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Cover Illustration

A selection of small bottles holding mineral material from the Leadhillls-Wanlockhead base metal mines, a small part of the 'Wilson Collection' held at BGS Edinburgh. Each bottle has a diameter of 22 mm and is 63 mm tall. BGS images P995082, 3 & 4. For more on the 'Wilson Collection' see the article by Graham Tulloch and Michael Togher on page 5.

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The Edinburgh Geological Society was founded in 1834 with the twin aims of stimulating public interest in geology and advancing geological knowledge. We organise a programme of lectures and excursions and also publish leaflets and excursion guides. For more information about the Society and membership, please visit www.edinburghgeolsoc.org.

No prospect of an end

An editorial ramble by Phil Stone

This is my final ramble. After eleven years and 22 issues of *The Edinburgh Geologist*, Bob McIntosh and I have decided that it is time to pass on the editorial pleasures to a successor — but fear not, to adapt James Hutton's well-known phrase, we see no prospect of an end for *EG*. Quite the contrary, as I'm sure that the new editor, Bob Gatliff, will bring fresh inspirations to the role. He deserves our sincere thanks for taking on *EG* immediately after completing a very successful two years as our Society's president.

Looking back over recent issues, I realise just how well-served we are in Edinburgh for geological connections. It all starts with the landscape of course, but with the National Museum and the National Library, Our Dynamic Earth, the universities and BGS, all with expertise, collections and archives, we have ready access to such a wealth of geological material and themes that the potential for future *EG* articles must also have no prospect of an end. And here it's worth celebrating the recent purchase of Charles Lyell's notebooks, 294 of them, for the University of Edinburgh Library where they join the pre-existing archive of Lyell material. The acquisition required a major fund-raising effort to match an overseas bid so many thanks to all those who contributed. From his published work, a case can be made for Lyell as the most influential geologist of all time (accepting the influence on him of Hutton's ideas), and his notebooks are bound to contain revealing and unexpected aspects of his work. Some are on display until late in March at the University Library in George Square, so you may still have time to see them there.

We touch on a few of Edinburgh's varied sources of geological fascination in this issue of *EG*. First, and providing some background to our cover picture, Graham Tulloch and Michael Togher delve into the BGS collection and unearth a curious, and rather mysterious, selection of minerals from the base metal mines of Leadhills. Next, Rachel Walcott produces something surprising from the collections of National Museums Scotland. Everyone knows of David Livingstone as a Scottish icon:

Some of Charles Lyell's notebooks. Image © Sotheby's.

African explorer, medical missionary, campaigner against slavery. But did you know of his geological interests? Well, read on.

Scottish icons come in many guises and perhaps the sport of curling can claim a place amongst them. Apart from ice, curling requires curling stones (or rocks as our Canadian competitors would have it) and everyone knows where the best ones come from: Ailsa Craig in the Firth of Clyde. The spectacular little island is formed principally of an unusual, alkali-rich microgranite, a part of Scotland's Palaeogene magmatic suite. It's a very attractive rock, and if you are not familiar with it there's no need to go the west coast, just head up to Edinburgh Castle and take a close look at the floor of the National War Memorial. But why is it so revered as a curling stone lithology? In our third article, Derek Leung examines some of its secrets.

It may seem an unlikely intellectual leap that would take us from Palaeogene microgranite to poetry or more specifically to geopoetics, which is a term I had not come across before encountering Patrick Corbett's exposition, our fourth article. It celebrates particularly the Ayrshire poet Kenneth White and illustrates the coastal scenery and its geology, by which he was strongly influenced, with a view across to – Ailsa Craig. Patrick also provides a timely reminder of the forthcoming 'Geopoetry 2020' event to be held here in Edinburgh on October 1st, with the support of EGS.

Opposite Ailsa Craig, on the Ayrshire coast south of Girvan, we find very different geology—the Ordovician ophiolite of the Ballantrae Complex. Ophiolite? It's a bit of oceanic crust that got thrust onto an active continental margin (obducted) rather than being carried beneath it (subducted). That makes for some fascinating geology, but not even the most ardent cheerleader for Scottish rocks could claim that the Ballantrae Complex is well-exposed, nor that the relationships within it are readily discernible. Luckily, there are ophiolite complexes in other parts of the world where things are very much clearer, and one of the finest of those lies in Cyprus, the Troodos Complex, and it is there that we travel for our final article.

One highlight of the EGS programme is the annual 'long excursion', sometimes to somewhere exotic but always to see classic geology. The 2019 excursion ticked both boxes and headed for Cyprus. The account of the geology seen is a multi-author effort, all compiled and edited by Beverly Bergman. It exemplifies an EGS institution for which once again, there is no prospect of an end. But fortunately for the rest of us it's not always necessary to travel to experience some different geology. Here in Edinburgh we have the advantage that geology often comes to us. Last year EGS co-hosted a meeting of the History of Geology Group, and this year the Geologists' Association annual meeting will be held in Edinburgh, 16–18 October.

The National Museum also brings us an eclectic programme of exhibitions, some with a geological theme; one such is currently the principal feature and stars that monstrous palaeontological favourite *Tyrannosaurus rex*. The opening of the exhibition in late January coincided with *EG* going to press, but the publicity promised that our preconceptions will be challenged by the opportunity to interact with dinosaurs in augmented reality. Amongst the spectacular specimens featured is *Scotty*, one of the largest and most complete *T. rex* skeletons ever found—the living animal's estimated weight was 8870 kg. The exhibition runs until 4 May.

Then of course there are the Edinburgh festivals. Tucked away in the 2019 Fringe was *She Sells Sea Shells*, an entertaining dramatization of the life of that doyenne of fossil collectors Mary Anning. Should it ever reappear, don't miss it. One might quibble over James Hutton's cameo appearance as a dour Scottish farmer, but at least he contrasted nicely with the southern geological gentry and clerics. This was in August, just as *EG 66* was going to press, and therein we had an article on the Dogger Bank. So, at the Book Festival, when I came across *Time Song—searching for Doggerland*, how could I resist? The author, Julia

Scotty. ***The remarkable* T. rex *skeleton discovered in Saskatchewan, Canada, in 1991. Image © James Horan. The name* Scotty *commemorates the bottle of whisky with which the find was celebrated!***

Blackburn, intersperses chapters on Doggerland's mythology, geology and archaeology (all from a very personal perspective) with 18 poems, the *Time Songs* of the title. These celebrate themes that range from the geological time scale, to fossil human footprints, to radiocarbon dating. They are geopoetry of the first order and well worth a look.

Finally, and still thinking about books, let's not forget Edinburgh's role in geological publishing. This issue of *EG* carries a review by Alison Tymon of Dunedin's *Introducing Stratigraphy*, by Paul Lyle, one of the latest contributions to a most useful series. Another recent addition is Alistair Dawson's *Introducing Sea Level Change*, and if you really want to understand what might have happened to Doggerland you should read it. As the ice melts, sea level rises—simple—right? Oh, dear me no, it's far more complicated.

With all this going on there is very definitely no prospect of an end to geological inspiration in Edinburgh. I'm sure that under Bob Gatliff's guidance, *Edinburgh Geologist* will continue to play its part.

