GEOLOGICAL CURATOR

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COLLECTORS, COLLECTIONS AND THE GEOLOGY OF SOUTHWEST BRITAIN

MAKING THE MOST OF A MOVE

GEOLOGICAL CURATORS' GROUP

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The Group is affiliated to the Geological Society of London. It was founded in 1974 to improve the status of geology in museums and similar institutions, and to improve the standard of geological curation in general by:

- holding meetings to promote the exchange of information
- providing information and advice on all matters relating to geology in museums
- the surveillance of collections of geological specimens and information with a view to ensuring their wellbeing
- the maintenance of a code of practice for the curation and deployment of collections
- the advancement of the documentation and conservation of geological sites
- initiating and conducting surveys relating to the aims of the Group.

2019 COMMITTEE

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Cover: see Figure 5 in Duffin, inside.

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EDITORIAL

As I conclude the production of my final issue of *The Geological Curator* by writing this last editorial, I cannot help but look forward to receiving future copies in the post where I have not already seen the contents in word-by-word detail. Patrick Wyse Jackson, Editor before me did 13 years in the role, producing 26 issues of valuable papers from across our whole group, and also from outside contributors. My term has strangely been the exact same number of years and issues, and I very much continued his approach and style. The journal has been entirely produced in the last 26 years by either Patrick or myself, doing the editorial work of accepting submissions, seeking reviewers for papers, communicating with authors and deciding what has merited being included in the journal. In addition. we have both done the production work on the journal too, laying out papers with desk-top publishing software, producing proofs for authors to check, adjusting them and finalising a pdf for the printers (at least after early years of producing 'camera ready copy'). All of these journal issues have then been printed in the Dublin area and distributed from Ireland to the largely UK based membership, but also a membership across the World.

For all of the issues I have produced, I really want to acknowledge the fine work done by Mark Rogers and his colleagues at Naas Printing (and formerly the Leinster Leader). They have been flexible, helpful, very competitive on cost and great to work with. Any faults with the journal have been my responsibility, not theirs. The limitations of my abilities, time to improve, and my software, particularly when it has involved colour management for figures, have not always produced the colour quality I would have desired, including in this issue. My very old computer and early version of Quark Express will be retiring along with myself!

Another person that deserves my special thanks has been Damien McGinnity, the Postmaster in Drumintee (formerly) and Jonesborough in Northern Ireland. As journals posted in Northern Ireland to UK addresses go at standard rates, it is much cheaper than posting from Dublin to the UK. Consequently, I have driven north to find a post office in Northern Ireland for the issues I have produced. After some initial trouble finding a suitable post office open, and hours spent in car parks sticking multiple stamps on each of several hundred copies, I was fortunate enough to find Damien in Drumintee. He has very kindly taken boxes of journals in from me for many years, and then posted them out when he was quiet, saving me hours of time in the process. I am most grateful to him for his kindness and help.

The journal requires authors to submit papers and I wish to thank everyone who has done so, including those who may have been disappointed by a rejection of their manuscript. Some issues have had thematic sets of papers and I would like to record my grateful thanks to Steve Donovan, Jeff Liston, Mike Taylor and Lu Allington-Jones for their major inputs to those issues. The peer review process demands diligent work on the part of the reviewer to appraise manuscripts. I owe a great debt to all those GCG members who have reviewed papers for the journal over the years - too many to name individually.

Lastly, I wish to acknowledge all of the editorial work of Pip Brewer in getting the papers for this issue together. She has made this issue happen, with my work limited to the production side. With Pip taking over the Journal Editor role on GCG Committee, the locus will move to London where Pip works in the Natural History Museum. There will no doubt be numerous changes and improvements as she modernises the journal, but they will be things she can tell members about as she implements them. I can only conclude by thanking her for taking on the journal and wish her every every good fortune in taking it forward.

Matthew Parkes

A GEOLOGICAL TALE OF TWO CITIES: CUVIER AND BRONGNIART'S MAP OF PARIS (1811) AND CONYBEARE AND DE LA BECHE'S MAP OF BATH (1823)

by Karen Severud Cook

Cook, K.S. 2019. A geological tale of two cities: Cuvier and Brongniart's map of Paris (1811) and Conybeare and De la Beche's map of Bath (1823). *The Geological Curator* 11 (2): 113-120.

This comparison of two early geological maps, Cuvier and Brongniart's 1811 map of Paris and Conybeare and De la Beche's 1823 map of Bath, explores their publication history, the connections between their French and English authors, and the design and reproduction of the maps. The Paris map was much published and is well known for Brongniart's use of associated fossils to identify the geological formations shown on it, while the Bath map survives in only a few copies and is little known. Nevertheless, the Bath map is interesting as one of the first geological maps to combine area patterns printed in colour with hand-applied area colours to distinguish and relate the geological formations on the map. The Paris map is rightly famous for its compilation and geological content, but the Bath map deserves recognition for its innovative symbolization and use of intaglio colour printing.

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Introduction

Several decades ago encounters with two early geological maps of the cities of Paris and Bath, seen in different libraries, aroused the writer's interest in comparing their creation, content and design. The maps are Georges Cuvier and Alexandre Brongniart's 1811 'Carte géognostique des environs de Paris' (Cuvier and Brongniart 1811a, b) (Figure 1) and William Daniel Conybeare and Henry Thomas De la Beche's 1823 'Map of 24 Miles around the City of Bath coloured geologically' (Conybeare and De la Beche 1823) (Figure 2). Recent access to a digital image of the map of Bath, kindly provided by the British Geological Survey Library, has allowed close comparison with Kenneth Spencer Research Library's copy of the map of Paris (Cuvier and Brongniart 1811b) and has facilitated this exploration of their similarities and differences.

Publication, Distribution and Survival

The 'Carte géognostique des environs de Paris' by Georges Cuvier and Alexandre Brongniart is dated 1810 but was first published in 1811 in the *Mémoires* of the Imperial Institute of France (Cuvier and Brongniart 1811a). When the un-illustrated first edition of the text had been published in 1808, they were not yet ready to display more than a preliminary draft of the map at the Institute of France (Cuvier and Brongniart 1808; Rudwick 2008). The first illustrated edition in 1811 was also re-published as a monograph later in the same year, the only change being the addition of a preface (Cuvier and Brongniart 1811a, b). In the WorldCat international catalogue searched in August 2018, North American and European libraries reported holding 73 copies of the two 1811 editions (WorldCat 2018). In 1822 and 1835, revised illustrated editions of the monograph appeared (Cuvier and Brongniart 1822, 1835). WorldCat also listed 69 North American and European libraries holding the 1822 edition and 54 libraries holding the 1835 edition. The revised and expanded 1822 and 1835 editions resulted from Brongniart's continuing studies, aimed at placing Parisian geology in wider context (Cuvier and Brongniart 1822, 1835). He found that international visitors to his study sites made interesting comparisons with the geology of their own countries (Cuvier and Brongniart 1822). International distribution of the text was also aided by Professor Robert Jameson of Edinburgh, who arranged for an English translation by Robert Kerr that was first published in 1813 without the map (Cuvier *et al.* 1813) and re-published numerous times thereafter.

The 'Map of 24 Miles around the City of Bath coloured geologically by the Rev. W.D. Conybeare and H. T. De la Beche' was published by J. Barratt, a Bath bookseller, in 1823. The authors' geological information had been added to an existing copper-engraved map of Bath (Masters 1820) by a combination of overprinting a second copper plate inked in

Figure 1. G. Cuvier and A. Brongniart's* Carte géognostique des environs de Paris *(1811b). Reproduced by permission of Special Collections, Kenneth Spencer Research Library.

two colours and by adding hand colouring. The resulting geological map, published in a single (probably very small) edition as a sheet map without accompanying text, is today extremely rare. In August 2018 the WorldCat database listed only two copies, one in the Natural History Museum in London and another in the British Geological Survey Library in Keyworth. A third copy, formerly framed for display and faded from exposure to light, is preserved in the Bath Record Office. There is also a related manuscript map in the École des Mines library in Paris (Conybeare and De la Beche c. 1823).

Conybeare and De la Beche did not write text to accompany the publication of their map in 1823 or thereafter. Conybeare was very close to his older brother, John Josiah Conybeare, who shared his interest in geology. After the latter died suddenly in June 1824, the younger Conybeare was so deeply affected that he gave up geology entirely for a number of years (Torrens 2004). In the summer of 1824 De la Beche, who had been in Jamaica since November 1823 dealing with his family estates and studying the geology of Jamaica, returned to England to face the break-up of his unhappy marriage (McCartney 1977; Secord 2004). Thereafter, he became involved in the founding of the Ordnance Geological Survey during the 1830s (McCartney 1977). Produced under his direction, the first Ordnance Geological Survey maps covering south-west England situated Bath in its regional geological context (McCartney 1977).

Anglo-French Contacts, Influences and Exchanges

Intervals of peace between France and England in the late eighteenth and early nineteenth centuries enabled geologists to make scientific visits across the English Channel. In 1790 Brongniart, aged 20, visited the mining area of Derbyshire (Eyles 1985). During a later visit to London in 1802, documented in his surviving papers, he attended scientific gatherings at the house of Sir Joseph Banks and meetings

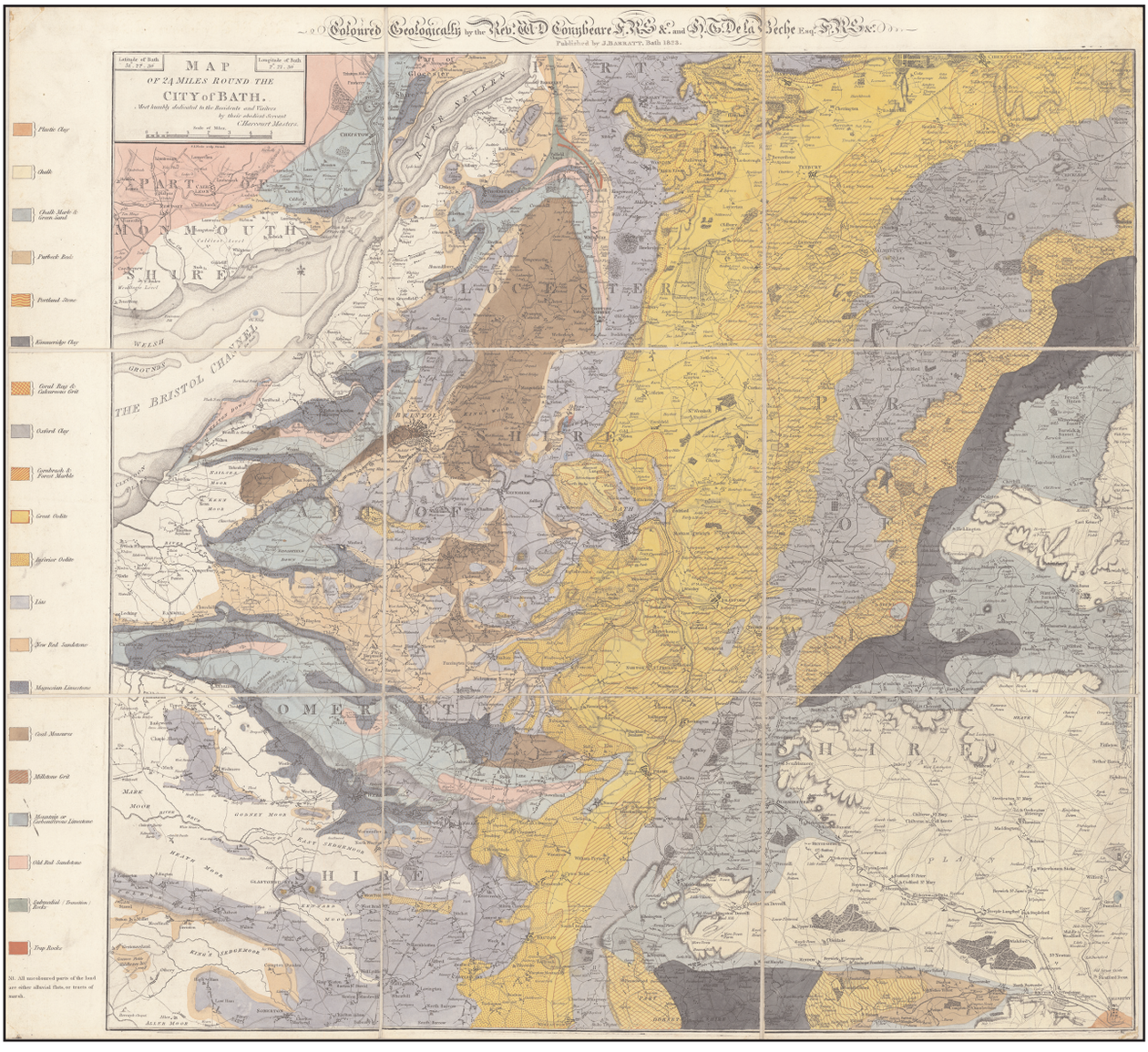

Figure 2. W. D. Conybeare and H. T. De la Beche's* Map of 24 Miles around the City of Bath coloured geologically *(1823). Reproduced by permission of the British Geological Survey CP 18/044

of the Royal Society (Taquet 2009). There Brongniart may have seen a preliminary version of William Smith's geological map of England and Wales in the possession of Banks. When John Farey, a mineral surveyor and friend of Smith, later saw Cuvier and Brongniart's map, he asserted that their method of colouring formations in particular hues was derived from Smith (Rudwick 1996). Martin Rudwick has also suggested that viewing Smith's map could have sparked Cuvier and Brongniart's idea of using fossils to identify formations (Rudwick 1996).

Georges Cuvier, born in 1769, was only a year older than Alexandre Brongniart. They met when Cuvier moved to Paris in the 1790s, and friendship and collaboration arose from their common interests. The vicinity of Paris was a convenient location for fieldwork during weekends (Rudwick 2008). When they began their study of the Paris region in 1804, their aim was to develop a system for dating the mammalian fossils occurring in sedimentary deposits in the area (Rudwick 1996).

William Daniel Conybeare, born in 1787, was a decade older than Henry De la Beche. They were drawn together by a mutual interest in fossils and geology, having met in 1818 at a meeting of the Oxford Geology Club (North 1933). De la Beche was away in France and Switzerland from July 1819 until June 1820, returning then to southwest England (McCartney 1977). During 1820 Conybeare and De la Beche participated in the founding of the Bristol Literary and Philosophical Institution and Society (North 1933). In 1821 they published a paper together about fossils of extinct marine reptiles (De la Beche and Conybeare 1821). As a boy De la Beche had moved to Bath with his mother and attended school near there (Morris and Sharpe 2013). Conybeare lived near Bath, so it was a familiar and readily accessible locale for them to study and map (Torrens 2004).

Cuvier and Brongniart's map of Paris may well have inspired Conybeare and De la Beche's project to map Bath and vicinity. While visiting Paris in late July 1819 De la Beche met Cuvier and spent a congenial evening with him, Brongniart and others (McCartney 1977). A few days later he visited Brongniart, who showed his collection of rocks and minerals to De la Beche (McCartney 1977). Conybeare also visited Paris in 1820 and met Cuvier (North 1933). As a result of these visits in 1819 and 1820, if not before, it seems likely that Conybeare De la Beche had learned of Cuvier and Brongniart's study of Paris.

The ideas of Cuvier and Brongniart could also have reached Conybeare and De la Beche indirectly. In 1811, Sir Henry Englefield engaged Thomas Webster to contribute a chapter on the geology of the Isle of Wight to his forthcoming book (Englefield 1816; Heringman 2009). A preliminary paper by Webster in the 1814 'Transactions of the Geological Society of London' praises Cuvier and Brongniart and summarizes their work on the geology of Paris (Webster 1814). One of Webster's illustrations is a map showing the location of the Paris Basin relative to the geologically analogous London Basin and Isle of Wight. Chalk and plastic clay form the base of the Paris strata, while the same two units occur atop the Bath strata.

Possibilities for French geologists to learn of the Bath map of Conybeare and De la Beche were more limited given the map's smaller circulation. International contact may have occurred during the summer of 1823, when André Brochant de Villiers, a professor at the École des Mines in Paris took two students, Pierre Dufrénoy and Léonce Élie de Beaumont, on a mineralogical tour of England in preparation for compiling a geological map of France (Dufrénoy and Élie de Beaumont 1827). Their book about the tour cites Conybeare's writings but doesn't say whether they met Conybeare or De la Beche or saw their just-published map of Bath. Possible evidence of contact is provided by a manuscript copy of the Bath map preserved in the library of the École des Mines in Paris (Conybeare and De la Beche c. 1823). That copy is hand drawn and hand coloured on the same printed base map as the published geological map. It differs in lacking the printed author-title information crediting Conybeare and De la Beche in the top margin of the published map. In addition, the outlines of geological units and area patterns on the map body and the legend boxes and labels in the left margin have been hand drawn (not printed) in a combination of pencil and ink. There have also been some erasures and corrections to several of the legend boxes. The geology has been added entirely by hand. While it was not possible to photograph this map at the time of viewing, the geological unit colours could be identified and recorded by visual matching to Munsell-derived colour charts (Kelly and Judd 1967). The hues of the area symbols on the manuscript map are very similar to those (also hand coloured) on the published map. The hand-drawn map in the École des Mines must be either an original manuscript draft by Conybeare and De la Beche or a close copy by someone else of a published example of the map. During the summer of 1823 one of the French visitors could have made or acquired a manuscript copy of the Conybeare and De la Beche map and taken it back to the École des Mines in Paris. The De la Beche papers in the National Museum of Wales do contain later correspondence about exchanging publications with Dufrénoy, Élie de Beaumont and other French geologists (Sharpe and McCartney 1998).

Map Design, Production and Reproduction

As mentioned above, both the map of Paris and the map of Bath were printed from engraved copper plates, the best and most common method of printing maps in the early 19th century. Cuvier and Brongniart had the luxury of using a purpose-made base map (Cuvier and Brongniart 1811a, b). The geological units on their Paris map are typical of early 19th century maps in being differentiated by hand-painted area colors and patterns that are identified in the map's legend.

In contrast, Conybeare and De la Beche used an existing map, C. Harcourt Masters's 'Map of 24 Miles around the City of Bath', as their base map (Masters 1820). Its publication may have inspired their mapping project and certainly facilitated it. If they had access to the original copper plate, the mark of the plate's edge pressed into the paper barely outside the map's border shows that there was no room to add a new title and geological legend to the same copper plate (Figure 3). Instead, the title, legend and geological patterns were added to a second, larger copper plate and overprinted on the base map, creating a second plate mark (Figure 4). The original map image with sharp controlled lines and lettering betrays the hand of a skilled copper engraver using a burin to incise lines directly in the copper plate. The granular-edged round-pointed lines of the geological patterns on the second plate are characteristic of etching, a less exacting technique that required only removal of a thin resistant ground and etching the exposed metal with acid to form sunken lines. It is possible that De la Beche, who was a talented amateur artist (McCartney 1977), could have been involved in creating the second copper plate. Unusually, the addi-

Figure 3. Detail of the upper right corner of the Bath map showing the plate mark where the edge of the copper plate pressed into the paper during printing (Conybeare and De la Beche 1823). Reproduced by permission of the British Geological Survey CP 18/044.

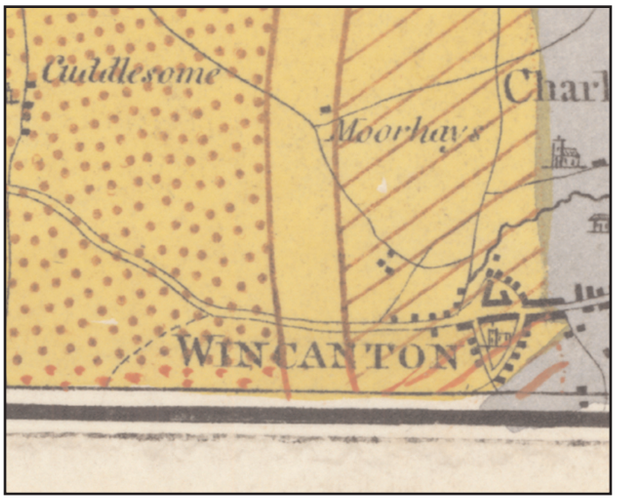

Figure 5. Detail of the bottom edge of the Bath map showing hand-painted dots and lines filling in the registration gap caused by mis-alignment of the red patterns printed from the second plate with the black border on the base map plate (Conybeare and De la Beche 1823). Reproduced by permission of the British Geological Survey CP 18/044.

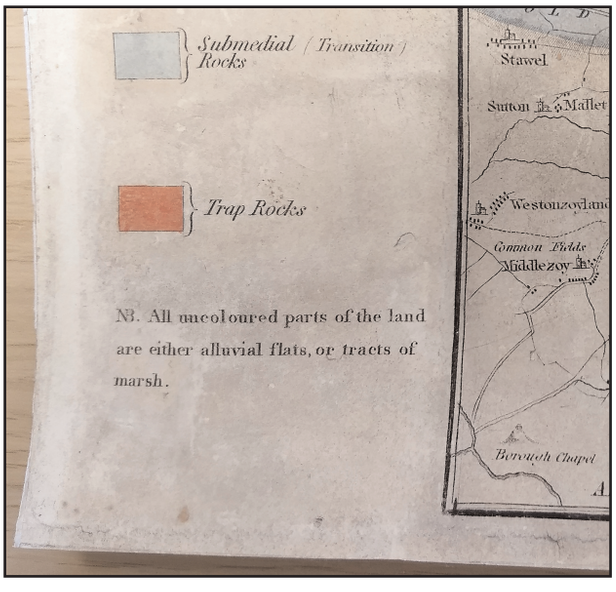

Figure 4. Detail of the lower left corner of the Bath map showing the second plate mark outside the legend boxes and the first plate mark (partially flattened during the second printing) just outside the neatline (Conybeare and De la Beche 1823). Reproduced by permission of the Bath Record Office.

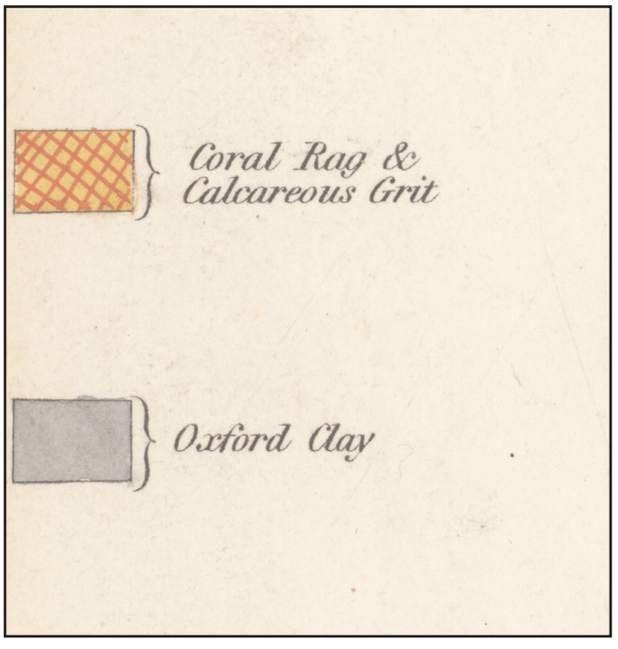

Figure 6. Detail of the Bath map showing the hand colouring of areas and patterns in the legend boxes (Conybeare and De la Beche 1823). Reproduced by permission of the British Geological Survey CP 18/044.

tional plate was inked and printed simultaneously in two colours (black and red), a method known as à la poupée colour printing. Although the method was common on pictorial prints in England and France (Stijnman 2012), this cartographic use of *à la poupée* colour is possibly unique. The title and legend boxes have been inked and printed black in the top and left margins of the map, while the geological unit outlines and area patterns have been inked and printed in red on the map body. The registration (alignment of the two printing plates) is imperfect and a gap between the red printed patterns and the black map border has been filled in by hand in a brighter red (Figure 5). Two-colour inking of the additional plate also explains why the patterns in the legend boxes were hand coloured (Figure 6). It would have been difficult to apply red printing ink inside the black legend boxes without mixing the two colors on the printing plate.

The mention of patterns leads into the final point of comparison between the two maps. The apparent similarity between the two maps when initially seen

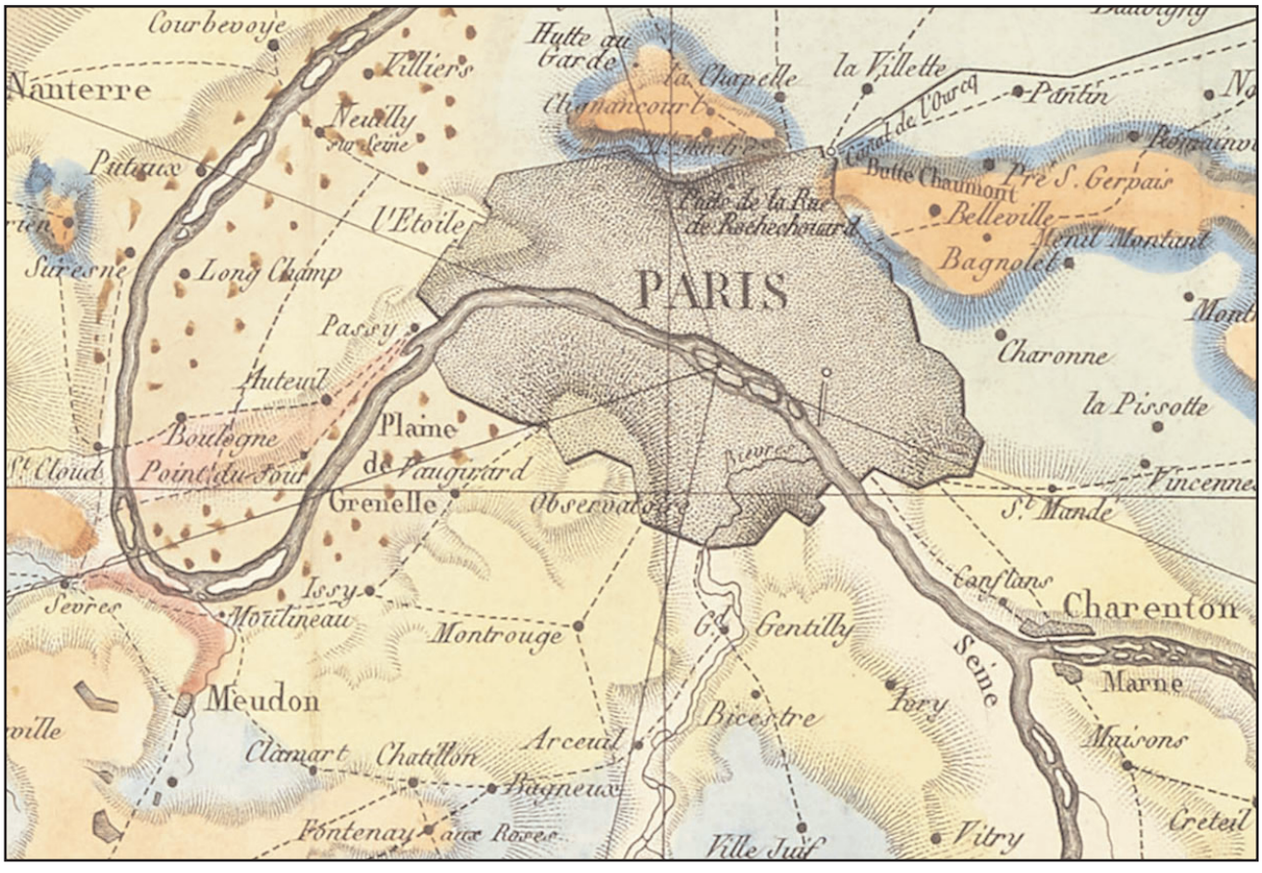

Figure 7. Detail of the Paris map showing the carelessly painted, hand-coloured dot pattern on the map body (Cuvier and Brongniart 1811b). Reproduced by permission of Special Collections, Kenneth Spencer Research Library.

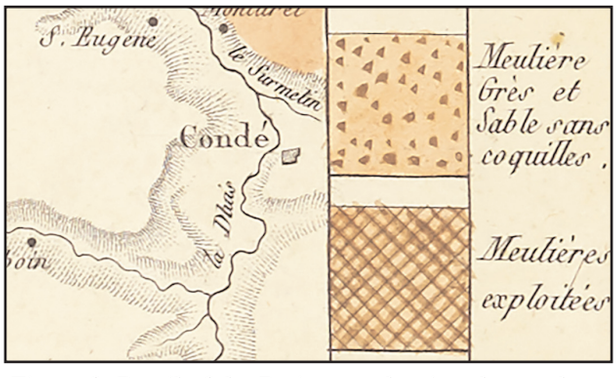

Figure 8. Detail of the Paris map showing the neatly hand-coloured dot and grid patterns in the legend boxes (Cuvier and Brongniart 1811b). Reproduced by permission of Special Collections, Kenneth Spencer Research Library.

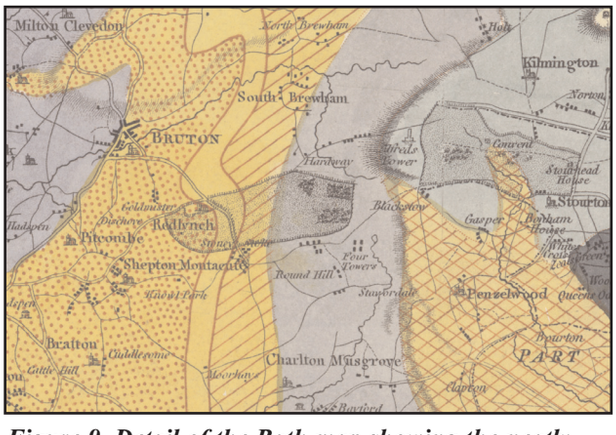

Figure 9. Detail of the Bath map showing the neatly executed red dot and line patterns overprinted on the black base map (Conybeare and De la Beche 1823). Reproduced by permission of the British Geological Survey CP 18/044.

in different libraries was due to the prominence of the open-textured dot and ruled-line area patterns in the legend boxes. However, a close look at the Spencer Library copy of the Paris map reveals that the coloured patterns on the map body have been carelessly added by hand, hardly resembling the neatly drawn patterns in the legend box (Figures 7 and 8). Also, the patterns on the Paris map appear only on geological units of limited extent, thus avoiding tedious application of the patterns over large areas. In contrast, on the Bath map the red line and dot patterns have been neatly printed on large areas of the map body and less carefully hand-drawn in the legend boxes (Figure 9). On the map the printed patterns easily cover large areas and serve to both relate and distinguish calcareous formations hand-coloured yellow. This design approach would become common on geological maps later in the 19th century with the general adoption of printed colour (Cook 1995), but in 1823 it was decidedly innovative.

Conclusion

This comparison of Cuvier and Brongniart's Paris map and Conybeare and De la Beche's Bath map has led to the conclusion that each in its own way was a significant milestone in the history of geological maps. While Cuvier and Brongniart were among the first to demonstrate the value of associated fossils for identifying and tracing geological formations on the ground, Conybeare and De la Beche deserve recognition for their innovative symbolization using area colours and patterns, applied by a combination of hand colouring and intaglio colour printing, to identify and relate the geological formations depicted on their map.

Acknowledgements

I would like to thank the British Geological Survey Library in Keyworth and the Bath Record Office in Bath for access to and permission to reproduce their copies of Conybeare and De la Beche's 1823 geological map of Bath, as well as Kenneth Spencer Research Library in Lawrence for access to and permission to reproduce Cuvier and Brongniart's 1811 map of Paris.

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FRANCIS BASSET, 1ST BARON DE DUNSTANVILLE AND BARON BASSET OF STRATTON, AND HIS MINERAL SPECIMENS AT THE BATH ROYAL LITERARY AND SCIENTIFIC INSTITUTION AND THE NATURAL HISTORY MUSEUM, LONDON

by Tom F. Cotterell and Matt Williams

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A small suite of historically significant Cornish minerals are recorded as having been donated to the Bath Royal Literary and Scientific Institution (BRLSI) by Lord De Dunstanville in 1826. Only sixteen specimens are extant but their quality, and the fact that they appeared to represent the largest known suite of mineral specimens owned by Francis Basset, 1st Baron De Dunstanville and Baron Basset of Stratton (1757-1835), marked them out as being of significance and worthy of further study. Subsequent investigations revealed a second, slightly larger suite of mineral specimens attributed to Lord De Dunstanville in the 'Russell Collection' within the Natural History Museum (NHM), London. This second suite was almost exclusively given by him to his sister-in-law, Lady Elizabeth Anne Coxe Hippisley (1760-1843), of Ston Easton Park, Somerset, in 1810-1811, thus providing a link to the city of Bath. The BRLSI specimens are described in detail and reviewed in comparison to the NHM specimens. In total fifty-four specimens with associations to Lord De Dunstanville are documented.

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Introduction

In 2013, the lead author arranged a visit to the Bath Royal Literary and Scientific Institution (BRLSI) on behalf of the Russell Society (Cotterell 2014). The purpose of the visit was to view the mineral collection, part of which dates to the time of the Bath Agricultural Society founded in 1777. Of particular interest was a small suite of Cornish minerals recorded as having been donated by Lord De Dunstanville in 1826. The yearly report recorded the donation as, '24 Cornish Mineral including the arsenate of iron & of lead and Native copper'. Many of the specimens, which are predominantly copper-bearing minerals can, due to their unusual nature and rarity, be provenanced with some certainty to mines formerly worked in the Parish of Gwennap in Cornwall and certainly date to the period post-1797. It is these specimens, of which 16 survive, that form the basis of this paper (Figure 1).

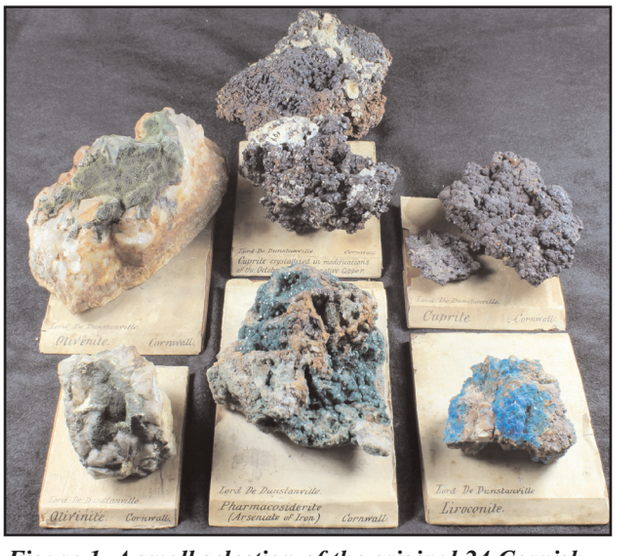

Figure 1. A small selection of the original 24 Cornish mineral specimens donated to BRLSI by Lord De Dunstanville.

Lord De Dunstanville is not a name that springs to mind when one thinks of historic British mineral collectors. His name is absent from Embrey and Symes' (1987) excellent work on minerals and mineral collectors in Cornwall and Devon. Prior knowledge of Lord De Dunstanville's mineralogical interests is restricted to notes produced by Sir Arthur Russell in

his paper 'Philip Rashleigh of Menabilly, Cornwall, and his mineral collection' (Russell 1952). Russell (1952: p. 110) very briefly listed him as: 'Basset (Francis), 1757-1835 of Tehidy, afterwards Lord de Dunstanville. Mineral Lord of many mines, including Dolcoath, in the Camborne district, Cornwall.'

Russell's use of the term 'Mineral Lord' is in reference to his mining exploits rather than any association with mineral collecting. Russell (1952) did not mention any specific mineral collection held by Basset, rather, he was highlighting that his name was recorded by Rashleigh in the list of donors entered in the front of his manuscript catalogue (Rashleigh undated) of his mineral collection which is preserved at the Royal Cornwall Museum in Truro. Russell's information was repeated with no new additions by Wilson (1994: p. 159).

Despite a thorough search of the extensive listings of letters received and sent by Rashleigh, as compiled by the late Ron Cleevely (some of which is included in Cleevely 2011), no correspondence between the two men has been found. Additionally, careful searching through Rashleigh's MS catalogue (Rashleigh [no date]) has failed to identify any specimen directly attributed to Francis Basset (Courtenay Smale pers. comm. March 2019).

During the course of this research it transpired that a slightly larger suite of mineral specimens attributable to Lord De Dunstanville, numbering 36 in total, and all Cornish in origin are preserved in Sir Arthur Russell's collection at the Natural History Museum (hereafter referred to as NHM), London (Appendix 1). Thirty-five of the specimens are documented by Russell as having been given by Lord De Dunstanville to Lady Elizabeth Anne Coxe Hippisley (1760-1843) of Ston Easton Park, Somerset.

Lady Coxe Hippisley was Lord De Dunstanville's sister-in-law. She was a very active mineral collector during the early years of the 19th century but, like him, very little has been written about her and her mineral collecting exploits. She spent proliferously in order to acquire the finest specimens, but her extensive geological collection lay hidden for nearly a century in the Literary and Scientific Institute at Frome near to her Ston Easton Park estate in Somerset. In 1937, it was discovered and acquired by Dr. Robert William Theodore Gunther, a science historian from Oxford (Russell 1944). Following Gunther's death, in 1940, Russell acquired the collection and assimilated the better quality specimens into his own personal collection which he bequeathed to the British Museum (Natural History) (referred to from now on as the Natural History Museum, London, or NHM), in 1964. Therefore, Russell would have been aware of specific mineral specimens traceable to Lord De Dunstanville when he wrote his paper on Rashleigh (Russell 1952).

