The Edinburgh Geologist

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Cover Illustration

Palaeogene volcanic rocks on the Isle of Eigg. Pitchstone lava forms the prominent ridge of An Sgùrr and overlies basalt of the Eigg Lava Formation. BGS image P000644.

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A good winter for geologically inclined couch potatoes, a scurrilous rumour and another last word on greywacke.

An editorial ramble by Phil Stone

I dare say that your enduring memory from the end of 2010 features snow and ice. Geological memories from earlier in the year probably involve volcanic ash, but perhaps lurking in the background are some of the other reported phenomena. For example, the latter part of the year was a good time for 'earliest' discoveries. So, in August we had a claim that the earliest animal fossils, about 650–640 million years old, had been found in South Australia. September brought an announcement that the Earth's oldest rocks, at 4.28 billion years had been discovered in Canada, on the shore of Hudson Bay—an Australian zircon crystal still holds the record though at 4.36 billion. Then in November came a claim for evidence of very early life on Earth from… Scotland! Research at the University of Aberdeen had detected a chemical signature of bacterial activity in 1.2 billion years old rocks from Lochinver, in the north-west Highlands; the rocks in question being lacustrine strata from the Torridonian, Stoer Group.

All this meshed very nicely with a sequence of BBC television programmes screened late in the year, in which Scottish geology also featured prominently. David Attenborough narrated 'First Life', and though rather more exotic localities dominated, he was to be seen on Crail beach (in the rain) admiring Carboniferous tree stumps, and then watching a fork-lift truck move a huge eurypterid fossil in the National Museums' collection store at Granton. Elsewhere, Iain Stewart was ubiquitous. His programme series 'How Earth Made Us' was pretty wide ranging geographically, but he became much more geographically focussed with 'Making Scotland's Landscape', though of course for this series geology was only one of the varied influences explored. For a geologist, the best series was undoubtedly 'Men of Rock' (though TV viewers outwith Scotland had to wait until January to see it) wherein, to quote the BBC, "Geologist Iain Stewart retraces the steps of a band of maverick pioneers who made

ground-breaking discoveries in the landscape of Scotland about how our planet works". Now programmes of this sort, whilst always welcome, can be a bit idiosyncratic and partial. 'Men of Rock' was certainly both at times, but overall it can be rated a great success — not least for the enhanced profile of geology that it created in the public consciousness. In that respect, I was struck by the review carried in 'The Scotsman' on 16 December 2010 in which Andrea Mullaney wrote of the "surprisingly interesting geology series". Her presumption must have been that geology was unlikely to be interesting, so that's definitely progress.

Channel 4 got in on the act in early 2011, with 'Birth of Britain' presented by Tony Robinson. This series took a broader brush to plate tectonics, volcanoes, ice ages and the like and was unashamedly populist. As a result it was perhaps less satisfying to a geologically-informed audience and to me seemed very disjointed at times, but still great for raising the profile of the science and its awesome implications. As usual though, for most the Scottish sections — Arthur's Seat, Glencoe, Skye — it rained! The exception was the nice sunny day for a look at Glasgow's drumlins, though the literal demonstration of 'basket-of-eggs topography' was a bit bizarre and not very convincing. The Channel 4 take on ice ages also demonstrated a difficulty arising from the plethora of similar programmes: the presentation of apparently contradictory conclusions drawn from the same evidence. The 'parallel roads' of Glen Roy were visited by both Tony Robinson and Iain Stewart, but as their respective explanations of glaciation developed, TR implied that the next Ice Age was long overdue whereas IS had previously warned us to expect the ice to arrive in about 40 000 years time. In truth, both of these figures are probably irrelevant. We may not have any clear plan to prevent global warming, but we certainly know how to prevent global cooling!

Three individual programmes made up the BBC's 'Men of Rock' series: 'Deep Time', 'Moving Mountains' and 'The Big Freeze'. In these, the likes of James Hutton, Arthur Holmes, Charles Lapworth, Edward Bailey and Louis Agassiz were given pride of place, whilst poor old Roderick Murchison was presented as a bit of a pantomime villain — very necessary when the underlying theme is the perennially fashionable 'mavericks versus the establishment'. Of necessity, plenty of scientific corners were cut, but I thought it a particular shame that