As for the greater scheme of things, I was encouraged by the following quote from Paul Smith, Director of the Oxford Museum of Natural History (*New Scientist*, 23 November 2019, p. 56): "Field geologists are like cockroaches—they will survive in a post-apocalypse world."

The 'Wilson Collection' of minerals from Leadhills and Wanlockhead

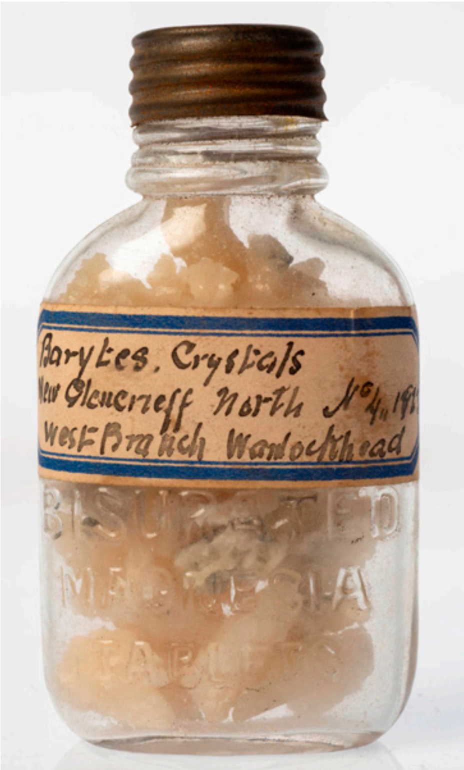
By Graham Tulloch and Michael Togher

The British Geological Survey holds many specimen collections, derived from disparate sources. Many of the collections were made during mapping surveys carried out by BGS staff over the organisation's 185-year history, with others being donated by eminent professional geologists, academics or amateur collectors. Generally, the donations have good paperwork to allow us to identify where the material was found, when and by whom. Unfortunately, some do not, and one such is our 'Wilson Collection'.

The 'Wilson Collection' (we are unsure if it is D L Wilson or D I Wilson) comprises several hundred specimens and occupies 15 of the approximately 7500 storage trays secured in the Lyell Centre's George Bruce Building, BGS Edinburgh. Most of the specimens are from the mineral veins of the Leadhills-Wanlockhead area and are contained in second-hand confectioners' glass tubes and a variety of small bottles. Some of the latter are uniform, as in the cover picture to this issue of *Edinburgh Geologist*, so were presumably purposefully acquired, but other bottles are recycled. Some specimens are labelled with mineral, mine and vein names, together with a date of collection, but for other specimens much less data is recorded.

The Leadhills-Wanlockhead mining field straddles the Dumfries & Galloway/Lanarkshire boundary sitting to the SE of the Leadhills Fault

A selection of the small glass tubes containing mineral material. These measure about 6 cm x 1 cm, but larger tubes range up to 16 cm x 2 cm. They originally held cake decoration produced by the Rowntree company. The small labels on the tubes carry only sparse information. BGS image P995093.



This recycled bottle is about 10 cm tall and carries good location details. Baryte was a widespread gangue mineral in the lead-zinc veins. BGS image P995098.

(Floyd 2003). The first recorded working in the area was by the monks of Newbattle Abbey who sunk a mine for lead in 1239 but it is assumed there was extraction before even then. Alluvial gold was mined in favour of lead for a period until 1562 when lead was imported to the area to assist with the extraction of the gold. Thereafter, and particularly from 1700 until the end of mining in 1958, lead was the principal product along with appreciable quantities of zinc and some silver.

Mineralisation probably occurred during Carboniferous times, and the main host rock to the veins is Upper Ordovician greywacke of the Portpatrick Formation, a component lithostratigraphic unit of the Southern Uplands terrane. The Portpatrick Formation greywackes are distinctive in containing an abundance of volcaniclastic grains, and the individual beds have a generally steep dip and strike NE-SW. In the NW of the formation’s outcrop are mainly thin-to-medium bedded sandstones, whilst towards the SE the formation becomes more thickly bedded. At its NW margin the strike-parallel Portpatrick Formation is faulted against older mudstone of the Moffat Shale Group, a juxtaposition that occurred late in the Ordovician, not long after deposition of the greywacke and during subduction-driven accretionary tectonics. For the most part, the Carboniferous mineral veins run NNW-SSE and terminate in the vicinity of the fault whilst failing more sporadically towards the SE.

The ‘Wilson Collection’ was accumulated over a 90-year period from 1843 to 1932 which suggests

Four of the recycled bottles containing mineral material, the largest of which is 11 cm tall. Note the range of handwriting on the labels. BGS image P995106.

the involvement of more than one collector, as does the appearance of at least four different styles of handwriting on the tube and bottle labels. The name given to the collection is most likely that of the person who donated it to BGS, but unfortunately, we do not have any clues as to who D L (or D I) Wilson was, nor if they were responsible for the collecting. Perhaps they inherited it, purchased it or discovered it in an abandoned office somewhere. It is tempting to associate the collection in some way with D V Wilson, who worked for the Geological Survey, mostly in Scotland, between 1911 and the end of the second world war. Amongst his publications was a Geological Survey memoir—*The lead, zinc, copper and nickel ores of Scotland* (Wilson 1921)—which devotes 35 pages to the Leadhills-Wanlockhead district and confirms that he had visited all the active mines. G.V. Wilson is thought to have died in 1960. Could a relative have passed on a collection after his death? Another possible association, although perhaps entirely coincidental, is the presence at Leadhills of a Wilson’s Vein and a Wilson’s Shaft.

To improve the value of the collection to researchers it would be a bonus if we could identify D L (or D I) Wilson and perhaps discover how he/she came by the specimens. Can anyone help?

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Gathering support —the mineral and rock collection of David Livingstone's first Zambesi expedition

By Rachel Walcott

David Livingstone (1813–1873) is regarded by many to be the single most important British Imperial travel writer [1]. This was no mean feat during the time of great global expansion of the British Empire, but it is not how he set out to be remembered. He was a deeply religious man who earnestly felt it was his mission to bring the 'three C's'—Christianity, Commerce and Civilisation—to the people of Africa. To do this he looked for trade routes and commercial potential in the then unknown-to-the-British area of southern central Africa. To support his observations, he returned to Great Britain furnished with a small collection of geological specimens gathered on his journey across southern Africa from Angola to Mozambique (Figures 1 & 2). This collection is now held by National Museums Scotland.