The specimens which Russell did not integrate into his own collection he used for exchange. Two examples of Lady Coxe Hippisley specimens attributed to Lord De Dunstanville are known in private collections. Both are identifiable by Russell's characteristic handwritten labels and both are olivenite from Wheal Gorland, Gwennap, Cornwall (Figures 2 and 3; Figure 4 in Mignan 2018). However, one can assume that the thirty-five extant specimens are not too far from the total given by Lord De Dunstanville. Crucially, the link to Lady Coxe Hippisley provides an obvious link to the city of Bath.

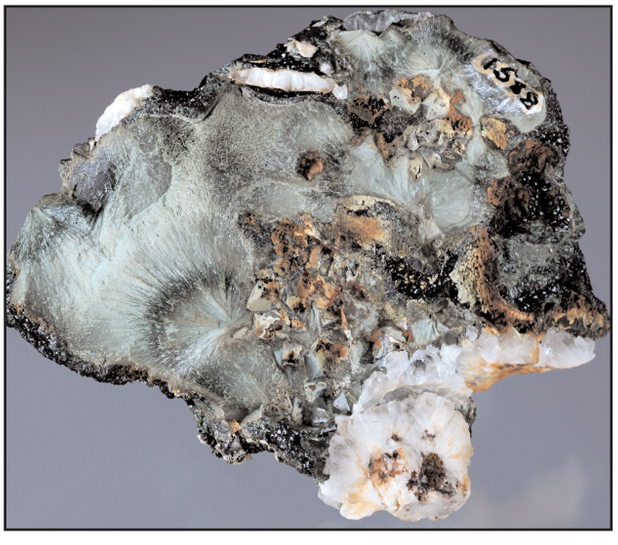

Figure 2. Olivenite with quartz from Wheal Gorland. The accompanying label recording its provenance is shown in Figure 3. Private collection.

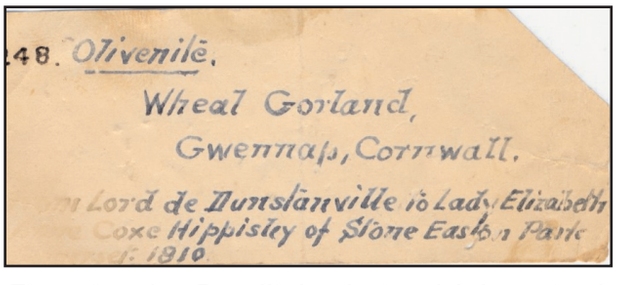

Figure 3. Arthur Russell's handwritten label associated with the olivenite specimen in Figure 2. Documenting the link to Lord de Dunstanville and Lady Elizabeth Coxe Hippisley. Private collection.

The other Russell collection specimen in the NHM attributed to Lord De Dunstanville was recorded by Russell on the associated label as: 'Redruth, November 6th 1811 John Williams, Scorrier House. Dunstanville. (Lord de Dunstanville).' This demonstrates that Lord De Dunstanville provided mineral specimens to other prominent collectors.

Shortly after his donation to the BRLSI Lord De Dunstanville donated 'Specimens of Wavellite' to the fledgling Royal Geological Society of Cornwall, as recorded in their *Transactions* (Anonymous 1828: p. 362). Nothing more is known of this donation and the specimens are not traceable within the RGSC collections which were, in November 2005, transferred to the British Geological Survey in Keyworth (Michael Howe pers. comm. April 2019).

Although Lord De Dunstanville (or Francis Basset) is not mentioned in contemporary accounts describing mineral collections of note in Cornwall (see for example Maton 1797; Warner 1809; Paris 1816; Gilbert 1817; Jameson 1829) it does appear that he possessed a collection. Indeed, Hext informs us that Thomas Staniforth, a successful banker of Liverpool, wrote in his diary (of a visit to Tehidy in 1800):

> …the rest of the day was spent in a pleasant domestic manner & his Lordship showed us some curious specimens of copper ore and Miss Basset play'd on the piano - forte whilst the ladies work'd & we had a pleasant conversation till 11 when the ladies retir'd & we all did so in about an hour (Hext 1965: p. 31).

Francis Basset, Lord De Dunstanville

Francis Basset, sometimes referred to as Sir Francis Basset (Rashleigh [no date]; Thorne 1986; Whetter 2014) and later Lord De Dunstanville, was an English nobleman, politician and one of the most famous Cornishmen in history. A comprehensive account of his life is provided by Whetter (2014).

He was born on 9th August 1757, at Walcot, near Charlbury, Oxfordshire, the first son of Francis Basset (1715-1769) and Margaret St. Aubyn (1728-1768). He was baptised at Charlbury, Oxfordshire on 7th September 1757. His father commissioned the construction of Imley (Evenley) Hall, near Brackley, Northamptonshire which was completed c. 1740. However, in May 1756, the unexpected death of his teenage nephew, John-Prideaux Basset (1739-1756), who as sole and posthumous heir of his father John-Pendarves Basset (1714-1739) resulted in him inheriting considerable land holdings in Cornwall, including the historic Tehidy estate near Camborne. The Bassets in Cornwall could trace their heritage back to Norman times, but Francis' was part of the junior line of the family - the senior line having previously relocated to north Devon.

These events must have led to his father making a rapid reassessment of his life. Within five months he married Margaret St. Aubyn daughter of Sir John St. Aubyn, 3rd Baronet (c. 1702-c. 1744) and Catharine Morice. They moved straight away to Tehidy where construction of a new mansion had been commenced in 1734 and was apparently still ongoing. Their first child, Francis (the subject of this paper), was born in August of the following year. In all they had seven children, two sons and five daughters.

Before Francis had reached his teenage years both of his parents had passed. As sole heir to their considerable estates he was destined to become one of the major landowners in Cornwall and a man of considerable means. In the interim, while he was still in minority, he was sent to Harrow (1770-1771), Eton (1771-1774), and Kings College, Cambridge (1775) for his education.

In 1777 he left university early to undertake a Continental Grand Tour accompanied by his tutor, the Reverend William Sandys (Whetter 2014). In Italy his portrait was painted by Pompeo Batoni (Figure 4), but he never got to see the finished work. The portraits (there were two) were delayed, and then seized en-route by a French man-of-war in the western Mediterranean in January, 1779 (Whetter 2014). The paintings, along with other cargo were sold to Spanish traders and the portraits ended up being purchased by Spanish royals (Vickery 2012).

Figure 4. Francis Basset, 1st Baron of Dunstanville, by Pompeo Batoni, 1778. ©Museo Nacional del Prado. Image is considered to be in the public domain.

Fortuitous land holdings and shrewd investments furthered his wealth. His Tehidy estate (Figure 5) incorporated one of the most extensively mined parts of Britain and it was from these mines, Dolcoath and Cooks Kitchen in particular, that most of his income was generated. He was also a partner in the Cornish Bank of Truro and Chairman of the Cornish Metal Company.

Figure 5. 'Tehiddy-House, Cornwall. The seat of Francis Basset, Baron De Dunstanville' by John Thomas after Thomas Allom (Britton and Brayley 1831).

In 1817, a fall in the price of tin and copper led to his income dropping from between £16,000 to £18,000 per annum to just £8,000 per annum with speculation that at its peak he was earning as much as £24,000 per annum (Thorne 1986). This compares with average annual earnings in 1817 of £33.

He was created a Baronet on November 24, 1779 (Burke 1832) in recognition of his services in marching his miners from Cornwall to Plymouth to repair the marine defences after an unexpected attack by the combined fleets of Spain and France who had anchored in the English Channel.

Basset married first on May 16, 1780, at St Marylebone Parish Church in London, Frances Susanna (sometimes spelt Susannah) Coxe (1761-1823), daughter of John Hippisley-Coxe (1715-1769) and Mary Northleigh (c. 1720-1771) of Ston Easton Park, Somerset. Their only child, a daughter named Frances Basset, was born in 1781.

As an M.P. he served the Cornish pocket borough of Penryn from 1780-1796 alongside his cousin Sir John St. Aubyn, 5th Baronet (1758-1839). St. Aubyn was an obsessive collector of many things, particularly minerals, and Basset must have been aware of his interests.

In London, he bought Radnor House on the banks of the River Thames in Twickenham, in 1785, and this remained in his possession until 1793 (National Gallery of Art 2019; The Twickenham Museum 2019). He was advanced to the peerage, as Baron De Dunstanville, of Tehidy, on June 17, 1796 (Burke 1832) and a second title, dated October 30, 1797, conferred upon him the Barony of Basset, of Stratton, with remainder to his daughter.

His wife died on June 14, 1823, and within thirteen months, on July 13, 1824, he married Miss Harriet Lemon (1777-1864), 4th daughter of Sir William Lemon, 1st Baronet of Carclew, and his wife Jane Buller. Remarrying so quickly after his wife's death and at the age of nearly 67 understandably led to much gossip, notably an account by Creevey in 1824 (referred to in Whetter 2014: p. 57). Ultimately, it appears to have been a last desperate attempt at providing a male heir. This was not achieved thus ending that line of the Basset family.

In 1829, he was elected as a Fellow of the Royal Society. Six years later, on February 14, 1835, Lord De Dunstanville died at his mansion 'Stratheden House' at South Place, Knightsbridge (Whetter 2014). In common with many from the upper reaches of society his body was returned 'home' to his country residence. This involved much pomp and splendour and was much reported in issues of the 'Royal Cornwall Gazette and the West Briton'. Tangye (2002) suggested that it was probably the biggest funeral procession ever seen in Cornwall.

His body was taken at walking pace in a cavalcade of unusually large proportions the 226 miles to Tehidy (Urban 1835). The journey, as described by Tangye (2002), took twelve days. His coffin, made of mahogany covered with crimson velvet, studded with gilt nails and mouldings, with handles representing a Baron's coronet enclosed another made of lead. The hearse, plumed, and with pennons bearing the Basset Arms, was drawn by plumed horses covered with velvet cloths, and also bearing the arms in silver borders. Two mourning coaches, each drawn by six horses, followed two carriages bearing Lady Basset, his daughter, and Sir John St. Aubyn. The whole was led by two mules with several pages and outriders with black cloaks and headbands.

In his home county a monument - a 90-foot Celtic cross - was erected on Carn Brea hill overlooking his estates 'to perpetuate the memory of the most munificent benefactor ever known in Cornwall' (Urban 1835: p. 657). He invested heavily in his local communities and paid for much needed improvements to the infrastructure to support the local mines. He oversaw the development of the harbour at Basset's Cove,

which was renamed Portreath, and provided the financial backing for a horse-drawn tramroad from the major mining area at Poldice to Portreath. This created a more direct route for the shipment of copper ore to South Wales for smelting. In Camborne he paid for the construction of a market house which was established in 1802 (Lysons and Lysons 1814).

The full history of the Tehidy estate is ably described by Poole (2019). Lord De Dunstanville's estates passed to his daughter who inherited his second barony as 2nd Baroness Basset. She died unmarried resulting in the Tehidy estate passing to her cousin, John Francis Basset (1831-1869) who, in 1861, commenced a massive rebuilding operation - replacing the Palladian building (Figure 5) for one in a neo-classical style. Upon his death, it passed through his two brothers: firstly, and very briefly, to Arthur Basset (1833-1870), and then to Gustavus Lambert Basset (1834-1888). Gustavus funded many local amenities in Camborne and provided a bequest to establish a laboratory and mining school in Camborne. After him the estate fell into decline. His son, Arthur Francis Basset (1873-1950), oversaw the eventual sale of Tehidy in 1915 thus ending over 700 years of ownership by the Bassets.

Complications occurred during the sale and, in 1919, the house eventually became a sanatorium. Within a fortnight of opening disaster struck. An electrical fire rapidly tore through the grand building, leading to the collapse of the huge roof in the main building. Much of the original contents of the building had, fortunately, been auctioned during September 1917, but it is not known if any mineralogical lots were included.

By January 1922 the mansion had been partly rebuilt, but in a different style to that which John Francis Basset commissioned in the 1860s. It operated as a hospital until 1988 after which it was converted into luxury apartments.

Lord De Dunstanville's mineral specimens at BRLSI

The suite of mineral specimens at BRLSI attributed to Lord De Dunstanville numbers just sixteen. Ordinarily, such a small number might not warrant in-depth research, but the quality of these specimens more than justifies their interest. His original donation was recorded in the 1826 yearly report as '24 Cornish Mineral including the arsenate of iron & of lead and Native copper' (Anonymous 1827: p. 30).

Any connoisseur of British minerals would recognise the quality and significance of the remaining specimens and therefore it is remarkable that they have survived, apparently untouched, to this day. Several high-profile museum collections were targeted by knowledgeable mineral dealers during the 1960s, 70s and 80s, but BRLSI appears to have remained largely unscathed. The reason for this may perhaps lie in the rather limited access to the collection but whatever the reason, we should be grateful - if these few specimens had been seen by dealers they would almost certainly now be in private collections and their historical significance never known.

What happened to the eight missing specimens is not fully documented. Collection records suggest that the two extant olivenite specimens had duplicates with both documented as '2 specimens', '1 to spares' (BRLSI Collections Database 2018). The whereabouts of 'spares' is not known but even if potential specimens were found, without the original documentation or labels, it would be very difficult to know for certain that they related to the donation by Lord De Dunstanville. The current electronic collection catalogue records only the extant specimens and therefore the identity of any missing specimens is not known.

Old display plinths accompanying the extant specimens bear the name 'Lord De Dunstanville' handwritten above the mineral name (see for example Figure 1). This has undoubtedly helped in tracing the specimens donated by Lord De Dunstanville because only one specimen has an old label affixed to it and that label does not appear to have any direct association to Lord De Dunstanville.

In most cases no, or very basic locality information such as simply 'Cornwall' is recorded on the plinths. However, some of the minerals are so distinctive, and came from mines which operated at very specific periods in time, that their source can be asserted with a reasonable degree of confidence. In the case of the copper- and iron-arsenates, many were discovered for the first-time during Lord De Dunstanville's lifetime from just one small area of Cornwall and their quality has never been repeated. The precise locality information provided with all of the Lord De Dunstanville specimens from Lady Coxe Hippisley's collection in the Russell Collection at the NHM (Appendix 1) has allowed a much clearer picture of provenances to be developed.

BRLSI GM1833: liroconite, locality unrecorded (Figure 6).

The world's best examples of liroconite were found at two adjoining mines, Wheal Gorland and Wheal Muttrell, near the village of St. Day in Gwennap Parish (in 1835 St. Day was established as a separate

Figure 6. Liroconite. Plinth 8 cm wide.

parish). We know by its absence in Rashleigh (1797), that liroconite had not yet come into his possession - and he had a very wide network of contacts providing him with the very latest specimens from Cornwall. However, by the time of his second publication (Rashleigh 1802), he had received many specimens of liroconite which he had copiously illustrated. The finest examples were recorded by Rashleigh (1802) as from Huel [Wheal] Gorland with a number of others from Huel Providence. The frequency of mines in Cornwall bearing the name 'Providence' has caused much confusion, but on one of Rashleigh's labels he recorded 'Huel Gorland, Unity or Providence' suggesting, perhaps, that all three mines were in close proximity (Courtenay Smale *pers. comm*. 2017). Embrey and Symes (1987: p. 117) speculated (in relation to a specimen of olivenite in Rashleigh's collection) that one possibility for Huel Providence was a small copper mine near Carn Brea, also known as South Wheal Tincroft.

The work of de Bournon (1801) who recorded the discovery (a couple of years earlier) of some of the finest examples of these unusual copper arsenates at Huel Gorland - a new copper mine in the parish of Gwennap, Cornwall allows us to further fine-tune the discovery date to c. 1798. This explains why this species was not figured in Philip Rashleigh's first book (Rashleigh 1797).

The history of Wheal Gorland and Wheal Muttrall [*sic*] is documented by Hamilton Jenkin (1981). Wheal Muttrell was a little mine worked under a separate grant, but within the northern part of the Wheal Gorland set. A report published in 1799 (cited by Hamilton Jenkin 1981: p. 13) shows that a small quantity of copper ore was sold between 1795 and 1798. Wheal Gorland appears to have commenced a little earlier. In 1792, Robert Were Fox speculatively purchased a 1/32 part in the mine for £300 and prospects proved very good. Within three years it was decided to erect an engine and to sink the shaft to 60 fathoms before cutting the lode. However, at 100 fathoms depth the Gorland lode was 'still a great gozzan and not yet into ore. I confess' wrote William Jenkin to the Marquis of Buckingham's steward (Hamilton Jenkin 1981: p.11). The gossan was so extensive that it proved to be to the detriment of the mine. Hamilton Jenkin (1981: p.11) wrote of Wheal Gorland, '…the latter, although a treasure-house of rare and beautiful minerals, was a 'bunchy' mine - sometimes poor, at other times so rich that close watch had to be kept on the men to prevent their selling the most valuable ore as specimens to mineral dealers'. Ores were sold during the years 1792 to 1798, but overall a net loss resulted and it is likely that the gossan massively influenced this.

The first species described by De Bournon (1801: p. 6-7): 'Arseniate of Copper in the form of an obtuse octaedron' is the mineral we now call liroconite. The same species (including liroconite) occur exactly similar in the adjoining Muttrell Mine (de Bournon 1801).

Subsequently, liroconite has been found in a small number of other Cornish mines, but never quite of the same quality as specimens from Wheal Gorland and its neighbouring mines. Perhaps the nearest in quality any other mine got was Ting Tang, near the village of Carharrack, in Gwennap Parish. A richly crystallized specimen of a slightly darker blue colour on display at the Royal Cornwall Museum in Truro is labelled as from 'Ting Tang Mine, Gwennap'. Unfortunately, the accompanying label provides a confusing picture: 'Thomas Hogg [referring to Hogg 1825] noted that beautiful specimens of copper arseniate were coming from this mine as he wrote, in April 1825'. Hogg (1825: p. 36-7) actually wrote: 'At the time of writing, (April, 1825) beautiful specimens of arseniate of copper, of a milk-white colour, plumose, acicular, and radiated, are found in Tingtang Mine.' Hogg was most likely describing varieties of olivenite and certainly not liroconite. Crystals of liroconite have, however, been collected in recent times from one of the old mine dumps at Ting Tang Mine as described by Bruce and Aubrey-Jones (1998).

Remarkably, well-crystallized liroconite has never been confirmed outside of Cornwall. The richness, quality, and colour of the crystals on this specimen allows us to say with some certainly that this speci-

men was derived from Wheal Gorland or the neighbouring mines of Wheal Muttrell or Wheal Unity. Two specimens of liroconite given by Lord De Dunstanville to Lady Elizabeth Anne Coxe Hippisley (Appendix 1) are recorded (on the associated label) as coming from 'Wheal Gorland, Gwennap, Cornwall'. Russell obtained this information from a handwritten label affixed to one of the specimens (BM 1964,R8898). The label (reproduced here as Figure 7) specifically names Lord De Dunstanville (as 'Ld D -') and Russell's own label (Figure 8) provides a speculative date of 'circa 1810'.

Figure 7. A very early handwritten label affixed to Russell Collection specimen BM 1964,R8898. Note the initials for Lord De Dunstanville, the terminology used which matches exactly De Bournon's published name for liroconite (de Bournon 1801), and the locality 'Huil Gorland'. Photo by Roy Starkey courtesy of the NHM, London.

Figure 8. Sir Arthur Russell's handwritten label accompanying specimen BM 1964,R8898. Photo by Roy Starkey courtesy of the NHM, London.

BRLSI GM1835: pharmacosiderite, Cornwall (Figure 9)

Pharmacosiderite was one of the first secondary arsenate minerals to be discovered in Cornwall but was mistakenly taken to be a copper arsenate because of its green coloured crystals (Klaproth 1787). The original investigations made by Klaproth involved specimens provided by his good friend John Hawkins which were from Carrarach (Carharrack) where microcrystals of several unknown green substances

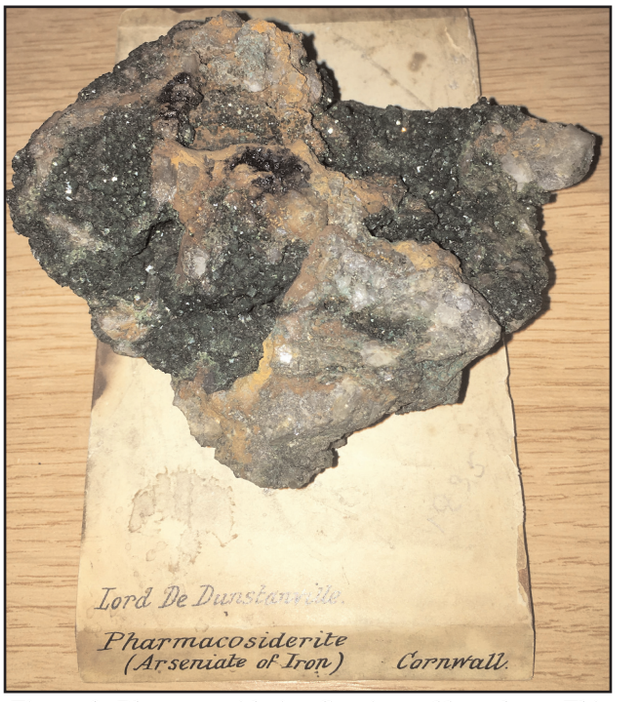

Figure 9. Pharmacosiderite. Specimen 11 cm long. This fine display specimen is labelled as from Cornwall, but there is little doubting the exact source - the vein system worked in the adjoining Wheal Muttrell and Wheal Gorland mines.

(including olivenite) had been discovered. However, much larger richly crystallized specimens of pharmacosiderite were discovered at about the same time as liroconite (c. 1798) in Muttrell Mine adjacent to and working the same vein system as Wheal Gorland. The discovery was described in detail by de Bournon (1801: p. 22) under the name 'Simple arseniate of Iron'. Subsequently, Phillips provided the most detailed account of the occurrence of this mineral at Huel Gorland:

> …[the] beautiful mineral, the cubic arseniate of iron, was also found at and near the junction of the Great Gossan and Muttrell Lodes; but occurred in greatest quantity in the latter, thirty fathoms west of the junction, about the adit level; being forty-six fathoms higher, though perhaps not immediately above the part in which the first discovery of the red oxyd [cuprite] took place. The cubic arseniate was also found in the Gossan before described (Phillips 1811: p. 27).

Pharmacosiderite of the size and quality described by de Bournon (1801) and Phillips (1811) was never again found in Cornwall. For that reason, Lord De Dunstanville's specimen must surely be derived from that discovery. Russell (1952: p. 106), however, alluded to a magnificent specimen of pharmacosiderite attributed to Tincroft Mine in Philip Rashleigh's collection and dating to c. 1792. Remarkably, this specimen was not featured in Rashleigh's first book (Rashleigh 1797).

Rashleigh's 'Tin Croft' specimens have caused considerable problems for researchers interested in the history of mineral collecting in Cornwall. Russell (1952) concluded that Rashleigh's 'Tin Croft' specimens 'almost certainly came from Wheal Gorland, Gwennap', but that might not be the end of the story. Rashleigh's MS catalogue (Rashleigh [no date]) contains multiple corrections associated with 'Tin Croft' specimens, suggesting that Rashleigh himself had doubts regarding their provenance (Courtenay Smale pers. comm. March 2019). It should perhaps be remembered that the source of mineral specimens was either directly from miners, or through mineral dealers, both of whom were keen to protect their source from others eager to profit from new discoveries. Consequently, false locality information was often provided (Cooper 2006; Cleevely 2011). This was not just a Cornish problem but occurred wherever fine minerals were to be found and still occurs today.

In 1792, when he first acquired them, Rashleigh was convinced that a range of new, green coloured, copper-based minerals were from Tin Croft (Hawkins 1792b - reproduced below under chalcophyllite). In a previous letter to Hawkins (Rashleigh 1792) describing one of the new substances (now identified as chalcophyllite) Rashleigh stated that the first specimen he saw was at Pendarves [presumed to be the collection of John Stackhouse (1741-1819) at Pendarves House south of Camborne]. How Rashleigh came to acquire his 'Tin Croft' specimens is not known, because John Stackhouse is not recorded in his list of donors at the front of his MS catalogue. During 1792, Rashleigh sent samples to his good friend John Hawkins in London who dispersed them across Europe.

Later, despite the discovery of fabulous pharmacosiderite at Wheal Gorland, mineral dealers were still apparently marketing new discoveries from Tincroft Mine. In August 1800, Joseph Tregoning of Truro - regarded as one of the most important Cornish mineral dealers of all time (Cooper 2006) - wrote to John Hawkins (Russell MS) that he had, 'some new crystals of "green iron" [pharmacosiderite] from Tincroft mine at Illogan.'

Lord De Dunstanville provided three specimens of pharmacosiderite to Lady Elizabeth Anne Coxe Hippisley all of which are labelled in Sir Arthur Russell's collection as from Wheal Gorland, Gwennap, Cornwall (see Appendix 1).

BRLSI specimen nos. GM1938 and GM1939: olivenite, both Cornwall (Figs. 10 and 11).

Figure 10. Olivenite. Specimen 6 cm long.

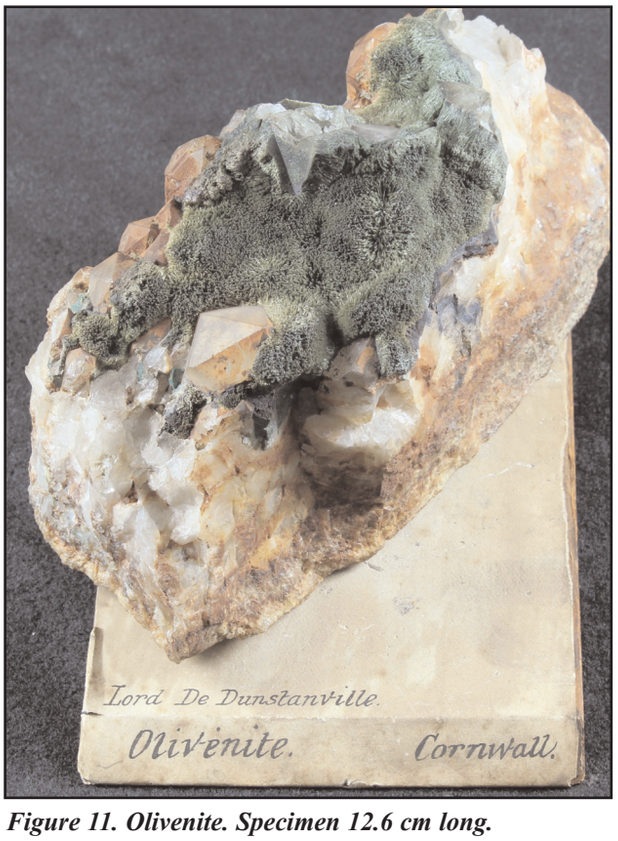

Figure 11. Olivenite. Specimen 12.6 cm long.

BRLSI GM1938 and GM1939 are extremely fine examples of crystallized olivenite and are remarkably undamaged considering the fragility of the acicular crystals. Both specimens are recorded as from

Cornwall and both can confidently be attributed to either Gwennap Parish (in particular the neighbouring mines of Wheal Gorland and Wheal Unity) or to Philip Rashleigh's mysterious 'Tin Croft' from whence he had several fine crystallized olivenite specimens.

The Russell collection at the NHM contains seven specimens of olivenite from Lady Elizabeth Anne Coxe Hippisley's collection documented as having been provided by Lord De Dunstanville. Five of them are noted as from Wheal Gorland and two from Wheal Unity (see Appendix 1). One of the Wheal Gorland specimens (BM 1964,R8300) bears an old handwritten label affixed to the underside identical in appearance to the one described above under liroconite and using mineralogical terminology like that published by de Bournon (1801). The label reads: 'Arseniate of Copper Crys^{d}. in elongated Octahedrons - Huil Gorland. - LD 1810'.

A privately owned specimen, recorded as having been given in 1810 to Lady Elizabeth Anne Coxe Hippisley by Lord De Dunstanville is labelled (by Sir Arthur Russell) as olivenite from Wheal Gorland, Gwennap, Cornwall (Figure 3). Another, preserved in the Tricottet Collection in Switzerland, is recorded by an accompanying Russell label as olivenite from Wheal Gorland, Gwennap, Cornwall (see Figure 4 in Mignan 2018). Wheal Unity was, at around the same point in time, producing large quantities of olivenite specimens from an extension of the same vein system, therefore either of these mines are likely sources.

BRLSI GM1020: copper, Cornwall (Figure 12)

Native copper was extremely common in the upper (near surface) sections of many of the copper mines in Cornwall therefore provenancing unlabelled specimens to individual mines is difficult and not normally recommended. However, the preponderance of specimens from Wheal Gorland - well-known as the source of some of the finest specimens of native copper in Cornwall - in the suite of minerals provided by Lord De Dunstanville to Lady Coxe Hippisley (Appendix 1) puts that mine forward as a strong candidate.

BRLSI GM1025 copper, Cornwall (Figure 13)

BRLSI GM1025 is an unusual specimen due to the presence of aggregates of cuprite (copper oxide) crystals in association with feathery, or dendritic, sprays of crystallized native copper. Again, putting a locality to an unprovenanced specimen when native copper was so widespread throughout Cornwall at that time would normally be frowned upon. However, the dominance of Wheal Gorland specimens within the suite of Lady Coxe Hippisley specimens preserved in the Russell Collection at the NHM makes it a very likely source.

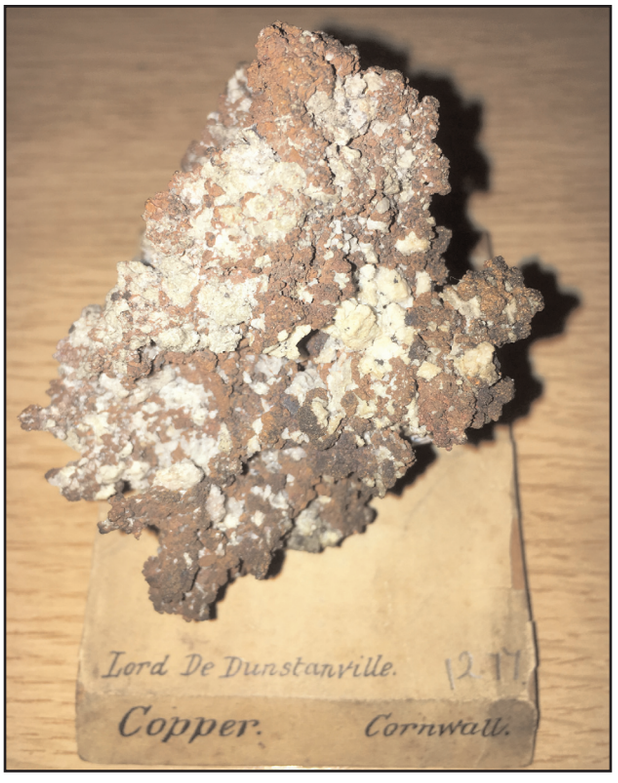

Figure 12. Native copper. Specimen 7 cm across. A dense aggregate of hackly native copper intergrown with milky quartz.

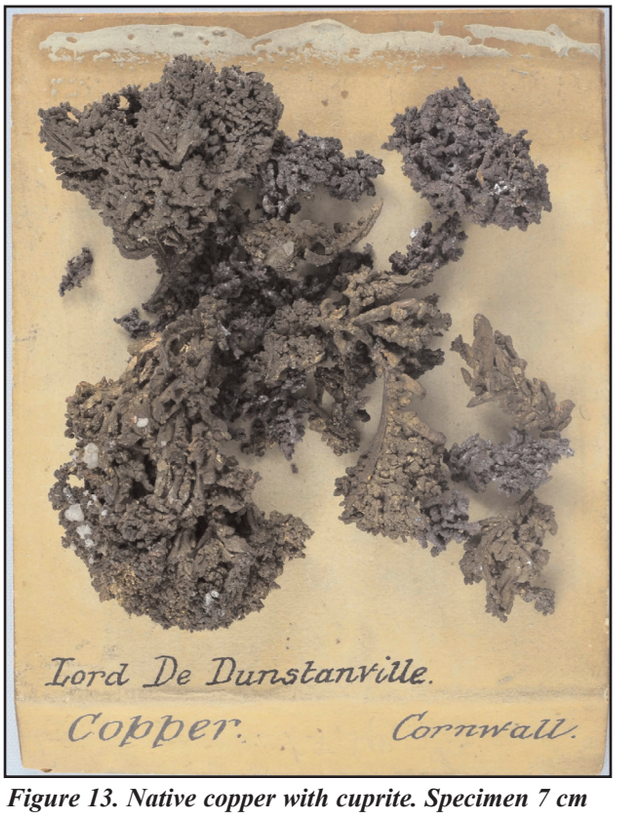

Figure 13. Native copper with cuprite. Specimen 7 cm in length.

BRLSI GM0984: cuprite with native copper, Cornwall (Figure 14)

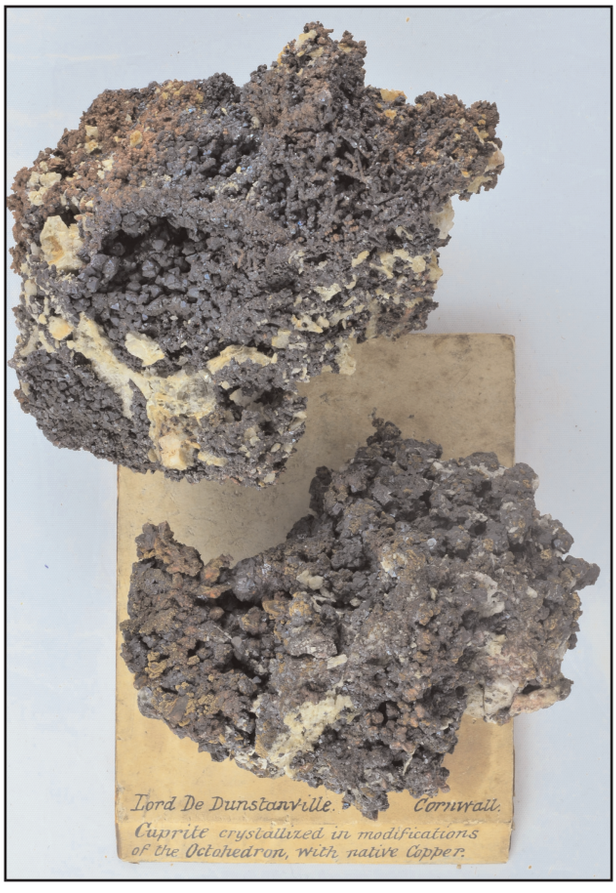

Figure 14. Cuprite on native copper. Specimens 10 cm (left) and 11 cm (right) across.

Two fine display-quality specimens are registered under one accession number (BRLSI GM0984). Both specimens consist of euhedral dark purple-red cuprite crystals aggregated together with milky quartz and hackly native copper. Cuprite was well-known in the Cornish mines from the mid- to late-18th century, but well-crystallized specimens were rare. Philip Rashleigh possessed some crystallized specimens from Gwennap Parish and from Huel Prosper, near Gwinear (Rashleigh 1797), but the first large-scale discovery of coarsely crystallized cuprite was made in Wheal Gorland and was documented by Phillips (1811).

Six specimens of cuprite from 'Wheal Gorland, Gwennap, Cornwall' given by Lord De Dunstanville to Lady Elizabeth Anne Coxe Hippisley are present within the Russell Collection at the NHM (see Appendix 1). On this basis it is highly likely that the BRLSI specimens were obtained from the same mine and several of the Lady Coxe Hippisley specimens (see under liroconite and olivenite) have dates of 1810, or 1811, associated with them which broadly fits with Phillips' (1811) account.

BRLSI GM0985: cuprite, Cornwall (Figure 15)

Figure 15. Cuprite. Specimen 10.2 cm long.

BRLSI GM0985 is another example of two specimens recorded under one accession number. The larger of the two specimens is a dense, solid aggregate of cuprite crystals. The dark purple colour of cuprite is often attributed to a reaction to sunlight causing ruby-red crystals to darken to an almost black colour. It is interesting that these specimens at BRLSI have very infrequently seen the light of day. This would suggest that these cuprite specimens have always been darker in colour. The quality and richness of these specimens is excellent, and would fit with the theme of many of the other specimens appearing to be from Gwennap Parish. During the first half of the 19th century a rapid expansion in the number of copper mines in Cornwall resulted in a profusion of new occurrences of crystallized cuprite, but a study of the localities represented by samples formerly in the Lady Coxe Hippisley Collection (Appendix 1) strongly suggests that Wheal Gorland was the source.

BRLSI GM0997: cuprite, Cornwall (Figure 16)

The very grey colour of the crystals making up this dense aggregate makes for the appearance of tennantite - copper arsenic sulphide - rather than cuprite. However, closer inspection under a microscope reveals that the crystals are cubic and are a very dark purple colour thus indicating cuprite. This is a well-crystallized specimen, but the authors are not aware of other occurrences of this distinctive form of cuprite in order to provide a potential provenance. However, as with the previous two specimens, evi-

Figure 16. Cuprite. Specimen 11.5 cm long.

dence from Lady Coxe Hippisley specimens in the Russell Collection at the NHM (Appendix 1) indicates Wheal Gorland as the potential source.