when Henry Cadell's mountain building apparatus was demonstrated in the second programme, its origin went entirely unacknowledged. Still, at least, John Mendum had covered that in the last issue of 'Edinburgh Geologist'. On the credit side, in the third programme much was made of James Croll's largely neglected contribution to the understanding of ice ages; he is definitely one of our hitherto unsung geological heroes. His 1875 book 'Climate and Time' laid the groundwork for subsequent calculations (made during First World War internment) by the Serbian mathematician/astrophysicist Milutin Milankovitch — who then got all the credit. But of course, the real highlight of the series, also in the third programme, was the Edinburgh Geological Society excursion to Blackford Quarry to show Iain Stewart 'Aggasiz's Rock' – the consensus seemed to be that it was indeed the work of ice, but I don't think anyone threw their hat in the air in emulation of Aggasiz's reported behaviour.

In his third programme, Tony Robinson used gold mineralization as a theme for travels around Britain, with Scotland represented (rather under-represented I felt) by some panning at Wanlockhead. Down in Wales, TR seemed rather more at home amidst Roman industrial archaeology at an old mine site where, when it came to explaining the folding of the local rocks, what should appear but Cadell's apparatus. Once again, it went entirely unacknowledged. The programme also reinforced my unease at the rather simplistic way in which the closure of the Iapetus Ocean is consistently portrayed by the Media as a great tectonic climax that almost instantaneously produced folded strata, mountain ranges, granite intrusions and mineral veins. Of course it was nothing like that, with the end of Iapetus a long-drawn-out and, in tectonic terms, a rather low-key affair. I suppose the alternative is just too good a story to resist, never mind whether it's true or not.

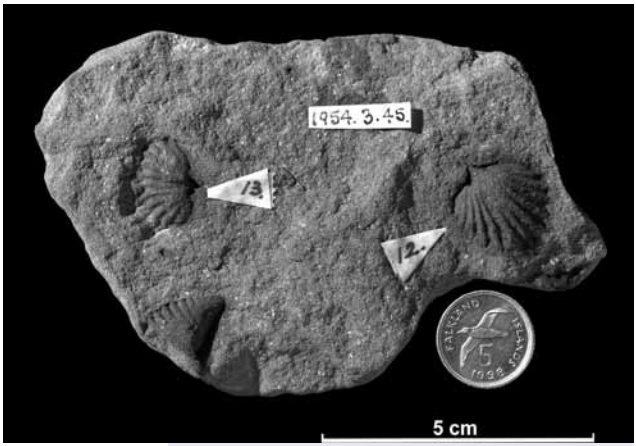
After his TV appearances, Iain Stewart was to be seen again in Edinburgh at the beginning of December, at Our Dynamic Earth, fronting a conference on Scottish geodiversity, and was then back at the beginning of February, 2011, delivering the James Wright Memorial Lecture, our Society's annual joint event with the Geological Society of Glasgow. His title — 'Scotland Rocks' — picked up on the characterisation developed in the 'Men of Rock' television series with the sub-title 'a three act structure'; those three acts — mystery, journey and resolution — being the key stages of any good story.

He attracted a large, over-capacity audience to Edinburgh University's David Hume Tower and the event must have established a record as the first Society lecture from which people had to be turned away. For those of us who did get in it was an entertaining and thought-provoking evening. Iain Stewart's TV persona can be a bit over-exuberant at times but in the flesh there was no doubting his commitment to scientific communication—the principal theme of his lecture. In many areas, not least in geohazard mitigation, there is an urgent need for geologists to grab a higher profile and get the facts across to the general public, who will need to be entertained if we hope to attract their attention. So, do your bit. Recycle *Edinburgh Geologist* positively—pass it on to a friend!

Emerging from the above extravaganza are several themes that we run with in this issue of *Edinburgh Geologist*. In tribute to a geological maverick overlooked by the BBC and Channel 4, John Mendum concludes his two-part celebration of Henry Cadell's work and explodes the myth of 'rival elephants on Suilven', another story that seems to have grown from an interpretation that features 'mavericks versus the establishment'. Beverley Bergman takes a look at some of Edinburgh's very own geodiversity, along the Water of Leith, and bravely samples the water of St Bernard's Well. Then it's back to the beginning, as Martin Litherland reassesses an enigmatic fossil discovery in the Dalradian that might just place the Earth's earliest known trace of animal life in Scotland. Our book reviews range across the same themes too: a popular account of modern geological discoveries, an introductory textbook, and a biography of another of geology's unsung heroes, Leonard Horner.