***Figure 1** A map showing the route of Livingstone's 1854–1856 expedition across the width of southern Africa. In red is his first journey from Linyanti in Botswana to Loanda in Angola, and in green, his journey from Linyanti to Quelimane in Mozambique.*

A taste for exploration

Rev Dr David Livingstone had humble beginnings. For thirteen years, from the age of ten, he worked in the mills of Blantyre, Scotland by day, and as a student by night. This dogged self-discipline which later proved to be such a valuable trait for an oft-ill explorer earnt him a medical degree in his late 20s and support of the London Missionary Association (despite some reservations) to go to South Africa in 1843. Unfortunately, he was not a particularly gifted missionary, only garnering a single convert in his first 13 years. Shortly afterwards, Livingstone decided that focussing on some of the other C's,

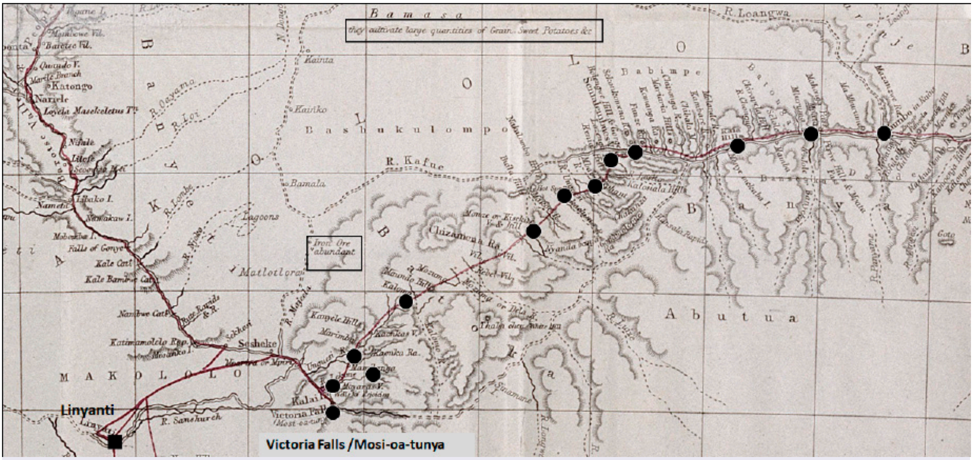

***Figure 2** Map showing that most specimens (indicated by dots) were collected around and down stream of Victoria Falls during the journey east of Linyanti to the coast. Copyright National Library of Scotland. Creative Commons Share-alike 2.5 UK: Scotland.*

particularly the commercial potential of the unexplored lands, might be amore promising, if indirect, way of introducing his values to Africans.

Livingstone's first journey across the Kalahari Desert to Lake Ngami in Botswana, central Southern Africa (1849–1851) was successful enough to earn him a reputation as an explorer back in Britain. Buoyed by this success, and by now fluent in Setswana language he decided to look for a trade route to the west coast. He convinced the chief of the Makololo tribe to loan him 27 guides and together they left Linyanti in November 1853 and headed up the Leeambye River, then west through Angola to the coastal town of St Paul de Loanda (Figure 1).

During this journey Livingstone corresponded regularly with Sir Roderick Murchison, the sometime President of the Royal Geographical Society, and a founding member of the Royal Commission on the British Museum. Livingstone's observations were published in the RGS journal consolidating his fame. The journey was arduous, taking about two years to return to Linyanti, and established that this would not be a suitable trade route. Possibly because of these difficulties only one specimen—a

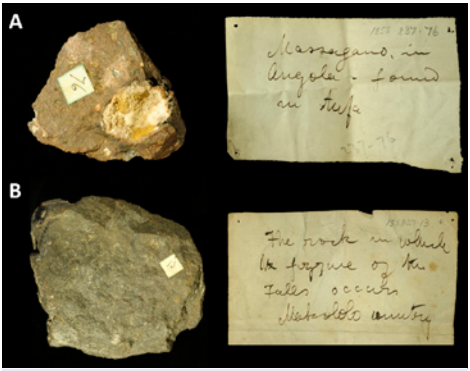

***Figure 3** (A) The only specimen known to have been collected on the journey west from Linyanti to the west coast. Label in Livingstone's handwriting reads 'Massangano, in Angola – found in tufa'*
(B) A sample collected near the start of Livingstone's journey to the east coast from Linyanti. Label reads 'The rock in which the fissure of the [Victoria] Falls occurs, Makololo country'.

small piece of tufa — is preserved from this leg of his expedition (Figure 3A).

Smoke that thunders

While resting up in Linyanti Livingstone realised that the river which he had followed north towards Angola, the Leeambye, was probably the same river as the Zambesi, a mighty and possibly navigable river which flowed east through central Mozambique to the coast (Figure 1). So once again, he set about organising an expedition to the east coast this time. In early November 1855, as the hot season came to an end Livingstone set off to the east coast accompanied by 200 Makololo men with newly gathered ivory. He funded his expeditions largely with ivory as at this time he only had his missionary's salary of £100 pa (equivalent of £12 000 today).

This time, Livingstone collected many more specimens. Perhaps he realised that should he find any rocks of commercial or scientific value the

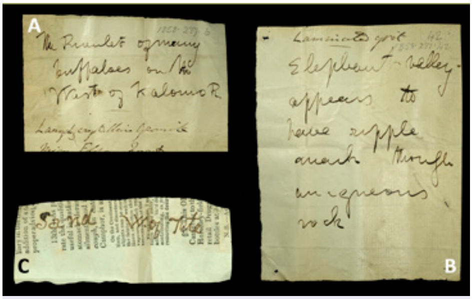

***Figure 4** Livingstone wrote the details of the specimens he collected on what appear to be torn pages from his field notebook. Usually only the locations were noted with lithological details added later by curators (see two sets of handwriting in figures 4A and 4B). Perhaps paper became scarcer towards the end of his journey because he wrote a label for one specimen from Tete (Figure 4C) on a strip of paper torn from a medical book.*

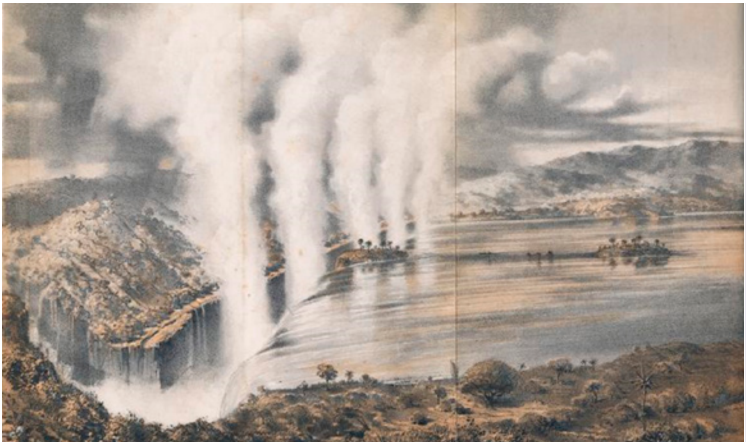

***Figure 5** The Victoria Falls, of the Leeambye or Zambesi River, 1857. Copyright National Library of Scotland. Creative Commons Share-alike 2.5 UK: Scotland.*

samples could support a funding bid to allow him to return to Africa and the Zambesi. His notes reveal he was familiar with most common economic rock types, for example sandstone, coal, iron ore and whinstone. However, in most cases he noted only the location where the sample was found. His first specimens were of basement rock north and west of Linyanti (Figure 4A-C). Shortly after, on 16th November 1855, he arrived at the spectacular waterfall then known as Mosi-oa-tunya ('the smoke that thunders' in Kololo), which he promptly renamed Victoria Falls (Figure 5). He collected specimens from this locality, including a sample of the basalt rock which makes up the Falls (Figure 3B).