BRLSI GM1604: cassiterite on quartz, Cornwall (Figure 17)

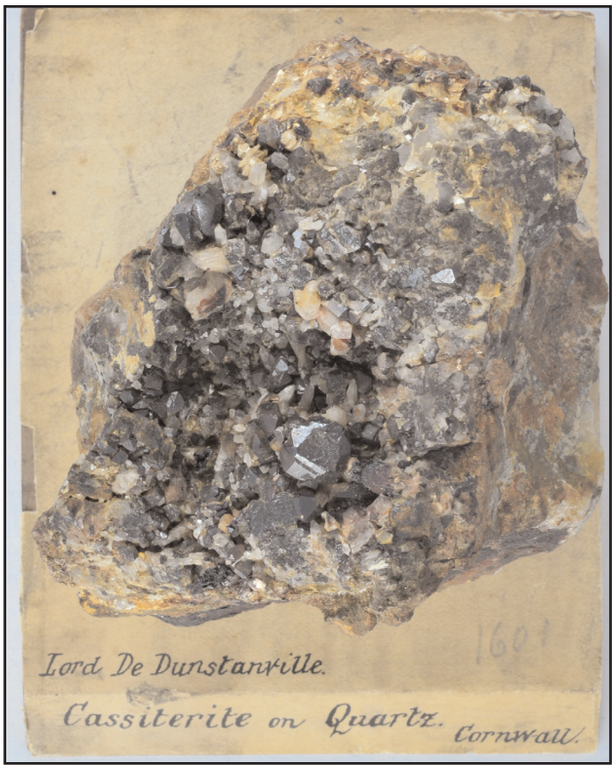

Figure 17. Cassiterite. Specimen 9 cm long.

BRLSI GM1604 comprises small crystals of cassiterite with poorly-formed quartz crystals in a cavity in veinstone cutting killas from 'Cornwall'. There is nothing unique about the appearance of this specimen and therefore it is impossible to attribute it to any one specific mine. The quality of the cassiterite crystals is unremarkable. This is particularly apparent when compared with the superb cassiterite crystals within Philip Rashleigh's collection.

A single specimen of cassiterite is present within the suite of Cornish minerals given by Lord De Dunstanville to Lady Elizabeth Anne Coxe Hippisley preserved in the Russell collection in the NHM, London (see Appendix 1). That specimen is recorded by Russell as coming from Seal Hole mine, St. Agnes, Cornwall.

BRLSI GM1326: pyromorphite, Cornwall (Figure 18)

Figure 18. Pyromorphite. Specimen 5 cm across.

Incidences of richly crystallized solid aggregates of pyromorphite in Cornwall are rare. Indeed, there is only one such occurrence - Wheal Alfred, Gwinear (Embrey and Symes 1987). This specimen, BRLSI GM1326, has all the hallmarks of others from that mine - the colour is correct, it has an intense waxy lustre and the crystals form short, stout, prisms.

Pyromorphite (or mimetite was it was sometimes recorded) was first discovered in a cross lode at Wheal Alfred in late 1824 (Cooper 2006: p.268). In 1826, the mining engineer and well-known collector of minerals, John Taylor - who owned the mine from 1823 to 1826 - provided the famous Scottish collector Thomas Allan with a specimen from the mine

(Embrey and Symes 1987: p. 119). If it was Taylor who supplied the specimen to Francis Basset then this must have taken place in the 1820s shortly before the suite of minerals were gifted to the BRLSI. This would explain why there are no specimens of pyromorphite amongst the suite of specimens he provided to Lady Elizabeth Anne Coxe Hippisley as they appear to have been given to her in around 1810.

BRLSI GM0686: azurite with malachite and bornite, Cornwall (Figure 19).

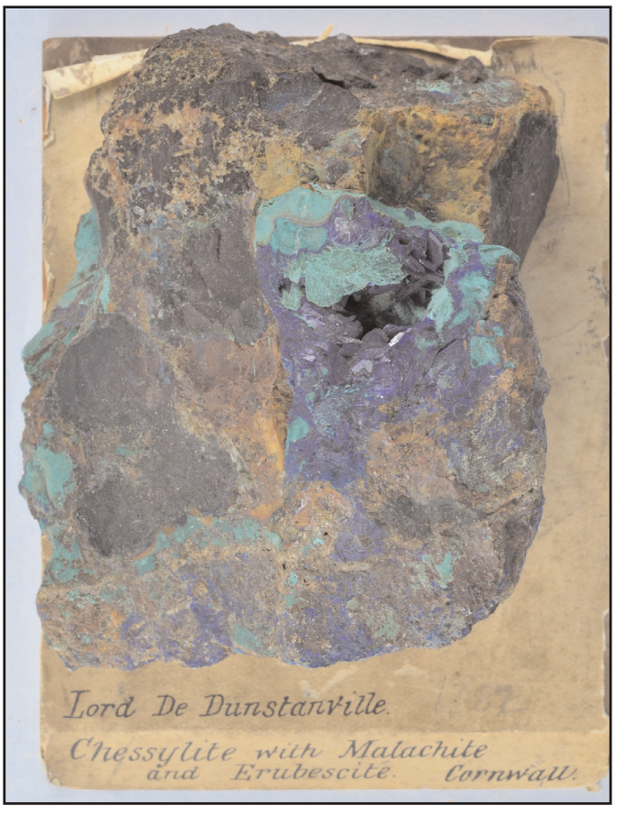

Figure 19. Azurite, malachite and bornite. Specimen 9 cm long.

Remarkably, well-crystallized specimens of azurite are uncommon in Cornwall. BRLSI GM0686 is an excellent example because it also displays the massive copper-iron sulphide, bornite, from which the secondary copper carbonates (azurite and malachite) have altered. The original display plinth records the early names for azurite (Chessylite) and bornite (Erubescite).

Lord De Dunstanville provided Lady Elizabeth Anne Coxe Hippisley with two specimens of azurite both of which are documented in the Russell collection in the NHM, London as from Wheal Gorland, Gwennap, Cornwall (see Appendix 1).

BRLSI GM1976: siderite from Crinnis Mine, Cornwall (Figure 20)

BRLSI GM1979 is the only specimen from the set that has a specific locality attributed to it and the only one which has an old number label attached (Figure 21), but no display plinth. It is unlikely that the number relates to Lord De Dunstanville, but whose system of numbering it is, is not known.

Crinnis Mine, near St. Austell, was owned by Charles Rashleigh (1747-1825), younger brother to Philip Rashleigh the famous mineral collector. The nearby settlement of Charlestown was named after him and he invested heavily in the local mines.

Out of all of the Lord De Dunstanville specimens preserved at the BRLSI this one seems atypical: it has no original plinth; the mine is located much further from Lord De Dunstanville's Tehidy estate than any of the others; and it bears an old number label.

Figure 20. Siderite. Specimen 6.5 cm long.

BRLSI GM0668: chalcophyllite, Cornwall (Figure 22)

Two specimens are registered under BRLSI GM0668. Both specimens are listed in the in the museum catalogue as from Col. Page and Lord De Dunstanville (BRLSI Collections Database 2018), but the single large display plinth is separated with the upper half labelled as Lord De Dunstanville and the lower half Col. Page followed by 'Chalcophyllite with Chrysocolla Cornwall'.

'Col. Page' was Col. Frederick Page, Esq. F.G.S. (1769-1834). He owned the Kennet Navigation and sold it to the Kennet and Avon Canal company for £100,000 (£70,000 in cash with £30,000 paid back gradually) in 1813 (Day 2019). In 1827, he donated

Figure 21. The reverse of siderite specimen GM1976 showing an old handwritten number label affixed to the reverse of the specimen alongside the modern museum number label.

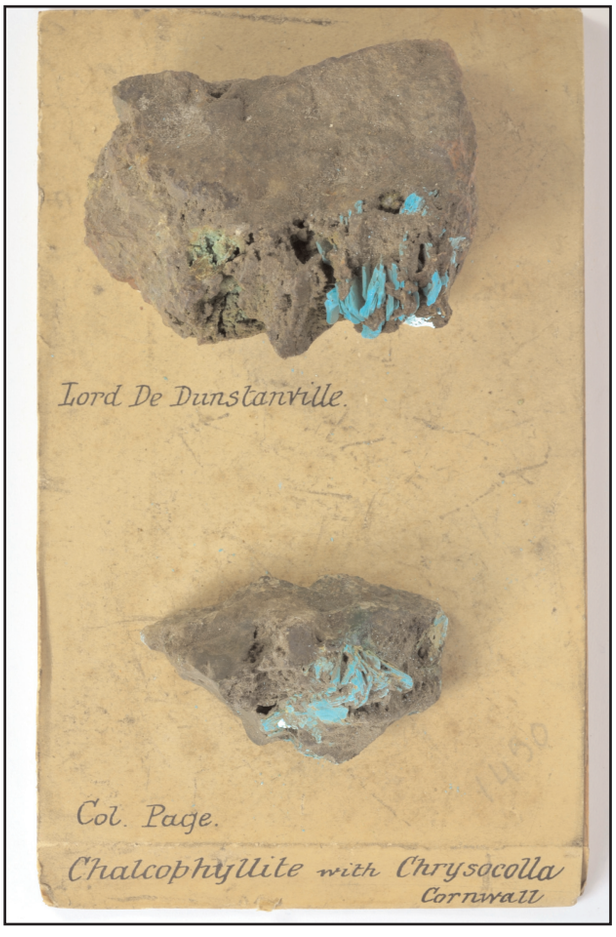

Figure 22. Chalcophyllite. Upper specimen 6 cm across.

67 principally Cornish mineral specimens to the newly founded BRLSI, so, at a similar time to Lord De Dunstanville's donation. Col. Page's minerals are of a high quality.

Chalcophyllite is another of the suite of unusual copper arsenate minerals found in the Gwennap Parish mines in Cornwall, representing his second species 'Arseniate of Copper in hexaedral laminae, with inclined sides' (De Bournon 1801: p. 8), but was later found in a number of other mines across the county including Marke Valley (Cotterell 2016) and Huel Tamar (Collins 1892). The occurrence at Huel Tamar was discovered a few years prior to Lord De Dunstanville's donation: Phillips (1823: p.317-318) reported that 'Copper mica' [chalcophyllite] was found 'also in Huel Tamar and in Gunnis Lake mines on the banks of the Tamar'.

In addition to this, uncertainty exists over the provenance of some specimens of chalcophyllite in Philip Rashleigh's collection. In 1797, Rashleigh figured a specimen (Figure 2, Plate IX) of, 'green copper ore, with hexangular semi-transparent plates of copper ore minerallized by the marine acid, in a stone of copper ore intermixed with white mundic and quartz' from Tincroft. Despite his error in describing its chemistry this is undoubtedly chalcophyllite.

His figured specimen (Philip Rashleigh collection no. 633) is extant and preserved in the Russell collection at the Natural History Museum, London (BM 1964,R8988). Russell's handwritten label reproduces information from Rashleigh's MS catalogue (Rashleigh [no date]) which states 'transparent bright green Hexagonal Micaceous Copper Ore with Malachites & Rich Copper Ore intermixed with Mundick from Tincroft' and 'very rare and discovered 1792'. Russell, however, questioned the provenance. Noting, 'though stated to be from Tincroft this specimen is almost certainly from Wheal Gorland'.

A hitherto unreported letter (Hawkins 1792b) sent by John Hawkins to Philip Rashleigh on August 13, 1792, makes it clear that they believed Tin Croft to be the source:

> The box with the Green Copper ore arrived safe and proved very interesting. The large peice [sic] of the Green plated Copper ore [chalcophyllite] as well as the large peice [*sic*] of the dark olive ore [olivenite] from Tin Croft being much superior to what I before possessed I have kept for my own cabinet, the rest compleat [*sic*] the series for Miss Raab which I will now forward without delay. [Sending some to Miss Raab, others to Madam Sonnenfils] … another female collector at

> Vienna, and a few larger to Count Warbna… [samples for Klaproth to Berlin] … a series of Cornish specimens I design for the Academical Cabinet at Freyberg in order to have their descriptions drawn up by Werner (Hawkins 1792b).

Whether Rashleigh had been provided with false information when he acquired the specimen is not known, nor is the supplier of his specimen. It was not uncommon for mineral dealers to falsify provenance details in order to protect their supply (Cooper 2006), but the date - 1792 - appears slightly too early for it to have come from Wheal Gorland. In an earlier letter to Hawkins, Rashleigh alluded to having first seen this substance at Pendarves (assumed to be in John Stackhouse's collection at Pendarves House):

> Green Crystallized Transparent Copper Ore…This Ore does not appear Solid, but is crystallized in thin Plates in the Hollow parts of the Stone...The chief Body of Ore in which these Crysals [*sic*] are found is a solid Red Substance intermix'd with Mundick [pyrite] or some other Mineral substance of the like Appearance. The Red ore is not the Common Red Copper Ore, it is not so Rich by half: & I should suppose contains much more Iron (Rashleigh 1792).

On July 10, 1792, Hawkins reported to Rashleigh (Hawkins 1792a) that he had traced his own, inferior, specimens of the 'the curious green plated Copper ore' from sources in London - 'Mr Turner in the New Turnstile' and 'the Jew in Meads Court' - indicating that it was not an isolated occurrence. Clearly, accurately provenancing Lord De Dunstanville's specimen with any degree of certainty is difficult, but given the notable size of the crystals it is likely that it came from one of the mines in Gwennap Parish, or, from the mysterious Tincroft Mine.

Interestingly, two specimens of chalcophyllite given by Lord De Dunstanville to Lady Elizabeth Anne Coxe Hippisley are preserved in the Russell collection in the NHM (see Appendix 1). Both are recorded on Russell's labels as from Wheal Gorland, Gwennap, Cornwall. On the basis that all of the other copper arsenate specimens attributed to Lord De Dunstanville in the Russell Collection are recorded as from Wheal Gorland, or Wheal Unity, these are the most likely candidates.

Discussion

The quality of the specimens donated by Lord De Dunstanville to the BRLSI is noteworthy, in particular because so little is known of his mineralogical dealings. Indeed, Whetter (2014) made no mention of any mineralogical collection in respect to either Lord De Dunstanville, or his house at Tehidy.

The only published records (Russell 1952; Wilson 1994) of his mineralogical interests relate to his name 'Sr:F:B - Sir Fr: Basset' inserted in the frontispiece of Philip Rashleigh's unpublished MS Catalogue of Minerals (Rashleigh [no date]). Rashleigh used the list as a key to the donors of specimens recorded within. Cleevely (2000), who reproduced the list, noted that the order of names reflects the sequence and history of his collection. Basset's name falls between those of Mr: Pennant (Thomas Pennant) and John Hawkins Esqr., thus, indicating that his contact with him was probably between 1786 and 1789. However, searches within Rashleigh's catalogue for individual specimens attributable to Francis Basset have proved fruitless (Courtenay Smale pers. comm. March 2019). An account of the life of Francis Basset by Whetter (2014) notes his interest in the arts and antiquities, but fails to mention any interest in mineralogy, or mineral collecting. So it appeared that the specimens in the BRLSI represented the only direct evidence of mineralogical material having passed through the hands of Francis Basset, Lord De Dunstanville. So many questions remained unanswered including, 'did he actually possess a collection himself?'; 'why did he donate the specimens to the BRLSI?' First and foremost it was felt that this, albeit small collection of minerals, should be documented and highlighted to the mineralogical world and, secondly, it was hoped that perhaps it would provide some clues to the mystery surrounding this famous Cornishman.

During our research it was brought to our attention that a second, slightly larger suite of minerals attributed to Lord De Dunstanville is preserved in the Russell collection in the NHM. During his lifetime Sir Arthur Russell assembled the finest collection of British minerals in existence. His skill was not only in field collecting, but in painstakingly researching the whereabouts of historic collections which he acquired through a variety of sources.

Of Russell's Lord De Dunstanville specimens, 36 have been identified and all but one formed part of Lady Elizabeth Anne Coxe Hippisley's collection which he acquired in 1940. The other specimen was part of the famous Williams family collection in Cornwall (see Smale 2011 for more details of the Williams' collection).

During the lifetime of Lord De Dunstanville, Cornwall was a place of remarkable mineralogical discoveries and, as a major landowner, he was perfectly placed to take full advantage of the opportunities presented. Initially though, there appeared to be

no documentation to prove the existence of him owning a substantive mineral collection. However, evidence is growing in support of him having had at least a small collection.

During the early 19th century the newly founded science of mineralogy was blossoming and collections of stature in Cornwall were actively being developed and were remarked upon by travellers. The main collections of note during that period were described by Paris (1816: p. 130-133) in his 'A guide to the Mount's Bay, and the Land's End': '…before the stranger attempts to purchase any mineral he ought to inspect the several splendid cabinets in the County, these are in the possession of Wm. Rashleigh Esq. M.P. of *Menabilly*, John Williams Esq. *Scorrier House*, Joseph Carne Esq. *Riviere*…' It should of course be noted that at the time of Paris' guide Philip Rashleigh's (1729-1811) famous collection and estate at Menabilly had passed to his nephew William Rashleigh (1777-1855) who continued to develop the collection (Russell 1952). Francis Basset, or Lord De Dunstanville, was not mentioned, nor was he included in Jameson's (1829) 'List of Geological and Mineralogical Collections in Great Britain and Ireland'.

It is notable that the significant mineral collection owned by Lord De Dunstanville's cousin, Sir John St. Aubyn, 5th Baronet (1758-1839), was also usually absent from the traveller's guides. This was, in part, because St. Aubyn's extensive collection was for many years housed in London where he employed the expert mineralogist, and refugee of the French Revolution, Comte Jacques Louis de Bournon (1751-1825) to curate and catalogue it. He reportedly removed his collection to his Cornish estate at Clowance in around 1806 before de Bournon had completed cataloguing it - '…Sr. John has removed his Collection from London' (Rashleigh 1806).

Rashleigh, who did not correspond with St. Aubyn, considered his own collection to be more complete. In the same letter to James Sowerby he wrote, 'Count de Bournon would find in my Cabinet many varieties to those he has seen at Mr. Greville's & Sr. Jo. St. Aubyn's…'. Rashleigh was certainly correct in his assessment. St. Aubyn's extant collection and catalogue indicate that he added little to it during the 19th century. Consequently, it is very much a late 18th century collection consisting predominately of his well-known acquisitions. These included the purchase of the collection of Dr William Babington (1756-1833) in 1799 for £3,000 (Currey 1975) and the fossil and mineral collection of Richard Greene (1716-1793) of Lichfield purchased for £100 in the same year (Torrens 1974; Currey 1975).

Babington's collection comprised even earlier material, purchased by him from the Earl of Bute (1713-1792) by whom he had been employed to curate Bute's colossal collection which was housed at Luton Hoo House, Bedfordshire (Redwood 2018). Babington used his own collection as the basis of his 'A New System of Mineralogy, in the form of catalogue, after the manner of Baron Born's Systematic Catalogue of the collection of fossils of Mlle Éléonore de Raab' (Babington 1799) which he dedicated to St. Aubyn.

Careful inspection of Babington's catalogue (Babington 1799) reveals that he had not kept pace with the rapidity of new mineral discoveries in Cornwall. This is particularly apparent when one studies his section under 'Arseniate of Copper' (p. 179-180) where he stated, 'This ore has hitherto been found principally at *Carrarach in Cornwall*…'. Under his singular variety 'crystallized' his descriptions of his six specimens clearly pertain to olivenite ('LXXII. a 1. In small lengthened tetrahedral prisms of a dark olive green colour…'), chalcophyllite ('LXXVI. c 1. In delicate transparent hexagonal tables, of a bright emerald green colour…') and what we now know to be an arsenate of iron - pharmacosiderite ('LXXV. b 1. In small cubes of an emerald green colour, numerously aggregated on brown feldspar'). By the same point in time Philip Rashleigh and John Hawkins had been discussing discoveries of the same three species at Tin Croft Mine for seven years, Rashleigh had published coloured figures of some of his specimens (Rashleigh 1797) and Wheal Gorland was just starting to produce what would become the world's finest examples of liroconite and clinoclase.

It is therefore no surprise that in St. Aubyn's collection (see Plymouth Museums Galleries Archives 2019) there is an absence of the high quality brightly coloured copper arsenates and copper oxide specimens from the mines in Gwennap Parish, Cornwall, that are so prominent within the Williams and Rashleigh collections. It is exactly these sorts of specimens that form the basis of the discrete set of minerals donated by Lord De Dunstanville to the BRLSI and those he provided to his sister-in-law, Lady Elizabeth Anne Coxe Hippisley (see Appendix 1). This indicates that he had better access to new mineralogical discoveries than his cousin, particularly around the early years of the 19th century.

To the east of Lord De Dunstanville's Tehidy estate was Scorrier House, home of the famous mineral collecting Williams family (see Smale 2011 for a detailed description of the Williams family collection). According to a label associated with a speci-

men in the Russell Collection at the NHM, London, Lord De Dunstanville provided a specimen of silver from Wheal Duchy, Calstock, Cornwall to John Williams (probably John Williams jnr., 1777-1849) of Scorrier House in November, 1811 (Appendix 1).

South of Tehidy was the Pendarves estate of John Stackhouse (1741-1819), and latterly his son Edward William Wynne Pendarves (1778-1853), who, like their predecessor at Pendarves - Grace Percival (1696-1763) - had an interest in minerals (Embrey and Symes 1987). St. Aubyn's, Clowance estate was just a little further south and a few miles to the west, in Hayle, the fabulous mineral collection of the businessman Joseph Carne was to be found at Riviere House.

Outsiders too, had interests in the mineralogical produce of Cornwall. Another contemporary collector who possessed a large number of Cornish mineral specimens was Matthew Boulton (1728-1809) of Soho House, Birmingham (see Starkey 2011, for details of Boulton's collection). Despite being based in the Midlands, Boulton assembled sizable suites of specimens from mines with which he had a business interest. In Cornwall that included Wheal Virgin and Carharrack Mine, and in Staffordshire he assembled a superb suite of minerals from Ecton Mine. He was a prominent member of the well-known Midlands-based group, the Lunar Society, along with such luminaries as Erasmus Darwin, William Withering and Joseph Priestley (Uglow 2002). His base in Cornwall was Cusgarne House, situated conveniently near to the copper mines in Gwennap Parish. Lord De Dunstanville is known to have taken a dislike to Boulton and his business partner, James Watt (1736-1819) - or at least to their business interests - as he was noted as wanting a Cornishman to have a contract for steam engines at Cornish mines (Rhodes 2018).

Lord De Dunstanville's albeit limited Cornish mineral specimens are of a much higher standard of quality when compared with Boulton's, whose collection is preserved at the Lapworth Museum, University of Birmingham. Like St. Aubyn, Boulton had stopped adding to his collection by the turn of the century and, in 1800, James Watt sold Cusgarne House indicating that their interest in Cornwall was waning.

That Francis Basset showed an interest in the study, and preservation, of scientific and archaeological objects in Cornwall is well-known. On September 25, 1792, he was one of seven gentlemen who met in Truro to discuss a proposal to form a County Library, Museum and Literary Society in Truro (Crook 1990: p. 13). Their intention was to bring to Cornwall an establishment similar to those of Manchester (Manchester Literary and Philosophical Society) and Birmingham (Lunar Society). Two of his colleagues were Sir William Lemon (who later became his father-in-law through his second marriage) and his distant cousin Sir Christopher Hawkins (with whom he fought a notorious duel in 1810).

Despite raising a considerable amount in subscriptions from invited selected individuals, the institution served only as a library. Of the initial 27 subscribers 10 went on the have an involvement in the Royal Geological Society of Cornwall founded, in 1814, in Penzance. It was the first of its kind in Cornwall. By that time literary and philosophical societies had already been established in the South West of England in Plymouth (1812) and Exeter (1813), but both cities had much larger populations. In 1818 the Royal Institution of Cornwall (RIC) was founded in Truro. Of the seven who attended the 1792 meeting none went on to be involved with the RIC and it appears that politics was very much at play.

Lord De Dunstanville, did not attend the first meeting of the Cornwall Geological Society (CGS), but minutes from that meeting show that he was chosen as Patron. Shortly after, on October 15, 1814, the society changed its name to the Royal Geological Society of Cornwall (RGSC) to acknowledge the Prince Regent agreeing to be Patron. He had been approached by Lord Yarmouth, the Lord Warden of the Stannaries, on behalf of the members at the instigation of Lord De Dunstanville (Crook 1990: p. 37). Lord de Dunstanville became a Vice-Patron and donated £90 to the society.

Despite clearly having an interest in the society, the only mineral specimens he donated were 'Specimens of Wavellite' given at some time between 1822 and 1828 and recorded in the society Transactions (1828) under 'The Right Hon. Lord de Dunstanville, &c. Vice Patron'. Crook (1990: p. 75) likened his position as more symbolic, stating that 'Lord De Dunstanville, a Vice-Patron, and Davies Gilbert, the President, can be most accurately described as acquiescent spectators of the proceedings.'

How Lord De Dunstanville came to obtain specimens of wavellite is not known and the specimens are no longer traceable in the RGSC collections housed at the BGS in Keyworth (Michael Howe pers. comm. April 2019). It is reasonable to assume that the specimens were derived from the type locality at Filleigh, near Barnstaple, Devon and would therefore have the appearance of disc-like aggregates of flattened radiating crystals on joint surfaces within clay-slate. By coincidence, the Devon branch of the

Basset family had a residence at Umberleigh, approximately eight miles south of Barnstaple and only about six miles west-southwest of Filleigh. Could he have acquired them from a relative?

Through his attendance at RGSC meetings Lord De Dunstanville would undoubtedly have met with mineral collectors of whom there were many. Notable names include his cousin Sir John St. Aubyn, Joseph Carne, Stephen Davey, George Croker Fox, Robert Were Fox, John Hawkins, William Rashleigh, Edward William Wynne Stackhouse (later Pendarves), John Williams snr., John Williams jnr. and Michael Williams amongst others. Not all of them attended meetings and many did not live in Cornwall. For example, John Hawkins is known not to have travelled to Cornwall between 1804 and 1828 (Crook 1990: p.52), but many others owned estates within a few miles of Lord De Dunstanville's Tehidy estate.

Interestingly, the early collections at the RGSC were quite poor and appeals were made for donations. In 1820, an appeal for donations to buy specimens was made (Crook 1990: p. 311), but this does not appear to have been successful. In 1826 'those members who have private collections' were urged to donate samples of minerals (Taylor 1826: p. 383). This may be what triggered Lord De Dunstanville to donate the specimens of wavellite, but the limited nature of his donation would suggest that he did not possess a large collection to be able to provide a larger suite of mineral specimens. However, it is worth remarking that some of the other well-known collectors within the society's ranks were also reluctant to part with large suites of minerals. These included William Rashleigh, who donated 'Notes on the Mineralogy of part of the Vicinity of Dublin', but no specimens, and Sir John St. Aubyn who presented nothing. Notable donors included Joseph Carne, Esq., who made multiple donations between 1814 and 1818. He too donated 12 specimens of Cornish minerals to the BRLSI in 1835. John Williams, jnr. presented a small number of interesting mineral specimens to the RGSC during the fledgling years of the society, but it is interesting to look at the range of Cornish mineral species represented in the RGSC collections housed at the British Geological Survey at Keyworth. What is immediately apparent is the paucity of iconic brightly coloured copper- and iron-arsenates, such as liroconite, clinoclase, chalcophyllite and pharmacosiderite, so famed within the private collections of the Williams and Rashleigh families. Perhaps specimens were once present, but were removed during the years of decline in the health of the RGSC, or, perhaps the society's requests for donations had fallen on deaf ears.

How Lord De Dunstanville came to acquire his specimens is not yet known. Based on the quality and the species represented in both the BRLSI and NHM, there is a strong possibility that they were exchanged or given by a member of the Williams family: John Williams, snr. (1753-1841) was agent for the North Downs and Gwennap mines and the first member of the illustrious Williams family of mineral collectors known to have assembled a collection (Smale 2011). He commissioned Scorrier House, built in 1778, slightly to the east of Redruth and, by serendipity, just a mile northwest of what would, during the late 1790s, become one of the most important mineral deposits ever discovered - Wheal Gorland. Williams' collection rapidly drew attention and by 1800 had been visited by the French Princes later crowned Louis XVIII and Charles X (Wilson 1994).

In 1817 Charles Sandoe Gilbert (1760-1831) went so far as to comment as follows in his 'An Historical Survey of the County of Cornwall': 'Scorrier House is known to contain the most valuable variety of Cornish minerals that was ever collected by any gentleman in Europe.' (Smale 2011: p. 213).

Other observers such as Paris (1816) considered Philip Rashleigh's collection at Menabilly to be superior. It is interesting to note that Rashleigh does not appear to have corresponded with John Williams, snr., but letters from John Williams, jnr., from about 1799 onwards suggest that Rashleigh was receiving specimens from him (see for example Williams 1799). This is supported by the entry of 'Jo: W: jun - Jo: William [sic] of Scorrier' in the list of donors written by Rashleigh in the front of his MS catalogue (Rashleigh [no date]). His position in the list - after 'Ma: Mr: Maw' (John Mawe) suggests that he provided specimens towards the very end of the 18th century.

We know from a single specimen in the Russell collection in the NHM (BM 1964,R3570, listed in Appendix 1) that Lord De Dunstanville provided material to the Williams family in 1811. Perhaps this was in exchange, or maybe they provided each other with examples of new mineral discoveries.

The inclusion of Lord De Dunstanville's (as Sir Francis Basset) name in the list of donors in Philip Rashleigh's MS catalogue suggests that his mineralogical interests started early - perhaps in the late 1780s. Unfortunately, no record of correspondence between Philip Rashleigh and either Lord De Dunstanville or his cousin Sir John St. Aubyn has been found. Given the wealth of Rashleigh letters preserved one can assume that he did not provide Lord De Dunstanville with samples, or else some

record would surely have been found.

The diary of Thomas Staniforth, a successful banker from Liverpool, provides a tantalising glimpse into what Lord De Dunstanville's collection might have contained. His entry relating to a visit to Tehidy in 1800, as reproduced by Hext (1965) and Tangye (2002) states: '…the rest of the day was spent in a pleasant domestic manner & his Lordship showed us some curious specimens of copper ore and Miss Basset play'd on the piano - forte whilst the ladies work'd & we had a pleasant conversation till 11 when the ladies retir'd & we all did so in about an hour.'

It is tempting to imagine that in 1800, the 'curious specimens of copper ore' were the newly discovered colourful copper arsenates found at Wheal Gorland, including liroconite, olivenite, clinoclase and chalcophyllite.

Lord De Dunstanville was one of the biggest owners of land in Cornwall. He possessed the famous Dolcoath Mine in Camborne which was, according to Morrison (1983, p. 14), reopened in 1799 through capital provided by among others 'Lord de Dunstanville of Tehidy House, the Williams family of Scorrier House and the Fox family of Falmouth'. Three of the specimens provided by him to Lady Elizabeth Anne Coxe Hippisley and preserved in the Russell Collection at the NHM, are from Dolcoath Mine (Appendix 1).

Lord De Dunstanville had an interest in other mines and his association with well-known mineral collecting families would certainly have opened collecting opportunities for him.

Looking at the range in localities represented by the 36 specimens with associations to Lord De Dunstanville within the Russell Collection only 8 different mines are recorded. Although it is not possible to provenance all of the Lord De Dunstanville specimens within the BRLSI collection it does appear that a very small number of mines are represented. This suggests that he was in possession of a discrete group of mineral specimens, perhaps all derived from mine workings with which he had some association, or ownership.

Contemporary Cornish collectors tended not to show such restraint in collecting from such a limited area and diversified their range to encompass minerals from around the World (see for example Philip Rashleigh, Sir John St. Aubyn and the Williams family).

The question naturally arises as to whether he possessed a larger collection of minerals. If he did, the subsequent history of the Tehidy estate means that any collection would likely have been dispersed. There are no records, but one possibility is that Gustavus Lambert Basset (1834-1888) who in 1876 provided a bequest to construct a laboratory in Camborne and after whom a memorial museum was established in 1888 might have donated specimens to the fledgling mining school. Gustavus was the son of Lord De Dustanville's nephew, John Basset, and inherited Tehidy in 1869.

The question of why Lord De Dunstanville donated specimens to the BRLSI is an interesting one. His association with Bath is not well documented, but his first wife, Frances Susannah Coxe, whose parents both of whom died when she was a child, lived at Ston Easton Park, Somerset, southwest of Bath. One must assume therefore, that he must have spent time in the vicinity of Bath, if not in the city itself.

Nothing is known of Frances (she was usually called by her second name, Susannah) and she is not recorded in any mineralogical literature, but there is a notable family association with mineral collecting - her sister-in-law, Elizabeth Anne Hippisley Coxe, née Horner (1760-1843) to whom he provided many mineral specimens.

In 1795, following the death of her first husband Lady Elizabeth inherited Ston Easton Park where she established her own chemical laboratory and kept an extensive mineral collection. In 1801, she remarried, to the distantly related Sir John Coxe Hippisley, 1st Baronet (1746-1825) - leading to a subtle change in her surname - and she rapidly expanded her collection. The dealer White Watson (1760-1835) of Bakewell, Derbyshire presented her with a suite of specimens in 1803 (Roy Starkey pers. comm. April, 2019) and an invoice of specimens bought at a Heuland (Henry Heuland) sale in 1809 was in her collection (Russell 1950). In about 1810, Sir Humphry Davy presented her with a small number of Cornish specimens (Russell 1944) and she is known to have corresponded with the scientist Charles Hatchett (Roy Starkey pers. comm. April, 2019). She (as 'Lady Hippesley') also provided James Sowerby with a specimen of Somersetshire ochre which he figured in his 'British Mineralogy' publication (Sowerby 1809: TAB 253).

Lady Coxe Hippisley's fine collection remained intact and unknown for nearly a century until 1937, when the science historian Dr. Robert William Theodore Gunther of Oxford acquired it from the Literary and Scientific Institute at Frome in Somerset (Russell 1944). Upon Gunter's death in 1940, it

passed into the possession of Sir Arthur Russell. Many of Lady Coxe Hippisley's finest British specimens were incorporated into Russell's superb collection which he bequeathed to the British Museum (Natural History) in 1964 and which are now part of the collections at the NHM. These include the 35 Lord De Dunstanville specimens previously referred to. The remainder of her collection was used by Russell as duplicates for exchange. Evidence for this is a Lady Coxe Hippisley specimen held in a private collection which bears Russell's handwritten label alongside that of an American mineral dealer, Hugh Alexander Ford (1885-1966) (Figure 23). Ford was based at the address 110 Wall Street, New York 5, N. Y., between 1946-1957 (Wilson 2019) indicating that he acquired the specimen from Russell before 1957. A second Lady Coxe Hippisley/Lord De Dunstanville specimen is in the Tricottet Collection in Switzerland (Mignan 2019). It is accompanied by Sir Arthur Russell's handwritten label which documents that it is olivenite from Wheal Gorland, Gwennap, Cornwall (Mignan 2018: Figure 4).

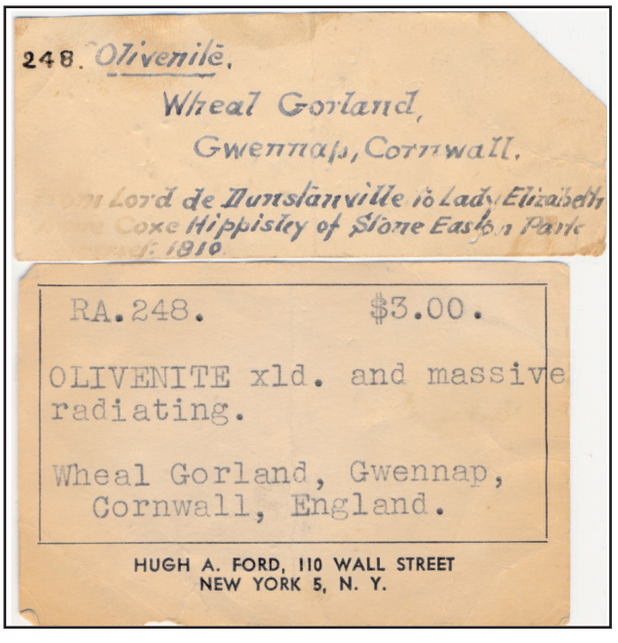

Figure 23. A handwritten Arthur Russell specimen label accompanied by a Hugh Alexander Ford dealer label dating from the period 1946-1957. Russell's label records the historic links to Lord De Dunstanville and Lady Coxe Hippisley. Private collection.

A number of Russell's labels bear the dates 1810 or 1811 and an old handwritten label affixed to one of the olivenite specimens (BM 1964,R8300) also records 1810. This was the time when Lady Coxe Hippisley was most active in her collecting.

Twenty-six of Lady Coxe Hippisley's Lord De Dunstanville's mineral specimens (including the two in private ownership) are recorded as having come from Wheal Gorland in Gwennap parish. This represents slightly over two-thirds of the total and demonstrates his interest, or fascination, in the mine which became renowned as a treasure trove of mineral specimens during the earliest years of the 19th century.

