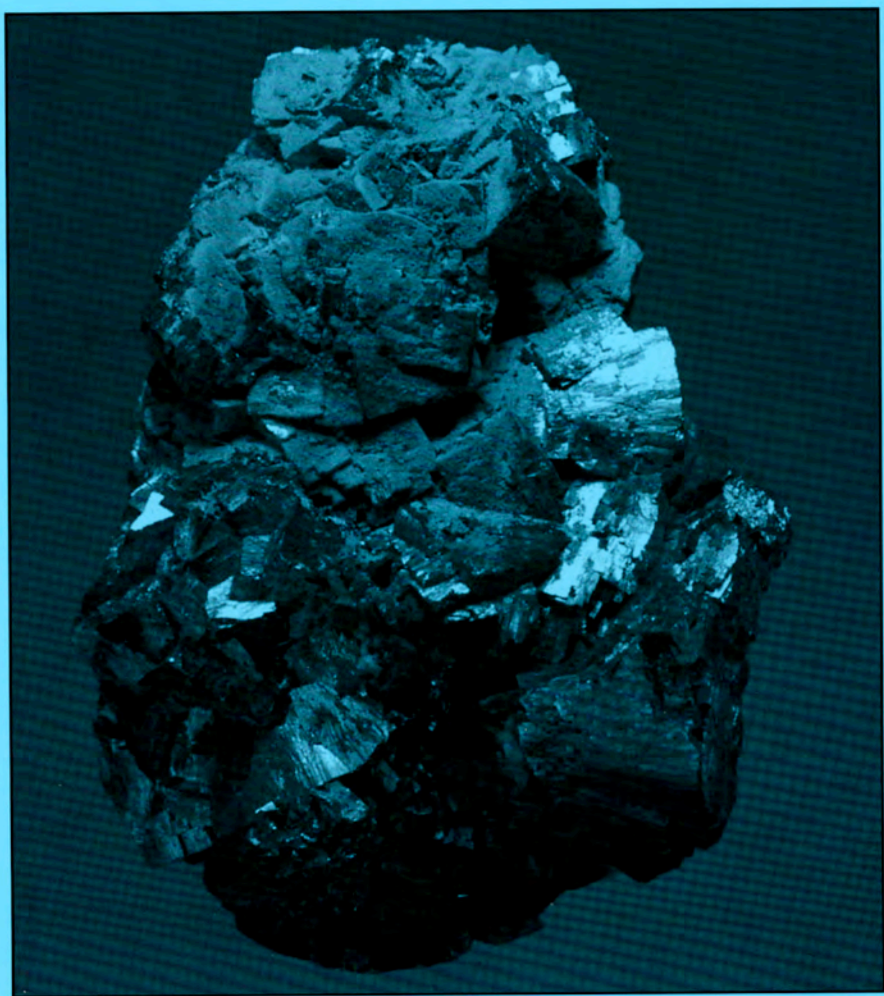
GEOLOGICAL CURATOR

GCG

Volume 8 **Number 2**



THE GEOLOGICAL CURATOR

VOLUME 8, No. 2

CONTENTS

GEOLOGICAL CURATORS' GROUP - November 2004

BIOEROSION, PREPARATION AND CURATION

by Jonathan D. Radley and Richard J. Twitchett

Radley, J.D. and Twitchett, R.J. 2004. Bioerosion, preparation and curation. *The Geological Curator* 8(2): 29-31.

The surfaces of fossils commonly preserve shallow-tier bioerosion traces that are of considerable use in palaeoenvironmental interpretation. However, they are often overlooked and are highly susceptible to destruction through mechanical preparation. In this note we encourage preparators and curators to familiarise themselves with these trace fossils, and preserve them where practicable.

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The surfaces of fossil bones, teeth, shells and other skeletal remains commonly record evidence of the activities of boring, grazing and scavenging organisms in the form of bioerosion traces (Bromley 1994 and references therein). Not only are these trace fossils a direct record of ecological interaction; they may also provide important palaeoenvironmental information and, in many cases, are often the *only* evidence of the existence of such organisms within the fossil community. As a rule, prolonged residence of skeletal remains in so-called 'taphonomically active zones' (zones of surficial disturbance) renders them more susceptible to destructive biogenic processes and more likely to preserve palaeoenvironmentally significant features such as borings and grazing sculptures (Kidwell 1991).

Preparators and curators of palaeontological specimens will have encountered post-Palaeozoic marine fossils that are infested by macroscopic borings such as the networks of clionid sponges, and sack-shaped bivalve crypts. These are especially characteristic of calcareous substrates such as molluscan shells. Obvious examples include oysters and other fossils from units such as the Jurassic Inferior Oolite and Cretaceous Lower Greensand. In this note we draw attention to a less conspicuous category of hard-substrate trace fossils – shallow-tier bioerosion traces, principally invertebrate grazing sculptures that are sometimes widespread on fossil shells and bones. Recent studies (summarised by Bromley 1994) have indicated the value of these traces as repositories of palaeoenvironmental information. Some, such as the gastropod/chiton radulation sculptures (*Radulichnus inopinatus,* Figure 1) and pentaradiate grazing traces of regular echinoids (*Gnathichnus pentax,* Figure 2) betray former abundances of algae and cyanobacteria in shallow-water, photic environments and are therefore useful in bathymetric reconstructions (Bromley 1994). Others, such as the microscopically grouped pits that represent the pedicle attachment scars of articulate brachiopods (*Podichnus centrifugalis,* Figure 3), have important implications for brachiopod palaeobiology and ecology (Bromley and Surlyk 1973). Additionally, the relative abundance of surficial traces within bioerosional trace fossil assemblages provides a measure of exposure time on the seafloor before final burial, with implications for sedimentation rates (Bromley 1994). For example, a range of these traces has been recognised on Early Jurassic *Gryphaea* shells, providing interesting insight into aspects of Lias Group palaeoenvironments (Radley 2003).

Given their surficial and largely microscopic nature (Figures 1-3), shallow-tier traces are highly susceptible to destruction through mechanical preparation of parent substrates, notably through percussive, grinding and sandblasting ('Airbrasive') techniques (Twitchett 1994). We would urge preparators to familiarise themselves with the morphologies of these traces through study of specimens and relevant literature (for example Bromley 1975, 1994, Bromley and Surlyk 1973,

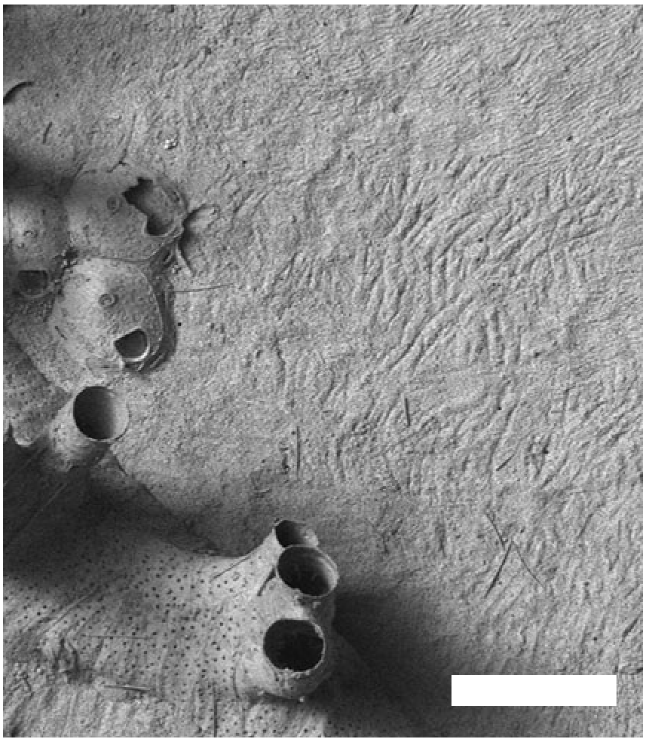

Figure 1. SEM image of a Recent scallop shell showing gastropod or chiton radulation sculpture. Fossil examples are known as *Radulichnus inopinatus*. [The shell is also encrusted with bryozoans (top and bottom left side).] Scale bar at bottom right = 588 µm.