Commercial potential of the middle Zambesi

From Victoria Falls Livingstone then travelled down the Zambesi, along the northern bank to the Kafue River, collecting specimens of the basement geology and basaltic dykes. In this region, he noted wide areas containing iron ore and fairly rich agricultural land (Figure 2), yet most of his specimens are of various kinds of basement rock with nothing of major economical value. At River Kafue, Livingstone and his entourage crossed the Zambesi then proceeded along the southern bank, bypassing the Carbora Bassa Rapids which at that time marked the western limit of the region known to Portuguese traders. It wasn't until he reached the Tete region in March 1856 that he started to see richer resources, namely coal and gold (Figure 6).

It took Livingstone and his men almost six months to reach the east coast from Linyanti so perhaps it is not a surprise that most of his specimens

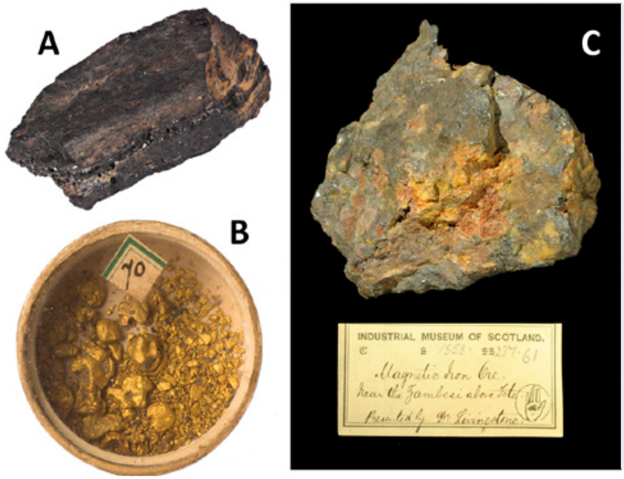

***Figure 6** Samples of coal (A), gold (B) and iron ore (C) from region around Tete, a Portuguese trading post on the Zambesi about 400 km from the coast. The collection was acquired by the newly established Industrial Museum of Scotland (1854–1864) which eventually became the National Museum of Scotland.*

are small, no more than 2–3 inches wide. The specimens typically exhibit weathered sides suggesting they were not freshly hewn out of rock outcrop as was customary in geological collections at the time. There are few of display quality and they seem to have been collected primarily as a record, possibly to impress Murchison or possibly as potential proof of the economic viability of the land he was passing through.

After Livingstone's return to Great Britain in 1856, the collection was briefly housed in the Museum of Practical Geology, Jermyn St, London, before being offered to the newly formed equivalent museum in Scotland — the Industrial Museum of Scotland. Annotations to the original labels reveal that specimens were identified by someone else, most likely a curator. There is no evidence that any were put on display for very long, if at all. In the end, the value of the collection was not in the scientific importance of the specimens, or the economic potential that they reveal, but rather as a window into the thinking of a man who tried so hard to bring the three C's to Africa but was more successful in bringing Africa to his homeland [2].

References and further reading

[1] https://www.livingstoneonline.org/
[2] Livingstone, David. 1857. *Missionary Travels and Researches in South Africa: Including a Sketch of Sixteen Years' Residence in the Interior of Africa*. London, John Murray.

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Curling stones: taken for granite

By Derek Leung

Curling is a classical Scottish and Olympic winter sport, and curling stones used in international competition only come from two places in the world: Ailsa Craig, Firth of Clyde, Scotland and Trefor, Llŷn Peninsula, North Wales (Figure 1). It is commonly assumed that the rocks have special properties, but there is a lack of scientific evidence to test this claim. Moreover, curling stones are a significant investment for the curling community: new stones cost about £450, or upwards of £60 000 for an eight-sheet facility. So why can't curling stones be produced elsewhere? As the first mineralogical and textural baseline study of curling stones since Heddle (1890), my research bridges a longstanding knowledge gap by (1) defining the varieties of curling stones used in international competition, (2) distinguishing running surface and striking band varieties, (3) commenting on the presence and desirability of quartz in curling stones, and (4) evaluating the uniqueness of the mineralogical and textural properties of curling stones.

Ailsa Craig is a Paleocene (61.5±0.5 Ma) alkali microgranite (Harrison *et al*. 1987) and Trefor comprises

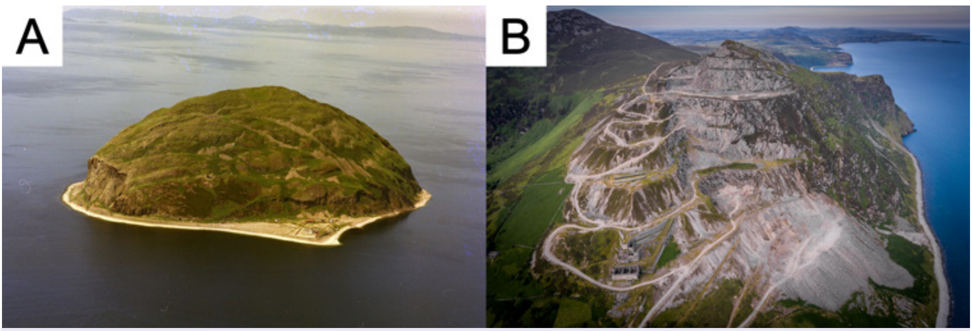

***Figure 1** Locations where curling stones are produced: A) oblique aerial view of Ailsa Craig, Scotland, facing W (BGS P000711; reproduced with the permission of the British Geological Survey ©UKRI. All rights reserved.); B) oblique aerial view of Trefor, North Wales, facing SW (photo courtesy of Terry Williams).*

a series of three mid-Ordovician granodiorite-porphyry intrusions (Tremlett 1962). Each locality produces two types of curling stones (Figure 2), although neither locality hosts true granites (despite casual references to granite in curling). Ailsa Craig Blue Hone and Ailsa Craig Common Green are harvested from the northeastern and southern regions of Ailsa Craig, respectively (note that the island is a bird sanctuary with quarrying restrictions), whereas Blue Trefor is quarried on a specific bench in the upper section of the Trefor Quarry and Red Trefor is quarried on the lower benches. Historical quarrying for road setts is responsible for the enormity of the Trefor Quarry—apparently a thousand people were employed in the quarry's heyday!

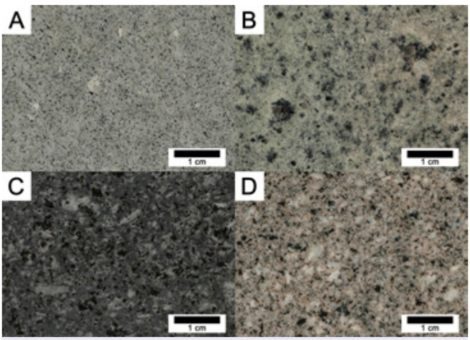

Figure 2 Curling stone types: A) Ailsa Craig Blue Hone; B) Ailsa Craig Common Green; C) Blue Trefor; D) Red Trefor.