A scurrilous rumour of palaeontological piracy

John Mendum's second article on Henry Cadell—as you will see—provides an interesting insight into how rumours start, in Cadell's case from a subjective assessment of the demeanour of a cartoon elephant. So, as an experiment, I thought that I'd start a scurrilous rumour and see how long it takes for it to be reported back independently. In John's previous article I was curious to note the association of Cadell with the Scottish Spitsbergen Syndicate, established in 1909 by William Speirs Bruce to prospect for coal and oil shale in that Arctic archipelago. Naturally, it led me to recall the Scottish National Antarctic Expedition, led by Bruce in 1902-04, and that's where my rumour starts.



A fossil specimen brought back by the Scottish National Antarctic Expedition from Port Louis, East Falkland. Internal moulds of the brachiopod* Australocoelia palmata *(Morris & Sharpe), showing ventral valve (12) and dorsal valve (13). The Falkland Islands 5-pence piece is 17 mm in diameter. BGS image number P599488. The specimen is in the collections of the National Museums of Scotland.

Early in 1902, the geologist J. Gunnar Andersson arrived in Port Stanley, the principal settlement in the Falkland Islands to rendezvous with the ship supporting the 1901–1903 Swedish South Polar Expedition led by Otto Nordenskjöld. Whilst waiting, Andersson spent time travelling around the islands studying their geology. He made several significant palaeontological discoveries and assembled a sizeable fossil collection, including many specimens from the locality at Port Louis that had been discovered by Charles Darwin in 1833. Many of Andersson's specimens were subsequently lost when the expedition's ship, the *Antarctic*, was crushed in pack ice and sank, forcing him and his companions to over-winter in the Antarctic under very difficult circumstances. Eventually they were rescued and returned to the Falkland Islands late in 1903 where, as Andersson subsequently wrote, they were disappointed to discover that "*… some cases with collections from Port Louis, which had been deposited in Port Stanley, were broken up during our prolonged absence in the South and many of the specimens were carried away*." The survivors of Andersson's ill-fated fossil collection are held by the Swedish Natural History Museum in Stockholm.

The Scottish National Antarctic Expedition sailed from the Clyde in November 1902 aboard the *Scotia*, and reached the Falkland Islands in January 1903. During a three-week stay the Governor, William Grey-Wilson, entertained the expedition's scientists and—allegedly—presented their leader, William Speirs Bruce,

with a collection of about two dozen fossil specimens, mostly brachiopods, from the Devonian sandstone at Port Louis. Now it may be no more than coincidence that the Scottish expedition had passed through Stanley, and acquired a pre-existing collection of fossils from Port Louis, whilst the Swedes were marooned and their collection from Port Louis mysteriously diminished. But could it be that Andersson's missing fossils now form part of the Bruce Collection in the Royal Museum, Edinburgh? Beyond the coincidence of time and place there is absolutely no evidence to support this proposition—which makes it a perfect scurrilous rumour. Please let me know if you hear it reported back from an independent source—but remember, you read it here first and it's probably not true!

Memories of Robert Campbell

There's another bit of Spitzbergen-related gossip in the following, sent in by Alyn Jones and also sparked by John Mendum's article on Henry Cadell. Is this another link with Bruce's Spitsbergen Syndicate? I'm not sure.

"I noticed in the article on Cadell that his obituary was written by Robert Campbell. He was Reader in Petrology at the Grant Institute when I was a student 1949 to 53. I find it interesting that a few generations take you back a long time. Bobby Campbell graduated from Edinburgh University in 1904 and became an assistant in the Geology Department, then situated in the Old Quad and later in an old W.D. hut. His first task was to carry James Geikie upstairs as he was crippled with arthritis. He told the story of his trip to Spitsbergen before the first war when he went by sailing ship. The crew were so drunk that they anchored off Inchkenneth for them to sober-up. He retired about 1955."

Another last word on greywacke

Our discussion of grapes and greywacke has been geographically broadened by an e-mail from Professor Gilbert Kelling—who certainly knows a thing or two about the lithology but describes himself as "an unrepentant red-man". He recollects driving past a 'Greywacke Vineyard' in the Sonoma region of northern California back in the 1990s, but was disappointed to learn that they didn't produce their own label. If climate change delivers, could there be a future prospect in the south of Scotland? From the New Zealand experience it would seem that a volcaniclastic component in the greywacke assists the *terroir*, so I would recommend investment in a south-facing slope on the outcrop of the Portpatrick Formation. Enough on greywacke—no more, I promise.