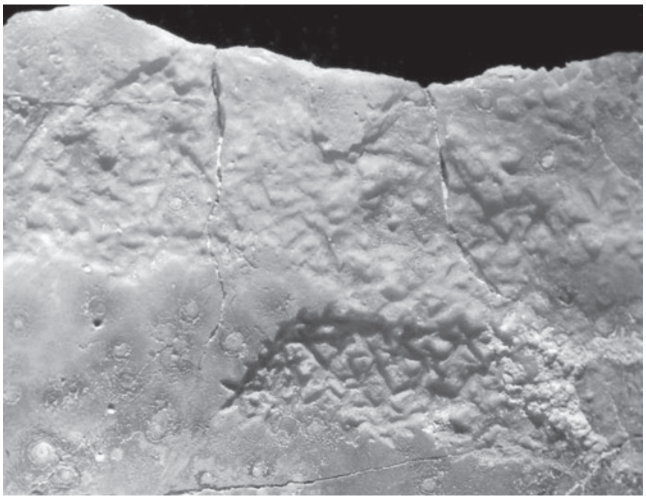

Figure 2. *Gnathichnus pentax*. Thin excavated channels *c*. 0.5mm long formed by echinoids grazing food from an oyster shell. Upper Cretaceous, Negev Desert, Israel.

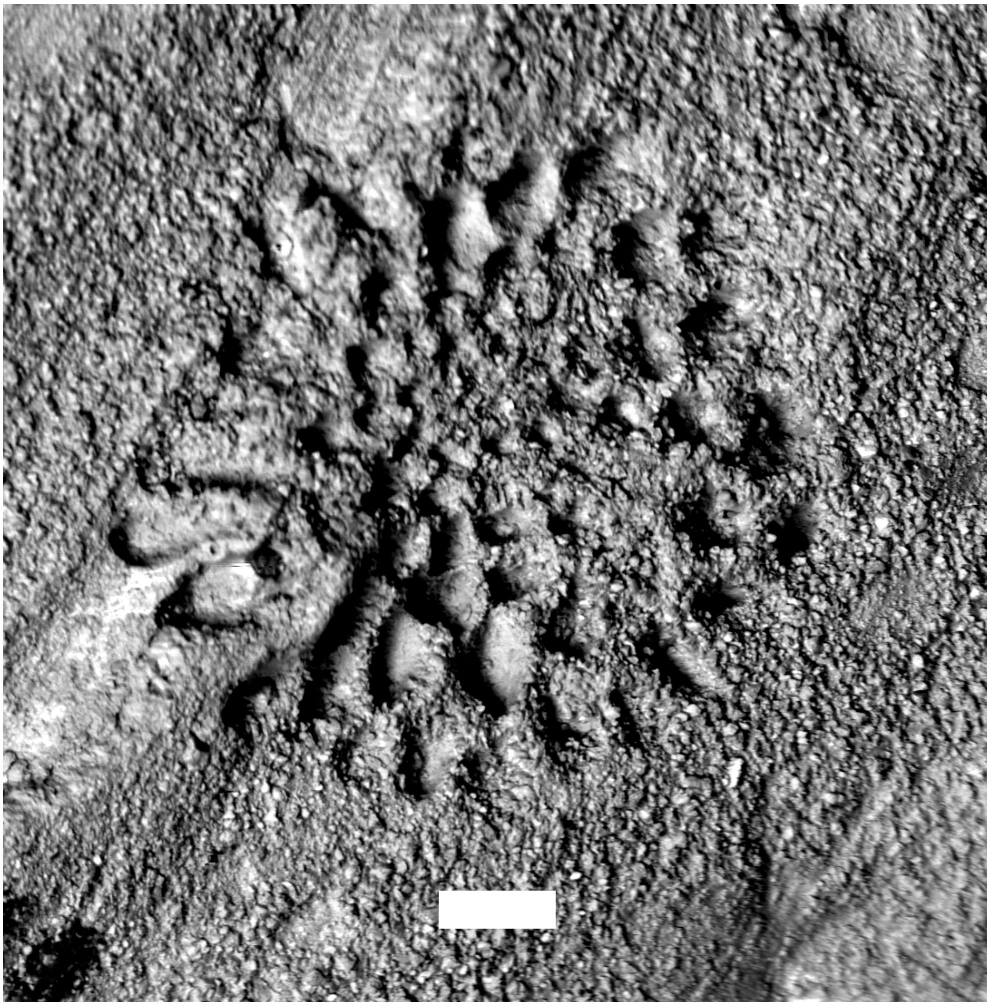

Figure 3. SEM image of brachiopod pedicle attachment scars (*Podichnus centrifugalis*) on an oyster shell. Lower Jurassic, Gloucestershire, England. Scale bar at bottom = 100 µm.

Bromley *et al*. 1990, Riegraf 1973, Taylor and Wilson 2003). There are also an increasing number of websites incorporating information and image libraries concerning bioerosion, for example Mark Wilson's site at www.wooster.edu/geology/Bioerosion/Bioerosion. We acknowledge that ultimate destruction of surface traces might be unavoidable for enhancement of specimen display quality, to allow taxonomic study, or to remove unstable (pyritic) matrix. In such instances we would urge that detailed records are kept, and where possible, representative areas of bioerosion selectively retained.

Finally, we argue that fossils preserving surficial bioerosion traces should be collected and curated more widely, as palaeontological specimens in their own right. They are usually overlooked, largely due to their commonly worn, imperfect preservations. However, in addition to their scientific utility, the diverse, intricate and often abstract forms encompassed by bioerosion traces render them potentially challenging and attractive materials for display and interpretation.

Acknowledgement

Professor Mark Wilson (University of Wooster, Ohio) kindly allowed reproduction of the photographic images used for Figures 1 and 2.

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BOOK REVIEW

Selden, Paul and Nudds, John, 2004. *Evolution of fossil ecosystems*. Manson Publishing, London, 160pp. Hardcover ISBN 1-84076-040-0, softcover ISBN 1-84076-041-9. Price: £39.95 (hardcover), £19.95 (softcover).

Some of the best-known and most spectacular fossils in museums around the world come from the exceptionally well-preserved biotas known as Fossil-Lagerstätten. Such deposits have provided detailed snapshots of individual ecosystems and have made enormous contributions to our understanding of the fossil record. They have received a lot of attention, and still do so, especially as new Fossil-Lagerstätten continue to be discovered.

There are a number of books describing individual Fossil-Lagerstätten, such as Stephen Jay Gould's *Wonderful Life* (1989) and Simon Conway Morris' *The crucible of Creation* (1998) dealing with the Burgess Shale; Barthel *et al*. on Solnhofen; Schaal and Ziegler on Messel; Nitecki on Mazon Creek; and Hauff and Hauff on Holzmaden, and so on, but mostly Fossil-Lagerstätten are given undeservedly brief coverage in palaeontology textbooks (although Briggs and Crowther's *Palaeobiology* deals with Fossil-Lagerstätten better than most). There are very few books to which one can turn for an overview and comparison of a range of Fossil-Lagerstätten. This gap was recognised by Paul Selden and John Nudds who teach a third-year undergraduate course on Fossil-Lagerstätten at the University of Manchester. They have produced a very attractive and well-priced book describing fourteen of the most famous deposits.