There are two main components of curling stones: (1) the running band (the ring-shaped bottom surface of stones; Figure 3A), which serves as the interface between the stone and the ice, and (2) the striking band (the convex band on the profile of stones; Figure 3B), which serves as the contact area between stones during collisions. The running band is responsible for curl (e.g., Maeno 2016) and is subject to pitting, a phenomenon where grains are preferentially removed from the running band, causing inconsistent performance. The striking band accumulates damage over time and thus limits the lifetime of curling stones.

Ailsa Craig Blue Hone is considered unsuitable for striking bands because it develops crescent-shaped chips (Figure 4A) but it is regarded as the best for running bands because of a perceived resistance to pitting. Thus, in the process of manufacturing

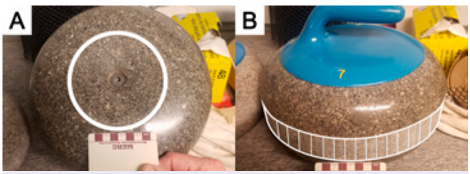

Figure 3 Key components of curling stones (highlighted in white): A) running band (diameter 11–12 cm, width ~6 mm); B) striking band (width 3–4 cm).

curling stones (made of Ailsa Craig Common Green, Blue Trefor, or Red Trefor), the bottoms of curling stones are cored out and replaced with Ailsa Craig Blue Hone ('inserting'; Figure 4B). For international-level competition, Ailsa Craig Blue Hone is used for running bands, whereas Ailsa Craig Common Green, Blue Trefor, and Red Trefor are used for striking bands. The main distinction between running bands and striking bands lies in grain size: Ailsa Craig Blue Hone is equigranular (apart from sparse phenocrysts), whereas the other three varieties have a larger grain-size distribution and a greater proportion of larger (millimetre-sized) minerals. This is partially explained by the tendency for large grains to pit in the running band, but the rationale is unclear in striking bands.

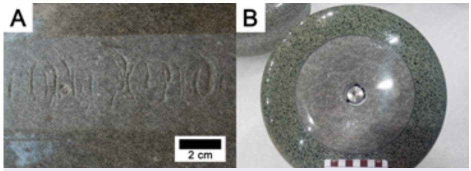

***Figure 4** A) Crescent-shaped chipping in Ailsa Craig Blue Hone curling stone; B) curling stone from PyeongChang 2018 Winter Olympics displaying inserted Ailsa Craig Blue Hone running band in Ailsa Craig Common Green curling stone.*

With respect to mineralogy, there is a longstanding belief that quartz is absent or undesirable in striking bands due to its brittleness (e.g., Heddle 1890, Cole 1951). However, curling stones contain appreciable abundances of quartz (15-25 modal %) as unstrained, anhedral, and interstitial grains, which challenges this traditional common knowledge.

In summary, curling stones can be characterised as fine- to medium-grained, variably altered, variably foliated and/or lineated, sparsely phenocrystic to phenocrystic, Phanerozoic granitoids. These characteristics are not unique to curling stones, so rocks with similar mineralogical and textural properties could be considered as potential candidates for curling stones. In the present-day search for alternative sources, curling stones are also produced in China and Finland.

This baseline study provides the basis for further research into the characteristics of running bands and striking bands, in the pursuit of evaluating past, present, and prospective sources of curling stones. For the running band, the physics of curling is controversial (e.g., Maeno 2016), and the relationship between the topology of the running band and the dynamics of curling remains unexplored. My current research focuses on the damage evolution of striking bands of curling stones, using a combination of analytical and experimental techniques, including synchrotron microtomography at Diamond Light Source (Oxfordshire, UK). This will be complemented with an on-ice curling stone impact experiment to quantify the mechanics of curling stone collisions. Given that the striking band limits the lifetime of curling stones, understanding their damage propensity will provide insight for future maintenance. Moreover, the rock physics of curling stone impacts is related to dynamic spalling and more broadly to rock failure, as these processes are ultimately related to the initiation and propagation of fractures.

Acknowledgements

This work draws heavily from my BSc thesis (Leung 2019) and my MScR plan. I thank my supervisors Prof. A M McDonald (BSc), R S Poulin (BSc), Dr F Fusseis (MScR), and Dr I B Butler (MScR) for their guidance. Research funding was provided by the Society of Economic Geologists Canada Foundation (BSc), Edinburgh Geological Society (MScR), and Moray Endowment Fund (MScR).

Please consider supporting my project by sharing my story or donating to my project (GoFundMe page: https://www.gofundme.com/f/curling-stones-research-masters-edinburgh).

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Geopoetry and Geopoetics

By Patrick Corbett

The idea to hold a second geopoetry meeting for the Geological Society in Edinburgh, on 1st October 2020—National Poetry Day, came from coming across Bryan Lovell's inspiration in holding the first such meeting in 2011 in London and a newfound interest in poetry. Looking at the arrangements for that meeting we quickly built up a steering committee with myself, Bob Gatliff (BGS at the time and EGS), Asif Kahn of the Scottish Poetry Library (ideally placed with its close proximity to Arthur's Seat in the centre of Edinburgh) and Stuart Harker (who had participated in the 2011 meeting). Bryan Lovell gave us his enthusiastic endorsement and we were off.

Asif indicated that there was a flourishing Scottish Centre for Geopoetics and Director, Norman Bissell was soon contacted and on board. The question that came up was 'What is the difference between Geopoetry and Geopoetics?'. To be honest, as a geologist of forty years standing, I hadn't heard of either term six months earlier! This question led to Dorrik Stow and myself attending the SCG summer meeting just outside Biggar in the Scottish Borders in June 2019 to hold a workshop entitled 'Geopoetry vs Geopoetics' and to look for an answer.

Here we need to digress, in order to understand more about the origins of the Scottish Centre for Geopoetics. The website for the International Institute of Geopoetics informs us that 'geopoetics' is originally of German origin and became current in the 1930s. That same website (http://institut-geopoetique.org/en/) contains a number of Precision Points—Geopoetics and the other 'geos'—but gives nothing on Geopoetics and Geology. An early proponent of geopoetics was Jacques Ancel, whose doctorate was on political geography at the

West Coast of Scotland (near Ardrossan) on a typical day—one that Kenneth White would surely have experienced.

University of Paris. Geo(world)poetics (making) captures the global aspirations of 'making the world new' (Bachelard, 1958) as highlighted by Marie McFadyen in her 2018 Annual Tony MacManus Lecture (http://www.geopoetics.org.uk/). Tony McManus founded the Scottish Centre for Geopoetics in 1995. The spirit of geopoetics seems to be more Human and Physical Geography rather than focused on the subsurface Geology that I was more familiar with. Certainly, geological processes are capable of 'making the world new'! From the Centre's website 'a poetics which places the planet Earth at the centre of experience' is a poetics that geologists could certainly relate to.

The International Institute of Geopoetics was founded in 1989 by Kenneth White. White is seen as the father of geopoetics. Born in 1936 and raised at Fairlie, on the west coast of Scotland, he was strongly influenced by the geology he encountered there walking along the Devonian Old Red Sandstone shorelines.

Old Red Sandstone strata on the beach at Culzean.

White describes himself as an intellectual nomad with three hermitages. The first hermitage found him in the Ardèche (1961) where he

A poetic view of Ailsa Craig from the Ayrshire coast.