Lady Elizabeth's second husband, Sir John Coxe Hippisley, was one of the principal promoters of the literary institutions of Bath and Bristol (Urban 1825) and his death, in 1825, might have been the trigger for Lord De Dunstanville to donate to the BRLSI in 1826. Bath at that time was a popular resort town with the aristocracy and, according to the 1801 census, was in the top ten most populous cities in England. The specimens he donated - being very similar to those he had previously provided to his sister-in-law - had probably been in his possession since the early years of the century. Why he choose not to present a suite of similar Cornish minerals to the RGSC remains unexplained, particularly, when evidence shows that he had access to specimens.

In total, including those in BRLSI, the NHM, and in private collections, fifty-four specimens with direct associations with Lord De Dunstanville are known. There are probably more and the authors would be very interested to hear about any other examples.

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Appendix 1

Specimens in the Sir Arthur Russell Collection at the Natural History Museum, London, given by Lord De Dunstanville to Lady Elizabeth Anne Coxe Hippisley of Ston Easton Park, Somerset.
BM 1964,R2371 Cuprite. Polgine mine (later part of Grenville United mine), Camborne, Cornwall.
BM 1964,R2380 Cuprite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R2381 Cuprite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R2382 Cuprite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R2387 Cuprite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R2394 Cuprite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R2397 Cuprite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R2940 Cassiterite.
Seal Hole mine, St. Agnes, Cornwall.
BM 1964,R3565 Silver. Dolcoath mine (South Central Lode), Camborne, Cornwall.
BM 1964,R3604 Copper
Wheal Gorland, Gwennap, Cornwall
BM 1964,R3605 Copper
Wheal Gorland, Gwennap, Cornwall
BM 1964,R3727 Argentite.
Dolcoath Mine, Camborne, Cornwall.
BM 1964,R4189 Chalcopyrite.
North Downs Mine, Redruth, Cornwall.
BM 1964,R4196 Chalcopyrite.
Dolcoath Mine, Camborne, Cornwall.
BM 1964,R4651 Fluorite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R7050 Azurite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R7056 Azurite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8127 Mimetite.
Wheal Unity, Gwennap, Cornwall.
BM 1964,R8289 Olivenite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8287 Olivenite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8300 Olivenite
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8307 Olivenite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8305 Olivenite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8338 Olivenite.
Wheal Unity, Gwennap, Cornwall.
BM 1964,R8351 Olivenite.
Wheal Unity, Gwennap, Cornwall.
BM 1964,R8584 Pharmacosiderite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8585 Pharmacosiderite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8592 Pharmacosiderite.
Wheal Gorland, Gwennap, Cornwall
BM 1964,R8976 Chalcophyllite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8987 Chalcophyllite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8833 Clinoclase.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8897 Liroconite.
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R8898 Liroconite
Wheal Gorland, Gwennap, Cornwall.
BM 1964,R11037 Wolframite.
Poldice Mine, Gwennap, Cornwall.
BM 1964,R11039 Wolframite.
Wheal Unity, Gwennap, Cornwall.
A specimen in the Sir Arthur Russell Collection at the Natural History Museum, London, given by Lord De Dunstanville to John Williams - The label with the specimens reads 'Redruth, November 6th 1811 John Williams, Scorrier House. Dunstanville. (Lord de Dunstanville).'
BM 1964,R3570 Silver. Wheal Duchy (Wheal Brothers), Calstock, Cornwall.

CHARLES MOORE AND LATE TRIASSIC VERTEBRATES: HISTORY AND REASSESSMENT

by Christopher J. Duffin

Duffin, C. 2019. Charles Moore and Late Triassic vertebrates: history and reassessment. *The Geological Curator* 11 (2): 143-160.

Ilminster-born Charles Moore (1815-1881) was an indefatigable West Country geologist who made significant and wide-ranging contributions to the science, both in terms of the material he collected and his publications. Following his permanent move to Bath in 1853, Moore collected extensively in Late Triassic rocks, amassing a rich haul of fossil vertebrate specimens. A pioneer of bulk sampling, his fossil vertebrate collection from the Rhaetian fissure infills at Holwell, Somerset has provided much research material for subsequent study; Holwell is now the type locality for several Late Triassic mammaliaforms, reptiles (lepidosaurs) and chondrichthyans. His collection of vertebrate remains from the Arden Sandstone Formation (Carnian Age) at Ruishton has never been fully described, but contains some significant material including isolated xenacanth and hybodont shark's teeth, dorsal fin spines and cephalic spines. The objective of this present paper is to raise the profile of Moore's work on late Triassic vertebrate fossils, to highlight his innovative approach to bulk collecting, and to assess the scientific importance of his collections in both historical and modern contexts.

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Charles Moore (1815-1881): early life

Born in Ilminster, Somerset, Charles Moore (Figure 1) was to become an amateur geologist of considerable renown, amassing a large and significant collection of fossils, a correspondent with the great and the good of the Victorian geological fraternity, and a prolific contributor to Somerset geology. He was also a committed churchman and ventured into local politics.

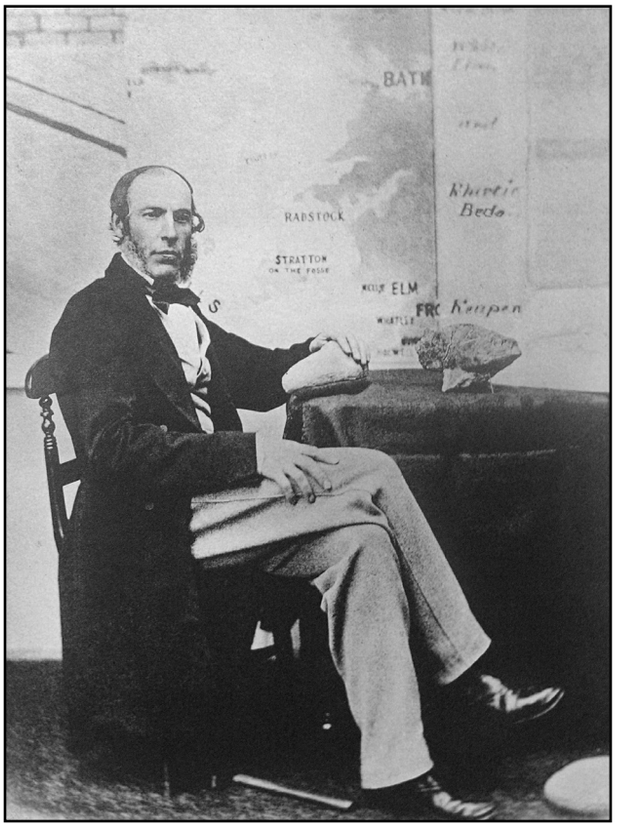

Figure 1. Portrait of Charles Moore (1815-1881). Image courtesy of Matt Williams and the BRLSI.

Details concerning Charles Moore's early life are rather sparse. He was born the third child and second son in a family of six children to John and Anna Moore (Torrens and Taylor 2004). His father ran a family printing and bookselling business (Copp *et al.* 2000), and once Charles had finished his education (at the Commercial School in Ilminster, and then a year in the free grammar school) he joined his father in the enterprise. His career path involved several changes of employer; he worked for his uncle, Samuel Moore, at his printing and bookselling business in Castle Cary for a period of time before first moving to Bath in 1837. Here, he joined Mary Meyler and Son, whose premises were at 5 Abbey Church Yard (now demolished) immediately adjacent to the Roman Baths, Pump Room and Bath Abbey itself. The firm was the publisher of *The Bath Herald*, but also published volumes of local interest

as well as providing a retail outlet for books and stationery. On the death of his father in 1844, Moore returned to Ilminster in order to join his eldest sister in running the family business.

Moore's interest in geology was stimulated by finds of Upper Lias (Toarcian) ammonites in the Ilminster area during his school holidays; he enjoyed 'rubbing them down to show their spar filled chambers' (Moore 1864). Although his interest was never quenched, his responsibilities in the printing and bookselling trade left little time for geology, but he did take the opportunity to visit local quarries in and around Bath while working for Meyler and Son. It was not until his return to Ilminster in 1844 that he was able to cultivate his interests further. He collected assiduously from the Jurassic rocks around Ilminster, amassing an impressive and representative collection of local fossils. Significant amongst these were a stunning set of invertebrate, fish and reptile (ichthyosaur and crocodilian) remains from the Upper Lias, especially in nodules from Strawberry Bank - fossils which continue to provide research opportunities in vertebrate palaeontology today (McGowan 1978, 1989a, b, 1990; Duffin 1979a, b; Copp *et al.*, 2000; Pierce and Benton 2006; Caine and Benton 2011; Marek *et al.* 2015; Williams *et al.* 2015; Audo *et al.* 2017; Cawley *et al.* in press).

Around the same time, Moore began to foster friendships with a number of palaeontologists, including Joseph Chaning Pearce (1811-1847), a surgeon from Bradford-on-Avon, and the brachiopod expert, Thomas Davidson (1817-1885). Reverend Peter Bellinger Brodie (1815-1897) accompanied Moore in the field, visiting the quarries at Beer Crocombe (near Ilminster) with him in 1847.

In 1849, Moore exhibited specimens from his collection at the first meeting of the Somerset Archaeological and Natural History Society, drawing delighted praise from William Buckland (1784-1856) (Moore 1877). With his collection steadily increasing in both numbers and quality, and drawing accolades from the luminaries of the day, Moore's geological ambitions began to come into conflict with the responsibilities of his day job. In 1852, he attempted, seemingly unsuccessfully, to acquire a post that would allow him to devote his energies to providing formal description of his fossils (Copp *et al.* 2000). To that end, he sought supporting testimonials from Richard Owen (1804-1892) and Thomas Davidson (Copp *et al.* 2000).

Following his eight-year sojourn in Ilminster, Moore returned to Bath. His motivation is not entirely clear, but it may well have been romantic as he married

Figure 2. 6, Cambridge Place, Bath, Charles Moore's home for the latter part of his life.

Figure 3. Trim Street Chapel, Bath.

Figure 4. BRLSI, original building at Terrace Walks, Bath. Image courtesy of Matt Williams and the BRLSI.

Eliza Deare shortly afterwards. The match was beneficial to Moore in several ways; he joined Eliza at her family home in or by 1856, and became financially independent, allowing him to pursue his geological interests free of any pecuniary and time constraint. 6 Cambridge Place (Figure 2), built on Widcombe Hill, south west of the City of Bath and the River Avon around 1830, is a three-storey (including a basement) detached Georgian villa (now Grade II listed); a smart walk down the hill would take Moore to the

Figure 5. The Charles Moore Collection on display in the BRSLI. Image courtesy of Matt Williams and the BRLSI.

Unitarian Chapel (Trim Street; Figure 3) at which he worshipped, and the Bath Royal Literary and Scientific Institution (BRLSI; Terrace Walks) which was to become his scientific home (Figure 4).

Founded in 1824, the BRLSI has had a somewhat chequered history (Torrens 1975; Vaughan 1993; Copp *et al.* 2000). Moore joined the Institution in 1853. Seeing an opportunity to make his collection accessible to a wider public, Moore offered to deposit it at the BRLSI for display as part of a free museum. The Institution accepted the offer and the stratigraphically arranged exhibits were housed in specially constructed glass-topped, multi-drawered cabinets in a designated space on the ground floor of the building, with larger specimens mounted on the walls (Figure 5).

When Moore made his permanent home in Bath in 1853, it is clear that he missed his beloved Upper Lias (Winwood 1892), but he began increasingly to appreciate the geology of the Mendip area and to become an enthusiast for its diversity, once writing he 'knew of no locality in England, or even the World, which was more interesting than the district a few miles around that town [Frome]' (Moore 1876: p. 32).

Moore enthusiastically communicated his finds to a wide range of academic bodies, including the Geological Society of London, the British Association, the Somerset Archaeological and Natural History Field Club, and the Bath Natural History and Antiquarian Field Club. He was clearly an engaging speaker with a story to tell for as William Pengelly (1812-1894) wrote in his diary, one of his addresses to the British Association 'truly and deservedly astonished the section' (Pengelly 1897: p. 100), while Hugh Falconer (1808-1865) remarked that Moore was 'made for the Rhaetic Bone Bed, and the Bone Bed made for him!' (Pengelly 1897: p. 100).

Evolving views of Triassic stratigraphy (1834-1861)

Friedrich August von Alberti (1795-1878; Urlichs 1999; Figure 6a) was a salt technician, inspector and engineer at Rottweil, near Stuttgart. In 1834, he named the Triassic for a series of German deposits, bounded by extinction events above and below and characterised by a distinctive fauna (Alberti 1834). The tripartite succession consisted of coloured sandstones, marine limestones and terrestrial marls and sandstones. He effectively consolidated these three units, established earlier as the Buntsandstein, Muschelkalk and Keuper, into what would now be considered as the Triassic System (Hagdorn and Nitsch 1999; Urlichs 1999). Alberti also recognised the presence of a sandstone formation rich in fossil vertebrates, called the Täbinger Sandstein, lying conformably above the Keuper Marl in Swabia. Difficulties of correlation of the Late Triassic Kössen Beds in the alpine region led the pioneering early

Figure 6. Geologists who helped to establish the Rhaetian. A) Friedrich August von Alberti (1795-1878); B) Eduard Suess (1831-1914), lithograph by Josef Kriehuber (1800-1876) c. 1869; C) Carl Albert Oppel (1831-1865); D) Karl Wilhelm von Gümbel (1823-1898).

biostratigraphers, Eduard Suess (1831-1914; Figure 6b) and Carl Albert Oppel (1831-1865; Figure 6c), to carefully sample and describe the fauna contained therein (Suess 1854; Oppel and Suess 1856). They were able to suggest that, on the basis of the common occurrence of bivalves including *Rhaetavicula contorta*, *Chlamys valoniensis* and *Protocardia rhaetica*, the Kössen Beds of the alpine region could be correlated with the Täbinger Sandstone in the extra-alpine area. Shortly afterwards, Karl Wilhelm von Gümbel (1823-1898; Figure 6d), then Chief Geologist for the Bavarian Geological Survey, revised the nomenclature of the alpine Triassic in his work on the geology of Bavaria (Gümbel 1861). Here, he identified the distinctive nature of the uppermost beds of the Triassic and introduced the 'Rhaetische Gruppe' as a formal stratigraphic term, named from classic exposures in the Rhaetic Alps:

> It would.., not be unnatural to form the highest beds of the alpine Keuper, the Kössen Beds, and the Dachsteinkalk into an independent group or formation between the Keuper and Lias, to which one may give the name Rhaetic Formation after the main area of its development in the Rhaetic Alps (Gümbel 1861, translation from Pearson 1970).

Recognition of the 'Rhaetic' in Britain

Moore was introduced to the Late Triassic rocks of Beer Crocombe by Brodie, who accompanied him in the field, in 1847 (Moore 1861c). Moore conducted careful fieldwork in the area, situated some 5 miles (8 km) northwest of his home in Ilminster. Brodie had made his own collection of fossils from the site available to Thomas Wright (1809-1884), a Cheltenham GP, for description (Wright 1860). Anxious to update the stratigraphy and the faunal list presented by Wright, Moore referred to more detailed fieldwork and collecting which he had undertaken alone at the locality in 1850 (Moore 1861c) and in which he had measured numerous sections in the 'Avicula contorta Beds', as they were then known. These additional sites included the tunnel for the Chard Canal (the canal was opened in 1842 as the last British canal constructed by private enterprise) and connecting Chard with the Bridgwater and Taunton Canal at Creech St Michael, and several quarries at Beer Crocombe. Moore's fossil collection was enhanced by material from an especially fossiliferous horizon which he referred to as the 'Flinty Bed'. His stated objective in an 1861 paper was to communicate 'this interesting fauna' and noted that rapid communication was:

> … the more desirable, since, unfortunately for what otherwise would have been an excellent and useful paper, that gentleman [Thomas Wright] has, in my opinion, either mistaken or reversed the proper order of the lowest Liassic zones--an error attending it throughout, and which, unless corrected, may lead to some confusion (Moore 1861c: p. 483-484).

Moore had clashed with Wright before over the stratigraphical position of the White Lias (Moore 1853), and would do so again in 1875, this time concerning misidentification of a crinoid as a cirripede (Moore 1875; see also Copp *et al.* 2000). Indeed, Winwood remarks upon the 'many passages of arms between these local champions' (Winwood 1892: p. 246).

Moore gave thorough descriptions of the invertebrate faunas, especially from Beer Crocombe, including 28 taxa named by himself. He marshalled his evidence in such a way as to:

> … show the desirability of adopting a different classification for those he has included in the group characterized by the *Avicula contorta*, which latter beds are placed by Dr. Wright with the Keuper; and finally offer reasons for removing them, with the "*White Lias*" to the "*Rhaetic Formation*" of Continental geologists (Moore 1861c: p. 488).

Thus, in the same year that the 'Rhaetische Gruppe' was recognised on the continent, Charles Moore (1861c) identified the presence of 'Rhaetic' beds sandwiched conformably between the Lower Lias and the Keuper Marls in Britain.

Holwell

Having settled in Bath in 1853, Moore's investigations began to increase his appreciation for Mendip geology. Might it be possible for him to replicate his former collecting successes in the Upper Lias? In 1858, Moore made a discovery, often alluded to in his later papers, which was to consolidate his reputation, and of which he was clearly immensely proud. He described what happened retrospectively:

> He [Moore] was going along the road to Wanstrow, and on one of the heaps of blue Carboniferous Limestone by the side of the road he saw a piece of yellow rock which looked altogether different from the other portions of the heap. He drew up, and on looking at it, and cracking it with his hammer - which was his constant companion, he found to his surprise fish teeth and bones. He at once saw that those remains belonged to a bed which came in at the bottom of the Lias, termed Rhaetic beds, in consequence of having large developments in the Rhaetic Alps. It was a surprise to him to find that stone in this neighbourhood, because he was not conscious of the beds being within twenty miles of the spot where he found it, and rather suspected that at some point or other, in one of the quarries, this bed came in on the edges of the upturned limestone. As soon as he could he examined the whole of the district, without success; but not very long afterwards he happened to be in the neighbourhood of Holwell, when he saw a vein of yellow limestone going down one of the quarries. On examining it he found that it was from that spot had been dug the stone of which he was in search, and to his surprise he found Rhaetic organic remains caught up in the Carboniferous Limestone. .[…]. It was not very long before he had exhausted the stone of its fish remains, but soon after he found another place in which there was a reddish or yellowish deposit of marl which had gone down one of the cracks. He found that it contained some remains and that he could get them out in immense numbers. He thought that if he could get the material home he should be able to do so more carefully, so he went to a farmer and asked for what sum he would remove it to his house. He replied that he (Mr. Moore) could get better gravel nearer home, and he said he could, but that he wanted that. A bargain was struck and for 55s he had removed to his house and placed in the cellar, three tons of infilling. On that he worked for nearly three years, and obtained from it more than a million fossils, every one of which he had picked out separately. He had with him at that moment 70,000 teeth of one kind of fish alone, found in three square yards of earth (Moore 1876: p. 34-35).

Moore clearly shows his passion for collecting on a large scale, and his willingness to invest money, time and effort into amassing large numbers of specimens from a single deposit. Transporting 3 tons of matrix a distance of some 20 miles by horse and cart and then processing the material by hand to extract the contained fossils was no mean feat. Moore was not a novice when it came to bulk collecting. Repeated visits to a small quarry at Bishopsworth (Bristol) to collect from fossiliferous sandy clay bands involved carrying away 'upwards of two hundredweight of sand' which was then picked under a hand lens and yielded a rich and significant invertebrate fauna (Moore 1861a; Copp *et al.* 2000: p. 7). In his consideration of large-scale extraction techniques for microvertebrates, Freeman (2010: p. 11) makes some interesting observations about Moore's work, and highlights Moore's experience of a 'hair-raising descent' of a disused lead mine shaft at Charter House Warren. Moore was later to become a victim of his enthusiastic and adventurous spirit - in 1872 he was trapped in a rock fall whilst investigating a cave in Murder Combe; it was some time before he was rescued and it has been suggested that it was ultimately the cause of the long illness which debilitated Moore in later life, and to which he eventually succumbed (Winwood 1892; Copp *et al.* 2000). Lead had been extensively mined in the region of Charterhouse Warren since Roman times, and a few companies were still exploiting mineral veins in the mid-nineteenth century. Moore's attention was caught by an experimental shaft, recently sunk but since abandoned. Tailings around the entrance yielded Liassic fossils which Moore was told had come from the base of the shaft:

> To prove the correctness of this statement, and learning that the ladders had been left in, I induced the manager of the adjoining works to uncover the shaft that I might go down for its examination,--a work, from the state of the shaft, not unattended with some danger (Moore 1867: p. 492).

He sampled a sandy deposit from the end of one of the galleries some 90 feet (27.5 m) down, and 'washed' it to reveal that 'it was found to be almost entirely composed of the dismembered joints of Encrinites' (Moore 1867: p. 492). Moore (1867)

notes his friendship with the highly productive micropalaeontologist, Thomas Rupert Jones (1819-1911), then Professor of Geology at the Royal Military College at Sandhurst (Frogley and Whittaker 2016). Jones clearly admired Moore, referring to him as 'one of the most enthusiastic of geologists, and a successful labourer among Lias fossils' (Jones 1872: p. 146). In 1858, the year Moore made his discovery and collection at Holwell, Jones published a paper detailing extraction techniques for isolating microfossils (Jones 1858). He advised that clays should be 'well dried in the sunshine or in an oven, should be placed in a glazed pot or pipkin, and covered with boiling hot water'. Disaggregation followed by hand-kneading the produced slurry and pouring off the supernatant, sometimes through several cycles, would yield the contained fauna. For more sandy deposits, essentially the same process was recommended and the washed sand 'residue should be dried, and then sifted into various degrees of fineness for convenience of picking' in either a wet or dry state (Jones 1858: p. 249). In the case of the latter, Jones recommended 'a metallic sieve, so as to allow the use of several moveable bottoms of perforated zinc, of different degrees of fineness' (Jones 1858: [. 249-250). Indicating that a stacked system was very effective, Jones also noted a commercial source for the sieves - 'Mr Snow, zinc-worker, 50 Millbank-street, Westminster, at a cost of 3s. each'. It is highly likely that Moore utilised a similar system of washing and sieving in order to process his Holwell material, in accordance with the experience of his friend. Clearly stimulated by his successes with the Holwell fissure filling material, Moore extended his investigations to 'the Carboniferous-Limestone veins of the North of England', again collecting in bulk and processing 134 different samples from a variety of lead mines in Cumberland and Yorkshire. He remarks that:

> The process necessary for the discovery of organic remains is often difficult, and needs much perseverance, a single sample occasionally requiring several days' examination. The samples selected are from the less mineralized portions of the veins, consisting generally of the " Dowks " or clays. They have therefore to be dissolved and washed, which, from the intractable nature of the material, is often a difficult operation; and the residue is then examined (Moore 1869: p. 429).

Moore described the matrix which he collected from Holwell in various ways - as a conglomerate (Moore 1859a: p. 93; 1859b: p. 173), a 'quartzose sand ..[…] … sometimes indurated but often friable' (Moore 1859a: p. 93), and as a 'coarse friable sand' (Moore 1860a: p. 88; 1860b: p. 316; 1861b: p. 301). He also cited it as a clay (Moore 1865: p. 59), repeated by Copp (1975: p. 110) and Whiteside and Duffin (2017: p. 679) as a 'greenish clay'.

Quarries in the Lower Carboniferous Limestone (Mississippian) of the Mendip Hills have been long worked for building stone and aggregate, especially the Black Rock Limestone Subgroup, Vallis Vale Limestone Formation, and Clifton Down Limestone Formation. Holwell Quarry, later referred to by Moore as the '*Microlestes* Quarry' (e.g. Moore 1880: p. 69), was located 'opposite this village' (Moore 1859a: p. 94), i.e. situated south of and adjacent to the A361, which runs from Frome to Shepton Mallet. Quarry workings exploited the Clifton Down Limestone Formation as exposed on the southern flank of the Beacon Hill Pericline and was described by Moore as being 35 feet (10.7 m) deep. After Moore's time the quarrying area was considerably extended to the north of the road, giving rise to a whole complex of quarries.

Moore described the fossiliferous deposit as belonging to 'a fissure about a foot in breadth, commencing under a thin capping of vegetable soil […] taking an irregular direction to the bottom of the quarry, where it increases to 10 feet in breadth' (Moore 1859a: p. 94). The latter dimension had increased to 15 feet in a later account (Moore 1861a: p. 87).

Although Henry Thomas de la Beche (1796-1855) had earlier considered the geology of the area (de la Beche 1846), it seems that Moore was the first to describe the geology of the quarries at Holwell. He provided a detailed description of the fissures cutting the Carboniferous Limestone at Holwell (Moore 1867) and provided a section to show their distribution (Moore 1867: p. 484, Figure 3; Figure 7), remarking that the progress of exploitation of the stone 'alters its precise features'.

Later in life, Moore mentioned that he had made a photographic record of the site (Moore 1881: p. 69). An album of photographs is present in the BRLSI collections, amongst which are some views of the quarry face at Holwell (Figure 8).

Moore was also able to introduce others to Holwell through organised field trips. In 1863, he travelled with Henry Hoyte Winwood (1830-1920) to the British Association meeting in Newcastle in order to secure nomination for Bath to become the venue for the 1864 meeting of the Association; he had first met Winwood in Bath the previous year (1862). Moore was successful and, as local secretary, acted as one of the organisers of the meeting. He led the field excursion to Frome, Vallis and Holwell on Saturday 17th

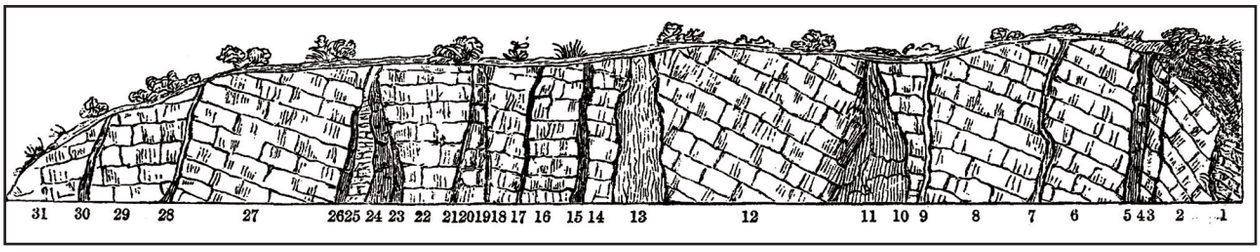

Figure 7. Quarry section at Holwell from Moore (1867, Figure 3).

September 1864. The excursion was well attended by both delegates and their wives, and Charles Moore can be seen leading the trip in a photograph taken at the time (Figure 9). Winwood's retrospective view of the event was that the:

> … excursion to Frome and the Vallis under his guidance was a memorable one, and the distinguished savans who were present expressed their great satisfaction at the interesting geological information he had given to them. The acknowledged success of the Bath Meeting, considered to be one of the most brilliant that had ever been held, was mainly due to Charles Moore's unwearied labours and his great power of organisation (1892: p. 252).

Winwood was to become a firm friend of Moore's. He also oversaw Moore's collection after his death and acted as his biographer (Winwood 1892). Moore led further field excursions to Holwell - for the Somerset Archaeological and Natural History Society in 1875, for example - and gave numerous lectures alluding to the quarry and its rich vertebrate fauna to that and other local societies.

The Holwell vertebrate fauna

Having collected the Holwell fissure material some time in 1858, Moore wasted no time in advertising his discoveries. He reported his initial findings at the Leeds meeting of the British Association for the Advancement of Science, held in late September of the same year (Moore 1859a). Even at this early stage he had developed a good grasp of the contents of the fauna and something of its significance. Moore always intended to write up the complete fauna himself but, as Winwood remarks:

> … many results of Moore's work leaked out before he had described them in print; he was always a slow writer and took a long time before making these results public. It was owing to this

Figure 8. Photograph of the quarry wall at Holwell, album of photographs in the BRLSI. Image courtesy of Matt Williams and the BRLSI.

Figure 9. Photograph of Charles Moore (top left, with David Livingstone and Sir Roderick Impey Murchison standing to his left) leading the British Association field excursion to Holwell on 17th September, 1864. Image courtesy of Matt Williams and the BRLSI.

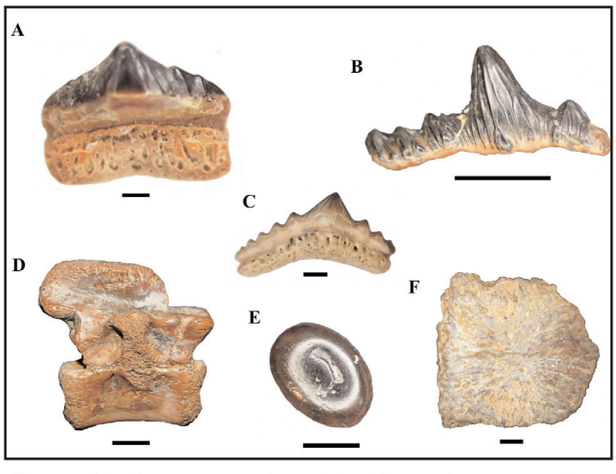

Figure 10. Some examples of fossil vertebrate remains from Holwell (Moore Collection, BRLSI). A. M64, tooth of* Lissodus minimus *in lingual view. B. M192, tooth of* Hybodus cloacinus *in labial view. C. M183, lateral tooth of* Synechodus rhaeticus *in lingual view. D. C28, vertebra of* Pachystropheus rhaeticus *in lateral view. E. M193, tooth of* Psephoderma alpinum *in occlusal view. F. CD10, osteoderm of* Psephoderma alpinum *in surface view. Scale bar = 1mm in figs A, C; 5mm in figs. B, D-F.

that the " special paper " which he promised upon his discoveries in the Microlestes quarry at Holwell never saw the light. This and many other facts which he trusted to his too retentive mind being now buried with him, and lost to science (Winwood 1892: p. 248).

1. Reptiles

In a general comment, Moore (1860a: p. 88) wrote that 'Of the order Reptilia there were probably eight or nine genera, consisting of detached teeth, scutes, vertebrae, ribs, and articulated bones'. The surviving material in Bath contains no articulated remains. In his initial faunal list, Moore (1859a) firstly indicates the presence of *Thecodontosaurus* and *Palaeosaurus*, both first described from a quarry at Durdham Down, Clifton, near Bristol (Riley and Stutchbury 1836, 1837, 1840). *Thecodontosaurus antiquus* was the fourth dinosaur to be named from England and is a basal sauropodomorph or prosauropod (Benton *et al.* 2000). *Palaeosaurus* has subsequently undergone much revision, part of the material now being assigned to a phytosaur (*Rileyasuchus platyodon*) and the remainder to *Thecodontosaurus cylindrodon*. The Durdham Down material has had a somewhat chequered history, and much, but not all was lost due to bombing in World War II (Benton 2012; Foffa *et al.* 2014). The age of the Durdham Down deposits was a matter of some debate at the time, but Moore (1881) considered them to be Rhaetian because he considered *Thecodontosaurus* and *Palaeosaurus* both to be represented in the Holwell fauna.

Moore mentions 'several teeth and vertebrae, and also several bony scutes or scales' (Moore 1859a: p. 94). The latter may be a reference to placodont osteoderms (see below) in the collection. Unfortunately, no dinosaur or phytosaur teeth or vertebrae are present in the Holwell collection today, making it impossible to verify his identifications. There is also the possibility that the vertebrae referred to by Moore might be those of *Pachystropheus* (see below), also represented in the collection.

Moore also had 'the pleasure of announcing …. the presence of the teeth of another saurian - the *Placodus*' (*ibid.*); Moore was excited because, although no precise equivalent to the Muschelkalk had been identified in Britain, this find represented the first record of one of its faunal components. The genus *Placodus* was erected by Agassiz (1833) for *P. gigas*, based on teeth and a partial skull, believed at the time to belong to a large fish. Richard Owen later (Owen 1858) identified the group as being reptilian, based on further skull remains. Moore cited the teeth

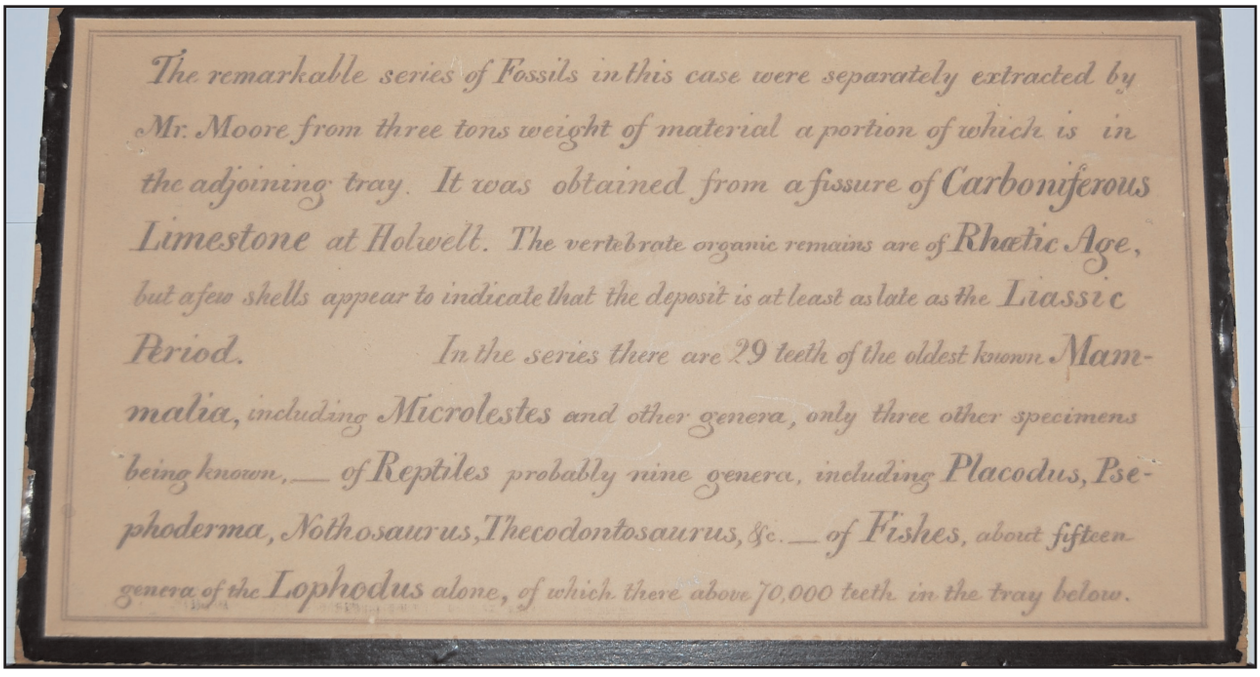

Figure 11. Display board originally accompanying Charles Moore's exhibit of Holwell vertebrate fossils.

of *Placodus* from Holwell several times (e.g. Moore 1859b: p. 173; 1860a: p. 316; 1860b: p. 19; 1861a: p. 88; 1861b: p. 302) but they were not described or figured until Duffin (1980) assigned them to *Placochelyanus stoppanii* (Osswald 1930).

Twenty-five isolated complete and fragmentary placodont teeth survive in the collections at Bath (BRLSI [formerly BATGM] CD.89A-CD.89I, M0193; Whiteside *et al.* 2016: Figure 2E; Figure 10E). Sub-circular to elongate oval in outline, they vary in size from 3 mm to 12 mm in diameter. Broken specimens have an enamel layer measuring up to 1 mm thick. Several of the larger specimens possess an almost circular groove on the occlusal surface (e.g. BRLSI CD.89A, CD.89H) and are probably anterior palatine teeth. Others possessing a more arcuate groove (e.g. BRLSI CD.89.C, CD.89.I) are probably posterior maxillary teeth. Those specimens lacking occlusal grooves are most probably anterior maxillary teeth.

The scutes which Moore mentioned (Moore 1860a: p. 88) in relation to *Thecodontosaurus* and *Palaeosaurus* are probably the osteoderms that he sent to Christian Erich Hermann von Meyer (1801-1869), usually referred to as Hermann von Meyer. Meyer was employed in public offices in Frankfurt, but made his name in palaeontology, setting up the renowned journal, *Palaeontographica* in 1846. In 1858, using that journal as a publishing vehicle, von Meyer described the osteoderms of an armoured placodont from the Rhaetian of the Bavarian Alps as *Psephoderma alpinum*. By summer 1864 Moore was in active correspondence with von Meyer (Keller and Duffin 2001) and had sent him some of the 64 complete and partial osteoderms from his Holwell collection (BRLSI CD.10 to CD.15; Whiteside *et al.* 2016: Figure 2D; Figure 10F) for description. In due course, von Meyer (1867) described the material as *Psephoderma anglicum*, distinguishing them from *P. alpinum* on the basis that the English specimens were a little smaller, had a less well-developed polygonal shape and possessed fewer superficial ridges on their outer surface. Considering the Bath material to come from individuals of varying ages, he rejected the idea that the Holwell specimens belonged to juveniles of *P. alpinum*. Nordén *et al.* (2015) briefly reviewed the British records of placodont reptiles and concluded that the most parsimonious explanation was that the material should be considered as belonging to *P. alpinum*, with *P. anglicum* the junior synonym.