A brief introduction explains the arrangement of the book and summarises the main types of Fossil-Lagerstätten. The book is well-structured and each chapter follows the same format. Beginning with the evolutionary context of a site and a summary of its discovery and history of study, each chapter continues with the description of the biota, goes on to consider its sedimentology, stratigraphy and palaeoecology, its comparison with other Lagerstätten, and concludes with suggestions for further reading. An appendix at the end of the book lists museums with collections from the sites and access details for the localities.

Arranged stratigraphically, the Fossil-Lagerstätten covered in the main chapters are the Ediacara biota of South Australia; the Burgess Shale of British Columbia; the Soom Shale of South Africa; the Hunsrück Slate of Germany; the Rhynie Chert of Scotland; the Mazon Creek biota of Illinois; the Grès à Voltzia biota of the Vosges in northeastern France; the Holzmaden Posidonienshiefer of Baden-Württemberg; the Morrison Formation of the western United States; the Solnhofen plattenkalk of Bavaria; the Santana and Crato Formations of northeastern Brazil; the Grube Messel oil shales of the Rhine Graben; Baltic amber; and the Rancho La Brea tar pits in California. Each locality is given between 8 and 12 pages, but the font size is quite small, and the text is double column, so a lot of information is packed into each chapter.

As you might expect with the visually spectacular specimens from these localities, each chapter is well-illustrated. Of the book's 266 illustrations, most are colour photographs of specimens or of the localities. These are supplemented by some fine colour maps and stratigraphic sections (admittedly most redrawn from previously-published diagrams) by Richard Hartley of the Department of Earth Sciences in the University of Manchester. He has also contributed line drawings of reconstructions of some of the fossils. The paper used is of good quality and the design attractive and inviting.

The authors have visited all or most of the sites, as witnessed by the picture credits and one particularly fine picture of John Nudds in a deep hole in Brazil with no apparent means of escape.

It is possible to argue about the choice of localities described in the book. I would have expected to see more on the recent discoveries in China such as Chengjiang and Liaoning. However, these are not totally neglected in the book as Chengjiang, along with Sirius Passet in northern Greenland is briefly described in comparison with the Burgess Shale biota, and Liaoning with the Solnhofen Limestone. Other sites which are covered in comparison with the described sites include the Devonian Gogo Formation of Western Australia and Achanarras Fish Bed in Caithness; the Jurassic of the Yorkshire coast; the Cretaceous Sierra de Montsech biota in Catalonia; and the permafrosts of Siberia and Alaska.

Continuing to be captious, it would have been nice, in the chapter on the Morrison Formation, to have an illustration of the well-exposed type section near the town of Morrison in Colorado, or of the famous site at Como Bluff in Wyoming. Oddly, the authors have chosen not to illustrate the best known exposure, that at Dinosaur National Monument, although perhaps it's so well-known that further illustration is unnecessary. A few minor errors have crept in: reference is made to an Edicaran-type biota from Pembrokeshire when in fact the site is in Carmarthenshire; a picture reference in the appendix to one of the Rhynie Chert illustrations refers to figure 72 instead of 71. But this is petty carping.

The authors have succeeded in their stated aim to provide concise summaries of the better known Fossil-Lagerstätten for students and interested amateurs. They've done this in a well-laid out, superbly illustrated, easy to use, very readable, and attractively-priced book. This is a book that every palaeontological curator should have, and at just £19.95 for the softcover edition, you have no excuse.

Tom Sharpe, Department of Geology, National Museum of Wales, Cardiff CF10 3NP, Wales. 16th July 2004.

ANTHROPOGENIC HUMBOLDTINE FROM CORNWALL, ENGLAND

by David I. Green

Green, D.I. 2004. Anthropogenic humboldtine from Cornwall, England. *The Geological Curator* 8(2): 33-36.

A pyrite specimen from Wheal Jane, Cornwall on which a crust of the rare iron oxalate mineral humboldtine had crystallised was recently identified in the Manchester Museum mineral collection. Careful examination indicates that the humboldtine is of anthropogenic origin and so it is not a natural mineral. It seems likely that it was produced during an attempt to clean the specimen in oxalic acid. Cleaning processes can modify mineral assemblages and it is worthwhile making a careful study of specimens to determine whether all of the minerals present are natural. Unusual mineralogical combinations such as the organic oxalate mineral humboldtine in a high temperature hydrothermal mineral vein should be treated with caution. There is no credible geological source for the oxalate anion in this system. The absence of such a source casts doubt on the only other British report of humboldtine from Pendarves Mine, Cornwall.

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Introduction

Humboldtine is a rare mineral that has been reported from relatively few localities worldwide. It was named in 1821 in honour of the famous German naturalist and explorer Alexander von Humboldt. At the type locality, Korozluky in the Czech Republic, humboldtine occurs with gypsum in brown coal (Gaines *et al*. 1997). It is one of a small group of minerals that are produced by organic processes.

Humboldtine

As a result of a redevelopment program, the mineral collection at the Manchester Museum was recently sorted into new storage cabinets. During this process a pyrite specimen (accession number MANCH: N16662) from Wheal Jane, Kea, Cornwall, UK partly coated by a yellow crystalline crust was examined. It measures approximately 50 x 35 x 25 mm and displays lustrous cubic pyrite crystals to 15 mm with curved faces (Figure 1).

The style of the label suggested that the specimen had been part of the Steve Uttley collection (catalogue number 632) and the donor, Peter Briscoe, subsequently confirmed this. The Uttley collection was purchased by Mr Briscoe in the late 1990s and the specimen, which is typical of material collected by miners at Wheal Jane during the 1970s and 1980s, was donated to the Manchester Museum in 2001.

Since the yellow crust was unidentified it was set aside for further study. Initial qualitative energy dispersive X-ray analysis of a minute fragment under a scanning electron microscope showed that the only element present with an atomic number greater than 10 was iron. This was surprising as most of the crusts found on pyrite specimens tend to be sulphate minerals generated by the well known process of pyrite decay. A small sample was subsequently detached for analysis by X-ray diffractometry (XRD). It was finely ground and applied in solvent suspension to a glass slide. The thin uniform film so produced was mounted in an X-ray diffractometer (CuKα radiation, 40kV, 20mA) and its diffraction pattern recorded from 5^{o} to 50^{o} in 2θ. Standard pattern matching algorithms identified it as humboldtine.

Discussion

Humboldtine is an iron oxalate, its chemical formula is $Fe^{2+}C_2O_4.2H_2O$. It is arranged with other oxalate, acetate and hydrocarbon minerals in a broadly organic mineral group in Dana's chemical classification of minerals. Oxalate minerals typically occur in the crusts that form at lichen-rock interfaces, in guano deposits, in muds in the deep ocean, in coal seams and even in human urinary calculi (Gaines *et al*. 1997). The oxalate anion occurs naturally in soils, bogs, sedimentary pore waters and sediment hosted geothermal systems (e.g. Graustein *et al*. 1977,

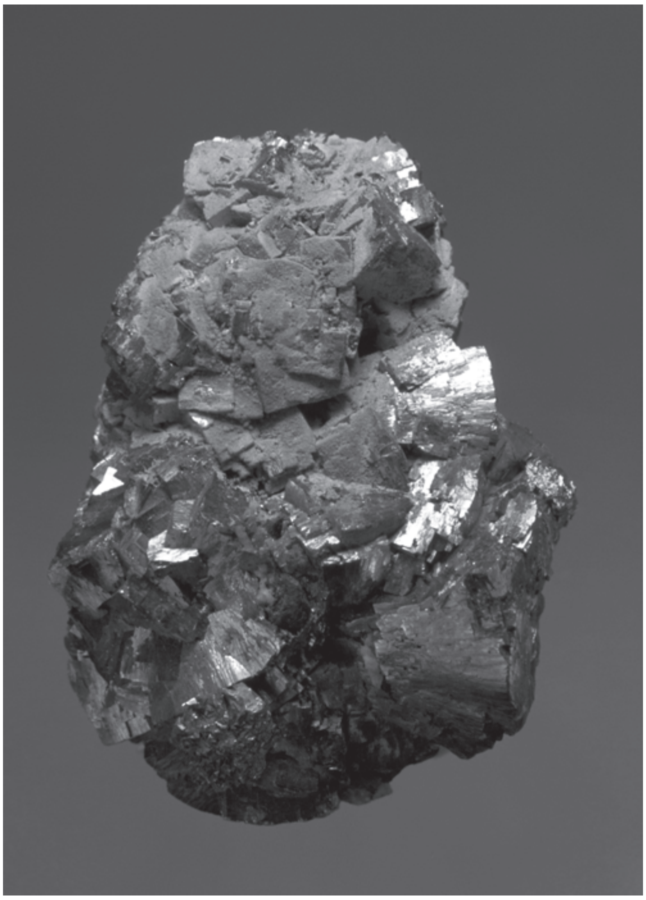

Figure 1. Pyrite specimen 50 mm tall from Wheal Jane, Cornwall showing a yellow iron oxalate crust on the uppermost crystals. Accession number MANCH: N16662.