Hearken, thou craggy ocean pyramid!
Give answer from thy voice ....

Thou answerest not, for thou art dead asleep.
Thy life is but two dead eternities –
The last in air, the former in the deep!
First with the whales, last with the eagle skies!
Drown'd wast thou till an earthquake made thee steep,
Another cannot wake thy giant size!

Lines from *Sonnet to Ailsa Rock*
By John Keats

'studied Provençal culture, taoism, buddhism, granite, schist and calcite'. The second hermitage was provided by a move to Pau (1967) where White 'went deeper into geology and geomorphology, studying primary sediments, magmatic intrusions and moraine complexes (groundings—like the growths of a mind) that led to Pyrenean Meditations'. Primary rocks are mountain building hard rocks and primary sediments implies what geologists would know as sedimentology. Moraine deposits are (often) primary sediments, gouged out by passing ice and then dropped (perhaps grounded) from melting glaciers.

Needing to get further away towards the margins (to live on the edge), he moved to his third hermitage, in Brittany in 1983—'on the Armorican promontory in an area known in geology as a centred complex (this is taken to be reference to the central part of the Armorican Massif). In *House of Tides*, written in Brittany and emerging from White's mental 'centred complex', White refers to an inscription (White, 2000) on a memorial to General De Gaulle 'Waves do not wear away granite' to which White comments "-Noble rhetoric, but bad geology, waves do most definitely erode granite and therefore bad poetry, which is a pity". This provides evidence that White had a deep understanding of geology and was influenced by the geology he had spent time to learn from, that perhaps eludes many poets, and geologists would certainly recognise bad geology (if not bad poetry!)

The last wave of his long poem 'Walking the Coast' has this to say on a strongly geological panorama and perspective (White, 2003)

like this rock before me
facing the tide
an outcrop
of dark grey sandstone
(so the ones on which
as children
we chiseled our signs)
with a blaze
of white granite
running right through it –

understand this, poet.

It is clear from this extract that the founder of geopoetics was strongly influenced by geology and left many an invitation in his writings to both geologists and poets to walk the White Path together.

Building stronger links between geologists and poets is well in hand in the run up to the Geopoetry 2020 event. Geological inspiration, in the form of a walk on Arthur's Seat, readings from geologists and poets, a session for new work to be read and critiqued, and an evening session to relax with tales of Edinburgh poets and their geological friends will all make for an interesting day. The Edinburgh Geological Society is committed to some sort of Geopoetry 2020 publication. Hopefully, this work, a modern contribution to geology and poetry, will add to the lexicon and inspire future geopoetry to enrich our geopoetic world.

Patrick Corbett walking the coast—on the White Path (on Harris).

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The EGS long excursion to Cyprus

By Beverly P Bergman, David Blythe, Douglas Holliday, Stephen Livera, Richard A Smith, David Stephenson and Christine L Thompson

The Edinburgh Geological Society Long Excursion 2019 took place in Cyprus from 11–19 May. The trip was organised by the extremely efficient Anne Burgess, with travel and accommodation arranged by Burnside Travel. The leader was Professor Alastair Robertson of Edinburgh University, a veteran of nearly 30 field trips to the island, many with students; our programme was a cut-down version of the student itinerary. The group was comfortably accommodated at the Hotel Moniatis in Germasogeia, on the outskirts of Limassol.

The island of Cyprus comprises three tectonic terranes; the Troodos Massif, the Mamonia Complex and the Kyrenia or Pentadactylos Range. The latter, in Northern Cyprus, did not form part of this excursion. The island is situated on the boundary of the African and Eurasian plates, on the upper plate of an active subduction zone. It underwent rapid uplift in the Late Pliocene-Holocene, largely driven by underthrusting of the Eratosthenes Seamount. The star attraction of Cyprus geology is the Late Cretaceous Troodos Ophiolite complex, a fragment of oceanic crust and mantle from beneath the Tethys Ocean, now exposed on land.

In Cornwall last year we had followed the typical ophiolite sequence from the mantle up into the sheeted dykes of the Late Palaeozoic Lizard Ophiolite complex. On our first day in Cyprus, we started with sheeted dykes and progressed further up into the overlying pillow lavas, in one of the most-studied ophiolites in the world. Our first stop was near Zoopigi, about 30 km north of Germasogeia, where a road cutting exposes the lowest part of the sheeted dykes. Here we saw basic dykes, fed by partial melting of the mantle in an extensional environment, and—surprisingly—granites. The latter were formed by extreme fractionation of the basaltic melt and are the only rocks in the ophiolite that can be dated (at c.90 Ma).

We then travelled through impressive 100% sheeted dyke terrain to the village of Palaichori (Fig. 1). In a road cutting here are numerous vertical sheeted dykes, with no intervening country rock, produced at a seafloor-spreading centre. By looking at their chilled margins it is possible to work out the relative order in which they were injected, and even estimate the direction in which the spreading axis lay. Next, at Apliki, we saw evidence for hydrothermal activity in the middle to lower parts of the sheeted dykes, where cold seawater had reacted with hot magma, dissolving dyke rock and precipitating metals on the seafloor. The sheeted dykes fed magma up to the seafloor; and at our final two stops we found dramatic evidence for the processes involved. In the Kamaropotamos Canyon we marvelled at giant feeder tubes that had spilled pillow lavas onto the seafloor and discussed the dynamic interplay of the volcanism with faulting. Finally, at Akaki Canyon we saw a magnificent pile of pillow lavas and hyaloclastites (sand-grain size fragments of basaltic glass) cut by swarms of dykes.

Figure 1 100% sheeted dykes near Zoopigi (© B P Bergman)

The following day, we drove into the Troodos Mountains to examine rocks of lower ocean-crustal origin, and then on to rocks from upper mantle depths, in a journey uphill through the palaeo-Moho and back. The smooth dome of uplifted ultramafic rocks, flanked by rugged masses of sheeted dykes and lavas, was seen from near Trimiklini Village. At the second stop we saw diffusion layering in gabbros with later pegmatitic sweats all cut by dolerite dykes. Stop 3 overlooked the disused Amiandos asbestos mine, where fibrous chrysotile veins in serpentinised harzburgite had been extracted (Fig. 2). It was once the largest source of chrysotile in Europe, although the average grade was only ~1%. Despite alteration and deformation in the nearby roadcut, we were able to clearly identify primary mantle layering within harzburgite.

Stop 4 was a sequence of layered cumulates with dunite pods and dykes of wehrlite, all cross-cut by dolerite dykes altered to rodingite (hydrated aluminium silicate). Then, after lunch in Troodos village, we examined an impressive detachment fault beyond

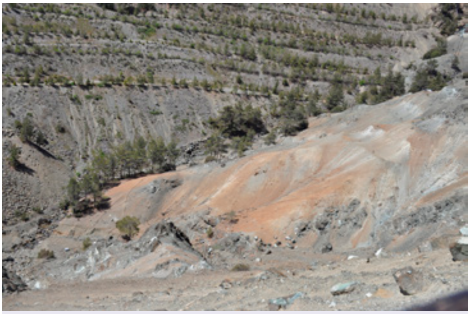

Figure 2 ***The partially-restored landscape of the Amiandos asbestos mine (© B P Bergman).***

Lemithou village that separates sheeted dykes from massive gabbro below (Fig. 3). This was caused by major extensional thinning near a former spreading centre. Back down towards Platres we observed cumulate-layered gabbros and minor pyroxenite and wehrlite in a fault-bounded block. Darker layers are rich in olivine. Ductile shearing at high temperature caused a mineral fabric sub-parallel to layering but also deformed that layering to produce a fine example of a reclined isoclinal fold at this locality.