Moore involved Sir Richard Owen (1804-1892) in the description of reptile remains from Holwell (Owen 1860); Owen described and figured two small vertebrae, 'more or less mutilated' (Owen 1860: p. 492) but was uncertain as to whether they were reptilian or mammalian in origin. One of the specimens (BRLSI C.35) is still present in the collection and has been figured by Whiteside and Duffin (2017: figs. 6E-I) as belonging to a probable gephyrosaurid sphenodontian lepidosaur, possibly a large individual of *Diphydontosaurus*, first described from Late Triassic fissure deposits at Tytherington (Whiteside 1986). The collection also contains a series of disarticulated bones which can be ascribed to sphenodontians, including a scapula (BRLSI 42a), interclavicle (BRLSI C.42b), chevron (BRLSI 42c), and an ungual phalanx (BRLSI DW.5a), none of which had been mentioned previously in Moore's papers. Investigation of further previously uncited material

in Moore's collection has also led to the recent identification of several lepidosaur taxa in the fauna (Whiteside and Duffin 2017): *Diphydontosaurus* sp., *Gephyrosaurus evansae, Penegephyrosaurus curtiscoppi* and several undetermined gephyrosaurids, an undetermined rhynchocephalian and the trilophosaur, *Variodens inopinatus*. A jaw fragment of an unidentified procolophonid is also present in the collection (BRLSI CD.8).

Further interesting material not referred to specifically by Moore in any of his papers include the tooth of the cynodont, *Pseudotriconodon wildi* (BRLSI C.108; Cuny 2004), previously believed to be confined to the Rhaetian of continental Europe. Amongst the larger bones briefly listed by Moore (1859a) as possibly belonging to *Thecodontosaurus* and *Palaeosaurus* are vertebrae which match the descriptions of those given for *Rysosteus*, a genus raised by Owen (1842) for specimens obtained from the Rhaetic Bone Bed at Aust Cliff, South Gloucestershire. Woodward and Sherborn (1890) added the species name 'oweni', but the lack of a diagnosis and a designated holotype means that the taxon has been recognised as a *nomen nudum* (Storrs 1994). Erika von Huene (1905-1969; the daughter of Friedrich von Huene, 1875-1969) described *Pachystropheus rhaeticus* on the basis of associated vertebrae and limb bones from the British and German Rhaetian (Huene 1933, 1935). Vertebrae in the Holwell collection clearly belong to that taxon (compare Figure 10D with Whiteside *et al.* 2016: Figure2F; Storrs and Gower 1993: figs 1C-E and Storrs 1994: figs. 7D-G). The affinities of *Pachystropheus* have been the subject of some debate; Storrs and Gower (1993) and Storrs (1999) have suggested that it is a choristodere, whilst Renesto (2005) has interpreted it as a thalattosaur.

2. Fishes

Whilst the reptilian components of the Holwell fauna had clearly caught Moore's interest, he went on to declare that 'the fish remains from these conglomerates were probably of equal interest' (Moore 1859a: p. 94). His initial faunal list includes the teeth of '*Acrodus, Hybodus, Saurichthys, Lepidotus, Gyrolepis*, probably the *Ctenoptychius* or *Petalodus* of Owen, and some minute palates allied to *Chomatodus*, a genus not yet found higher than the carboniferous limestone' (Moore 1859a: p. 94); this list of taxa would require later modification.

Moore was particularly impressed by the sheer numbers of isolated chondrichthyan teeth yielded by his processed samples. He was fond of recording how many specimens of '*Acrodus*' teeth had been isolated - his estimates ranged from 45,000 (Moore 1860a: p. 316, 1860b: p. 18; 1861a: p. 88) through 50,000 (Moore 1863: p. 421) to 70,000 (contemporary explanatory board in the Moore collection; Moore 1876: p. 35; Figure 11). These records refer to teeth of *Acrodus minimus*, first described by Louis Agassiz in his 'Recherches sur les Poissons Fossiles' (Agassiz 1833-1843; Figure 10A). The taxon has subsequently been assigned to the hybodont shark genus *Lissodus*, and the large numbers of specimens in the Moore Collection proved essential in characterising the heterodonty shown by the taxon (Duffin 1985, 1999, 2001; Cross *et al.* 2018).

The teeth of *Hybodus* recorded by Moore (1859a) likely included those of *Hybodus minor* (being common in the Holwell collection and well known from elsewhere in the British Rhaetian), originally raised by Agassiz, but now transferred to the genus *Rhomphaiodon*. The teeth are interesting because they are one of a series of enigmatic sharks which have hybodont-like tooth morphologies but a typically neoselachian enameloid ultrastructure (Duffin 1993; Cuny and Risnes 2005). Moore's record probably also embraces the teeth of the palaeospinacid neoselachian *Synechodus rhaeticus*, first described from his collection (Duffin 1998b; Figure 10C), and *Hybodus cloacinus*, a larger hybodont better known from the early Jurassic (Figure 10B). Dorsal fin spines also belonging to the former species have also been described from Moore's Holwell material (Duffin 1982).

Moore (1859a: p. 94) also refers to 'very peculiar thorn-like spines of not less than ten distinct varieties, belonging to some very peculiar fish as yet undetermined, to the dermal coverings of which they were probably attached'. Later, he referred to:

> …a number of curious bodies, each of which was surmounted by a depressed, enamelled, thorn-like spine or tooth, in some cases with points as sharp as that of a coarse needle; these the author supposed to be spinous scales, belonging to several new species of fish allied to the *Squaloraia*, and that to the same genus were to be referred a number of hair-like spines, with flattened fluted sides (Moore 1860a: p. 88).

In all probability these thorn-like structures are not dermal denticles, but the teeth of *Pseudocetorhinus pickfordi*, first described from Moore's material (Duffin 1998a). These teeth show close morphological similarity to those of Basking sharks (Family Cetorhinidae); the suggestion that they might represent remains of the earliest basking shark in the fossil record have been the subject of some debate

(Duffin 1998a, Shimada *et al.* 2015; Cross *et al.*, 2018). The 'hair-like spines' is probably a reference to numerous gill raker teeth, originally suggested as also belonging to *Pseudocetorhinus* (Duffin 1998a, 1999), but perhaps more likely being osteichthyan in origin (Slater *et al.* 2016; Landon *et al.* 2017).

Moore (1861c: p. 499) refers to 'abundant' vertebrae from Holwell; he believed that these and similar specimens from the Rhaetian of Beer Crowcombe, belonged to *Squaloraja*, a distinctive holocephalian originally described from the Lower Lias of Lyme Regis by Agassiz. The specimens, still held in the Moore collection, are more likely to come from neoselachian sharks such as *Synechodus rhaeticus* (Mears *et al.* 2016).

Sorting through Moore's collection of chondrichthyan remains from Holwell some 140 years after its original collection has yielded further new taxa - *Palaeobates reticulatus*, the latest record for that particular hybodont genus in the fossil record, and *Duffinselache holwellensis*, originally allocated to *Polyacrodus* but since removed to a monotypic genus of its own (Duffin 1998b; Andreev and Cuny 2012). Holwell is the type locality for both of these taxa.

Moore's reference (Moore 1859a: p. 94) to 'minute palates allied to *Chomatodus*' must be an allusion to the toothplates of myriacanthoid holocephalians housed in the collection. The earliest record of this group was from the Lower Lias of Lyme Regis until Duffin and Furrer (1981) recorded *Agkistracanthus mitgelensis* from the Rhaetian and Hettangian of Austria and Switzerland. Comparison of the Holwell specimens with that of the type material revealed that they should also be assigned to *Agkistracanthus* (Duffin 1994, 1999).

Amongst the Rhaetian osteichthyans from Holwell, Moore (1859a) listed *Saurichthys, Gyrolepis* and *Lepidotus*. The last of these three is known from Rhaetian deposits, but is a rare component of the fauna and not always easily recognised (Nordén *et al.* 2015); Moore's record probably refers to durophagous teeth of *Sargodon tomicus*, which also has marginal chisel-like incisiform teeth, such as those described by Moore (1861c).

Saurichthys is an elongate fish with a fusiform body and enormously extended jaws comprising around a third of the total body length. Probably a high-speed ambush predator, it is known from articulated specimens (e.g. Rieppel 1985), but the genus was originally raised for isolated teeth and isolated jaw fragments by Louis Agassiz in 1835, with *S. apicalis* from the Muschelkalk of Bayreuth as the type species. Amongst the other species erected on the basis of isolated teeth, Agassiz described *S. acuminatus* and *S. longidens*, both from the Rhaetic Bone Beds of Aust Cliff (Agassiz 1833-1843). When Moore refers to the teeth of *Saurichthys* from Holwell, his comments embrace both these species. The subsequent history of understanding of these species is somewhat complex (Blazejowski *et al.* 2013). Savage and Large (1966) concluded that they were synonyms and should be incorporated into the genus *Birgeria* as *B. acuminata*; Storrs (1994) later transferred the material to its own monotypic genus, *Severnichthys*. This move has been tentatively accepted by later workers, often referring to *Saurichthys longidens* and *B. acuminata* tooth morphotypes when giving descriptions and tooth counts from different localities in the British Rhaetian (e.g. Allard *et al.* 2015; Nordén *et al.* 2015; Mears *et al.* 2016; Slater *et al.* 2016; Lakin *et al.* 2016; Landon *et al.* 2017; Cavicchini *et al.* 2018; Cross *et al.* 2018).

Moore (1860a: p. 88) further mentions 'some most minute fish-jaws and palates, of which the author had, either perfect or otherwise, 130 examples'. Recording up to 90 teeth on one particular specimen, these are probably the ectopterygoids of an as yet undetermined taxon.

3. Mammaliamorphs

Moore was justly proud of his discovery of 'mammal' teeth at Holwell, remarking that they were 'by far the most important remains in the deposit' (Moore 1860a: p. 88). Wilhelm Heinrich Theodor Plieninger (1795-1879), who studied theology and natural sciences at Tübingen and worked as a lecturer at the Katharinenstift Gymnasium in Stuttgart, had described *Microlestes antiquus* on the basis of two isolated teeth from the Grenzbreccie bone bed at Degerloch in Germany some 13 years earlier (Plieninger 1847). Moore (1860a: p. 88) reported that he had found 'fifteen molar teeth, either identical with, or allied to, the *Microlestes*, and also five incisor teeth, evidently belonging to more than one species.' Moore also referred to 'a very small double-fanged tooth', plus 'a single fang' which he believed represented, respectively, a second and third mammalian genus. He cited the vertebrae discussed above, later sent to Owen for description, and concluded it reasonable to infer that:

> … if twenty-five teeth and vertebrae, belonging to three or four genera of Mammalia, were to be found within the space occupied by three square yards of earth, that portion of the globe which was then dry land, and from whence the material was in part derived, was probably inhabited at this

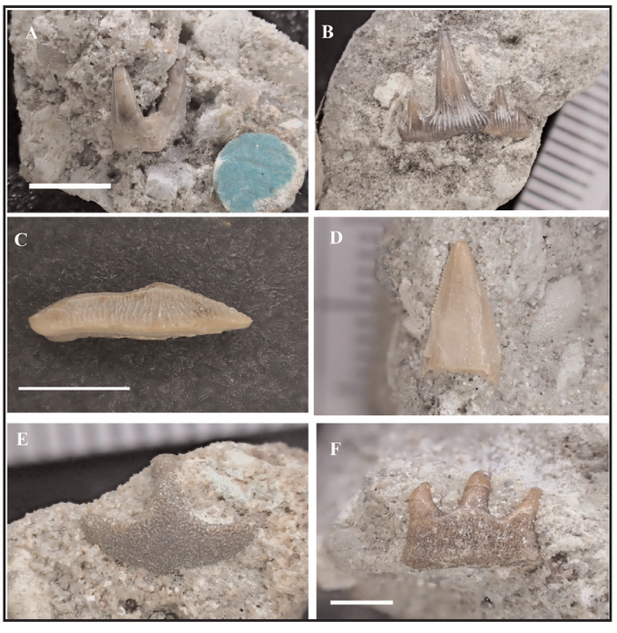

Figure 12. Fossil vertebrate remains from the North Curry Sandstone (Carnian, Upper Triassic) of Ruishton, Somerset (Moore Collection, BRLSI). A. Holotype (M4) of Mooreodontus moorei in labial view. B. Isolated tooth of Polyacrodus krafti in labial view (M6). C. Tooth of Palaeobates keuperinus in labial view (M12). D. Unidientified thecodont tooth (M21). E. Hybodont cephalic spine (M4858). F. Unidentified tooth in labial view (M4866). Scale bar = 5mm.

> early period of its history by many genera of Mammalia, and would serve to encourage a hope that this family might yet be found in beds of even a more remote age (Moore 1860a: p. 88).

Moore displayed the specimens at the BRLSI, and the Handbook which he prepared for the 1864 meeting of the British Association for the Advancement of Science at Bath lists 'twenty-nine teeth of the oldest known mammalia' in case no. 41 (Moore 1864).

The teeth were sent to Owen in 1858; he assessed their identity and importance and made a series of notes about them (Owen 1871). These notes then formed the basis for his description of *Microlestes moorei*, which was part of his review of the Mesozoic mammals known at the time. Plieninger's generic name, *Microlestes*, was later found to be preoccupied, necessitating the provision of a new designation for the German teeth - *Thomasia*. Simpson (1928), agreeing with Owen concerning the close similarity between the German teeth and those from Holwell, decided to erect the genus *Microcleptes*, also raising *Microcleptes fissurae* for three specimens transferred to the then British Museum (Natural History) by exchange with the BRLSI (Simpson 1928); he also identified *Microleptes* sp. in the Bath collections. Thus, early in the 20th century, Moore's opinion that at least three taxa of early mammals were present in the Holwell fissure had been vindicated. Unfortunately, it later became apparent that *Microcleptes* was, itself, already preoccupied, so Simpson later (Simpson 1947) replaced it with *Haramiya*.

Simpson remarked that his 'Microcleptidae', a family embracing *Microcleptes* (now *Haramiya*), *Hypsiprymnopsis* (based on a single lost tooth from the Rhaetic of Watchet) and *Thomasia* was 'one of the most troublesome and least known of mammalian families' (Simpson 1928: p. 53). Things were not to become any clearer very quickly. The Holwell teeth were reviewed by Butler and MacIntyre (1994: p. 433), who concluded that '*Haramiya* and *Thomasia* are interpreted as upper and lower teeth, respectively'. The two genera continue to be treated as distinct units, however. Further taxa have been added to the Family Haramiyidae, which has been incorporated into the Haramiyida, whose relations continue to be rather obscure. Articulated haramiyidan remains from the Jurassic of China are beginning to show promise in this regard (e.g. Zheng *et al.* 2013).

As noted by Duffin (1978), Moore responded to a request from Othniel Charles Marsh (1831-1899) by sending him nine of his mammal teeth from Holwell on 27th September 1881. It seems that of these, only two specimens remain extant, the remainder not having been incorporated formally into the Peabody Museum Collections at Yale University. The surviving Holwell mammal teeth are now carefully conserved in the BRLSI type and figured collections.

Thus, the vertebrate fauna collected by Moore from the Holwell fissure filling was not only noteworthy in the nineteenth century, when Moore distributed specimens to the experts of the day for description and enthusiastically advertised and promoted his finds, but it has also proved very important subsequently. Holwell is now the type locality for several chondrichthyan, lepidosaur and mammaliamorph genera and species, all described from material in Moore's collection. The fishes are highly representative of the Rhaetian fauna as a whole, and many of the new taxa described from Holwell have now been recorded from the Rhaetian elsewhere in the West of England (Allard *et al.* 2015; Korneisel *et al.* 2015; Nordén *et al.* 2015; Lakin *et al.* 2016; Mears *et al.* 2016; Slater *et al.* 2016; Whiteside *et al.* 2016; Landon *et al.* 2017; Cavicchini *et al.* 2018; Cross *et al.* 2018). Furthermore, they have played an important part in discussions relating to the dating of fissure infills and their terrestrial faunas from South Wales and the West of England (Whiteside *et al.* 2016; Whiteside and Duffin 2017), as have the recently described herpetofaunal components (Whiteside *et al.* 2016; Whiteside and Duffin 2017).

Holwell remains one of the only British Late Triassic sites to yield mammaliamorph teeth and placodont reptile remains.

Ruishton

Another, slightly older collection of Late Triassic vertebrates was made by Moore from west central Somerset. He states that 'on proceeding by road from Taunton to Hatch [now the A358], the Keuper Sandstones are exposed about midway at Ruishton' (Moore 1867: p. 468). Here, he noted that the excavations for the construction of a house had been cut into the sandstones; he collected from the building site and, after having sorted his material, gave a preliminary faunal list as follows, 'teeth of *Labyrinthodon*, serrated teeth of *Belodon*?, A. keuperinus etc., with E. minuta in the more indurated shales' (Moore 1867: p. 468). He subsequently (Moore 1880, 1881: p. 81) added the teeth of *Thecodontosaurus* and *Palaeosaurus*, *Batrachia*, *Sphenonchus, Diplodus*, and '*Triplodus*' to his developing faunal list. The house whose foundations were being excavated has since been demolished and is now the site of a large park-and-ride car park for Taunton.

The Keuper Sandstones recorded by Moore now belong to the North Curry Sandstone Member, an arenaceous unit in the upper part of the Mercia Mudstone Group overlying the Somerset Halite Formation, and superseded by the Blue Anchor Formation. It is probably a lateral equivalent of the Arden Sandstone Formation of Warwickshire and Worcestershire and may be correlated with the Schilfsandstein of Germany (Simms and Ruffell 1990). Miospore assemblages suggest that it is no older than early Carnian (Cordevolian), and more likely to be later Carnian (Julian or Tuvalian) in age (Warrington and Williams 1984). The North Curry Sandstone was probably deposited as fluviatile distributary channels during a wet phase generally referred to as the Carnian Pluvial Episode or CPE, and which may be a significant in dinosaur evolution (Ruffell *et al.* 2018a, b; Simms and Ruffell 2018).
Considering the effort he invested in exploiting contacts for the description of his vertebrate collection from Holwell, it is rather surprising that Moore did not develop and publish on the Ruishton fauna further. The matrix associated with the extant specimens from Ruishton in the BRLSI varies from a greenish grey siltstone with white and grey pellets to an oligomictic conglomerate with a variety of siltstone intraclasts and suggests that the vertebrate remains come from basal rip-up channel deposits.
The only material formally described from Ruishton is a collection of isolated teeth belonging to xenacanth sharks (Figure 12A). Nine specimens were described by Arthur Smith Woodward (1864-1944) as *Diplodus moorei* (Woodward 1889). Subsequently, the generic identity of these teeth has been the subject of considerable debate; Patterson (1967) assigned them to *Dittodus*, since *Diplodus* was preoccupied, and Johnson (1980) considered that they should be placed in *Xenacanthus*. More recently, Hampe and Schneider (2010 in Ginter *et al.* 2010) raised a new genus, *Mooreodontus*, for the Ruishton teeth.

Whilst not all of the taxa listed by Moore can be found in the Ruishton material preserved at the BRLSI, several shark taxa are present which, rather surprisingly, were not described by Woodward. These include the teeth and dorsal fin spines of *Palaeobates keuperinus* (Figure 12C), originally described by Murchison and Strickland (1840) from the 'Keuper' of Warwickshire. Some of the most striking specimens in the collection are isolated crowns of the hybodont shark *Polyacrodus krafti* (Figure 12B), first described from the German Carnian by Seilacher (1943). Hybodont cephalic spines, presumably those referred to by Moore (1881) as *Sphenonchus*, are also represented (Figure 12E) and appear to be identical to those described and figured by Winkler (1880) as *Hybodus non striatus*. In addition, there are specimens of isolated, unidentified chondrichthyan teeth (Figure 12F), thecodont teeth (Figure 12D), osteichthyan scales, fin rays and teeth and possible phytosaur teeth in the collection.

Conclusions

Charles Moore was clearly a gifted Victorian geologist and the scientific significance of the collections which he made, despite their history of neglect, is a fitting legacy to a man of considerable focus, energy and insight. An accomplished worker in the field, Moore approached collecting on a grand scale, pioneering techniques of bulk sampling and sediment processing, and was rewarded with the discovery of many important specimens. He produced numerous measured sections of Late Triassic and Early Jurassic strata, recording the faunal composition of the layers which he sampled. Some of his descriptions of Rhaetian localities, such as the Hapsford Bridge section in Vallis Vale and the Marston Road section near Holwell (Moore 1867), have acted as stimuli for later collectors (e.g. Duffin 1982; Nordén *et al.* 2015). His intimate knowledge of Late Triassic localities and his remarkable appreciation of the literature being published at the time resulted in his identification of the 'Rhaetic' beds in Britain.

Fostering mutually beneficial links with the BRLSI in Bath, Moore was able to ensure that his collection was accessible to both the scientific community and the general public. An enthusiastic promotor of the faunas which he collected both in print and in his contributions to both local and national scientific meetings, Moore overcame some of his misgivings when dealing with certain members of the geological establishment and passed many of the most significant elements of his collections to the experts of the day for formal description. His collection of fossil vertebrate remains from the Rhaetian fissure infills at Holwell is still yielding valuable information, especially concerning aspects of the biogeography of the Late Triassic, and the site is the type locality for a whole raft of taxa including mammaliaforms, reptiles and chondrichthyans. By contrast, the Carnian fauna which he collected from Ruishton in Somerset is very much understudied, a situation only now being rectified, some 160 years after its collection.

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MR SANDERS' MAP

by Deborah Hutchinson

Hutchinson, D. 2019. Mr Sanders' Map. *The Geological Curator* 11 (2): 161-172.

William Sanders' major contribution to geology was as a pioneer in large-scale geological mapping, surveying the area in and around Bristol. Together with the significant contribution he made to the Bristol Institution, Sanders' 'Map of the Bristol coal fields and country adjacent geologically surveyed by William Sanders. F.R.S. F.G.S.' first published in 1862 is a remarkable achievement and legacy that further developed the understanding of the complex geology of the Bristol area.

The map was made on a scale of four inches to a mile and was started with the encouragement of Henry Thomas De la Beche and John Phillips. It was constructed from Sanders' own geological surveys together with a topographical map constructed from collating many parish maps on different scales. In total his map covers 720 square miles and was paid for entirely from Sanders' own pocket (Tawney 1876). This huge task took him many years to complete, starting around 1835, finally being published in 1862 in sheet form and in 1864 as a folio atlas. Bristol Museum & Art Gallery (BRSMG) cares for several copies of his folio atlas, individual map sheets and geological material that Sanders donated.

> No single amateur has ever produced such a work on his own resources (Tawney 1876: p. 505).

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William Sanders (1799-1875)

William Sanders was born in Bristol on 12th January 1799. His father Thomas Sanders (c. 1768-1854) was a hop and seed merchant (Clark 2004) and co-founder of the Prudent Man's Friend Society in December 1812 (Latimer 1884). Sanders was interested in geology and, in particular, mineralogy from an early age (Tawney 1876), perhaps inspired by his schooling and the interests of his wider family. Sanders was educated at the private school of Thomas Exley (1774-1855) (Clark 2004), a mathematics teacher who also perhaps inspired scientific interest in him. He initially went into the family business in partnership with one of his three brothers, Edward Sanders (c. 1801-1872), but retired from business in 1856 to concentrate on geology (Clark 2004).

Figure 1. Portrait of William Sanders (1799-1875), a framed copy of which was donated to Bristol Museum by his nephew Thomas Richard Sanders Jnr (c. 1792-1876) in 1890. © Bristol Culture.

Sanders did not publish extensively but his publications did cover a wide range of topics. One of his earliest publications is a short pamphlet on the crystalline form of the strontium ore celestine found at Pyle Hill, Bristol (Sanders 1840). The mineral celestine was once commercially mined in the Bristol area, in particular at Yate, South Gloucestershire (Lane and Hardwick 2013). He was a founding member of the Bristol Naturalists' Society and from their foundation in 1862 was their first President, re-elect-

ed annually until his death (Tawney 1876). He also led geological excursions in the Bristol area for them and read several papers at their meetings.

Sanders contributed five papers to the British Association, including a paper on the raised beach at Woodspring Hill near Bristol (Sanders 1841) and a paper on the fossils of *Thecodontosaurus* and *Palaeosaurus* from the Bristol area (Sanders 1850).

The Bristol Institution for the Advancement of Science Literature and the Arts (hereafter referred to as the Bristol Institution) was founded in 1823. The Sanders family were deeply involved with its foundation, development and management. William's father Thomas, and his uncle John Naish Sanders FGS JP (c. 1777-1870) in particular were active members of the Institution's buildings committee from 1809 (Clark 2004). John Naish Sanders donated significant fossil material to the Institution and also provided financial support. William Sanders was also involved in the life of the Bristol Institution from its founding, donating specimens of natural history, mineralogy and palaeontology throughout his life and serving as Honorary Secretary of the museum sub-committee from 1827 to 1856. After the third curator Robert Etheridge (1819-1903) left the museum to take up a post at the Museum of Practical Geology, the Museum Committee felt that there was not enough money to employ a curator, so Sanders took on the role in an honorary capacity. He became Honorary Curator from 1856 and retired in 1872 (Clark 2004), having overseen the merger of the Bristol Institution with the Bristol Library Society and the opening of the Bristol Museum and Library in 1871 (Tawney 1876).

Sanders donated many geological specimens to the Bristol Institution collected from all over the country,

Figure 2. The Bristol Institution in 1825, drawing attributed to Alfred Montague. This was the first purpose-built building housing the Bristol Institution, located on Park Street, Bristol. BRSMG K4539 © Bristol Culture.

Figure 3. A fossil rib fragment from the Bristol & Exeter Railway cutting at Uphill. Part of the of William Sanders collection. BRSMG Ce16760. © Bristol Culture.

including many from the Bristol area. Around 80 geological specimens donated by Sanders still survive in the collection of Bristol Museum & Art Gallery today. Some specimens can be associated with his mapping of the area, for example BRSMG Ce16760 is recorded as being from the Bristol & Exeter Railway cutting at Uphill, Somerset where Sanders is known to have made a survey of the cutting.

He was elected a Fellow of the Geological Society of London in 1839 and was elected a Fellow of the Royal Society in 1864, in recognition of his geological map (Tawney 1876), supported by his lifelong friend John Phillips (1800-1874) (Morrell 2005). Sanders had a quiet and retiring nature (Clark 2004) and never married. He died in Clifton, Bristol on 12 November 1875 and is buried at Arnos Vale cemetery, Brislington, Bristol in a family plot with his uncle, John Naish Sanders.

Figure 4. The Sanders' family plot at Arnos Vale cemetery, Bristol. © Deborah Hutchinson.

The making of Mr Sanders' map

Around 1835 Sanders had been working with John Phillips and Henry Thomas De la Beche (1796-1855), the first Director of the Geological Survey, in some of their surveying of the geology of north Devon and Cornwall (Clark 2004). Sanders was a friend of Phillips and may have learned some of his mapping skills from him having spent time learning from Phillips in Devon 1840 and in Pembrokeshire in 1841 (Morrell 2005).

Around 1840, De la Beche invited Sanders to geologically survey the area around Bristol (Sanders 1865) and by June 1841 Sanders was working on the geology of the Bristol area for the Geological Survey on his own, hoping eventually to find employment in the Geological Survey (Morrell 2005). Sanders used a copy of the one inch to a mile Ordnance Survey map enlarged to six inches to the mile as a base to trace out most of the surface geology of the area, except for the coal measures that were mapped by Geological Survey staff (De la Beche 1846). The Geological Survey was at this time producing maps using the Ordnance Survey one inch to a mile maps as a base. They had agreed to pay expenses for the work, but never did, leaving Sanders feeling disappointed and hurt and by 1844 had given up hope of ever being employed by them (Morrell 2005). The work that Sanders produced was incorporated into the first edition of Sheet 35 (De la Beche 1846), and published in 1845 with Sanders named as one of the authors.

In transferring Sanders' more detailed geological work from the six inch scale to the smaller one inch scale adopted by the Geological Survey, much of the complex detail was not retained. De la Beche encouraged Sanders to pursue his large-scale mapping of the Bristol area on a scale of at least two inches to a mile (Sanders 1876) to better reflect the geological complexity of the area and to better understand the mineral wealth of the coal fields (Etheridge 1876). As no base map at a larger scale was available, Sanders started his survey by collecting the parish maps for the area, eventually amassing about 218 in total (Sanders 1865) to create a base map. He carried out all the geological surveying himself over the summers of 12 years, during which time he employed a professional draughtsman at the Bristol based cartographers Ashmead's to produce the two inch map, as per the instruction of De la Beche (Sanders 1865).

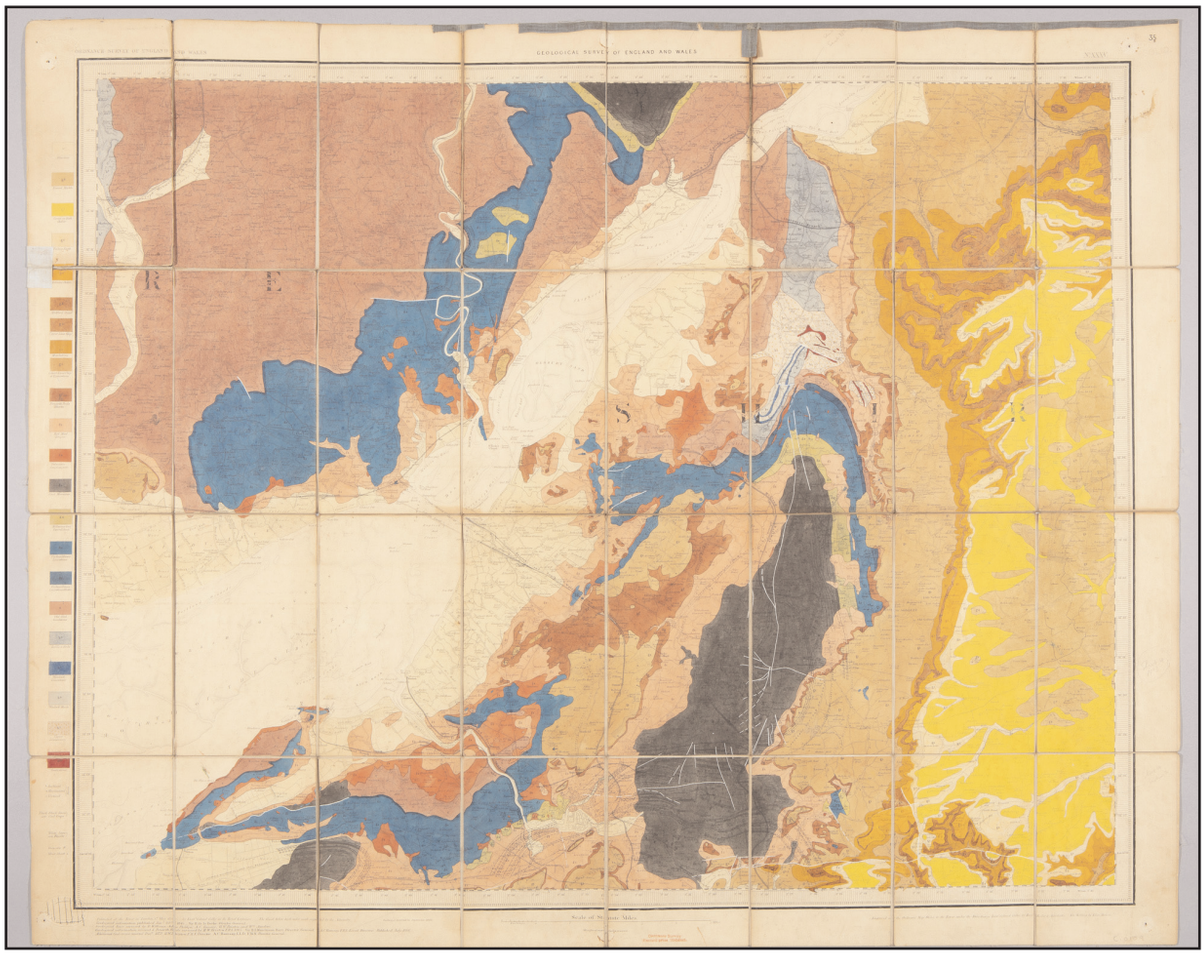


Figure 5. Geological Survey of England and Wales, Sheet 35. One inch to a mile. First published in 1845. BRSMG Ci109. © Bristol Culture.

Figure 6. 1939 image of a wooden road measuring wheel or 'waywiser' used by George Ashmead, cartographer, Bristol c. 1825-1835 for surveying Bristol streets. BRSMG J2760. © Bristol Culture.

Sanders submitted his work to the Geological Survey; however they suggested that the two inch scale would now be too small a scale (Sanders 1865). The Ordnance Survey had begun mapping at the larger scale of six inches to the mile firstly in Ireland from 1824 and then later in Scotland and northern England starting in 1841 (Oliver 2013). During the mid-19th century there was much discussion among surveyors and government officials over what scale should be used to map the country, two inch or six (Oliver 2013).

To his credit Sanders began again but chose the scale of four inches to the mile for constructing his map (Sanders 1865), perhaps feeling grieved at his previous treatment and wanting to retain total autonomy and authorship of his map or perhaps not wanting to directly compete with the Ordnance Survey.

Sanders worked at this new scale for a further three years, finally publishing his completed map in 1862 (Neve 1983; Morrell 2005), four years before the Geological Survey published their revised one inch to a mile Sheet 35 in 1866 and many more years before the six inch to a mile county series maps for Gloucestershire and Somersetshire were published by the Ordnance Survey.

The completed map

Consisting of 19 sheets in total with an index page on Sheet 1 (see Figure 7), the whole map covers an area of 720 square miles from Berkeley in the north to Wells in the south and from Bath in the east to Weston-super-Mare on the Severn coast. A pamphlet insert was printed in 1865 (Sanders 1865) to accompany the map. The map was published by John Lavars of Broad Street, Bristol and was available as an un-coloured topographic map or for a higher price, geologically coloured (hand water-coloured, see Figure 8) reflecting the boundaries of geological surface outcrops and alluvium deposits surveyed by Sanders.

Initially individual single sheets were available for purchase, and from 1864 a bound folio atlas was produced. A title sheet produced separately (see Figure 9) illustrates the area covered by the map and also the pricing of individual sheets and the atlas either coloured or plain. The atlases in the collection at Bristol Museum & Art Gallery measure 660 x 460 x 30 mm overall and are half bound in sheep-skin leather with marbled paper sides.

Sanders took pains to check the geographical accuracy of his base map by comparing it with the one inch to a mile Ordnance Survey map reporting only a small amount of error (Sanders 1865). He commented that field boundaries may not be totally accurate as reducing original parish maps resulted in adjoining maps not always aligning perfectly (Sanders 1865). Sanders felt the accuracy of his geological surveying was broadly sound, having by this time spent many years surveying the geology of the Bristol area. However he did acknowledge that he did not think the map was perfect and pointed out that there were still areas of the map that required further geological investigation and resolution, inviting comments and new information (Sanders 1865).

Owners of Sanders' Map

The map had value as a topographic map in its own right. It details many features alongside the surface geological boundaries such as; height above sea level, dip of strata, field boundaries, woodland areas, houses, roads and train lines. This level of detail was possible due to mapping at the four inches to a mile scale, detail that was very useful to many wealthy individuals and landowners with interests in the Bristol area.

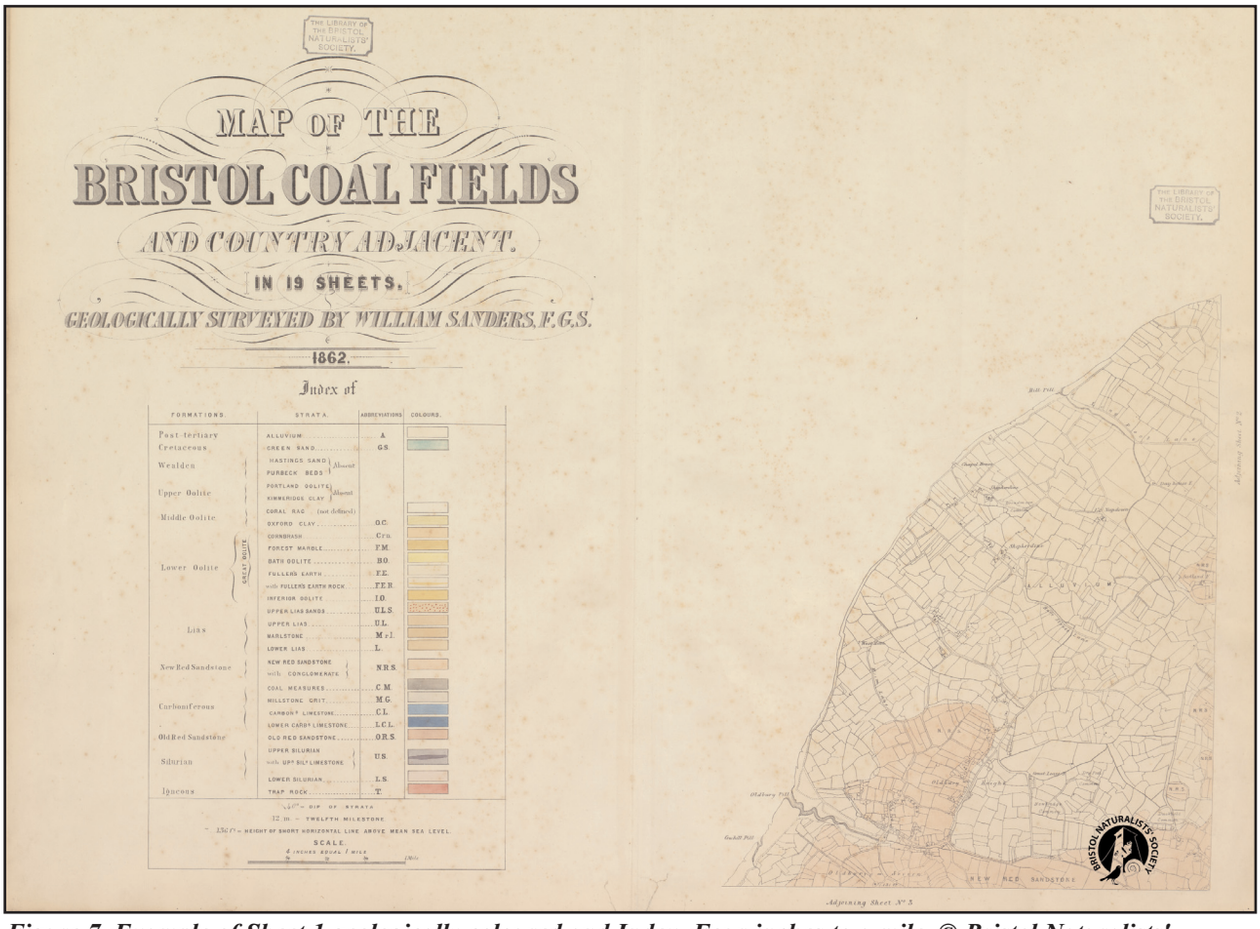


Figure 7. Example of Sheet 1 geologically coloured and Index. Four inches to a mile. © Bristol Naturalists' Society.