Thurman 1985, MacGowan and Surdam 1988, Martens 1990). Oxalate minerals are not typically found in high temperature hydrothermal vein deposits such as those at Wheal Jane. Humboldtine has been reported in a wider variety of geological environments than other oxalates (e.g. Lorenz 1995, Matioli *et al.* 1997) but as discussed in the following paragraphs great care is needed to make sure that it is not an unrecognised artefact of specimen cleaning processes.

The unusual association of high temperature vein pyrite with humboldtine prompted a careful re-examination of the specimen. The pyrite had a similar lustre on its crystal surfaces, which had clearly developed within a cavity in a vein, and on its base, a fracture surface which would only have been exposed after it was collected. This is unusual as sulphide fracture surfaces tend to have a brighter lustre than the accompanying crystals. It gave the impression that specimen might have been chemically cleaned. Initial visual inspection suggested that the humboldtine had only formed on the exposed pyrite crystal faces (Figure 1), however a careful examination of the broken base using a stereomicroscope revealed several places where inconspicuous Humboldtine crusts had formed on

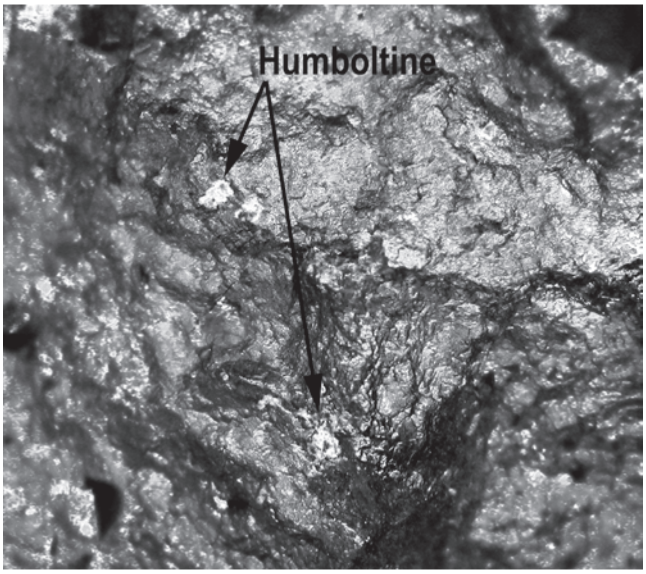

Figure 2. A small area of the fractured back surface of specimen N16662 showing inconspicuous yellow iron oxalate crusts.

fracture surfaces (Figure 2). This observation is important as it indicates that the humboldtine must have formed <u>subsequent</u> to collecting.

Efflorescences commonly form on pyrite specimens subsequent to collecting, but they are almost always sulphates generated during pyrite decay. There are no reports of pyrite decay producing oxalate minerals and the pyrite on the specimen showed no sign of decay, so an alternative explanation for the occurrence of humboldtine is required. The most likely possibility is treatment in oxalic acid in an attempt to “clean” the pyrite. Oxalic acid is widely used by mineral collectors and dealers for removing films of iron oxide from minerals (e.g. King 1983). This “cleaning” process is usually an attempt to enhance the aesthetic appeal of the specimens. Unfortunately the use of chemical cleaning is rarely recorded by collectors and dealers on the specimen labels and cleaned and therefore possibly modified specimens can be added into museum collections without the curators knowledge.

In an attempt to discover more about the history of the specimen, Peter Briscoe, who had donated it to the Manchester Museum was approached: he had not cleaned it in oxalic acid and nor had its previous owner Steve Uttley, but more details were not available (Peter Briscoe, personal communication). Communication with other collectors and dealers suggests that the gentler dithionite technique described by King (1983) has largely supplanted oxalic acid as a means of removing iron stains over the last decade. However specimens were commonly cleaned in oxalic acid by miners and collectors in Cornwall in the 1970s and 1980s.

It is easy to see how humboldtine, an iron oxalate mineral, could crystallise on a pyrite specimen left in oxalic acid. Oxalic acid treatments are designed to remove iron oxide crusts, sequestering the iron into Fe(III)-oxalato complexes. The complexes can undergo photo-induced ligand to metal charge transfer producing Fe(II) and an oxalate radical (Waite 2002). Humboldtine would crystallise from a solution containing Fe^{2+} and $C_2O_4^{2-}$ when its solubility product was exceeded.

A cautionary tale about the manganese analogue of humboldtine, $MnC_2O_4.2H_2O$, which crystallised on material which was being cleaned in oxalic acid is provided by White (1976). A considerable amount of research was done on this "new mineral" before the investigators realised that it was being produced by the oxalic acid treatment used to clean the specimens.

In this context it is worthwhile speculating on the only other report of humboldtine in the British Isles, from Pendarves Mine, Camborne, Cornwall (Golley and Williams 1995). This record is based on an XRD identification carried out in 1986 at The Natural History Museum (London) on a specimen submitted by David Baker (George Ryback, personal communication). David Baker was a collector and dealer who specialised in Cornish minerals who died in 1999 (Hacker, 2000 provides an obituary). The whereabouts of the specimen is unknown, but given the geological situation in which it was found (recent workings in a high temperature hydrothermal vein in a deep mine), it too must be regarded with some suspicion.

The processes to which mineral specimens are subject in an attempt to improve or enhance their aesthetic appeal are becoming increasingly sophisticated (e.g. Edwards 2003) and it is easy to see how apparently authentic mineral species with novel structures or specimens displaying unusual parageneses could be unwittingly produced. It is important to ask collectors and dealers if specimens have been cleaned when making an acquisition (although if a specimen has had several owners, as is the case with the pyrite described above, it is unlikely that the information will be available).

Substances that form by anthropogenic intervention are not regarded as natural minerals (Nickel 1995) and since the specimen described above almost certainly falls into this category it has been re-classified as an artificial analogue. As the techniques available for the characterisation of small amounts of substance increase in sophistication further examples of anthropogenically modified mineral assemblages are likely to be encountered. It is useful to keep this in mind when supplying material for research as such specimens have the potential to generate spurious data. More research and description of substances which form by anthropogenic interference is clearly desirable.

Acknowledgements

Thanks are due to Peter Briscoe for providing further information on the specimen and to the late George Ryback for information on The Natural History Museum humboldtine identification. Thanks are also due to thank the Department of Earth Sciences at the University of Manchester for access to analytical equipment.

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A NEW TOOL FOR PALAEONTOLOGICAL PREPARATION: THE SPLIT-V PEN

by Adrian M. Doyle, James Fletcher and Paul R. Ratcliffe

GEOLOGICAL CURATORS GROUP GCG

Doyle, A.M., Fletcher, J. and Ratcliffe, P.R. 2004. A new tool for palaeontological preparation: the Split-V Pen. *The Geological Curator* 8(2): 37-42.