Day 3 was spent examining the northern side of the Troodos cover, a relatively condensed sequence of Miocene to Quaternary age. However, the excursion commenced at Agrokipia Pit where opencast mining of copper and iron ores (predominantly sulphides) was carried out between 1952 and 1971, leaving a deep water-filled excavation (Fig 4). The mineralisation is confined to the Lower and Upper Pillow Lavas and was emplaced by the circulation of hydrothermal fluids along extensional faulting. Weathering has enriched the upper part of the ore deposit in secondary minerals.

A succession of Miocene deep-water chalks and overlying shallow-water conglomerates was examined during

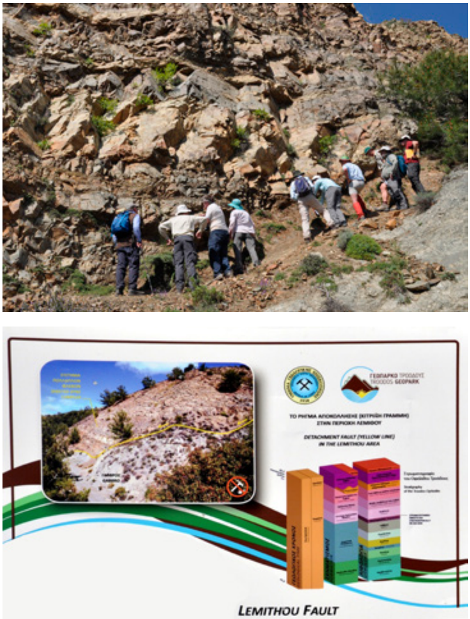

Figure 3 ***Members of the group standing on the Lemithou detachment fault, with part of one of the impressive interpretation boards situated at geological sites in Cyprus showing the line of the fault (© B P Bergman)***

Figure 4 Agrokipia Pit mine (© S Livera).

the ascent of Kottaphi Hill. The conglomerates were sourced from higher ground, adjacent to Agrokipia Pit, which remained emergent at this time due to faulting and uplift. Thick deposits of evaporites were formed in the Late Miocene during the closure of the Tethys Ocean. Two types of gypsum were examined at Kato Moni Quarry; a fine-grained alabastrine and a much coarser selenitic type where pulses of crystal growth have created a banded appearance. Pliocene channelised bioclastic sands, overlain by Pleistocene conglomerates, were viewed at Chryssospiliotissa ('Madonna of the Golden Cave'). The road section at Xeri afforded the opportunity to examine Pleistocene fan-conglomerates; in the view towards Troodos, their dissected nature reflects an episodic history of uplift and erosion.

The fourth day was devoted to the cover sequence south of the Troodos, which is thicker than that seen on Day 3 but otherwise similar in many aspects. It illustrates the gradual shallowing from deep water, c.2000 m, in the Late Cretaceous and Palaeogene, to fully emergent by the Quaternary, resulting from the uplift of the Troodos ophiolite. Following a brief overview stop near Pano Lefkara, a nearby road-cutting in Palaeogene chalks was examined. These rocks, of turbiditic origin, are replaced locally by dark-coloured chert and more generally by opal-CT. Such silicification is particularly abundant in rocks that formed at the time of the Eocene Thermal Maximum. Younger, Lower Miocene, calcareous channel sandstones containing bioclastic debris and fragments derived from older rocks during uplift of the Troodos ophiolite were examined in a quarry at Tokni. After lunch in Khirokhitia, where an important Neolithic site provided an opportunity to view some of the archaeology of Cyprus, more channel sandstones of Late Miocene age were seen in an adjacent valley. A cliff section showing a sequence of stacked channels was the subject of much discussion.

Near the south coast, a small quarry in latest Miocene (Messinian) gypsum was visited at Maroni (Fig. 5). In addition to selenitic and fine-grained laminated (turbiditic?) alabastrine gypsum (similar to that seen the previous day at Kato Moni) the locality is particularly notable for the occurrence of reef-like masses of celestite ($SrSO_4$), in part stromatolitic. The day ended at the Vasiliko cement works where Pliocene fossiliferous marls of relatively shallow-water origin (c.200 m) are overlain by Quaternary channelised terrestrial sands and gravels exhibiting palaeosol horizons. The development of these deposits can be related to the terrace gravels and phases of Troodos uplift seen the previous day in the north.

***Figure 5** Fan-shaped coarse-bladed selenitic gypsum, Maroni (© B P Bergman)*

Day 5 was devoted to the South Troodos Transform Zone, an 8–9 km-wide zone of strike-slip movement and a wonderful example of a type of plate boundary that is difficult to study in the modern environment. Several characteristics, which have been identified in modern examples, can be studied: extreme local seafloor relief, deformation-induced unroofing of deeper crust, deformation fabrics including sub-horizontal shear, remelted already depleted upper-mantle rocks, and gabbroic rock intruded into 'out-of-place' hosts.

After an overview stop, we walked to study slumped umber deposits of the Parapedhi Formation overlain by distinct pinkish Late Campanian radiolarites, showing a combination of 'black smoker' and Tethyan silica-diatom bloom deposits on unstable submarine slopes. The roadcut at Legeia showed another unusual combination of slumped and rafted lava breccia and fine-grained red volcaniclastic sedimentary rocks with current ripples. Modern oceanic transform-fault scarps show strong relief enabling the deposition of this type of sedimentary sequence, in an environment of very cold water with no land-derived sediment.

The next stop allowed us to study rare boninitic pillow lavas. Boninites are distinctive mafic rocks created by the hydrous remelting of already depleted mantle. High in magnesium and silicon, in ophiolitic settings they are thought to form above former subduction zones. Eruption into cold seawater forms glassy chilled pillow margins and highly brecciated hyaloclastites. Near Ora we discussed the shear rotation of sheeted dykes adjacent to transform faults, palaeomagnetic data aiding the explanation of N-S-orientated Troodos sheeted dykes as being rotated clockwise, indicating right lateral shearing during emplacement. The last two stops of the day at Dhierona and 'Wehrlite corner' showed some characteristic 'dyke-in-dyke' features of varying rock types. The latter highlighted a country rock of serpentinised harzburgite intruded by wehrlite dykes and then finer grained picritic dykes with strongly chilled margins.

Our final day covered the Mesozoic sedimentary and volcanic sequences of the Mamonia Complex, exposed in inliers in SW Cyprus. These rocks formed on the margin of the early Tethys Ocean (Neotethys) in Late Triassic time, long before genesis of the Troodos Ophiolite complex. There was much discussion on how the separate Troodos and Mamonia terranes were rotated and juxtaposed before being overlain by latest Cretaceous deep-water melange and chalk.