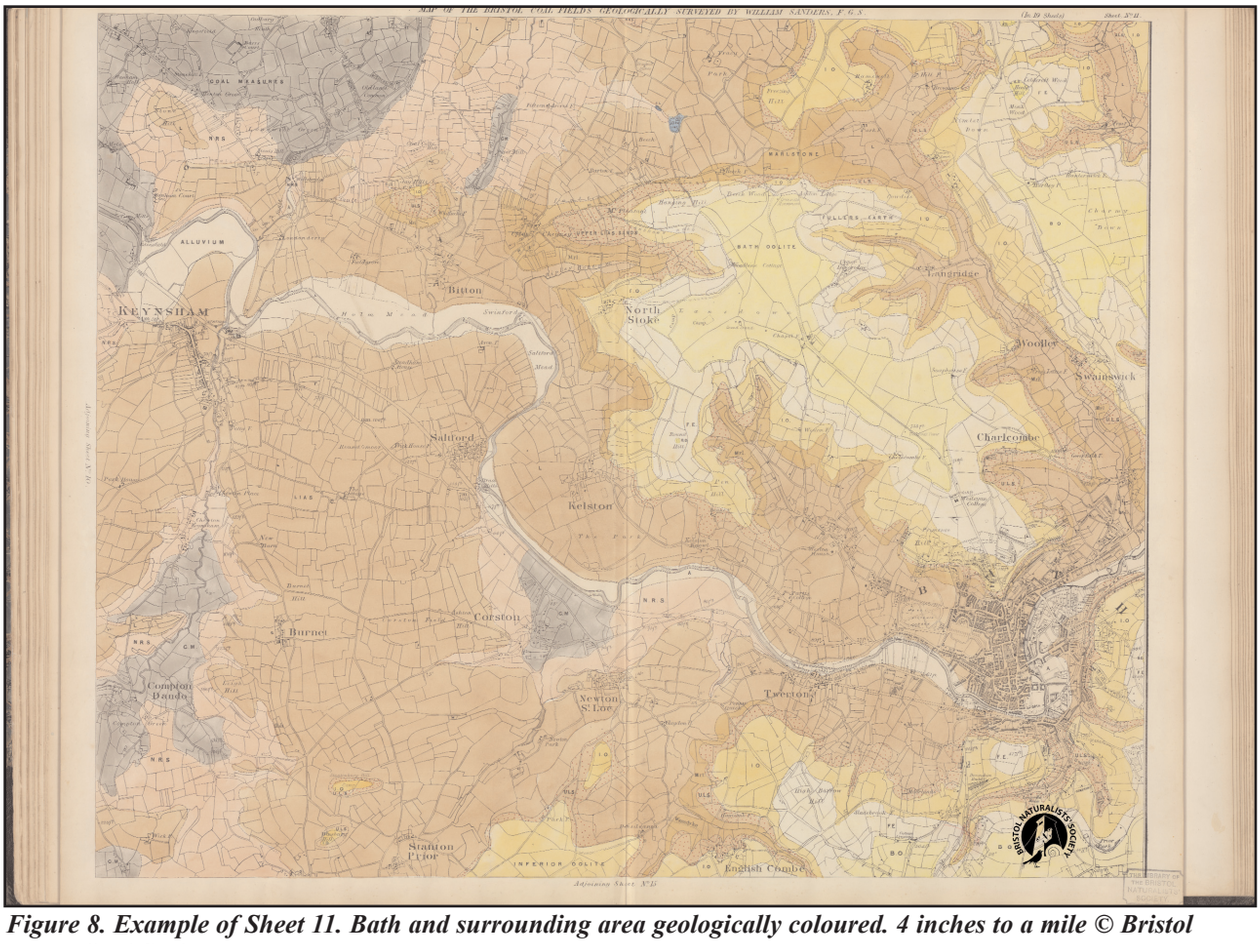


Figure 8. Example of Sheet 11. Bath and surrounding area geologically coloured. 4 inches to a mile © Bristol Naturalists' Society.

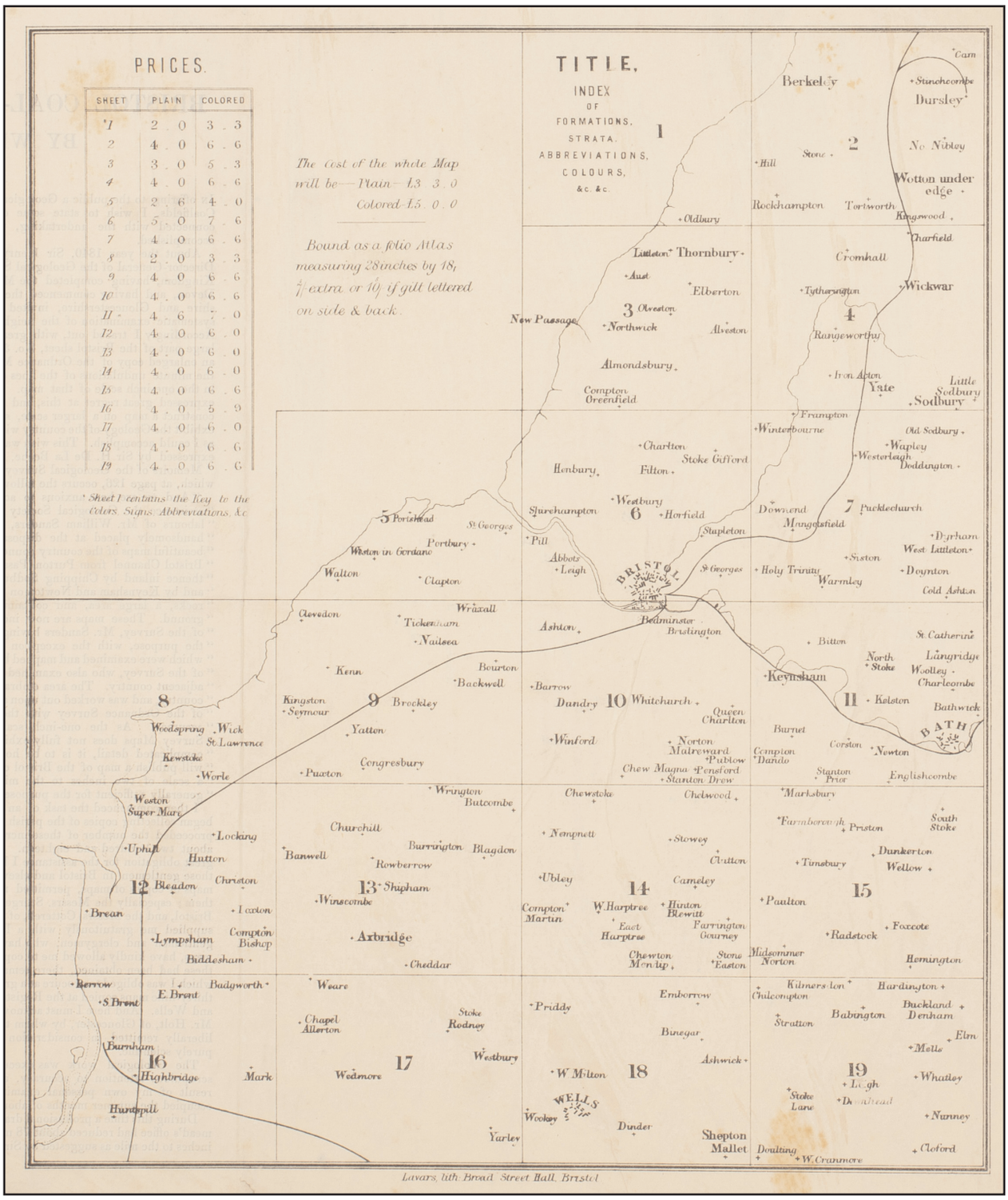
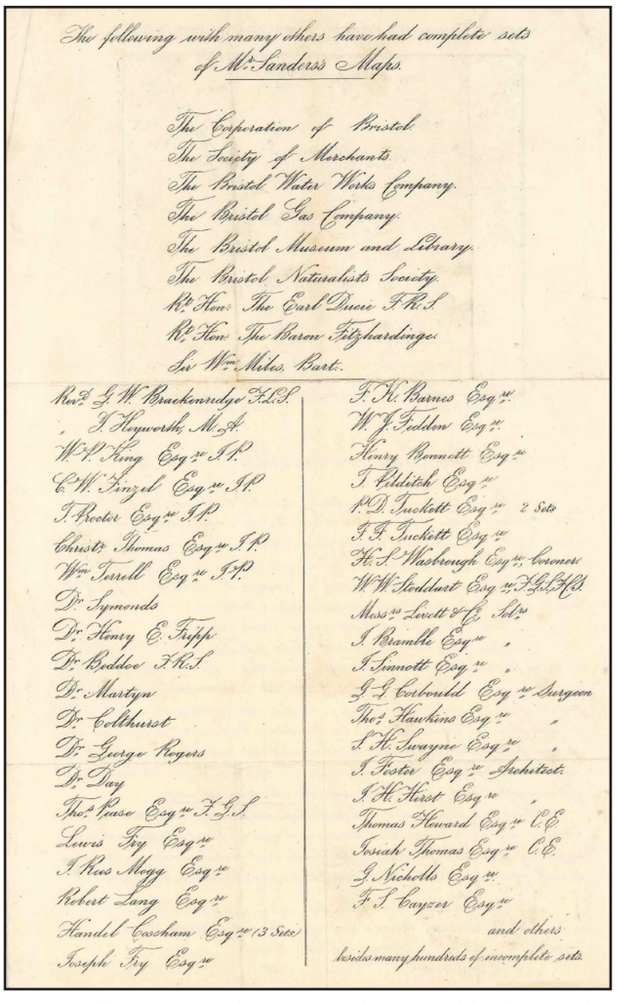


Figure 9. Example of title sheet. BRSMG Ci275. © Bristol Culture.

Sanders' wanted the purchase price of his map to only cover the cost of publication and he wanted his map to be accessible to those who were interested in geology (Sanders 1965). This is generous considering the outlay involved in so much work for so many years and that Sanders paid for production entirely from his own pocket. One atlas in the care of Bristol Museum & Art Gallery (BRSMG Ci242) shows that in 1864, the year of the atlas' production, a coloured copy would cost £4. 19. 0.

After Sanders' death in 1875, Lavars continued to publish the map and produced a sales pamphlet subtitled: 'To the Nobility, Clergy, Landowners, Solicitors, Parish Officers Etc.' indicating the client base they were hoping to appeal to as potential purchasers. This pamphlet also named the gentleman, businesses and institutions that had already purchased a copy of the folio atlas, some of whom buying multiple copies.

Figure 10. Sheet 12 detail. Weston-super-Mare area showing some of the topographical features included in the base map. 4 inches to a mile. BRSMG Ci242. © Bristol Culture.


The following with many others have had complete sets of Mr. Sanders's Maps.

The Corporation of Bristol
The Society of Merchants
The Bristol Water Works Company
The Bristol Gas Company
The Bristol Museum and Library
The Bristol Naturalists Society
Rt. Hon. The Earl Ducie F.R.S.
Rt. Hon. The Baron Fitzhardinge
Sir Wm. Miles, Bart.

Revd. J. W. Brackenridge F.L.S.
J. Heyworth, M.A.
W. P. King Esqre. J.P.
C. W. Inzell Esqre. J.P.
J. Procter Esqre. J.P.
Christr. Thomas Esqre. J.P.
Wm. Terrell Esqre. J.P.
Dr. Symonds
Dr. Henry E. Fripp
Dr. Beddoe F.R.S.
Dr. Martyn
Dr. Colthurst
Dr. George Rogers
Dr. Day
Thos. Pease Esqre. F.G.S.
Lewis Fry Esqre.
J. Rees Mogg Esqre.
Robert Lang Esqre.
Handel Cossham Esqre. (3 Sets)
Joseph Fry Esqre.

F. R. Barnes Esqre.
W. J. Fedden Esqre.
Henry Bennett Esqre.
T. Biddlecombe Esqre.
P. D. Tuckett Esqre. 2 Sets
F. F. Tuckett Esqre.
H. S. Washbrough Esqre. Coroner
W. W. Stoddart Esqre. F.G.S. F.S.A.
Messrs. Lovell & Co. Solrs.
J. Bramble Esqre.
J. Innott Esqre.
J. J. Corbould Esqre. Surgeon
Thos. Hawkins Esqre.
S. H. Swayne Esqre.
J. Foster Esqre. Architect.
J. H. Hirst Esqre.
Thomas Howard Esqre. C.E.
Josiah Thomas Esqre. C.E.
J. Nicholls Esqre.
F. S. Cayzer Esqre.
and others
besides many hundreds of incomplete sets.

Figure 11. Reverse of Lavars' sales pamphlet listing the gentleman, businesses and Institutions that had already purchased a copy of the folio atlas. BRSMG Ci241. © Bristol Culture.

This pamphlet is a window onto the audience that Sanders' map had attracted by 1875 (see Figure 11). Copies were now owned by learned institutions such as The Bristol Museum and Library, and the Bristol Naturalists' Society (Sanders himself donated a copy) infrastructure and civic organisations, important local individuals, Members of Parliament, Justices of the Peace, colliery owners such as Handel Cossham (1824-1890) (3 sets), the mountaineer Francis Fox Tuckett FRGS (1802-1868) and geologists such as his friend William Walter Stoddart FGS (1824-1880).

Individual sheet maps and atlases in the collection at Bristol Museum & Art Gallery also record annotations made by their owners, reflecting their practical application (see Figures 12 and 13).

Significance of the Map

Sanders' map is by no means the only geological map of the area produced in the 19th century and a summary of early geological mapping in the Bristol region can be found in Kellaway and Welch (1993). In 1799 William Smith (1769-1839) produced a map covering the area five miles around Bath, including the eastern part of Bristol and Somerset coalfields, on a scale of one and a half inches to a mile.

The interesting and diverse geology of the Bristol area has been studied for over four and a half centuries with the Bristol and Somerset coalfield possibly being one of the earliest in the country to have been mined (Kellaway and Welch 1993). As Bristol's importance as a port city grew and with the onset of the Industrial Revolution, coal from the Bristol area was increasingly in demand in the 19th century. As a result, interest in understanding the geology of the area and its mineral resources also grew (Kellaway and Welch 1993). The significance of Sanders' achievement lies in his geological mapping of the Bristol coalfield and surrounding area in such detail, singlehandedly, many years in advance of the Geological Survey. Its significance also lies in the map furthering the understanding of the complex geology of the area at a time when interest in the science of geology was high, and extracting mineral wealth was important.

Figure 12. Sheet 15 detail Writhlington area. 4 inches to a mile. Showing annotations in red. BRSMG Ci240. © Bristol Culture.

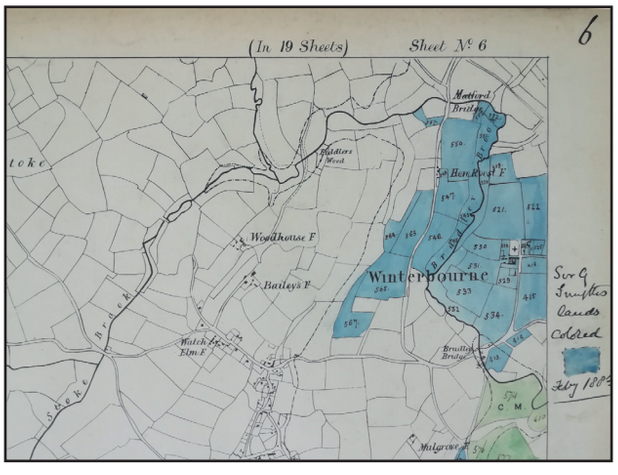


Figure 13: Sheet 6 Winterbourne area. 4 inches to a mile. Detail indicating ownership of land belonging to Sir G[revile] Smyth in 1883. BRSMG Ci241. © Bristol Culture.

The practical applications of the map were important to many such as landowners, mine owners and local utility companies for example the Bristol Water Works Company and also the Royal Coal Commission (Etheridge 1876), as the detail afforded by the large scale format of the map allowed information to be recoded with a new level of accuracy.

Surviving copies of Mr Sanders' map

Sanders' maps are aesthetically beautiful documents in their own right and many surviving copies are in excellent condition. This is particularly the case for the maps of the folio atlases, being enclosed in book form and therefore protected from light damage, their colours are generally well preserved. Bristol Museum & Art Gallery is home to numerous copies of Sanders' maps including individual single maps of various Sheet numbers; some of which once belonged to the Bath geologist Charles Moore (1815-1881).

The museum also houses five complete atlases; three as bound folios (BRSMG Ci240, Ci241 and Ci242), one unbound folded atlas (BRSMG Ci274) and one as an unbound and unfolded atlas stored flat (BRSMG Ci275). It is available to view via Bristol Museums' online collections website.

Also in the collection are two copies of a much larger, single sheet version of Sanders' map on a scale of one inch to the mile reduced from the larger map, with only field boundaries omitted. One copy is folded (BRSMG Ci152) and the other is unfolded and stored rolled (BRSMG Ci7) (see Figure 15).

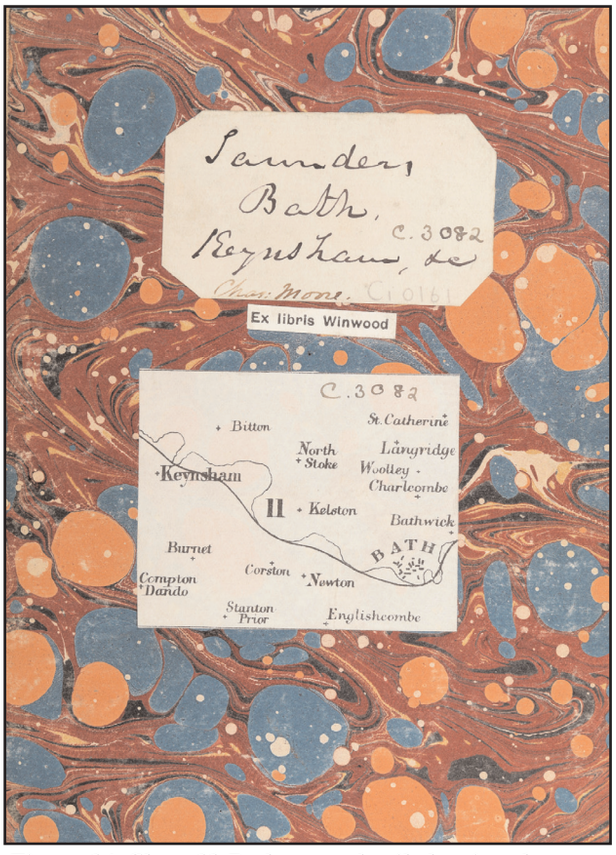


Figure 14. Sheet 11 Bath cover detail showing the name 'Chas: Moore.' Note the spelling of Sanders' name as 'Saunders'. BRSMG Ci161. © Bristol Culture.

Figure 15. 'Map of the Bristol Coal Fields and country adjacent. Geologically surveyed by William Sanders FRS FGS Scale one inch - one mile reduced from the larger map'. 76cm x 96cm. BRSMG Ci7. © Bristol Culture.

Many examples also survive in other collections. A well preserved geologically coloured atlas is cared for in the Library of the Bristol Naturalists' Society. Bristol Archives contain numerous examples of Sanders' atlases and single sheets and the South West Heritage Trust also cares for some single sheets. Copies of the atlas exist in the Special Collections of the University of Bristol and survive in private collections. Copies of maps and atlases may also be held elsewhere in public collections in the UK and abroad and the author would welcome communication advising of any known locations of Sanders material.

Sanders' other maps

Sanders produced several other geological maps and surveys in the years before publishing his main atlas. In the 1830's the railways came to the west and Sanders took advantage of the cuttings needed to build the Great Western Railway and the Bristol to Exeter Railway. He surveyed the cutting between Bristol and Bath (Tawney 1876) reporting his progress in 1841 to the British Association (Sanders 1842).

He also surveyed the section from Pyle Hill to Uphill during the construction the Bristol to Exeter Railway (Etheridge 1876) (see Figure 3). In the report of the British Association's meeting in 1846 he describes in detail the geology of the section cut along the line between Bristol and Taunton (Sanders 1847).

Sanders contributed a geological map and section of Bristol and Clifton for the parliamentary inquiry into the health of towns published in 1845 (De la Beche 1845). In 1850, a geological map of Bristol and four geological cross sections of the city by Sanders were included in a report to the General Board of Health (Clarke 1850) and in the same year 'Lander's Electoral District Map of The City and County of Bristol, Geologically Surveyed and Coloured by William Sanders FGS' at a scale of one inch to a mile was published (see Figure 17).

Conclusion

The achievement of William Sanders in creating a map of the Bristol coalfields at a scale of four inches to a mile merits attention. With the initial encouragement of De la Beche and Phillips, Sanders' map was, at the time of its publication in 1862, the most detailed geological map of the region. Surveyed singlehandedly by Sanders, the map records in detail the complex geology and mineral wealth of the area many years before more detailed maps were produced by the Geological Survey.

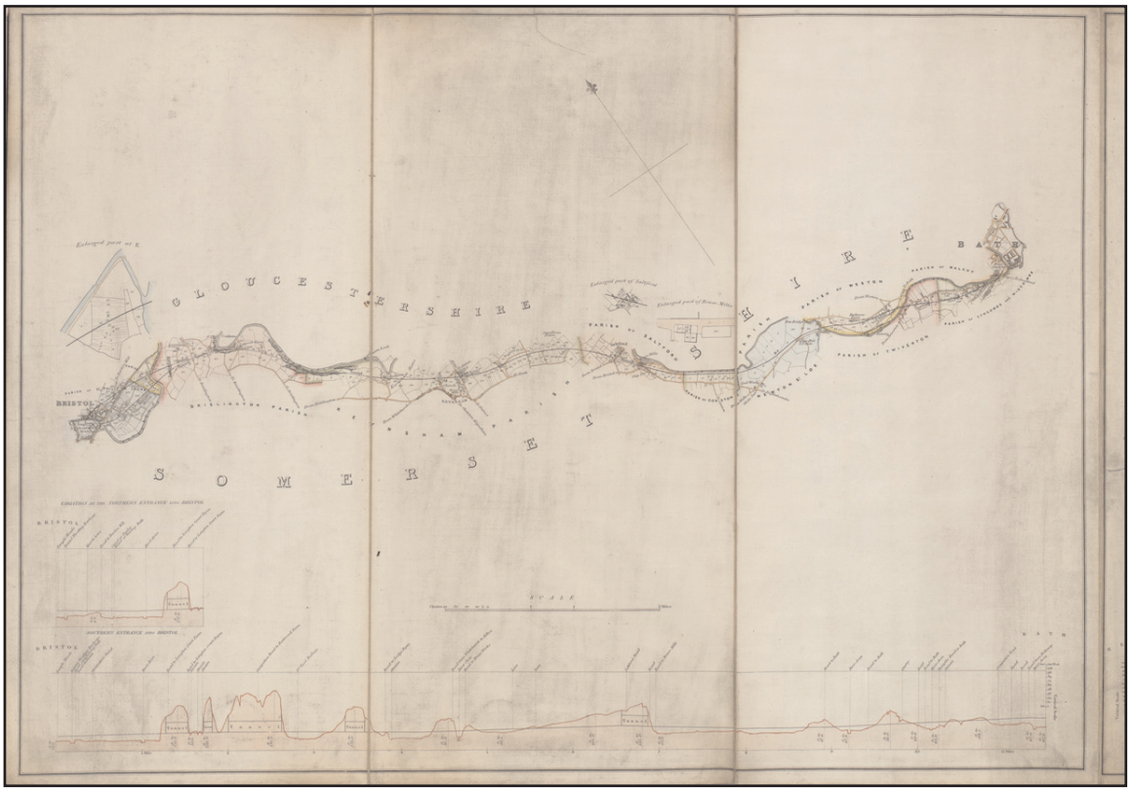
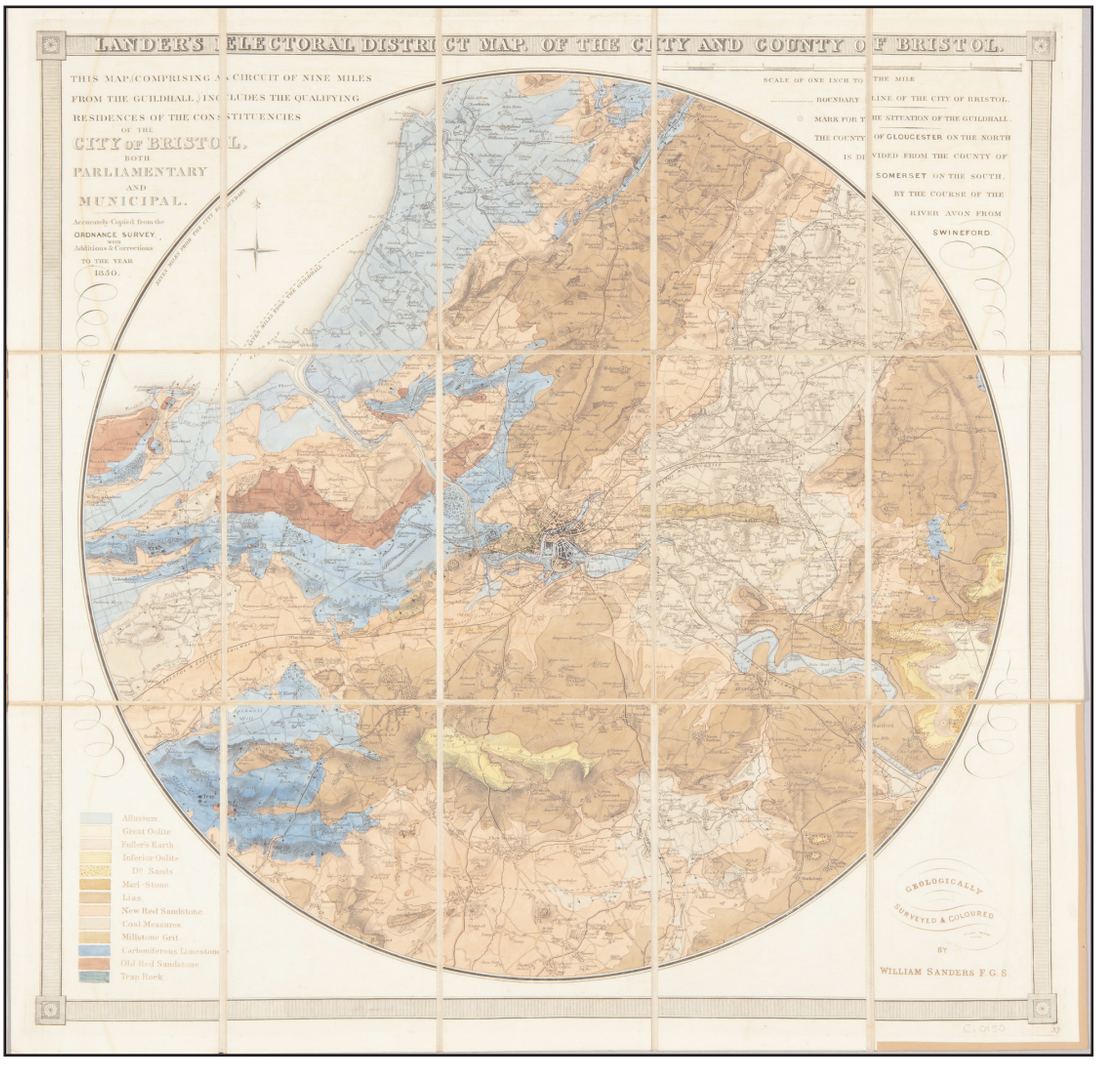


Figure 16. 'Plan of a Railway from London to Reading and from Bath to Bristol, c. 1834. To form portions of a Railway, to be called the Great Western Railway, I K Brunel, esq, FRS, engineer.' This section illustrates the planned route from Bath to Bristol. © Bristol Archives 1035



The map is also a social history document in that it records features of the landscape such as woodlands, commons, field boundaries and buildings - a 19th century view that has changed beyond recognition since the map's publication in 1862.

Further details regarding William Sanders and his map are still being researched but it is hoped that this paper highlights his remarkable achievements. In 1894 Edward Wilson (1848-1898) described how Sanders' map was wall mounted on display in Bristol Museums' second purpose-built building for visitors to enjoy (Wilson 1894), a fitting acknowledgement from the institution he served for many years.

Acknowledgements

The author would like to thank Geoff Walton for correspondence, Jim Webster and David Clegg of the Bristol Naturalists' Society for allowing reproductions of their copy of Sanders' map to appear in this paper, Bristol Archives for allowing reproduction of the Isambard Kingdom Brunel diagram, Alan and Jane Bambury at the Arnos Vale for correspondence, Ray Barnett for reading and commenting on several versions of this paper and Sarai Vardi for her conservation expertise regarding the Bristol Museum atlases. Thank you also to editor Pip Brewer and John Henry who both provided valuable comments and guidance that substantially improved the present paper.

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Facing page: Figure 17. 'Lander's Electoral District Map of The City and County of Bristol, Geologically Surveyed and Coloured by William Sanders FGS'. One inch to a mile. 1850. BRSMG Ci150. © Bristol Culture.

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COMPACTOR STORAGE FOR THE FOSSIL MARINE REPTILE COLLECTIONS AT THE NATURAL HISTORY MUSEUM

by Lil Stevens, Sandra Chapman and Chris Hughes

Stevens, L., Chapman, S. and Hughes, C. 2019. Compactor storage for the fossil marine reptile collections at the Natural History Museum. 2019. *The Geological Curator* 11 (2): 173-178.

Moving museum collections never seems to happen in the same way twice. The differences in specimen types, scale, distance, timescale, funding, staff resource, governance and scope seem to render lessons learned from previous moves almost pointless. Surely there must be a finite number of things that can go wrong, things to bear in mind and things never to do again? This report details our experiences in the hope that one day someone will conduct a specimen move in which all goes to plan.

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Introduction

The fossil marine reptile collections at the Natural History Museum in London comprise many thousands of specimens, from isolated teeth to mounted skeletons. They are broadly grouped into plesiosaurs, ichthyosaurs, amphibians and associated footprints, eggs and coprolites. In the last two years the collections have been moved into compactor storage, a process that has presented a range of challenges, which will be discussed here. The focus will be on project set up, planning and logistics. The technical aspects of preparing, protecting and packing the specimens are presented by Chapman *et al*. [Editor to add link to poster on GC web page]. In combination, this report and the poster presentation provide a complete picture of this re-storage project, including workflows, metrics, experience and advice.

Project organisation

This project combined two collections into one storage area at the museum, with the aim of creating space for an extension of the Conservation Centre. The project was internally funded and was governed using a gentle version of the PRINCE 2 project management method, in which a board comprising staff both from the Science Group and Finance provided assurance, took responsibility and set the scope, convened by a museum project manager who has overseen both the move and the extension. The project manager was also the conduit for our internal support, such as Estates and Security, and the external suppliers and contractors. The authors' roles were to plan the collections move and ensure that the specimens were protected and documented throughout. We provided data on sizes, weights and counts to the moving contractors and cabinet suppliers as well as scoping the new storage, designing the layout and developing packing and moving processes.

Planning the move

1. Count and measure everything first!

Chris Hughes was hired to assist with the move and provide a constant and consistent presence in the collections. Chris spent the first few months counting and measuring the collections and redistributing some of the specimens that could be incorporated into other parts of the department. Counting and measuring became something of a joke between us because we had to do it so many times for different people - we needed to know how much space the specimens would take up in storage, how big the new cabinets needed to be, how heavy the collections were for floor loading limitations, how many boxes and crates would be needed to pack them, how long that would take and how many people. This was our biggest learning curve and something we will do differently next time.

2. Storage

We also needed to find suitable places to store the specimens from the area where the compactors were being fitted. The spaces had to be big enough and strong enough to hold tons of rock and of course available for the time we need them. We didn't have many choices for such a large collection and so unfortunately, we had to store some of the collections in places where the environmental conditions were sub-optimal, which led to some problems later.

3. Moving contractors

Contractors were hired to move the collections into storage and for the return journey. The contractors were more experienced with domestic moves but were very enthusiastic about working with us and gave some examples of how we could pack and move the collections. The main issue was that although the collections were only being moved internally, the route was rough and the length of time they were being stored for meant that they needed to be properly packed. We decided on wooden crates because they would provide protection for the specimens and were also more cost effective than wire trolleys over the long storage period. The bespoke design of the crates also allowed us to pack whole drawers and whole shelves, with the specimens wrapped and packed but still in their original storage. A repeating series of foam and boards were used to support the shelves and drawers within each crate, so that around ten layers could be constructed without undue pressure being placed on the specimens.

Figure 1: Specimens wrapped and packed in situ.

4. Don't underestimate resources!

Estimation of resources is always a difficult issue. Each project is slightly different and often smaller details are not documented, such as how much bubble wrap was needed or how many pieces of tissue were used per drawer. To avoid excess, we bought packing materials in smaller quantities and re-ordered them when stocks were low, but we encountered delays caused by funding authorisation and our obligation to try to use approved suppliers. Our data on numbers of drawers and shelves did allow us to accurately estimate how many crates and boxes we needed and how much space they would require. The data also ensured that the collections would fit back into the compactor cabinets, leaving expansion space where possible. We managed staff resource by having both a dedicated team and a group of staff, students and volunteers who helped when we needed more people. We are fortunate to have such a resource at the NHM and we could not have managed without them.

5. Scheduling - it always takes longer

Figure 2: Packing specimens using bubble wrap, Plastazote and Really Useful boxes

The timing of the collections moves was restricted by other dependencies, such as refurbishing the new collections area, installing the compactors and leaving time for the Conservation Centre to create their new space. Fortunately, after a massive effort by a large team of staff and volunteers, we did get packed up and moved out on time. We also made sure that everyone in the Earth Sciences Department knew what was happening, and that everyone who helped was recognised and thanked. On big projects like this, we sometimes put out a call to all departmental staff asking them for some time and expertise. We think it's a great learning and bonding experience, even if we are left somewhat less popular.

Packing

It's only when you move a geological collection that you realise how varied it is, and this collection was no different. There were drawers with big specimens, little specimens, only one specimen and specimens standing proud of the drawer. There were multiple shelves with the same specimen, specimens that stretched across multiple shelves and multiple specimens on one shelf that needed to be kept in order, such as vertebrae. There were heavy specimens that could be packed onto pallets and big slabs that needed bespoke cases and specialist lifting equipment. How we packed the collections was all dependent on how they were being moved, where to and for how long. Most of the collections were put into 'no-access' storage such as sealed crates. These were stored in a secure room for the duration of the refurbishment works. Very delicate specimens were put onto open racking with minimal packing. Very heavy slabs were crated and moved to our out-store for the duration of the project.

Figure 3: Wooden crates formed using collars placed around drawers and shelves on pallets.

The collections were closed to visitors during the project, so we did not have to maintain access. It's a good idea to think about access and what you're able to give during a large project so that you can warn users before you start in case they are planning projects.

Please see the Chapman *et al*. poster contribution [https://www.geocurator.org/images/resources/prev_events/2017AGM/pres/chapman_et_al_nhm_collections_move.pdf] for the technical aspects of packing the specimens and the processes we developed. We had a great team of staff and volunteers to help us pack. One of the most cumbersome specimens was a 3m long model of Dippy, which clearly wasn't going to fit into any box. We eventually wrapped it in reams of bubble wrap, leaving the outline clear so that the fragile tail, in particular, could be kept safe.

Documentation - keep it simple?