The mechanical preparation of certain types of palaeontological material using ultrasonic tools, primarily used for industrial applications, has been commonplace for over 30 years and early developments produced favourable results. Recent developments in technology have allowed for a wider range of tools that are becoming cheaper and more readily available. The Split-V is a fine bladed ultrasonic tool, designed for removing excess solder from printed circuit boards, that can be used to remove rock and sediments in delicate preparation situations. As against other tools currently available on the market, the Split-V transmits very low vibration, cuts quickly, is very accurate and has an interchangeable handpiece that can accept a variety of blades for different purposes. This paper is part of a major review of this tool for other applications including recent (i.e. non fossilised) zoological specimens.

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Introduction: preparation using percussion instruments

Traditionally, much palaeontological preparation has been carried out using percussion instruments which consist of a handset that holds a tip which moves back and forth a particular distance (pitch) at a specific frequency. When correctly used, this 'micro-hammering' action breaks down the matrix surrounding a specimen, leaving the specimen itself untouched (Rixon 1976). Most of these tools fall into one of two distinct groups:

Pneumatic engravers (air scribes)

Air scribes are perhaps one of the most versatile of preparation tools (Figure 1). A number of models are available, ranging from large pitch, low frequency models that are suitable of bulk matrix clearance to low pitch, high frequency models that are suitable for the ultra-precise removal of hard matrix close to a specimen. All air scribes emit a flow of air from the tip, making them unsuitable for use on highly fragile or loosely consolidated specimens that might be easily disassociated. They are also of little use for soft and easily disaggregated matrices (e.g. poorly consolidated sandstones), as they tend to dig a small, steep sided hole rather than clearing the matrix.

Electric engravers

These tools operate at a low frequency, and have a low, variable pitch (Figure 2). They are little used nowadays compared to the air scribes, but are suitable for the ultra-precise removal of hard matrix close to a specimen, and are often used on more fragile or loosely consolidated specimens that might otherwise be disassociated by the air flow from a pneumatic tool. They also have the advantage of being able to take an assortment of pointed tips. However, work with these tools is very slow and they are also unsuitable for soft and easily disaggregated matrices.

A major problem with all percussion tools is that the movement of the tip transfers an unknown and relatively uncontrolled amount of vibration to the specimen. This causes cracks to open up and the structural integrity of the specimen can fail. The amount of vibration transferred to the specimen reduces as a) the pitch is decreased and b) the frequency increases. This suggests that a new generation of tools that operates at ultrasonic frequencies would be of great utility to preparators.

The Palaeontology Conservation Unit of The Natural History Museum has been investigating ultrasonic tools as part of our drive to improve the level of preparation work offered. One of the first of these

Figure 1. A typical air scribe.

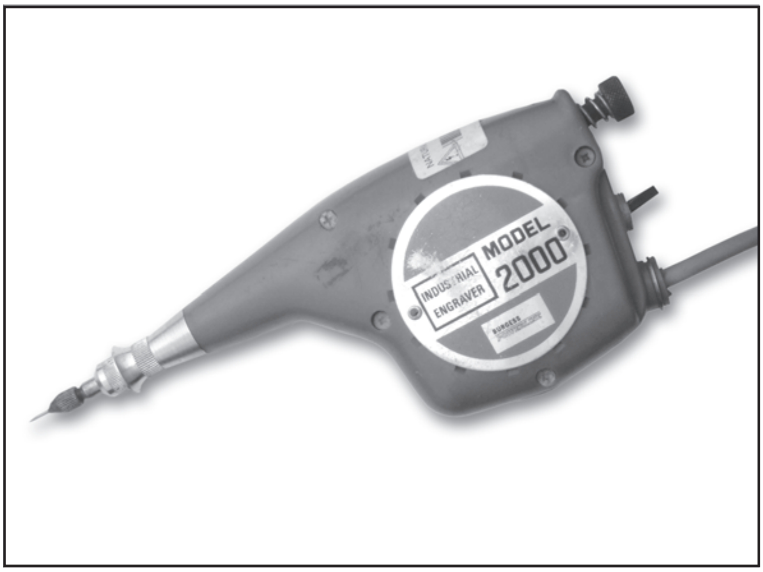

Figure 2. A typical electric engraver.

Figure 3. An ultrasonic descaler.

Figure 4. The Split-V.

new generation tools to be used was the ultrasonic descaler, as used in dental surgeries (Figure 3). Effective operation of this tool requires a spray of water to flow across a tip that is vibrating at an ultrasonic frequency. The cavitating action helps to disassociate soft or poorly cemented matrices. A number of different tips can be used, but available tips are based around the requirements of the dental profession.

The presence of the water jet makes this tool useful for only a relatively small proportion of specimens not soluble in or damaged by water.

Similarly, those that have been previously consolidated and adhered with synthetic resins will react unfavourably with water as will specimens historically treated with animal based adhesives and fillers.

New to the market are dry ultrasonic tools that are primarily aimed at the electronics industry for the preparation of printed circuit boards. This paper outlines a number of tests carried out using one such tool, the Split-V® made by Sonotec.

The Split-V

The Split-V unit (Figure 4) comprises a power pack that provides 25KHz frequency of vibration with a 20W maximum power output, a handpiece and several attachments. It is quite compact at 120x230x120 (mm) and weighing 2.0kg. It runs of a 100V AC, 50/60Hz power supply at 60W.

The accompanying handpiece (SP-9600) varies from 15 - 28 mm in diameter is 130mm long and weighs 130g. The headpiece comes with a gripping tip holder (HR-2120) that can be adjusted by allen key to accommodate the various tips that form the actively vibrating part of the tool. The unit uses an optimal power control system that automatically compensates when a load is put on the tip keeping the output level constant. This means that the tool can be used for long periods without heat build-up.

There is a selection of tips available direct from the manufacturer (Figure 5). These consist mainly of tungsten carbide or a ceramic compound and come in a variety of differing shapes. The carbide tools include the "O-shape", which has a circular cross-section tip,

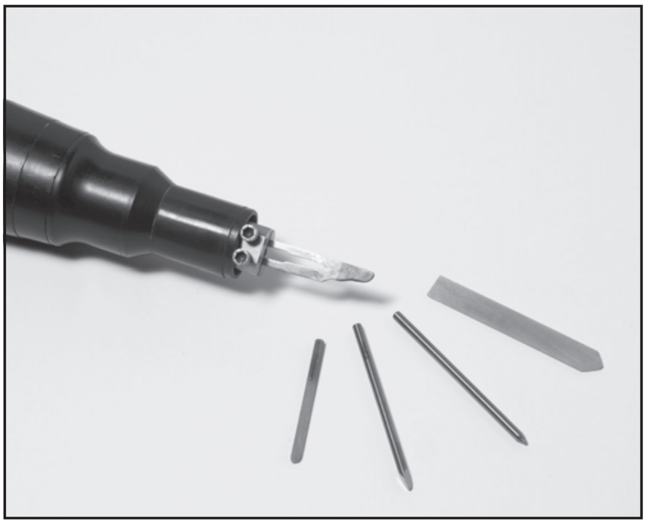

Figure 5. A selection of tips.

Figure 6. The Split-V in use.

and a range of "V-shape" tips with differing angles of nib (30˚, 60˚ and 90˚). The ceramic tools include the "Cylinder" and the "Flat" - a blade-like tool for scraping. Scalpel blades can also be used with the tool.

The Split-V in use

Ethnographic conservators have been using the Split-V tool for some time, and it has been successfully been used by staff of the Museum of London Department of Conservation for cleaning decay products from metals as well as preparation on stone and archaeological artefacts. On the invitation of the Museum of London, preparators from the Palaeontology Conservation Unit of The Natural History Museum undertook initial tests on the Split-V in 2002 with a view to using it for palaeontological preparation. On the basis of this initial test, a successful bid was made to purchase a Split-V tool to use for further research at The Natural History Museum.