Space does not permit more than a few highlights, but the day started near the headland where the legendary Aphrodite emerged from the sea (Fig. 6). Pillow lavas at beach level have been shown from trace-element patterns to be within-plate, oceanic island basalts. The volcanic rocks are associated with Late-Triassic (Norian) reef limestones, suggesting seamounts capped by carbonate atolls. The basalts and reef limestones, together with pink deep-water limestones, all occur as angular blocks in a melange forming the base of the overlying and entirely oceanic Dhiarizos Group. Inland, the deformed and disrupted Ayios Photios Group structurally overlies the Dhiarizos Group but comprises contemporaneous, continental-margin deposits; turbiditic sandstones and redeposited shallow-water ooidal limestones near the base of the group contain inverted sedimentary structures.

Next, we traversed across one of several major strike-slip shear-zones that form arcuate linear outcrops of serpentinite and Late-Cretaceous mid-ocean-ridge-type volcanic rocks within the Mamonia Complex. A road cutting with highly sheared

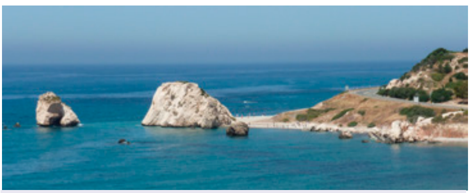

***Figure 6** The 'Birthplace of Aphrodite' near Petra tou Romiou (© D Stephenson).*

serpentinite, 'knobbly' lava breccias and pillow lavas with interbeds of radiolarian chert and red pelagic limestone provided some excitement when visible radiolaria were found. Farther north, we crossed the main suture between the Mamonia and the Troodos terranes. Their docking resulted in rapid submarine erosion that generated debris-flows (the mid-Maastrichtian Kathikas Formation) extending across both terranes. The debris flows contain a varied assemblage of angular clasts, some up to 3 m in size, from both the Troodos and Mamonia terranes, overlain by a Maastrichtian to Oligocene sequence of deep-sea chalk, the Lefkara Formation (Fig. 7).

As we gathered with some apprehension beneath the large angular overhanging blocks at the last locality, Alastair treated us to a very neat summary of the tectonic evolution of Cyprus from the Late Triassic to the Anthropocene. He made it all seem so simple by relating all that we had seen during the week to events starting with sedimentation and volcanism within and on the passive margin of Neotethys, 220 million years ago, and progressing to the final uplift of the Troodos Ophiolite complex, attributed to subduction of the Eratosthenes Seamount from around 4 million years ago. Of course we all know that nothing is ever as simple as that

Figure 7 ***Debris flow deposits of the mid-Maastrichtian (late Cretaceous) Kathikas Formation (© D Stephenson)***

but, as a framework on which to hang all that we had seen during a highly informative, entertaining and enjoyable week, it was a perfect ending, leaving us to contemplate all the detail and interpretations at our leisure.

Further information

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The Troodos Mountains have been designated a UNESCO Global Geopark, with an informative website at www.troodos-geo.org. Also useful is the Cyprus geological heritage educational tool: www.cyprusgeology.org.

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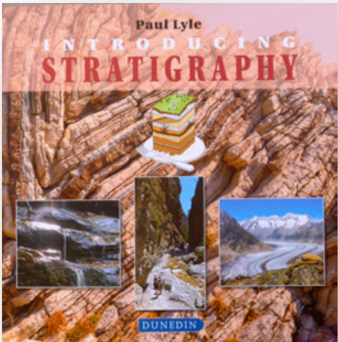
Book review

Introducing Stratigraphy by Paul Lyle. Dunedin Academic Press, Edinburgh, 2019. Paperback, 132 pp. Price £14.99. ISBN 978-1-78046-022-2.



Paul Lyle's new book is an excellent purchase for those with some geological knowledge who want to refresh their understanding of the latest topics in stratigraphy, including the branches of biostratigraphy, magnetostratigraphy and chemostratigraphy. Each chapter adds information to show how the stratigraphic column has been refined, firstly by outlining time intervals such as eras and periods, then by describing the development of relative and absolute dating and finally by illustrating the stratigraphic column as geologists now understand it, by including the classic and very beautiful International Chronostratigraphic Chart, complete with golden spikes.

"How long did that take to form?" is the difficult question that many geologists face when studying a sedimentary rock face. The chapter on Charles Lyell's uniformitarianism and George Cuvier's catastrophism theories leads into the nature of the earth's cycles, from the very long scale of Tuzo Wilson's plate tectonics theory, to the recognition that catastrophic events such as major volcanic episodes and asteroid impacts have resulted in rapid changes to the earth's landscapes and its rock record.

The basic principles of radiometric dating are explained, followed by an account of Arthur Holmes' early success in providing an accurate timescale for the geological column. A later chapter describes how stratigraphic units are defined and explains the distinction between chronostratigraphic units of time (e.g. periods) and the geochronological units, the rocks deposited in that period of time (e.g. systems). Explanation of the way in which Global Standard Stratigraphic Point (GSSP) locations are defined is included, with several interesting examples. The base of the Ediacaran Period in South Australia is shown in a close-up photo of the 'golden spike' and marks the GSSP of the newest addition to the geological timescale. Future editions may need to include a GSSP for the proposed Anthropocene Epoch.

A brief geological history of the planet is prefaced by an account of the factors which have defined the major divisions of the stratigraphic column, from major glacial periods and changes in atmospheric composition during the Precambrian, to sea-level changes in the Mesozoic and the effect of the asteroid impact at the K-T boundary. The extinction of life forms, including the Phanerozoic mass extinctions, is described and the section concludes with a helpful graphic illustration of the remarkable variation in fossil genera at period boundaries.

Sequence stratigraphy is the basis for the understanding of sedimentary basins. However, the theory is not particularly easy for non-specialists to understand, particularly as it is garnished with a proliferation of terms. Walther's Law of Correlation introduces the idea of facies sedimentation in an early chapter and the theory of sequence stratigraphy is elaborated with the help of a beautifully illustrated example from the Cretaceous rocks of Book Cliffs, eastern Utah, USA, as well as many graphic logs and diagrams of tract models. The application of stratigraphy in economic fields, such as oil and gas exploration, uses interesting examples such as wire-line logging and seismic techniques.

Throughout, the theoretical material is interspersed with examples, beautifully illustrated with photos, maps and diagrams. A cross-section of the Grand Canyon is used to explain the nature of unconformities, dyke swarms in Iceland illustrate cross-cutting relationships and a photo of Tunguska in Siberia reminds us of the catastrophic effect of asteroid impacts. There are excellent diagrams, such as explanations of varve correlation and the use of zone fossils, which lend themselves to use in teaching situations, being large and clearly labelled.

There are many terms which are defined in the text which do not appear in the glossary; the lack of the essential word 'parasequence' is an inconvenient omission, amongst others. Captions to illustrations contain errors and ambiguities and some maps have no key. An explanation of the use of 'myr' and 'mya' would have been useful and the abbreviations are used inaccurately in places. But despite these minor irritations, this book has a concisely written text with clear explanations of a range of stratigraphic ideas and principles and is enjoyable to read, browse or use for reference.

Alison Tymon

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