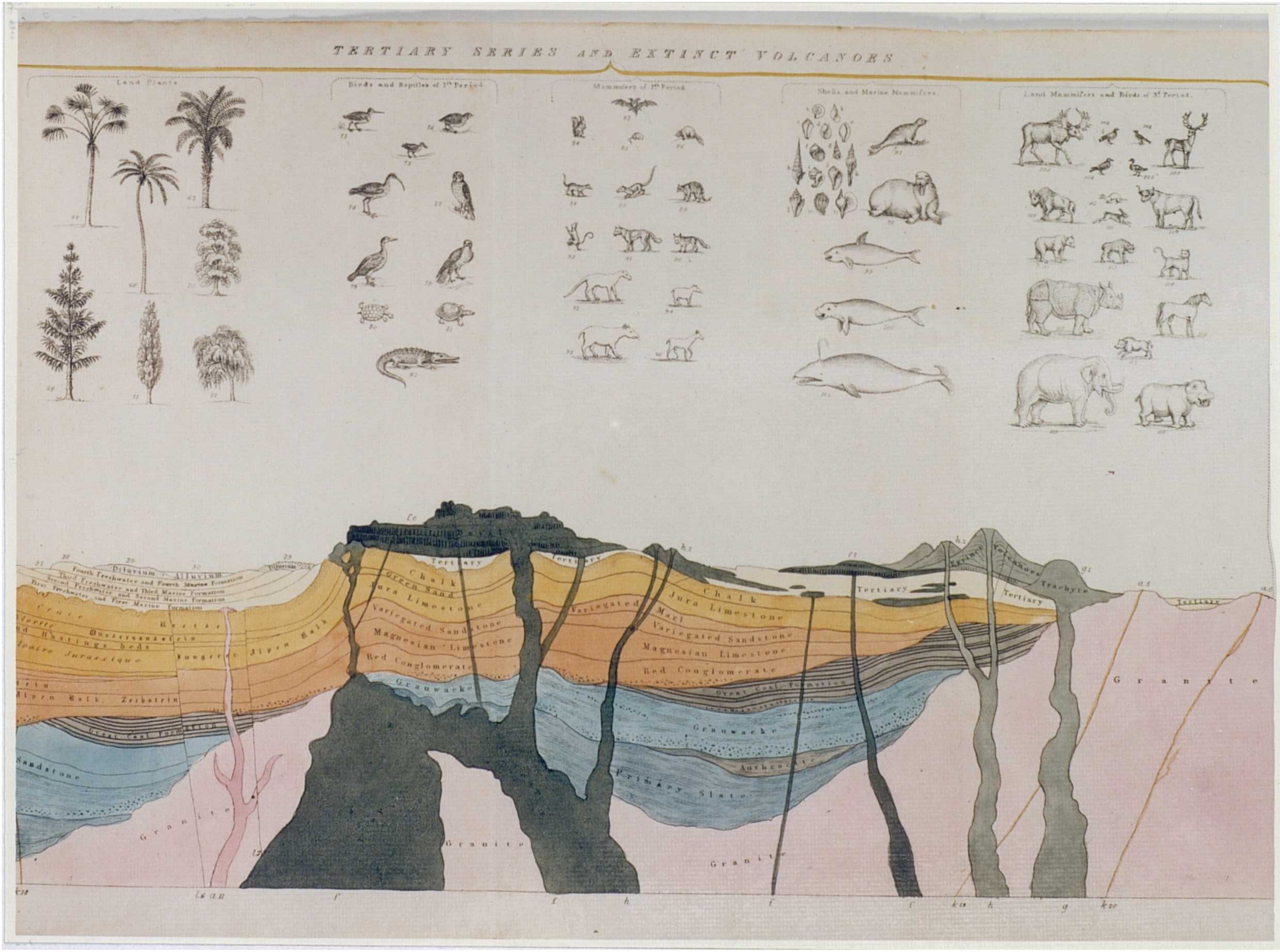


Fig. 7. "Duria Antiquor" by Henry De la Beche

In fact, Buckland made very extensive use of what Martin Rudwick (1976) has termed "a visual language for geological science", including not only maps and conventional drawings of fossils, but also of attempts to reconstruct both individual animals and plants and whole environments. The still-uncatalogued and largely unresearched collection of large-scale teaching illustrations (M.S. OUM, Buckland Papers), include many such images prepared by or under the guidance of Buckland, as well as classroom display-sized copies of both serious and humorous drawings by others, most notably De la Beche. A composite Jurassic landscape based on the work of Buckland, Conybeare and De la Beche himself was used in De la Beche's Duria Antiquior ("Ancient Dorsetshire" - McCartney, 1977: 44-47), and in his Awful Changes. Man only found in a fossil state. - Reappearance of Ichthyosauri (Rudwick, 1975; McCartney, 1977: 50-53), and in each case Buckland paid for additional lithographic prints to be run off at his own expense and distributed them very widely amongst his scientific friends. Commenting on Duria Antiquior (or more likely the large-scale copy of it still in the Buckland papers at Oxford), Buckland told De la Beche in October 1821 that he was using the reconstruction "by way of a syllabus" and had attracted a 30% increase in his student numbers because of it (McCartney, 1977: 44), (see Fig. 6).

Finally, it should be noted that Buckland regarded as a central part of his scheme for the Bridgewater Treatise the (exceedingly expensive) preparation of a single large plate (measuring approximately 120 cm. by 20 cm.) which would encapsulate in one image all the essential facts that were known in the field of historical geology. This took the form of a single, continuous, hypothetical section illustrating the whole of British geology, and was supported by 120 drawings of the typical plants and animals that had been identified from the "Transitional Series" to the present day. In the case of extinct species, most of the drawings were in the form of reconstructions of the living animal, and although some of these are now known to be incorrect (e.g. the drawing of a quadrupedal Iguanodon), the plate was quite without parallel at the time of its conception in about 1832, or indeed at the time of its publication in 1836, although the composite geological section as such was based on an earlier one by Thomas Webster. The printed explanation of this illustration (Plate 1) occupied no less than 17 pages of the second volume of the Bridgewater Treatise (Buckland, 1836B). (A portion of this plate has been reproduced as Fig. 7.)