We are starting to use barcodes at the NHM for digitisation and translocation projects, but we hadn't developed a good system for collections moves when we started this project so we decided to keep the documentation for this project very low-tech. We used a Microsoft Excel spread sheet to detail the original and new position of every drawer and shelf. Onto this we mapped box numbers or specimen numbers and storage locations. This worked well in general, and the simple approach made quick restorage of the drawers and shelves much easier. Of course, there were times when we had to change the order of shelves, if specimens didn't fit, and this has added to the post-project inventory work. We also developed packing protocols for the volunteers, for all of our different types of specimen storage, and we used specimen handling guidelines from previous projects. These will be kept and made available for future projects. Let us know if you'd like to use them.

Moving out

It's amazing how a seemingly flat piece of road can become very bumpy when you're moving several hundred-weight of fossils on a trolley, how many doors there are between rooms a short distance away and how you'd never noticed that step before. Our route to the main storage area was no more than a hundred metres away but involved two ramps, a nasty threshold, a bumpy road and nine sets of fire (non-prop-able) doors. Our very valiant moving contractors said the doors were the biggest thing slowing them down. We did what we could with the bumpy road, such as laying boards over the worst areas, but in the end relied upon good packing to protect the specimens.

Figure 4: Moving contractors packing crates and boxes into the storage area.

The contractors were excellent. Having had little experience of moving natural history specimens, they listened to us and were very careful with the move. Because of space limitations, we had to be packing as we moved the bulk of the specimens out and so the process was carefully orchestrated. However, the sub-contractors they used for moving the very big slabs to our out-store were less professional. They were seen kicking specimens and one of them was found sitting on one of the slabs! This has taught us an important lesson and we've since developed guidance for contractors working in collections areas.

While in storage

Our collections are housed in a series of old buildings and environmental conditions vary between rooms, depending also on the time of the year and activities going on. The basement store is cool and slightly humid, as all the best basements are. Unfortunately, the room in which we stored the most delicate specimens is hot, cold, humid and dry in turn and our specimens did not like it and some developed pyrite decay. The specimens have since been treated and conditions improved in the room, but this is something we'll be much more careful of next time.

Redesigning the room

While everything was being taken out of the room, we were also thinking about how to improve the design. A new screed was laid to refresh and level the floor for the compactors. We had the lighting changed to be better placed and brighter. Light paint colours were chosen for the walls and floor, and the cabinets were painted a standard cream, which means that we can spot pest infestations easily.

Arranging the cabinets so that we got as much space as possible was a huge job. We were adding a large collection of marine reptiles into a store we previously considered full, so using compactor cabinets and reducing shelf depth were really our only options. We have lost some expansion space but the one positive is that having extra shelves in the cabinets does create space throughout the collections. We also thought about movement through the store and how lighting would be most effective. We had heard that diagonal lighting gave a constant light when using parallel rows of cabinets, particularly when moving compactor cabinets means that the lights are not always overhead. In the end we were constrained by existing fittings, but just increasing the brightness of the lights has made an enormous difference.

Compactor cabinets

Here we did manage to learn some lessons from other departments who had done similar moves. We had a very enlightening session with a curator who gave us useful tips such as "make sure you get inspection plates in the bottom of each cabinet so if the roller mechanism breaks, they don't need to take out the whole row to fix it" and "make sure the floor is level, otherwise the drawers will come out to meet you". One thing we didn't manage to see was how metal compactor cabinets deal with heavy specimens. Our supplier reassured us that it would be fine and so far, so good, although the floor runners sagged slightly once we'd got the whole collection in and needed to be re-levelled.

We tendered for a cabinet supplier and they have been generally good at communicating and responding to our comments and queries. They don't always understand how collections work, so we had to work hard to ensure we got what we needed. For example, when they designed the layout of the cabinets, they didn't realise that the specimens were in taxonomic and stratigraphic order and that it was important to maintain that order! We tested as much as we could, from handles, to shelves, to doors, to floors, to drawers, and label holders. Changes were made throughout the process even though it sometimes caused delays. We think it was worth making sure we got what was best for the collections and their users.

We have salvaged as much as we can of the old cabinets because we think it's important to re-use and recycle, and many parts of the old cabinets will be useful for repairing others in the department.

Moving back in

Unpacking had to be even more tightly orchestrated than packing up because it was impossible to store the crates and boxes in a particular order and the new compactors meant we could only work in one or two aisles at once. This meant that we couldn't have a big team of people helping, and we had to work quickly to keep up with the movers. We hired two interns, who provided a consistent presence during the move, and used the same moving contractors who had good experience of how the collections were stored. We also unpacked wrapped specimens onto shelves and into drawers, and then unwrapped later, which saved time and was safer for the specimens.

Working in the new space

The collections are now open again and researchers are able to come and study the specimens, using a lovely new workbench, built by Paul Mansfield and

his joinery team from some of the old wood. The room is much brighter and airy than it used to be, thanks to the new lighting and colour scheme, which is needed in a space densely packed with tall units.

There are also lots of opportunities for improvement when you're moving a big collection. Sandra Chapman, the curator, is designing a new documentation system for locating specimens or collections with the updated information she's now got. We have shelf and drawer liners on the surfaces to protect the specimens when the cabinets are moving. The museum is looking at improving the WiFi in the collections areas and our data management team is thinking about testing a new location barcode system in this area.

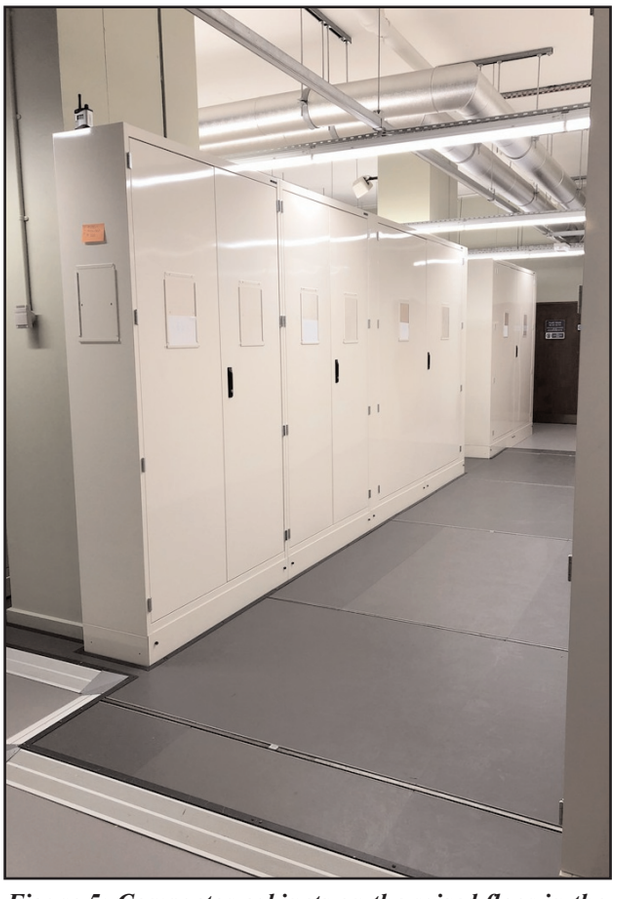

Figure 5: Compactor cabinets on the raised floor in the new store.

There are some downsides too, mostly and predictably associated with the limitations on space. Due to the nature of compactor storage, only one row can be accessed at a time. The available space between rows is small for manoeuvring large objects. The cabinets are much taller than they used to be (up to 2.4m), which impedes access, and the ramp from the raised floor to the ground is difficult to negotiate with a trolley. There is a lack of storage areas for the trolleys and ladders. We are housing our large slabs two deep in a huge cabinet with roller racking, but the depth and height of the cabinet means that access is difficult and we are still designing a lifting system. The area is also one of the entrances to the department, meaning that many people walk through the space, and need to access rooms leading off the store. This has implications for collections security and ease of access for collections users.

Lessons learned

These are things familiar to all of us in the museum sector, but somehow, it's difficult to be prepared for all of them. The biggest lesson we learned is not to underestimate resources required, and that resource is mainly staff. Everybody is busy and taking on a big moving project requires help. Volunteers are great, but you need to set very specific tasks and manage the sessions so that everyone can spend their precious time effectively. In the NHM we're developing a Task Force to provide curatorial assistance to projects like this and we're lucky to be able to do so. This was the Task Force's first big job and we've learned lots of lessons about working with different groups of people, when to step in and when to step back, who to ask for help and how to say thank you. Please get in touch with us if you have any questions or advice on your collections moves.

Business as usual

We are pleased to say that visitor numbers have increased across the 3 major and associated collections and that we can now offer a PC to search the on-line database for the locations of specimens across the three major and associated collections. There is also a searchable e-portfolio of Risk Assessments and Collections Access Procedures e.g. for moving the rows of units using the end rotators, accessing drawers and shelves safely, changing the interchangeable drawer and shelf brackets plus using heavy lifting equipment or hydraulic lifting tables for large heavy specimens. Also provided is a Camera Stand plus additional table lighting and we are anticipating improved WIFI in the space. For security we offer a lockable unit for visitor personal belongings due to 'through' route in and out of the space for all staff and contractors.

It is unfortunate that space also houses an Estates Engineering hub for NHM Air Conditioning and Heating so that access to this by Estates staff/contractors needed to be factored into the design. This was done by creating a flexible width corridor (as shown in figure 5) leading to the hub based on Health & Safety Guidelines with a minimum width for personnel and maximum width for personnel delivering heavy equipment e.g. chiller units. However to access parts of the plesiosaur collection the width

needs to minimized for visitor activity and maximized at the end of each day so advanced warning of staff needing to work in the Estates Engineering hub is essential.

We are currently creating a locations database for the 3 main and associated collections to up-load into the CMS Locations Module to supersede the original pre-compactor locations. Plus we are searching for the appropriate trolleys and high loaders to service the custom built unit 2.8 meters tall x 2.15 meters wide to house the large extra heavy slab preserved specimens stored on roller shelving that due to the lack of space would need to be stored elsewhere on the NHM site. Finally we are working to resolve how to bring into the space high level 'off-loading' equipment though doors that are too low and a lift that is too small!

We would be pleased to hear from anyone who can offer suggestions for a suitable lifting system for the 'slab' unit.

A TALE OF HEAVY FOSSILS: THE HISTORY AND STORAGE OF THE CHARLES MOORE ICHTHYOSAUR COLLECTION.

by Cindy Howells

Howells, C. 2019. A tale of heavy fossils: the history and storage of the Charles Moore ichthyosaur collection. *The Geological Curator* 11 (2): 179-183.

Amgueddfa Cymru - National Museum of Wales (AC-NMW) holds a large collection of fossil ichthyosaurs on long term loan from the Bath Royal Literary and Scientific Institution (BRLSI). This collection was assembled by Charles Moore (1814-1881) in the mid-19th Century, mostly from Somerset, although it now also includes Lyme Regis specimens obtained from Mary Anning and previously donated to the BRLSI. Historically they have suffered many moves, and sometimes less than ideal storage, so in 2017, a new shelving system was acquired by the AC-NMW to maximize safe access whilst minimizing damage to the specimens. This paper has been expanded from a poster displayed at the seminar 'Making the most of a move' in Dublin, November 2017.

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History of the collection

The geologist Charles Moore was born in Ilminster, Somerset, and lived in Bath from 1837-1844, and then again from 1853 onwards. He was an avid fossil collector, discovering the famous Strawberry Bank lagerstätte from Ilminster, and Rhaetic fissure deposits from Holwell, amongst many others outside the remit of this paper. He also assembled an astounding set of articulated marine reptile skeletons, mostly ichthyosaurs, mounted flat in wooden frames. He became a member of the Bath Royal Literary and Scientific Institution in 1853 and offered them his extensive collection on the condition that it would be exhibited as a free museum. He was readily given the use of their large ground floor room in Terrace Walk. By 1856 he had at least 23 ichthyosaurs in mounted splendour on the walls, and by 1879 there were at least 43 large vertebrate specimens, which included plesiosaur casts, and a small mounted teleosaur (Pickford, 1975, M. Taylor pers comm.). The rest of his collection was displayed in purpose built glass topped cabinets with drawers below. It is however worth noting that Copp *et al*. (1996) suggest that older BRLSI ichthyosaur specimens may have become incorporated with the ones that Moore actually obtained himself. The 'Moore' collection in the AC-NMW includes a huge 3D *Temnodontosaurus* skull, donated to the BRSLI by the engineer W. H. Eastwick in 1825 (Torrens, 2008) which is supposed to have been one of those collected by Mary Anning, although the only evidence for this is a small label in Moore's own handwriting (M. Williams pers. comm.). One of the mounted skeletons was presented by J. Templeman, and this has been shown by Torrens (2010) to have been purchased from Mary Anning in 1828.

After Moore's death in 1881, an appeal raised £1200 to purchase the collection from his widow Eliza, and the Rev. H.H. Winwood was appointed honorary curator. Luckily we have good photographs of the gallery in its original form, some with Moore himself in a central pride of place, as things seem to have deteriorated after his death. As reported in the anonymous Notes and Comments of *Natural Science* in December 1895:

> "No geologist can visit the Bath Literary and Philosophical Institution without feeling deep and just indignation. The specimens are nominally under the care of an accomplished honorary curator of wide experience, universally respected by his fellow geologists; practically, his advice is set aside by a preponderance of conflicting interests, and the result is a disgrace to anybody of educated men at the end of the nineteenth century, beautiful slabs of rock with delicate projecting skeletons of reptiles are left to the tender mercies of the audience who crowd into the *quondam* museum, attending lectures and entertainments. Ugly pieces of wood are nailed across the frames, and occasional pieces of coarse netting testify to at least some qualms of conscience on the part of the

Figure 1. Moore's marine reptiles on the wall of the BRSLI, pictured before the iron gallery was built in 1875. Image courtesy of Matt Williams @ BRLSI

> Bath committee. If these precious specimens are to be kept apart from the remainder of the collection and to decorate a lecture hall, they ought to be covered by secure glass cases, which would preserve them from accident and mischievous fingers. Better still if the subscribers who purchased the Moore Collection for the native town of the geologist who amassed it, had the opportunity of making some competent State Commission its permanent trustee, and rescuing it from the vagaries of a mixed local committee." (Anon 1895)

Various moves

In 1899 the BRSLI amalgamated with the 'Bath Athenaeum' and all specimens except the large mounted reptiles were moved upstairs with some muddling of labels and loss of specimens. Winwood died in December 1920, and the care of the collections declined still further. Old annual reports record vandalism and thefts (Copp 1975). In 1932 the institution was moved to 18, Queen's Square, as a new road scheme meant the old building was to be demolished. Here, the ichthyosaurs were remounted on the walls of the new 'Moore Room', and reunited with the rest of Moore's original exhibition cases. At the outbreak of war in 1939, the curator, F.S. Wallis, was given 48 hours' notice to quit before the building was requisitioned by the Navy (Copp *et al*. 1997). The large specimens were hurriedly boarded over, whilst the rest of the collection, packed into 58 wooden crates, suffered a move to Bristol Museum for the duration of the war, not returning until 1959. The full story of the main collection can be read in several papers within Volume 1 (3) of the *Geological Curator*, and also Copp *et al*. 1997.

Removal to Cardiff

By 1959, there were 34 large frames containing ichthyosaur and plesiosaur remains in the BRSLI, although 3 were casts (Pickford 1975). The entire collection was now under the care of Ron Pickford, a long term GCG member, who took a personal and intense interest in restoring the collection to its former eminence (Torrens 2010). In 1960, Dr Robert M. Appleby, of University College, Cardiff visited the collection to record the ichthyosaurs. Three years later, in April 1963, most of these were removed from the walls by Pickford and a "large (but strong in the arm and thick in the head) Porter/Custodian" (Torrens 2010, p.248). Pickford made crates for each one, and they were sent to Cardiff for study and conservation. This was to result in a paper describing two new species of the genus *Protoichthyosaurus* (Appleby 1979), with the two holotypes and two paratypes being part of this collection. The National Museum of Wales agreed to house all the specimens for safe keeping for the duration of his research,

Figure 2. Ichthyosaurs stacked in one of the stores.

Figure 3. The old racking, just prior to its removal in spring 2017.

keeping them stacked in several piles on the floor of the Palaeontology store. In order to stack the specimens, several had to have their frames deepened with the addition of extra timber strips - from whatever wood could be found. They were also then 'protected' with a thin 'lid' of hardboard screwed onto the top. This all necessitated lifting them by hand and unscrewing the lids when any were required for study by Appleby, who invariably wanted the specimen at the bottom of the pile! (S.R. Howe pers. comm.)

Although most of the collection had come to Cardiff in 1963, it was pointed out by Ron Pickford in 1981 that one huge specimen had been left behind as the team had been unable to move it. Ron had concerns about the safety of this remaining specimen and hoped it could be brought to the National Museum of Wales after all. A team was assembled and headed off on a rescue mission. This specimen was composed of fairly thick blocks of limestone, set in plaster, in a large frame, and was stored in the tiny boiler room in the museum basement. It had to be carefully man-handled through small doorways, round tight corners and up a flight of stairs, all by hand. The four man team (Steve Howe, Tom Sharpe, Ron Pickford and Bill the van driver) had just achieved success and emerged with the specimen onto the pavement in front of the building, when suddenly the whole specimen detached itself from its frame and crashed to the floor in separate blocks - right in front of a visitor to the BRSLI. At least it was easier to get into the van that way! At the same time, two plaster casts, of an ichthyosaur and a plesiosaur were also transferred to Cardiff.

Storage on racking

Most of the ichthyosaurs are mounted flat, set in plaster and still supported by their original wooden frames dating back to the mid, or early, 19th century. They were originally designed to be mounted and displayed vertically, and weren't built with the longitudinal strength to cope with unsupported horizontal storage. They are mostly very heavy, and many of the longer ones are prone to flexing, thus causing much damage over the years. Eventually the AC-NMW purchased Dexion racking units to store the fossils, and save staff injuries. These were customised by the addition of a few ingenious home-made runners on each level which could be slid sideways to support the frames where needed. Unfortunately the Meccano-like construction of these had projecting portions both above and below each rack, which restricted the available space.

Along with the shelving, the museum purchased a small, battery-powered, fork-lift truck in order to assist with the moves. This had a customised ball-table which enabled the heavy frames to be easily slid and rotated, thus saving much muscle power. After several decades, the huge batteries became difficult to maintain and to keep charged, so the fork-lift was replaced with a sturdy, manually operated scissor-lift trolley, with a ball-table top, which can be extended up to the penultimate shelf, and allows even the heaviest specimen to be extracted by just two people. The scissor-lift trolley was purchased from Advanced Handling Ltd, of Peterborough.

Moves and conservation

Major building projects in 1990 led to the redesign of part of the Geology Department and the 'Boiler-

Figure 4. Accessing the specimens with the trolley.

house Store' became a stairwell. All the roller racking compactor-units and specimens from that room were relocated to the 'Basement Gallery Store', including the old Dexion racking that held the ichthyosaurs. Some of the specimens were displayed in the NMW 'Dinosaurs from China' exhibition between 1986 and 1988, and were conserved at this time. Subsequently, funding from the Area Museum Council for the South West enabled most of the specimens to be strengthened by the addition of block-board or plywood bases in the late 1980s. Avon Libraries also contributed £1,000 towards the cost of the materials for this project (Taylor, 1985). Several were conserved before being lent to other museums (eg, Bristol City Museum, and Hancock Museum, Newcastle) for various exhibitions in the 1990s.

Figure 5. Block-board bases for extra strength.

Safety concerns

Recently, renewed interest in the revision of ichthyosaur taxonomy has resulted in many academic visits to the collection in the last decade. However this also increased the wear and tear on the old Dexion racking system to the point where some of the long beams were starting to warp, and the supporting runners were able to drop out of place. This was found to be not a result of downward load forces, as the ichthyosaurs were all well within the weight limit of the racks, but was a result of the forward and backward movement applied whenever the heaviest specimens were accessed. Initially the racking had been installed with metal retaining straps to prevent this happening, but over the years these had mostly become lost. Due to concerns about the safety of staff and also the specimens, in 2016 the racking was put out of bounds until it could be replaced.

New, modern racking

In 2017, funding became available through the AC-NMW, to replace the racking with a totally new system based on the same requirements as before. The option just to replace defective parts of the original racking was quickly ruled out as newer Dexion units are incompatible with the older non-metric system. The project was put out to tender and three companies were considered. *Link 51* were chosen as they offered a system that gave both sensible and accessible storage within a reasonable budget. Their 'carton-flow' system is designed to be used on a slope to allow boxes to be loaded from one side, drift down the slope through gravity, then picked up from the other. If the shelves are instead laid horizontal, this allows easy movement of even fairly heavy objects, as long as they have a flat base.

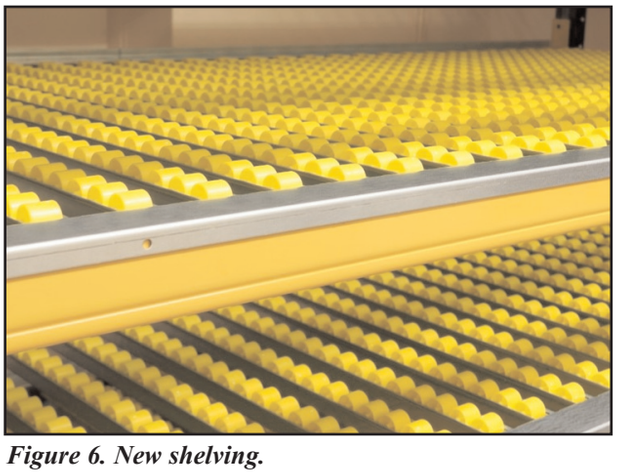

Figure 6. New shelving.

The most demanding part of the project was then figuring out how and where to safely store the specimens whilst the racking was being built. Several heavy specimens had been unmoveable for many years as struts running lengthwise underneath them were jammed on the rollers, and these eventually had to be carefully lifted off by a 6 man team! Space was found in various stores; smaller specimens on benches, and larger ones stacked with chocks to allow fork lift access. Great care was taken to minimize further flexing of specimens as they were moved to other locations, down ramps and round corners, using every available fork-lift, ball-table, trolley and skate.

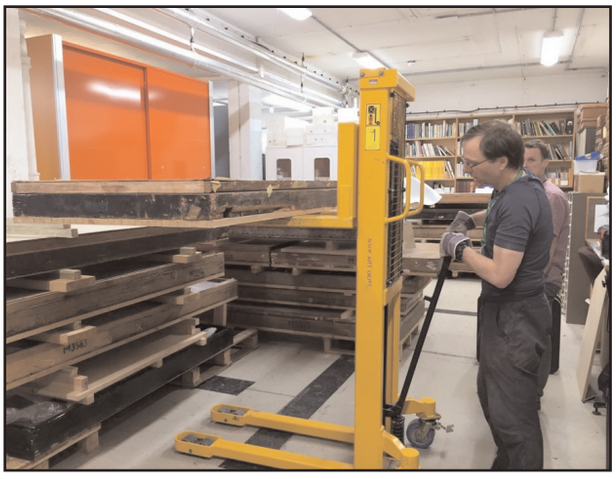

Figure 7. Temporary stacking in the zoology store.

The old racking took just one day to remove, and the new system was easily installed in a further three days. This has a continuous surface of rollers on each level, supporting the large frames much better than just using two or three runners as before. Although there is no sideways movement, even the heaviest frames move freely forwards and back. A slightly raised lip at the back of each level prevents specimens from rolling off the back. One or two of the specimens still had longitudinal struts underneath which didn't move freely on the runners, so a flat base plate was mounted underneath them. All the specimens can now be easily accessed by two, or at most, three members of staff, with no heavy lifting involved.

Figure 8. New racking with specimens, 2018.

All the specimens have now been re-photographed in high resolution and these images should allow for remote study of the specimens. At least four papers on the ichthyosaurs have been published in the past few years, with more in preparation. The new, improved racking allows much safer and easier access for staff and researchers, and it is hoped that a programme of future conservation work on these specimens will be possible, subject to funding.

Figure 9. The holotype of* Protoichthyosaurus prostaxalis *©AC-NMW.

Acknowledgements

With grateful thanks for information from Steve Howe, who mentored me from the very beginning, and is still a fount of all knowledge about the NMW, its collections, and its history. Also to Matt Williams of the BRLSI who helped with useful information about the Moore collection, and the image of the original gallery. Finally thanks to Mike A. Taylor who was able to add many useful comments when reviewing this paper, having been involved with the collection in the past.

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ONE VERY LONG SLOW MOVE - WITH BENEFITS: IRELAND'S NATIONAL GEOLOGICAL COLLECTION

by Matthew Parkes

Parkes, M. 2019. One very long slow move - with benefits: Ireland's national geological collection. *The Geological Curator* 11 (2): 185-191.

This paper outlines the benefits of a protracted move, over many years, accompanied by a concurrent documentation project, for the geological collections of the National Museum of Ireland. Long neglected, and in storage for nearly 60 years, the collections have now been unpacked and moved to one site in the Collections Resource Centre, near Swords in County Dublin. An Inventory documentation project has collated basic data on the collection into an Adlib database, but all the physical storage and organisation has been improved in the process. The long, slow, careful move has made the collections fully accessible for the first time in around a century. It has opened up the potential to make further significant improvements in collections care, access, data records and use in exhibitions and research.

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Introduction

This paper briefly outlines how the geological collections of the National Museum of Ireland have benefitted from a protracted process of an inventory level documentation project coupled with a slow relocation of collections from one Natural History collections store to a new Collections Resource Centre for the whole National Museum of Ireland. The long timescale involved in the process was advantageous in allowing a careful, considered approach with an emphasis on improved access to collections, as well as significant improvements in the standard of collections care and storage.

Historical background

A general history of the Natural History Museum in Dublin was written by the former Keeper, Colm O'Riordan (1983) but the only significant publication on the geological collections to date, is that by the present Keeper of Natural History, Nigel Monaghan, included in a thematic set of papers from a GCG Meeting on Geology in Irish Museums (Monaghan 1992). Figure 1 illustrates the Annexe building which housed the geological collections, which have in large part in crated storage since 1962.

A survey of the state and status of geological collections in the Republic of Ireland (Parkes and Wyse Jackson 1998) of course included the Natural History Museum in its results, but these were categorised and amalgamated to look at the national picture, without museum-specific detail. A comparative study and report on the needs of the Natural History Museum (Moriarty *et al.* 2005) found the Museum to be significantly under-resourced in staffing, but did not examine collections in any depth.

The origins of the Inventory Project

In 2007, the Comptroller and Auditor General (effectively the State's own financial and value-for-money watchdog) published a report on the National Museum of Ireland. In terms of Collection Management, the report was quite critical:

> …there are significant shortcomings in its capacity to keep track of its collections
>
> …An important step in tracking artefacts would be to establish a comprehensive electronic record of all collection objects
>
> …many artefacts continue to be stored in poor conditions in 11 of the 17 storage facilities of the NMI…Overall, the NMI faces a considerable challenge in attempting to provide for the curation and preservation of all the material that comes into its ownership and care.

Whilst these criticisms were valid, the prolonged under-resourcing of the National Museum of Ireland, since at least the foundation of the State was argued by the Museum as the reason for the poor state of collections care. The Government response, through the Department of Arts, Sport and Tourism, was to fund a major Inventory Project, with an initial lifespan of

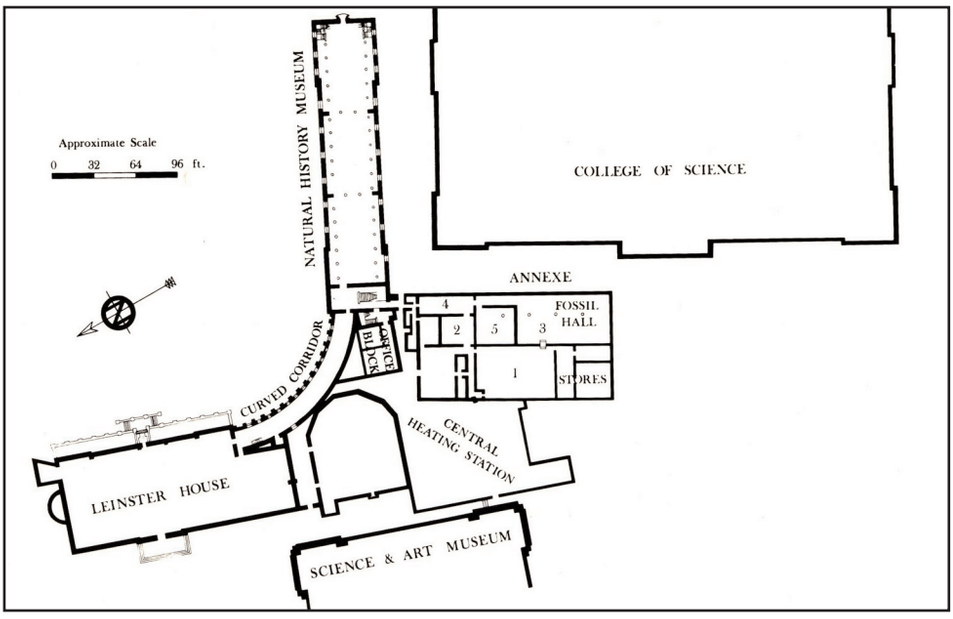

Figure 1. A building plan of the Natural History Museum and the Fossil Hall in the Annexe. Today's museum is only a zoological gallery. The annexe which housed the geological collections was demolished in 1962 to make room for the bar and restaurant in the Dail, the Irish Parliament.

five years. Approximately 20 extra staff, as Documentation Officers and Documentation Assistants were engaged to populate the Museum's Adlib database with inventory level records of the entire collection. Inventory level records, in the context of Natural History collections are the fundamental data of a specimen number, an identity (as historically recorded), locality, acquisition source, relevant dates and confirmed current storage location of the specimen. In reality, all available data for specimens on labels and in registers was recorded except where detailed published data was available, and this was not included due to time constraints. The inventory level recording was intended to get a measure of control on collections management but it was accepted that MDA standards would not be met. This project began in 2008 with a team operating at each of the Museum's four divisional sites (O'Neill 2010; Anderson 2013). Four Documentation Assistants supervised by one Documentation Officer were assigned to Natural History as a whole. As the scale of the task became better understood as every room, every crate and every drawer were opened and investigated (Figure 2). Although individual team members left and were replaced, the number in each team remained constant (Figure 3). However, the scale of the task meant that the whole project was extended from an original 5 years, effectively to 8 years long.

In the 8 years that the project ran, nearly everything in the Earth Science collections was documented at a basic level, although inevitably some residual collections remain to be sorted and curated. The author is currently dealing with the estimated 10% of conventional geological collections (rocks, fossils, minerals) which are problematic in some way. In addition, a large and as yet not fully documented collection of Irish Quaternary mammals excavated from caves and other Quaternary faunas remain to be documented and moved. It should be recognised that in natural sciences especially, many collections are document-

Figure 2. A small sample of some 650 crates of geological collection, which have all been opened, assessed, registered, organised into new storage and then moved to Swords CRC.

Figure 3. The last Documentation team, left to right: Sara Dickinson, Alan O'Connor, Stephen Callaghan, Joanne O'Meara.

ed at only the level of a jar or container, especially with zoological collections, and the tens, hundreds or thousands of individual specimens within, await closer attention in the future. Similarly with Quaternary cave faunas many boxes have hundreds of bones within them.

Moving collections to Swords Collections Resource Centre

Moving collections to the Collections Resources Centre (CRC) initially arose as a separate project, unrelated to the Inventory Project, but the two processes quickly became intimately linked to each other. In 2007 there was a plan to undertake a major renovation of the Natural History Museum in Merrion Street in the heart of Dublin City. The plan included adding a sliver of a new building to the side of the existing 1857 construction to help resolve many of the fundamental flaws arising both from the age of the building and time. Modern requirements for universal access were to be addressed as well as providing much needed facilities for today's visitors. Although the implementation of this plan was sadly and unexpectedly halted due to the collapse of an historic staircase, some of the preparations it had initiated continued and were instrumental in the creation of the CRC.

At this time, exploratory visits to large commercial warehouse style premises were made with a view to housing the entire Natural History Museum collection for the duration of the renovation and building project. One of these premises was the former electronics factory in Swords (a large town to the north of Dublin City, close to Dublin Airport), which became the CRC (Figure 4). The poor storage facilities identified in the Comptroller and Auditor General's Report (2007) were a contributory factor in the decision to take on a massive storage project. It was decided to move and consolidate collections from many storage locations, often with poor environmental conditions, including some scattered across the Midlands of Ireland.

Figure 4. Swords CRC is a former electronic factory, seen here from the front.

Rather than simply moving problematic collections, which had never been documented beyond a line in an acquisition register, from one location to another, it was decided that nothing should move to the CRC without being registered in the current systems and entered in the Adlib database by the curator or by the Inventory Project team. This decision alone represents a major step forward. In essence, the approach taken within the Division was that no move of collections should take place that did not result in some material improvement in the status of those collections. The National Museum of Ireland was also able to make the required capital investments, as part of developing the CRC, to acquire adequate new furniture in rows of metal storage cabinets, new Z-MDF (zero formaldehyde emissions) drawers to take the specimens and new long-span shelving for larger specimens. In essence this move provided the opportunity to have all the natural history collections, not on public display, in one store, all registered and accessible for the first time.

Inevitably, a residual quantity of specimens still remains to be worked through but this is being tackled steadily, since what remains is either long neglected material, divorced from any actual data about it, or is problematic in some way, requiring focused, extensive time commitment. Part of the reason for these elements not having been tackled to date, is the acquisition of extensive new collections during the course of the Inventory Project and the move to the CRC. The new material included approximately 10,000 mineral and rock specimens, plus several thousand fossil specimens from the teaching and reserve collection of the School of Geosciences in University College Dublin (see later discussion). As with any acquisitions, a Museum must balance the projected costs and resources required to absorb a large collection, but as a National Museum, such Irish material is a priority acquisition target and they will remain secure, even if the curatorial capacity (i.e. the author) is not available now.

During the gestation of this paper, a further Inventory Project has been applied for, approved and funded, and is expected to start early in 2020. It is estimated that fully resolving the geological collections to bring everything up to inventory level documentation will take several years. It is anticipated that the project will also support the curator in improving the depth of data for many collections and further improvements in the physical organisation and care of the collections.

Removal protocols

Physical movement between the store in Beggars Bush and the CRC was virtually all completed with the assistance of professional movers (in this case William Tracey and Sons Ltd.) who had tendered for the Museum contract. Their skills, resources and adaptability to 'difficult' museum specimens were vital to dozens of successful moves. Establishing a good working rapport with them was essential and mutual trust was quickly settled.

For the bulk of the geological collections a protocol of preparing 26 pallets (the capacity of two specific trucks) worked smoothly. Each pallet was of a plastic type, kept clean and free of dirt and insect pests. Previous experience with pest infestation from the Natural History Museum itself (Vaucheret and Leonard 2015) emphasised the importance of pest management. The majority of geological collections was deemed fit to move without freezing, having been thoroughly examined, cleaned, rehoused in new trays or boxes and stored in new drawers, and not being composed of edible material, like the various zoological collections which were moving in parallel. However many larger items, such as ichthyosaurs in historical wood and plaster frames (Figure 5), and especially intricate specimens such as stalactite blocks were sealed in plastic on arrival and left in a quarantine store in the CRC for many months before being released after checking for any visible pest evidence. If possible anything from Natural History Division moving to Swords CRC was frozen to kill any pests, but not all materials or custom storage cabinets were possible to freeze and quarantine was applied to all of these.

To compile a pallet, four stacks of seven standard geology drawers was put together to form a rigid block (Figure 6). Each drawer had a light packing of cut-to-size bubble wrap on top of the specimens if required, which stabilised them in transit. The sides of the pallets were braced with metal shelves from a redundant or disassembled cabinet system. Hard plastic tape, of the sort used in packing white goods in retail and distribution was used to clamp the block of drawers to the pallet and around them to hold them together. Re-usable clips meant the tapes could be reused a number of times.

The four top drawers in a pallet block could be used for specimens that were higher than the sides of a drawer. Alternatively an inverted drawer could provide a 'box' for larger specimens and obviously some custom packing was required for very delicate or odd sized specimens. However, in the course of dozens of moves this system worked exceptionally well and no

Figure 5. Some of the large collection of ichthyosaurs and plesiosaurs ready to move to Swords CRC in a Tracey's truck with air-ride suspension and thick cushioning mats on the floor of the truck. A large roll of thick plastic is ready for wrapping them in position on their long span shelves as a quarantine measure against pest transfer.

Figure 6. A series of pallets ready for a move.

breakages were seen as a result of the moving process. The pallets could be very quickly loaded and unloaded with a pallet truck and only required stabilising with extra hands if on a ramp or slope out of the building (the truck had a tail lift, Swords CRC has proper loading bays with adjustable levels). The folded layers of bubble wrap rolls were reused with the next transfer with minimal effort if kept in their flat layers.

New Acquisitions

Broader awareness within the Irish geological community of upgrades in collections care, coupled with the significant new capacity in storage provided new opportunities to address issues with geological collections outside of the Museum. This resulted in several new major acquisitions during the course of the twin projects, whose registration and storage was also completed by the Documentation Team.

Figure 7. The PhD collection of Ordovician discoidal fossils collected in Morocco by Breandán Anraoi MacGabhann of NUI Galway before its transfer to NMI.