Using the tool

The Split-V is hand held like a pen at an angle of approximately 30˚ to the surface of the object (Figure 6). The tip is then scraped lightly over the matrix to be removed allowing the ultrasonic vibration of the tip to disaggregate the matrix which can be brushed or blown away from the surface.

The amplitude of the ultrasonic vibrations is easily controlled via a rotary dial with an associated series of LED's showing the power applied to the handpiece. The amplitude assists in controlling the thickness of the layer of matrix that is disaggregated. During work, this level can be adjusted to ensure that only a thin layer of matrix is disaggregated at a time, allowing work to be carried out to an extremely high level of accuracy.

It is vitally important not to place too much pressure on the tip as this will either a) quickly dig a hole through the specimen, which could easily be damaging or b) cause the tip to shatter.

Health and safety implications

The low weight of the handpiece and lack of transmitted vibration means the tool can be used comfortably for extended periods. Nevertheless, the use of gloves to further dampen any vibration is recommended. Suitable ear defenders should be worn at all times to prevent hearing damage, and work should not be carried out too close to people who are not similarly equipped.

As with all mechanical preparation work, adequate extraction must be used and eye protection should be worn at all times as deemed by health and safety regulations risk assessment procedures.

Effectiveness on differing matrices

Materials

The effectiveness of the Split-V tool was tested on vertebrate specimens embedded in three different matrices. For each matrix, a number of different tips were tested.

(1) Poorly cemented sandstone containing *Edmontosaurus* remains from Horseshoe Canyon Formation, Campanian-Maastrichtian Upper Cretaceous. Red Deer River Valley, Alberta, Canada.

(2) Moderately soft, intermingled silty clay and sandstone bed containing *Iguanodon* remains from

the Weald Clay, Barremain Lower Cretaceous, Smokejacks brickworks, Ockley, Surrey, England (see Ross and Cook 1995).

(3) Hard dolomitised micritic limestone containing *Brachiosaurus* remains from Tendaguru Beds, Kimmeridgian-Lower Portlandian Upper Jurassic. Tendaguru approximately 75 km north west of Lindi, Tanzania.

Results

(1) Sandstone

The medium-fine grained sandstone containing the *Edmontosaurus* remains is moderately hard, but poorly cemented. The *Edmontosaurus* material itself is well preserved and considerably harder than the surrounding sediment.

The nature of the matrix makes the use of traditional percussive preparation tools problematic, as they tend to simply dig a steep sided hole in the sediment rather than clearing it away from the surface.

The ultrasonic vibrations from the Split-V quickly disaggregated thin layers of the sandstone allowing it to be brushed away from the surface. Using a scalpel blade as the tip with relatively high amplitude provided an extremely fast way of cutting through large areas of bulk matrix. Varying the amplitude setting allowed for work to be carried out close to the surface of the specimen itself without causing visible damage.

Once the bulk matrix had been cleared away, the "Flat" ceramic tip was used with lower amplitude to scrape matrix directly from the surface of the specimen. Too high an amplitude caused damage to occur to the *Edmontosaurus* remains (light surface scratching), but the lower setting caused no visible damage.

(2) Clay

The *Iguanodon* horizon consists of medium grey silty clay with lenses and nodules of fine-grained sandstone. The clay is much harder and better cemented than the sandstone tested above. The *Iguanodon* specimen itself is well preserved and much harder than the surrounding matrix.

The *Iguanodon* material was possible to develop using traditional air-scribes, however, the fragility of some of the finer bones made them difficult to prepare using this method. It was these bones that we used to test the Split-V.

Using the scalpel blade and moderately high amplitude allowed thin layers of the clay to be disaggregated fairly quickly and with a high level of accuracy, although progress was much slower than with the sandstone matrix bearing *Edmontosaurus*. The "Flat" ceramic tip made only very slow progress through this matrix. Fortunately the hardness of the specimen meant that work could be carried out using the scalpel blade right up to the specimen itself with no visible damage.

(3) Dolomitised limestone

The dolomitised limestone containing the *Brachiosaurus* material is extremely hard and well cemented. In addition, specimen itself is very fractured and fragile.

The *Brachiosaurus* material responded well, although slowly, to preparation using air scribes.

Attempting to use the Split-V on this matrix proved unsuccessful, the matrix does not disaggregate even at high amplitude and the scalpel blade quickly blunts. Applying extra force to the tool-tip causes even faster blunting and risks causing the blade to shatter and even detach from the handpiece if continued.

Summary

The Split-V tool appears to be an extremely effective tool for the development of softer, less well cemented matrices – an area where traditional percussive tools are of little utility and as such is a welcome addition to the preparators' tool range. Additionally, it appears to be of most use on relatively soft, easily disaggregated matrices, making it the perfect partner to, rather than replacement for, more traditional percussion tools, which outperform it on harder matrices. It can be used to an extremely high level of accuracy, as there is a much less percussive effect in close proximity to fragile specimens. However, it is of little or no use when applied to hard matrices such as dolomitised limestone, where the traditional tools provide the best option.

Other dry ultrasonic tools

Although the Split-V tool is of great utility, there are other dry ultrasonic tools on the market. These units are currently untested by us and hence we cannot endorse them, but if their capabilities are similar to that of the Split-V they tools could be of great significance to palaeontological preparation.

One other alternative from the same manufacturer that is of particular interest is the SonoFile. The SonoFile is unlike the Split-V because it is specifically designed for grinding and finishing of metal die-cast components and other similar uses. These units are capable of more than double the ultrasonic output (45W) of the Split-V (20W) and hence may be more practical in use on fossil materials with hard matrices. The SF- 5600 unit combines ultrasonic capabilities with a 30W 35,000-rpm electric rotary hand piece, thus combining the benefits of both ultrasonic and rotary techniques in one single unit.

All of these units can be used with various manufacturers tips including diamond files, diamond abrasive stones, ruby abrasive stones, ceramic abrasive stones, wood and brass nibs. This wide variety has obvious advantages when working on hard matrix, especially those that are found very close to the fossil that cannot be removed without damage using current tools.

We are currently in discussion with Sonotec as to which of these tools will have the best potential effects in preparation and conservation.

Acknowledgements

We wish to acknowledge the assistance and cooperation of the following people and institutions: David Gray, Andrew Ross, Sandra Chapman and staff from the Photographic Unit of The Natural History Museum; Sonotec; Staff from the Conservation Department of the Museum of London.

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Appendix 1. Materials and Suppliers

Split-V

Sonotec Ltd

http://www.sonotec.com/esitemap.htm

HUGH MILLER'S GRAPTOLITE REVISITED

by David M. Bertie

Bertie, D.M. 2004 Hugh Miller's graptolite revisited. *The Geological Curator* 8(2): 43-45.

Hugh Miller's graptolite from Macduff was shown in 1973 to have been mistakenly localised, probably by "Dr Emslie" of Banff. Dr Emslie was a member of the Banff Institution. A second graptolite, presented to Banff Museum (but now lost) by another Banff Institution member is shown to have been probably also wrongly localised. Old records of specimens in museums should be treated with caution unless the specimen in question is available for study.

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Introduction

Hugh Miller's graptolite from the Macduff Slates has been one of the most controversial Scottish fossils (Dunning, 1972). In his *Rambles of a Geologist*, Miller (1858) stated that graptolites had been recently found in "a slate quarry at Gamrie-head" by a Dr Emslie of Banff. Miller seems not to have visited the actual locality when he was in the area in 1847 but apparently received a graptolite specimen from Dr Emslie. The specimen, which was subsequently acquired by the Royal Scottish Museum (R.S.M. 1859.33.253), bears the label "Greenskares, Gamrie".