Rudwick (1976) has examined in detail the emergence of various approaches to the visual presentation and interpretation of geology during the period 1760 to 1840, and has drawn particular attention in this to the central role of the Geological Society of London in this. Within this context it was to be expected that Buckland, as one of the key figures in the development of the Society in the period up to 1840, would himself have been very concerned with the development of the visual language of the emerging science. Buckland's involvement in this area was predictable, but in the case of Buckland's vision of long-extinct forms of life, their mode of life and their living environment, I am not convinced by the view that "this visual communication was (and is) broadly complementary to verbal communication." (Rudwick, 1976: 182 - his emphasis). Buckland's own writings in this area time and again indicate that he has a very clear visual image of the plant, animal or period in question, whether or not he had attempted to reduce this image to some form of sketch or other visual representation, and that his written descriptions were in fact reductions to paper of that image. The



<u>*Fig. 8.   Part of Buckland's "Ideal Section of a Portion of the Earth's Crust",*</u>

<u>*Bridgewater Treatise, Plate 1.*</u>

De la Beche caricature portraying Buckland in the midst of his Coprolitic Vision (McCartney, 1977: 48-49), was not only a friendly commentary on Buckland's current obsession with coprolites and the whole excretory process, but also a tribute to his powers of visualising past environments, hence De la Beche's use of the word "Vision".

Despite the jokes, Buckland's vision in the area of palaeontological and paleoecological reconstruction not only delighted his own generation and successive classes of students at Oxford through more than a quarter of a century, but also established methods of interpreting and visualising problems that are the everyday tools of the trade of present-day taphonomists and paleoecologists.