The new acquisitions included a major PhD collection of Ordovician discoidal fossils collected in Morocco by Breandán Anraoi MacGabhann of NUI Galway (Figure 7), and the private collection of Carboniferous fossils from his own land of the late Gerard Spencer, donated by his family. The family of the late Peter Lewis also donated his personal collection of rocks, fossils and minerals, much of it collected during his time as President of the Irish Geological Association, although this came after the Inventory Project had ended.

The single biggest entity to transfer collections was the School of Geosciences in University College Dublin (UCD). Although the transfer of collections occurred in several different phases, it was essentially all driven by two factors. The important primary one was the organisational demands on space within the University and a lack of adequate storage space available as student numbers grew and buildings were renovated. Secondarily, the transitions in teaching methods and styles meant that actual rock, fossil and mineral specimens no longer play such a pivotal role as they did in the past. In a curatorially satisfying way, some of the transferred specimens were in fact returning from century old loans (Figure 8). When the Royal College of Science for Ireland (a predecessor to UCD) occupied the buildings adjacent to the Museum on Merrion Street, they also shared some staff, who treated the collections as teaching collections and were clearly somewhat cavalier in their approach).

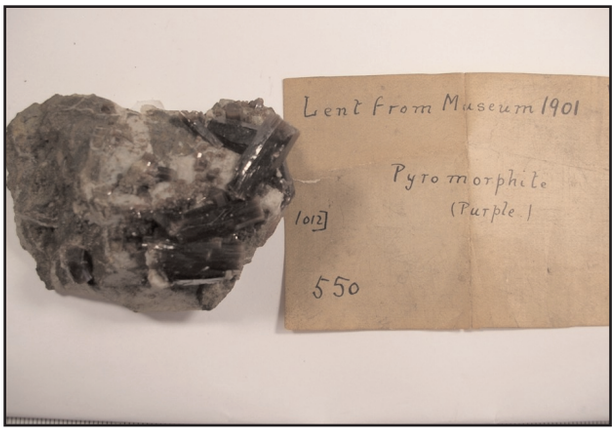

Figure 8. A pyromorphite specimen lent to the Royal College of Science and Art from the Museum in 1901 and returned more than a century later with the UCD collections transfer.

The first collection to transfer was a large palaeobotanical collection, mostly from the famous late Devonian Kiltorcan locality. Then the bulk of the palaeontology teaching collection was transferred. In a separate move a large teaching collection of minerals was transferred from very poor storage in shipping containers, which had been a temporary measure during building works, but which had become a long term problem (Figure 9). The rescue and cleaning of these minerals became a major project for a volunteer team led by Dr Patrick Roycroft (with some financial support from the Heritage Council), whose search for some specimens of Cotterite (Roycroft 2016) precipitated the collaborative transfer with the positive support of Professor Stephen Daly and Professor Frank McDermott, as successive Heads of School. Subsequently, further transfers of more mineral and rock collections were made, which collections are now in the queue for curation.

Figure 9. The short term solution becomes long term and then becomes problematic, with very poor environmental conditions for specimens for the UCD rock and mineral collections.

Benefits of the move

The primary result of the prolonged move of geological collections has been very significant improvements in collections care across the spectrum of the rocks, fossils and minerals. In summary, these improvements include:

- an electronic record of all collection specimens through the Documentation Project
- almost all specimens, registered, numbered and curated
- many specimens have significantly improved storage
- delicate minerals and fragile fossils in shaped plastazote beds
- almost all specimens now in acid free card trays, or other improved containers
- many specimens have had individual card tray labels added
- many specimens have been cleaned in the process
- the collections are now physically accessible for research and use (Figure 10)

It is not possible to put absolute numbers or percentages on the quantities of specimens whose storage has been improved as this was not monitored or recorded during the process. The simple fact is that every specimen extracted from 1962 newspaper wrappings within sealed crates has been improved by being unwrapped and made accessible with a registered number and an accompanying database entry. An acid free card tray or plastic box or a plastazote™ lining in a Z-MDF drawer is the minimum improvement for most specimens. Particularly delicate minerals or fossils will mostly have had a custom-cut plastazote™ bed made for them.

Identified tasks for further collections improvements
In addition to the immediate improvements in collections care established by the combination of Inventory Project and the collections moves to CRC, there are many further upgrades enabled by the changes. Many of these are either now in hand or are planned for the immediate future. The principal new situation is that the documentation and physical reorganisation combined with easy access means that prioritisation of collections research projects and consequential upgrades is now achievable. The following section briefly outlines some examples, concerning radioactive specimens, asbestos specimens, pyrite decay and so on.

Although preliminary checks indicate that all of the naturally occurring radioactive specimens have very low levels of activity, there is a necessity to address the issue as a Health and Safety concern. An immediate priority is an assessment of the improvements and protection needed for the suite of radioactive specimens which have now been identified. Assessing what type of emitter they are, in consultation with the Museum's Radiological Protection Adviser will determine what measures are appropriate to best manage the risks involved.

Figure 10. For the first time in a very long time, the geological collections of the National Museum of Ireland are accessible for research.

As another example, health and safety concerns with asbestos minerals required specialist external assistance. This has developed into a management plan to further improve the curatorial handling of this mineral group. In addition, aside from a large selection of neglected historical mineral specimens without any data or identifications, an assessment of the scope of toxic minerals needing repacking and labelling is now possible. The task of bringing in specialist mineral curators to assess and identify the neglected collections is also now quantifiable and will be commenced as resources can be allocated to the project.
The perennial problem of pyrite decay was seen in multiple cases but attempting to halt it with treatment or to provide customised storage was not feasible in the course of the Inventory Project and the move to the CRC as there was continual pressure to feed work with organised collections to the Documentation Team. The necessary work to arrest pyrite decay and provide longer term storage is now needed.

The packing of collections into storage in 1961 was clearly done rapidly and with people who were not all geologically trained. Many of the inventory sheets inside each crate were annotated with description or lists of contents that were not made by a geologist. Aside from understanding these limitations, it is clear that many of the specimens were already in a disorganised state of neglect since the foundation of the State or even before. Of course, the physical han-

dling of specimens and their organisation from out of storage has provided the potential to 'resurrect' many collections, especially of minerals or building stones. One such priority will be to recognise the founding Leske Cabinet Collection again as it had been integrated into the 'General Collection'. The Royal Dublin Society purchased the mineral and rock collection from Leske's widow in 1792 for £1350, with a view to stimulating the search and development of economic resources on the lands of the members. Some 7331 specimens were later catalogued but are now only represented by around 1500 'Leske' specimens in the Adlib database. Familiarity with label styles across the collection means that it should now be possible to reclassify thousands of specimens as part of that founding collection which transferred from the Royal Dublin Society to the Natural History Museum.

Conclusions

The previous multiple moves of geological collections cared for by the Natural History Museum in Dublin have largely been a case of moving the problem from one physical location to another, which is probably the case for many other museums addressing urgent buildings problems. The recent opportunity to have a very prolonged move, coupled with a significant project team of Documentation Assistants working on an Inventory Project, has meant that the collections have been massively upgraded in all respects, with scope and potential for many further improvements. This includes collections care and organisation for curatorial benefits, in data records about the collection, in physical access for use in exhibitions and research and for their promotion as a national heritage asset. It also provides the future proofing of both good physical infrastructure of cabinets, shelves and drawers and an expertise in moving them, such that when another move may become necessary, the task will be relatively uncomplicated and safe. In fact it is likely that a future move will allow the small anomalies in organisation of storage of collections to be eliminated and their arrangement improved again. Space allocations for likely (policy led) future acquisitions can also be allowed for in a future move.

Acknowledgements

The following people are thanked for their various contributions to this paper: Nigel Monaghan; Paolo Viscardi; all of the members of the Documentation Team over many years; Judith Finlay; all of the team of William Tracey and Sons Ltd; Patrick Roycroft for his work on the UCD minerals and all of the very many volunteers who have contributed enormously to the work of the Natural History Division. Including names involves the risk of accidentally missing out someone, but the collective input of all those individuals is immeasurable.

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GEOLOGICAL CURATORS' GROUP

44th Annual General Meeting

44th Annual General Meeting of the Geological Curators' Group.
Collins Barracks, Benburb Street, Dublin, Ireland.
Tuesday 14th November 2017, 4pm.

1. Apologies for absence.
John Martin, Paul Ensom, Tom Sharpe, Adrian Doyle, Mick Stanley, Alex Peaker, Sarah King, Helen Kerbey, Will Watts, John Nudds, Steve Howe.

2. Acceptance of the minutes of the 43rd AGM held at the M-Shed, Bristol.
Acceptance proposed: Mike Howe. Seconded: Emma Bernard. Agreed, with the following amendments:
6. Treasurer's report.
Change date of accounts from 2104 to 2014.

5. Secretary's report.
5.2 Sum offered is £100 not £1000.

12. Collection Officer's report.
Capital letter in British Geological Survey.
Abbreviation for International Geosample Numbers is IGSN not IGDN.

3. Matters arising.
17. Presentation of the Brighton medal.
The medal presentation was postponed, but has been presented to Graham Worton recently by Giles Miller. The event was posted on GCG social media sites.

4. Committee reports.
This year it was decided that the GCG Committee would produce an Annual report instead of separate reports from individual Officers. This was sent to all registered delegates. The following is a brief overview of the sections covered in the Annual report.

4.1. View from the Chair.
Matthew Parkes gave an overview of GCG work over the past year, in particular, the overhaul of the GCG website and changes that allow it to host readable issues of publications and take events bookings and payments. There have been changes to how the Committee functions; and our relationship with other groups such as NatSCA and SPNHC, in particular we have signed a Memorandum of Understanding with these two groups. Our relationship with the Geological Society (GS), of which we are a Specialist Group, has been rejuvenated and we now have a GS advisory representative, Sally Thompson, who acts as liaison between the two groups. We are also trying to strengthen overseas links by exploring connections with groups such as the Society of Mineral Museum Professionals (SMMP) in the USA.

4.2. Membership and networks.
GCG subscriber numbers have been stable for several years and we now have members in 20 countries. We now have online membership payments and renewals, which we hope will make it easier for people to join GCG.
As noted above, GCG has regular contact with the Geological Society, NatSCA and SPNHC. We also consult with the Earth Science Education Forum (ESEF). Email correspondence has been received on a variety of topics. A new website, and publishing committee email addresses, has helped this with enquiries now being logged. This is a reflection on the work going on behind the scenes in making GCG more visible and the first point of contact for geological collection enquiries.

4.3. Events and participation.
2016 Seminar & AGM "From the shore to the store", in Bristol. A full programme of 7 talks, with over 50 delegates attending. 19 also visited Redcliffe Caves and Bristol Museum Stores on day 2.

Reorganisation has led to a reduced events programme in 2017, but GCG supported the 26th SPPC meeting held in conjunction with SVPCA in Birmingham. GCG will be looking at ways to develop this long-standing event in future years. We are rolling out online booking for events, which we hope will streamline the experience for attendees and organisers. Events for 2018 include May - Workshop on dealing with pyrite decay; September - Joint meeting with HOGG on collectors and collections of South-west England, and the AGM in December. Potential events include a workshop on the Isle of Wight on chalk fossils, a minerals workshop in Edinburgh and a possible re-run of the Hazards workshop.

4.4. Publications.
The peer reviewed Geological Curator journal is a

flagship benefit of GCG membership. In 2017 two parts were published (Volumes 10, numbers 7 and 8). Volume 10, number 9, due in 2018, will be a series of papers on ethics, including contributions from the GCG AGM in Bristol in 2016.

Coprolite has been published since 1990, with three issues each year. With a new website and a relaunched blog, we are looking at the future role and format of our newsletter.

4.5. Collections support.
Collections monitoring is an important part of the work of GCG. A number of collections have been affected by restructures this year including Dudley moving out of its historic building to the Town Archives. Gloucester City Council made two curators and a museum manager redundant, and the geology and natural history collections put into storage. GCG were happy to offer our support to the North West Highlands Geopark when their funding was withdrawn. On a positive note, the Lapworth Museum was shortlisted for the Art Fund Museum of the Year award; Birmingham Museums Trust escaped potential cuts of £750,000 and the BGS has been in discussions to become a UK-wide issuer of International Geo Sample Numbers (IGSN), which would make UK collections more easily accessible at an international level.

Care of Collections is equally important, and GCG has reinstated the Care of Collections Officer co-opted post. This will help us to better support geological conservators and the conservation of collections.

4.6. Online activity.
A large project this year has been the relaunch of the website (www.geocurator.org). In the period April - October 2017 the site had over 55,000 unique visits from nearly 150 countries, and it is encouraging to see a lot of use for our archived material, which underlines the value of retaining our archive and making it available on the website.

The GCG blog has been redesigned and content expanded. We are now inviting contributions on a series of themes, or members can suggest a topic. We are reviewing how Coprolite and the blog will work together in the future.

GCG uses Facebook and Twitter and we are developing a Social Media policy to inform how we use these tools. On Facebook we have both a group and a page. Posts typically reach 2000-3000 people each week. Twitter has 961 followers and the numbers are growing steadily.

GCG has a JISCMail account: "geo-curators". Its purpose is to allow wide and fast communication of news and requests for help or advice. It is not restricted to GCG members and now has 272 subscribers. Since the 2016 AGM there have been 107 posts. We thank all those who offered advice and support to list members.

4.7. Outreach and profile.
We have a banner, a family activity ("Be a Curator") and various promotional materials available to anyone to advertise GCG and its work. The banner has been seen at the NatSCA AGM in April, and we agreed to sponsor the annual Palaeontological Association student conference (Progressive Palaeontology) in June 2017, with trial drafts of Steve Tunnicliff's 1983 paper going into delegate packs. Feedback from these will inform the final version of this revised paper. We have also offered support to the GA annual conference.

4.8. Accounts.
Balance sheet circulated separately. Expenditure has increased but this is offset somewhat by increased income from workshops. The PayPal system of payment is proving very useful and popular with members. A consequence of this may be the closure of the US Dollar account.

5. Election of Committee for 2018.

Helen Kerbey and Luanne Meehitiya have stood down from Committee. They are thanked for all their work for GCG.
Will Watts, Emma Nicholls and Hilary Ketchum have been nominated as co-opted members of committee.
Agreed by those present.
Matthew Parkes welcomed the new people to Committee.

6. Any other business.

6.1. Representation.
Zoë Hughes is standing for the council of the Palaeontological Association. This will be very useful as it strengthens GCGs links with this important organisation.

7. Date of next meeting.
Cardiff or Edinburgh. Theme, venue and date to be confirmed.

Meeting ended 17.25.

Geological Curators' Group
44th Annual General Meeting, Dublin 14/11/2017

2017 Accounts

Income			**Expenditure**		
Unspent cheque	*£77.00*				
JN payments in 2017	*£115.00*		*JN payments from 2016*	*-£26.71*	
Subscriptions	£5,706.56	(4867.45)	Geol Curator 10.6, 10.7	-£3,017.51	(1870.00)
Workshop income	0	(980.00)	Coprolite 80, 81, 82	-£1,334.80	(621.00)
Gift Aid	0	(499.92)	(AGM) Workshop expenses	-£1,451.78	(810.26)
Money from US account	£4,165.00		Committee expenses	-£1,268.18	(916.15)
Anonymous Donations	£240.01		Web site fees	-£213.48	(100.03)
Uncashed cheques		55.85	JISC GB/3D payments	-£250.00	(463.56) [£66.87]
			Brighton Medals	-£785.14	
			Conference sponsorship		(100)
			Error on accounts		(20)
	£10,303.57			-£8,347.60	
Balance as at 14/11/2016	£11,423.28		Balance as at 27/10/2017	13,379.25	

NOTES

American Account at (11.01.17	$ 287.78	($ 3,315.42)
European Account currently at	€ 772.66	

R C Walcott Treasurer 27/10/2017

Auditors:

Caroline Buttler

Christian Baars

GEOLOGICAL CURATORS' GROUP

45th Annual General Meeting

45th Annual General Meeting of the Geological Curators' Group.
National Museum Wales, Cardiff.
4th December 2018.

1. Apologies for absence.
Mike Howe, Isla Gladstone, Tom Sharpe, Alan Howell, Nigel Larkin, Nigel Monaghan, Mick Stanley, Will Watts, Patrick Wyse Jackson.

2. Acceptance of the minutes of the 44th AGM held at National Museum Ireland, Collins Barracks, Dublin.
Acceptance proposed: Cindy Howells. Seconded: Emma Bernard. Agreed.

3. Matters arising.
None.

4. GCG Annual Report.
This is the second year of reporting in this format, although this 2018 version differs in format from that 2017. A copy is sent to all registered delegates. Matthew Parkes thanked Sarah King for compiling the report. The following is a brief overview of the sections covered in the Annual report.

4.1. View from the Chair. Matthew Parkes.
Matthew Parkes gave an overview of GCG work over the past year.

Website.
Simon Harris has consolidated changes to the GCG website started last year. This, and work done by Sarah King on our archive of records, policies and processes, will support Committee work and allow GCG to keep a better record of how and why certain actions and decisions have been made.

Resources.
We now expect to finish a revised "Advice booklet" for geology students and their supervisors very soon. The original drafts have undergone major revisions and redesign by Hilary Ketchum.

Organisation.
Sarah King has worked hard to produce the materials for today's AGM. She has also been looking after GCG governance, Liaison with the Geological Society, Charity Commission compliance and duties organising Committee meetings. Thanks also to Alex Peaker and Emma Bernard for their work on a social media policy.

Accounts.
GCG Finances are currently healthy, helped by Rachel Walcott keeping control and upgrading our capacity with card readers. Money taken at meetings in such ways goes towards increased activities and campaigning.

Publications.
Coprolite has evolved into a shorter pdf format. This notice of meetings and events is being issued regularly. Email version saves GCG expenditure on printing and postage. Other former elements of the newsletter are now being delivered in the form of two blogs: "News from the sector" covers all sorts of information, whilst the general GCG blog carries more reflective or discursive discussions. Thanks to Emma Nicholls for work on all of these publications.

Collections.
Loss of posts and closures are an ever-present threat. GCG will continue to support curators and collections in individual cases, but these plans often only become public knowledge when effectively signed off. It is our belief that advocacy on behalf of collections and curators before they are under threat is the best use of our capabilities.

Programme.
I thank Zoë Hughes for developing our 2018 programme and her work on developing an interesting schedule of meetings for 2019.

Geological Society.
Our relationship with the Geological Society is constructive and we contribute to the Science Committee's works and policy in different ways. Dr Sally Thompson attends most of our meetings and acts as a liaison between the Society and GCG.

Relationships with the wider world.
We are looking at better communications with SPNHC, but have a good relationship with NatSCA. Whilst Isla Gladstone (GCG/NatSCA representative to both committees) was on maternity leave Emma Nicholls fulfilled this role. We hope Isla will be managing a new project, jointly submitted by GCG and NatSCA to Arts Council England for funding.

I have attended meetings of the Geoconservation Committee of the Geological Society, and hosted their Annual Gathering in Dublin this year. Nigel Larkin, conservator and member of ICON, has

briefed GCG on relevant matters throughout the year, as well as working with Cindy Howells to deliver GCG's joint meeting the Symposium on Palaeontological Preparation and Conservation (SPPC) at the SVPCA meeting in Manchester in November.
Emma Bernard has been attending the Earth Science Education Forum (ESEF) for GCG.
The Arts Council England previously hosted a meeting of Subject Specialist Networks, and the groups involved have been active in developing a continuing network. GCG hope to play a more active role in this network in future. We aim to have a permanent representative on board soon.

4.2. Accounts.
The year ended in a profit of £3672. PayPal has been popular and is being used by our international members so the US Dollar account has been closed. We still operate the Euro account, although it includes operational fees, as this can be used by Matthew Parkes in Dublin for Geological Curator related expenditure. The Euro account will be reviewed in the coming year to determine the best costs for GCG. Donations towards various costs added £1340 to the accounts. Thanks to auditors Andy Ross and Neil Clark. Thanks also to Tiffany Adrain who took care of the US GCG account for many years from Iowa.

4.3. Membership and Networks.
4.3.1. Membership and reach.
There has been a real rise in new subscriptions due to the ease of registering and paying on our new website. Membership currently stands at 269.

4.3.2. Correspondence and networks.
We continue to meet annually with the Geological Society and now have representation with ESEF. We had representation at the Munich Mineral Show (October), in an effort to broaden our networks in mineralogy. Our joint bid to ACEs Subject Specialist networks fund is called "Realising the potential of natural sciences collections in a changing climate". The result of the bid should be known within the next week. The GEO-CURATORS JISCmail list still attracts enquiries and requests to send messages about disposals, jobs and general queries.

4.4. Events and participation.
The 2017 winter seminar and AGM was held 14-15th November at the NMI, Collins Barracks, Dublin, entitled "Making the most of a move". Both talks and workshops got positive feedback.
Compared to 2017, GCG was back to a full annual programme of three well-attended events.
10th May. "Pyrite oxidation: where are we now?". Workshop. NHM.
25-26th July. Moulding and casting workshop. BGS, Keyworth.
18-19th September. "Collectors, Collections and the Geology of South-West Britain". Joint with HOGG. Bath Royal & Literary Scientific Institute, Bath.
We thank all hosts, facilitators and contributors to our events this year, without whom GCG would not be able to run its programme.

4.5. Publications.
4.5.1. The Geological Curator.
In 2018, one part of the Geological Curator was published (Vol. 10, Number 9) in October. It carried three papers and an account of the 2017 Brighton medal presentation to Graham Worton.
The second part for 2018 should appear after the AGM. For 2019, we are looking at three thematic sets covering material from the two GCG events in 2018, as well as the 2017 AGM on collections moves. We thank all contributors and referees for our 2018 issues.

4.5.2. Coprolite newsletter.
Coprolite has been published since 1990, and has had three issues a year, giving 83 up to the end of 2017. Emma Nicholls was elected Newsletter Editor at the end of 2017 and the start of 2018 saw a change in format (see above).

4.6. Collections support.
4.6.1. Collections monitoring.
Collections monitoring is an important part of the work of GCG. A number of collections have been affected by threats and funding cuts.
Torquay Museum escaped a devastating cut from Torbay Council. Funding is now guaranteed at current levels until April 2020.
Hampshire Cultural Trust restructured with the loss of several subject specialists.
Kingston University Earth and Marine Sciences department is being closed over the next two years, with the disposal of 70 years worth of geological teaching materials, some being rehomed at BGS and the NHM.
BGS is now an issuing agent for IGSNs (International Geosample Numbers) which would make UK collections more easily accessible at an international level.

4.6.2. Care of Collections.
As reported above, the pyrite decay workshop was a success. Videos of the talks are available to GCG members on the website.
SPPC in Manchester was attended by 30-40 delegates. The 2019 meeting will be held on the Isle of Wight.

Plans are being made for a two-day conference of fossil marine mammals in May 2019. This will be in the Etches Collection, Dorset.
September 2019 will see a visit to Edinburgh for a meeting on geological fakes and forgeries.

4.7. Online activity.
4.7.1. Website.
Newly launched GCG website includes a number of new features. This year we hope to continue to add information to the site. There are still significant amounts of historic data to be scanned and indexed for inclusion.

4.7.2. Blog.
Emma Nicholls has worked to ensure that at least three new articles are posted each month throughout 2018. Blog posts saw a 400% increase in views on previous years, showing blogs are a popular format for disseminating information within our sector.

4.7.3. Social media.
We have developed a social media policy. This is available on the GCG website. We are represented on Facebook in two ways: as a group and a page (both called Geological Curators' Group). All content is posted to both, with posts typically reaching 2000-3000 people every week. We have 1068 Twitter followers (@OriginalGCG), and JISCMail (GEO-CURATORS@JISCmail.ac.uk) has 276 members.

4.8. Outreach and profile.
We scaled back our physical attendance at outreach events in 2018 in order to maximise the use of GCG funds in promoting ourselves and our events. We now have full colour postcard sized fliers that are suitable to put out at various events, and a supply of branded tote bags. We will continue to investigate avenues of promotion and revenue to ensure that GCG remains sustainable while delivering on its aims. Please let us know if you would like fliers to promote GCG at any events you attend or organise. If you know of organisations that might like to sponsor a GCG event please also get in touch.

5. Election of Committee and Auditors for 2019.

5.1. Committee.
Will Watts is to step down from Committee but will continue in a voluntary, advisory role. GCG will benefit from his expertise.

Lil Stevens (NHM) and Pip Brewer (NHM) have been co-opted for archive support and Journal Editor transition respectively.
Hilary Ketchum has become an Ordinary member of Committee.
These changes have to be agreed by the AGM.
Proposed: Emma Bernard, Seconded: Alex Peaker.
Agreed.

All other postholders remain as detailed on the agenda.
Proposed Emma Nicholls. Seconded: Zoë Hughes.
Agreed.

5.2. Auditors.
Neil Clark and Andy Ross have agreed to take on this role. Agreed.
Chairman thanked the previous auditors, Caroline Buttler and Christian Baars, for their assistance in previous years.

6. Any other business.
Friends of Crystal Palace dinosaurs.
The charity set up to promote the long-term conservation of the statues, and the larger site, has made a request to GCG for a donation to help fund an access bridge. Committee have agreed a sum of £250, but needs the agreement of the AGM.
Question from Matt Williams (Bath) regarding ownership of the dinosaurs. Park ownership is with Bromley Council.
Donation of £250 agreed.

7. Date and venue of next meeting.
Venue and date to be confirmed after next Committee meeting. Possibly venues: Cambridge or Liverpool.
Theme to be decided later.

Meeting ended 17.08.

Geological Curators' Group
45th Annual General Meeting, Cardiff 3/12/2018

2018 Accounts

28/10/2017 - 27/10/2018

Income			**Expenditure**		
Workshop income	£2,785.37	(£2,513.43)	Geol Curator 10.7, 10.8	-£1,356.14	(-£3,017.51)
Subscriptions	£5,307.16	(£5,133.13)	Coprolite	-£358.00	(-£1,334.80)
Donations	£1,373.48	(£250.01)	AGM & Workshop expenses	-£2,964.99	(-£1,736.78)
			Committee expenses	-£635.05	(-£1,268.18)
			Website fees	-£116.07	(-£213.48)
			JISC GB/3D payments	£0.00	(-£250.00) [£66.87 remaining]
			Brighton Medals	£0.00	(-£785.14) [£1214.86 remaining]
			Equipment	-£247.98	(0.00)
			Eu Acct Bank Fees	-£126.70	
	£9,466.01			-£5,804.93	
Balance as at 27/10/2017	£13,379.25		Balance as at 27/10/2018	17,040.33	
European Account	€ 772.66		includes European Account	€ 462.91	(0.87 exchange rate)

Auditors: Neil Clark

Andrew Ross

NOTES

American Account at (27.10.18) $0.00

Rachel Walcott, Treasurer 22/11/2018

PRESENTATION OF THE A.G. BRIGHTON MEDAL TO MONICA PRICE, DECEMBER 2019

Geological Curators' Group Brighton Medal Award to Monica Price

It is the most pleasing duty of the Chairman of the Geological Curators' Group, at the end of a three-year term of office, to make an award of the Group's own medal to a deserving person. The recipient in 2019 is Monica Price, recently retired from a variety of roles in the Oxford University Museum of Natural History, which together represent a lifetime career of curating mineral and rock collections.

Monica started her geological curating career in Leicestershire Museums whilst an undergraduate studying Combined Sciences at Leicester University. She compiled and entered data for Leicestershire geological sites on one of the earliest museum computer databases in the UK. In 1978-79 she took the MSc in Museum Studies at Leicester University. As the only geologist that year, she spent every Monday afternoon learning geological curation from Bob King and Roy Clements - excellent teachers, who taught so many geological curators. This was also when she joined GCG.

After the Leicester course, she got a temporary post as Assistant to the Curator of the Mineral Collections at the Oxford University Museum of Natural History and then worked there for forty years, until her recent retirement. Her first job was cataloguing new acquisitions of minerals. As an honorary associate at the Museum now she is still enjoying doing the same thing but by tapping on a computer rather than using her best handwriting in fine old bound volumes of registers. Thousands of specimens later, generous donations from collectors and transfers from other universities are still keeping her busy.

In a permanent post as Assistant Curator of the Mineral Collections, she looked after minerals, gemstones, meteorites and eventually the rocks too. In those days it included all the jobs that would be done by specialists today - display design and production, education and outreach; and IT management (when computers eventually arrived in Oxford!). Monica took satisfaction from steering the Museum through Designation and Accreditation,

dealing with policies and forward planning. She had a brief spell as Acting Director, managing buildings, budgets and her colleagues, but then went back to Assistant Curator duties. Monica emerged from a big Museum restructuring as Head of Earth Collections, but later happily stepped back to be a part-time Collections Manager for the minerals and rocks as she wound down a little.

In that Oxford career, Monica has been an integral part of many aspects of professionalising the role of geological curators. She was on the Museums and Galleries Commission's committee developing 'Standards for the museum care of geological collections' back in 1993. She ran mineral curation and identification workshops, and completed collections evaluations (e.g. Leeds, Horniman). More recently she collaborated with colleagues from the National Museum of Wales, the Hunterian Museum Glasgow, the National Museums Scotland, and health & safety professionals to develop sector specific guidelines relating to the management of hazardous geological specimens.

Monica Price demonstrating geiger counters during hazardous minerals course for GCG.

In topographic mineralogy she researched classic British and European locality material; developing her experience of identification techniques including energy dispersive X-ray analysis and Fourier transform infrared spectroscopy. For Monica, mineral and fossil shows in the UK and overseas became great places to meet the collectors, dealers and other curators. Great places too, to hone bargaining skills, build the Oxford collection, and most importantly, learn about, value and appreciate the specimens she was already looking after.

Monica's book *Decorative stones: the complete sourcebook* was published in 2007 and remains an excellent resource for curators. Decorative stone and in particular the Corsi Collection of 1000 samples of ancient and modern stones, became a major project for Monica, with a grant from the Esmée Fairbairn Foundation. This resulted in a website resource, whose reach extends far beyond geological curators. Decorative stones are some of the most valuable geological collections for supporting research and good practice in the arts. The number of conservators, architects, furniture historians, archaeologists, historians, artists and craftsmen using the Oxford collections and expertise, continues to grow; not just from UK universities, cathedrals, stately homes, museums, auction houses and such like, but via the Corsi website, from around the world.

Monica Price with a drawer of Corsi Collection polished building stones.

When it comes to involvement in professional groups, Monica has been a contributor too. She has been Vice President of the Russell Society, and involved in the editorial committee for their journal. She has had two stints on the British Geological Survey Collections Advisory Committee, and her advice made a big difference to the successful transfer of the Gilmerton core store from Edinburgh to Keyworth amongst other projects. She was also on the GCG Committee for a good many years and worked on the production of both *Geological Curator* with Peter Crowther and on *Coprolite* with Tom Sharpe.

Selected publications:

Horak, J., Faithfull, J., Price, M. and Davidson, P. (2016). Identifying and managing asbestiform minerals in geological collections. *Journal of Natural Science Collections* **3**, 51-61.

Jackson, D. and Price, M. (2015). Decorative stones in the church of St. Gregory the Great, Cheltenham. *Proceedings of the Cotteswold Naturalists' Field Club* **46** (2), 297-308.

Jackson, D. and Price, M. (2014). Decorative stones of Cheltenham Part 2: Shops and public buildings. *Proceedings of the Cotteswold Naturalists' Field Club* **46**(2), 188-209.

Price, M.T., Horak, J & Faithfull, J. (2013) Identifying and managing radioactive geological specimens. *Journal of Natural Science Collections* **1**, 27-33.

Price, M.T. & Jackson, D. (2013) The decorative stones of Cheltenham Part 1, Churches. Proceedings of the Cotteswold Naturalists' Field Club 46 (1) 96-119.

Green, D. Bridges, T. & Price, M.T. (2012) The Norman Thomson Collection. *UK Journal of Mines and Minerals* no. **33**, 21-34.

Price, M.T. (2012) The Corsi Collection website www.oum.ox.ac.uk/Corsi

Price, M.T. (2007) *Decorative stone: the complete sourcebook* Thames & Hudson, London 288pp. (published by Firefly Books, Ontario as The sourcebook of decorative stone, an illustrated identification guide, and also published in Italian and Spanish editions).

Price, M.T. & Walsh K.L. (2005). *Pocket Nature: Rocks and Minerals* London, Dorling Kindersley, 224 pp.

Cooke, L. and Price, M.T. (2002) The Corsi Collection in Oxford *In*: Herrman jr, J.J., Herz, N. and Newman, R. (eds.) *Interdisciplinary Studies in Ancient Stone, Proceedings of the 5th International Conference of the Association for the Study of Marble and Other Stones in Antiquity, Museum of Fine Arts, Boston, 1998*. Archetype Publications, Boston, 415-420.

Price, M.T. (2000) Gemstones *in* Hancock, P.L. and Skinner, B.J. *The Oxford Companion to the Earth*. Oxford University Press, Oxford pp.380-384.

Price, M.T. (1997). Museums and the mineral specimen market. *in* Pettit, C. and Nudds, J. (eds)., *Proceedings of the International Conference on the Value & Valuation of Natural Science Collections*. 154-157

Goulding, J. and Price, M.T. (1995) Well-crystallised fraipontite from Machen Quarry, Mid Glamorgan: a first Welsh locality. *Journal of the Russell Society* **6** (1) 50.

Price, M.T. (1992) The stability of minerals *in* Howie, F.M. (ed.) *The care and conservation of geological material: minerals, rocks, meteorites and lunar finds*. (Butterworth-Heinemann).

Brighton Medal Reply

To receive the Brighton Medal is a huge honour and a lovely surprise, and I'd like to thank you, Matthew, and the Geological Curators' Group, very much indeed.

I remember when I started at Oxford, being a bit intimidated by the sheer scale of the collection, and thoroughly terrified by the huge number of different minerals having white or colourless crystals which I was now supposed to be able to tell apart! I was lucky to have had the tutoring of Bob King during my Museum Studies days, and in Oxford, the wise guidance of Brian Atkins, a university lecturer who was instinctively an excellent curator. Permanent posts like mine were like gold dust and today they are rarer still. It takes time to get to know such large and diverse collections in order to navigate them speedily and use them well, and I have been fortunate in having that time. I am still learning, not the least from the visiting researchers and mineral enthusiasts who bring their expert knowledge when they come to study our minerals and rocks.

When I joined GCG, I found a friendly community of specialist geological curators, mostly from local authority and university museums. Leicestershire Museums, where I had been working, had three specialists looking after just the geological collections, and most local authority museums had at least one specialist geologist or natural history curator. Now alas, we subject specialist curators are rare breeds, on the red list and dwindling in numbers. I don't need to tell you we are crucial to the museum sector if the health, safety and best use of our heritage of Earth science specimens is any consideration.

But looking on the bright side, thanks to those IT savvy documentation officers, specialist educators, and professional display production companies, information about our collections is more accessible than ever been before. Our displays are more attractive and engaging, and what we are teaching the next generation is communicated far more professionally. It'll just be good for the welfare of our collections if there are more geology graduates becoming the documenters, educators, exhibitors, fund-raisers and most importantly of all, the managers and leaders in the museum sector.

And speaking of fund-raisers, have you noticed how much more of our precious time we are spending working up grant applications to do 'projects', each application a project in itself? All good projects must be innovative, completed in a specified timescale and as we all know, have a suitably diverse audience. In my experience, basic collection stewardship is fundamentally important, but it can be quite a solitary repetitive process that's been going on for centuries and has no endpoint; not exactly an easy activity to build into funding applications.

Having said that, when I think back on my career, so many of my highlights have been the completion of projects; re-storing the mineral collection, memorable temporary exhibition openings, setting up our internship programme, getting our Corsi decorative stones online and being used, to name a few. We all need our projects to see through to completion. They have introduced me to many imaginative and talented people over the years; temporary staff, volunteers, school and university students, who, together with my OUMNH colleagues, have been a pleasure to work with and enriched my working life in so many ways.

Opportunities to collaborate with colleagues in other institutions have been a particular pleasure as well, and that takes me back to GCG. It's good to see us thriving 40 years on from when I first joined. Meetings are still followed by dinner and a pint or two; invaluable time to catch-up, share information, make plans and maybe have a therapeutic mutual grouse about challenges in the sector. Now that so many geological posts have gone, GCG with its digital message boards and use of social media, has become a community that's more important than ever for providing support to the wider museum sector.

So, thank you, all of you geological curators for all your friendship and support throughout my career, and for awarding me this medal. It is a huge honour.

Monica Price

THE GEOLOGICAL CURATOR

Publication scheme

Two issues of *The Geological Curator* are published for each year (usually in the Spring and the Autumn); a complete volume consists of ten issues (covering five years) and an index.

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3. **Single space** your file. Use a **single (hard) carriage return** at the end of each paragraph.
4. Single space-bar between words, **double space-bar between sentences**.
5. **Do not attempt** to format your article into columns. Use a minimum of tabs and indents.
6. Author names in the references should be in capitals.

If no computer facilities are available to authors, please discuss submission of proposed articles with the Editor, Matthew A. Parkes, Natural History Museum, Merrion St., Dublin 2, Ireland (tel 353-87-122-1967; e-mail: journal@geocurator.org).

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THE GEOLOGICAL CURATOR

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