The slate rocks at Gamrie belong to the Macduff Slate Formation of the Southern Highland Group of the Dalradian. The graptolite specimen has been identified as *Monograptus priodon* (Bronn) (Trewin 1973), which comes from the *griestoniensis* zone of the Upper Landovery. If the specimen does indeed come from Greenskares, this would suggest that the Macduff Slates are of Lower Silurian age, about 430 Ma. The Macduff Slates, however, are intruded by a number of granites and basic intrusions: the Strichen granite has been dated to 475 ± 5 Ma, the Longmanhill granite to 470 ± 50 Ma, and the Insch gabbro to 489 ± 17 Ma (Stephenson and Gould 1995). Not only are these radiometric dates at odds with an Upper Llandovery age for the Macduff Slates, microfossil evidence suggests an early Ordovician age (Downie *et al*. 1971), though the microfossil evidence remains controversial. Furthermore, the existence of "glacial" dropstones and pebble beds at the top of the Macduff Slates suggests a late Precambrian age (basal Vendian, about 670 Ma).

Trewin (1973) examined the matrix of the fossil in thin section and considered that, given the matrix composition, the fossil could not have come from the Macduff Slates in the vicinity of Greenskares, and was more likely to have come from Grieston Quarry in Peebles-shire. Trewin concluded that the specimen had been "wrongly localised" and that "if this is the case Dr. Emslie becomes the chief suspect, and Hugh Miller...can be absolved from any blame".

Alexander Leith Emslie

Who was this Dr Emslie, who appears to have been the source of such misinformation for over a century? Recent studies into the early history of the Banff Institution and its Museum add a little more substance to the story, while not clarifying the confusion.

The Banff Institution was founded in 1828 and immediately established a Museum. The Museum was located in Banff Townhouse until 1838 when it was removed to the newly-built Banff Academy. The Institution during the years up to 1859 went through several cycles of activity and dormancy. One period of dormancy appears to have ensued in the wake of the Disruption in the Church of Scotland in 1843. A fresh period of activity in the Institution began in March 1852.

Aberdeen-born Alexander Leith Emslie (or Elmslie) became a Licentiate of the Royal College of Surgeons of Edinburgh in 1838 and was awarded the degree of M.D. from King's College, Aberdeen in 1840 (Anderson 1893) and was resident in Banff from at least 1844. He left Banff in September 1853 to take over his brother's medical practice in Auchtermuchty, but died in March 1854. He had substantial botanical interests and during 1852 published in the *Banffshire Journal* a series of lists of flowers to be found in Banffshire over the summer months. He was a member of the re-invigorated Banff Institution after 1852 and was appointed by the Institution's committee in August 1852 to draw up a new catalogue of the geological and mineralogical specimens. He gave one lecture to the Institution in November 1852, entitled "The aborigines of Scotland".

Emslie's encounter with Hugh Miller took place in 1847, during one of the Banff Institution's fallow periods, and four years after the first written account of graptolites in Peebles-shire (Nicol 1843). Had Emslie, in the meantime, visited Peebles-shire and collected some graptolites there or had he been sent some specimens? It has to be remembered that there was a considerable exchange of specimens between collectors at this time. Miller's account of Emslie's discovery of graptolites in "a slate quarry at Gamrie-head" is so specific that one wonders if Emslie misidentified some mineral in the Macduff Slates as a graptolite. Miller's account is not specific as to how he obtained the "Greenskares" specimen, but the assumption has always been that he was given it by Emslie. Taylor (2003) has raised the possibility that Miller mislabelled the specimen, "especially if it was some time before he could get home and do the necessary work".

David Grieve's graptolite

It is now known that another graptolite specimen was present in Banff in the hands of another Banff Institution member. In August 1853, David Grieve presented to Banff Museum a specimen of "Graphtuliphus foliacius (from greywacke at Greeston, Peeblesshire)". Grieston is the location suggested by Trewin for the Hugh Miller graptolite. Two questions are begged – could there be any connection between the two graptolite specimens and was there any connection between Grieve and Dr Emslie?

Edinburgh-born David Grieve, Collector of Her Majesty's Customs in Banff from at least 1850, was one of the re-invigorated Institution's most active members. He had become a member of the Institution in February 1852, just before it took on a new lease of life and gave six lectures over the next two years. The subjects of his lectures included Arctic geology, sponges and corallines of the Banff area, earthquakes, "osseus remains found in Boyndie", and a discussion of the annelid *Aphrodita aculatea*. Some of these lectures seem to have been based on actual research. The sixth lecture given was the reading of a paper on the blenny fish written by Charles Peach, a fellow Customs Officer at Peterhead (and father of Benjamin Peach, the Geological Survey geologist). Grieve's strong natural history interests are pointed up by the fact that he bought a substantial number of natural history books at the roup in July 1853 of the library of the late Rev. James Smith (one of the Banff Institution's original founders). Grieve was also appointed by the Institution's committee in August 1852 to draw up a new catalogue of the geological and mineralogical specimens. There was a decline in the activity of the Institution after he was posted to Dover early in 1854.

The name "Graphtuliphus foliacius" is odd and may possibly be the *Banffshire Journal* editor's mistranscription of *Graptolithus foliaceus*. *Graptolithus foliaceus* Murchison (now *Diplograptus foliaceus* (Murchison)) is an Ordovician fossil and could not possibly have come from Greiston where the rock is Llandovery in age. Unfortunately, Banff Museum suffered considerable disturbance to its collections during the course of the twentieth century and Grieve's graptolite specimen appears to have disappeared or, at best, to be no longer identifiable in the remnants of the geological collection. In the absence of the specimen itself, it remains impossible at present to make any further meaningful comment on Grieve's graptolite specimen.

Discussion

In the end, we are left with the situation of two graptolite specimens in the hands of two Banff Institution members in the time-frame of six years who appear to have wrongly localised their graptolite specimens. The moral for museum curators may be to be prepared to accept that locality attributions in nineteenth-century collections may not always be correct and that the existence of the specimen itself will be required to help settle any discrepancies.

Acknowledgements

I am grateful to Nigel Trewin, Aberdeen University, for his comments on an early draft of this paper, after alerting him to the identity of "Dr Emslie". Claire Mellish, of The Natural History Museum, suggested the possible identification of "Graphtuliphus foliacius" with *Diplograptus foliaceus* (Murchison). Steven Kerr, Assistant Librarian at the Royal College of Surgeons of Edinburgh, corrected the Fifeshire Journal obituary entry which claimed that Alexander Leith Emslie was a Fellow of the Royal College of Surgeons of Edinburgh. The detailed accounts of the Banff Institution, its Museum and its members are

derived from an unpublished thesis written in 1996 in part-fulfilment of a Graduate Diploma in Museum & Gallery Studies at St Andrews University.

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MURIEL AGNES ARBER (1913–2004)

Muriel Arber died on 10th May 2004, aged 90. Throughout her long life, she admired scholarship and enjoyed the excitement of scientific investigation. She came from a very academic background, but had a varied career, ranging from school teaching, and academic research, to the support and leadership of groups devoted to the widening of the appeal of geology.

Muriel was remarkable for the way she enriched the lives of people who got to know her well. Her great interest in people and her sense of humour, readily overcame the rather formidable impression created by her great height and independent manner.

Muriel Arber was born in July, 1913, in Cambridge. Her father was E.A.Newell Arber, who was Demonstrator in Palaeobotany from 1899 until his early death in 1918 at the age of 48. Newell Arber worked initially in the Woodwardian Museum, near Senate House Passage in Cambridge, and was a key figure in the move to the new Sedgwick Museum in Downing Street. The centenary of the opening of this building by the King in 1904 has just been celebrated, and Muriel was able to provide personal memories of the early days in what is now part of the "downtown" buildings of the Department of Earth Sciences. She remembered with relish an account of a visit with her father to the Sedgwick when she was four. During this visit she had met some of her father's colleagues and later felt it necessary to point out to an aunt, that, of course "I don't actually work there myself"! In spite of his early death, Newell Arber published six monographs on geological and palaeobotanical topics, as well as some ninety papers and articles.

Muriel's mother lived to the age of 82, and became academically even more distinguished than her father. She was one of the first women to be elected FRS. She published at length on the history of botany, and the philosophy of biological observation, as well as writing detailed monographs on cereals, bamboo, grasses, and the general morphology of monocotyledons and aquatic angiosperms.

Muriel was admitted to Newnham College, Cambridge, to read English, but almost immediately switched to Natural Sciences, and eventually graduated in Geology. She then embarked on research on fossil brachiopods, under the supervision of O.M.B. Bulman, and this led to three detailed published papers. This work was unpaid, and, as was often the case in those days, money was scarce in the academic world. Indeed Muriel often made the comment that she owed her existence to the consulting fees that her father had earned by applying his knowledge of palaeobotany to the stratigraphy of the Kent coalfield, because these fees had allowed him to marry her mother.

In 1942, Muriel abandoned her full-time study of fossil brachiopods, and joined the staff of the King's School, Ely, where she relished the beautiful medieval surroundings, as well as her daily dealings with lively young people. Eventually a school reorganisation meant that she had to take up a new teaching position in March, involving a rather longer daily train journey across the Fens from Cambridge.

Muriel's father's palaeobotanical work was largely focused on material of Devonian and Carboniferous age, and he became involved in field collecting along the spectacular cliffs of the North Devon coast, in south-west England. The physical challenge of this exploration must have appealed to him, because this work resulted in a general book for cliff explorers, *The coast scenery of North Devon*, published in 1911, two years before Muriel was born.

This delight in West Country coastal scenery was taken up by Muriel herself in later years, and became a continuing research interest for the rest of her life. Annual visits to the West Country at Easter and in the early summer became part of her routine, and North Devon often alternated with the somewhat gentler coast of South Devon and Dorset, particularly Lyme Regis. Indeed residents of the Lyme Regis area recently celebrated Muriel as their oldest tourist! She published a succession of papers in the *Proceedings of the Geologists' Association* and the *Geographical Journal* on the geomorphology of both coastal areas, with special reference to sea-level change, cliff profiles and the active land-slipping.

Muriel Arber's long connection with the Geologists' Association led naturally to her election to the Council, then to Vice President and then President for 1972–1973. Not only did she have a wide interest in the subject, but she clearly understood the interests of both the professional and the amateur members of the Association. Muriel had an excellent memory, and her attention to business detail was acute. She was a long-term supported of the Cambridgeshire Geology Club, and a member of long standing of the Geological Curators' Group.

In her last three years, she helped significantly in the foundation of the Friends of the Sedgwick Museum, and was the first President. In spite of increasing disability, she took part in the first event, a walk around the building-stones of Cambridge, and a visit to Charles Darwin's Down House, in Kent, where she particularly relished the audio presentation available because she was, by then, partially blind.

Mention has already been made of Muriel Arber's excellent memory and her enthusiasm for science. To this should be added her enthusiasm for the countryside. Evidence for this is a 27 page book of poems that she had published in 1951, when she was 38. The book was entitled *The old Mermaid and other Poems* and covers a wide range of her thoughts on historical, topographical and personal topics. For a geological readership, it seems apt to reproduce the poem offered below. Muriel combined many unusual abilities with a feeling that she was ordinary, a warmth of personality and a sense of fun.

The portrait of Muriel, aged 21, comes from a group photograph of the Sedgwick Club taken in the Summer of 1935.

Peter Friend

Newmarket Heath from Ely

Here I stand among the Fens
Spread level all around,
But far away a faint blue line
Shows me the rising ground

If I could follow that chalk scarp
South-west I should be led,
Clean across England to the sea
By Branscombe and Beer Head

So though I cannot leave the Fens
And reach the Devon sea.
That dim horizon-marking hill
Brings Beer Head here to me

Muriel Arber, 1951

LOST & FOUND

Enquiries and information, please to Patrick Wyse Jackson (Department of Geology, Trinity College, Dublin 2, Ireland; e-mail: wysjcknp@tcd.ie). Include full personal and institutional names and addresses, full biographical details of publications mentioned, and credits for any illustrations submitted.

The index to 'Lost and Found' Volumes 1-4 was published in *The Geological Curator* 5(2), 79-85. The index for Volume 5 was published in *The Geological Curator* 6(4), 175-177.

Abbreviations:

CLEEVELY - Cleevely, R.J. 1983. *World palaeontological collections*. British Museum (Natural History) and Mansell Publishing Company, London.

GCG - *Newsletter of the Geological Curators' Group*, continued as *The Geological Curator*.

LF - 'Lost and Found' reference number in GCG.

258. Catherine Raisin collection.

Ian Rolfe [e-mail: ianrolfe@macace.net] has written to say that CLEEVELY p. 239 lists respositories of her material including the Hunterian Museum, Glasgow Unversity. A further note regarding association with W.H. Hudleston's collection in to be found in the microfiche directory of collectors appended to H.E. Stace *et al*. 1987. *Natural Science collections in Scotland,* National Museum of Scotland. Other material is held at the Sedgwick Museum and The Natural History Museum.

Professor J.W. Gregory was the power behind Glasgow Unversity's purchase of several London collections around this time, including Frank Rutley's collection (its fate was unknown to CLEEVELY but given in Stace *et al*. 1987).

259. A collection of fossils donated to the Blandford Forum Museum, Dorset.

Barbara J. Pyrah, 50 Cedar Glade, Dunnington, York, YO19 5PL (Keeper of Geology, Yorkshire Museum, 1968-88) writes:

The collection of fossils acquired by gift at the Blandford Forum Museum, Dorset, and listed by Dr Michael Le Bas (2003), is typical of material offered for sale by Edward Charlesworth. The method of presentation (see below) and the handwriting on the labels is identical to that on Charlesworth material in the Yorkshire Museum.

Edward Charlesworth (1813–1893) was the eldest son of the Rector of Flowton, near Ipswich, and as a child collected fossils from the Crag pits there. He studied medicine at Guy's Hospital London. In his early 20s he held the position of Assistant Secretary of the Zoological Society, and had the temerity to argue with Charles Lyell on the Crag Formations; he was elected a Fellow of the Geological Society and was Honorary Curator of Ipswich Museum. In 1836 he was appointed to the staff of the British Museum and in 1837 Assistant to the Museum of the Zoological Society, and also took over Loudon's *Magazine of Natural History*.

In 1840 he accompanied a "young gentleman of fortune" through Central America.

He was Keeper of the Yorkshire Museum from 1844 to 1854, following John Phillips in the post, and worked with honorary curators of various collections - geological, archaeological etc. While at York he founded the London *Geological Journal* and formed the British Natural History Society to employ collectors and distribute identified collections of fossil material to its members, starting with Hampshire Tertiary fossils (which was as far as it ever got).

When he left the Yorkshire Museum in 1858 "he settled for a time in London, and carried on a Natural History and Geological Agency... [He became] one of the most active buyers of fossils in London; always seeking to secure the best specimens and paying the highest prices for them...he generally had some exquisite specimen, temptingly displayed on pink cotton wool in a glass-topped box, for his private customers..." (Anon. 1894).

During the last 20 years of his life illness meant that he was often bedridden. It may be no coincidence that the last of the Yorkshire Museum manuscript catalogues is dated 1878, so it would seem probable that the collection now at Blandford Forum was purchased while Charlesworth was dealing in London between 1858 and say 1880.

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