Henry Moubray Cadell and Lionel Wordsworth Hinxman: 'elephants on Suilven'

By John Mendum

In the previous issue of the Edinburgh Geologist (No. 48) I outlined Henry Cadell's brief but influential career in the Geological Survey (1883–1888) and his experimental work on thrusting and folding. His subsequent life as chairman of the family's Bridgeness Company, his many overseas travels, and his involvement with land improvements and many public service roles, made sure he remained a busy man until his sudden death in 1934.

left: ***Henry Cadell photographed in about 1917.***
BGS image P584994a.

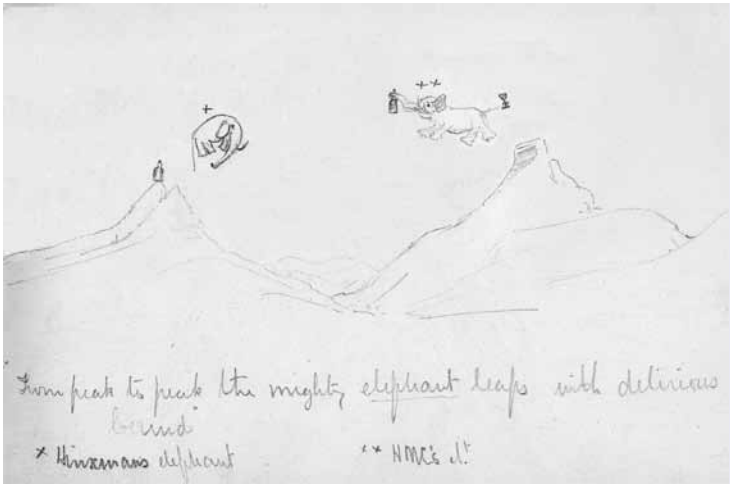
right: ***Lionel Hinxman photographed in about 1914.***
BGS image P225759

Whilst employed by the Geological Survey, Cadell had mapped the geology of the wild mountainous Ben Hope—Craig Shomhairle—Foinaven area of Sutherland in considerable detail between 1884 and 1886. R.W.H. Butler has recently drawn attention to his mapping of the thrust and imbricated succession in the Moine Thrust Belt, highlighting Cadell's recognition of the essential geometry of a thrust duplex and the link to his experimental work and deductions about thrusting mechanisms (Butler, 2004, 2010; see also http://www.see.leeds.ac.uk/structure/assyntgeology/cadell/index.htm). Butler went on to suggest that Cadell was given neither suitable credit nor recognition by the Survey, even proposing that his work merited authorship of the 1907 Northwest Highlands memoir. Certainly, with hindsight, both Cadell's field interpretations and modelling

were impressive, and have proved to be substantially correct. However, Cadell's subsequent input to the 1:10 560 scale field map compilations (termed 'clean copies' in the Survey) and to the NW Highlands memoir was relatively minor. The clean copy that includes Foinaven (Sutherland 32) was not checked by Ben Peach until 1912 and only deposited in 1915. It shows little evidence of further input or interpretation by Cadell. His field maps, notebooks, sketches were used in the compilation of material for the memoir, but its coverage of the structure of Cadell's mapped ground is actually somewhat sparse. His input is readily acknowledged, both in the preface and in the text, and a summary of the more salient results of his thrusting and folding experiments is reproduced and the conclusions spelt out in full. The memoir is largely given over to detailed descriptions of the geology and related stratigraphical and structural interpretations and its authorship reflected the amount of input. Indeed, the inclusion of Cadell's experimental material stands out as unusual; some geologists were even prevented from publishing their interpretations of surveyed areas, e.g. Barrow in the SE Highlands. Thus, the support given to Cadell to publish his experimental results by Peach (and ultimately Geikie) now looks quite generous given the conventions of the time. Geikie not only officially recorded his regret at Cadell's resignation in 1888, but in his autobiography (Geikie, 1924) he reported that in the summer of 1885 Cadell accompanied him on a trip to Strath in Skye to ascertain the nature of the 'white marble'. They were successful in finding fossils that showed the limestone correlated with the Cambro-Ordovician Durness limestone rather than being Jurassic (Lias) as previously suggested by Macculloch and initially accepted by Geikie. On the way to Skye, Geikie and Cadell traversed across parts of Mull collecting samples and visited Carsaig to study the relationship between the Palaeogene basaltic lavas and the underlying Mesozoic succession. Geikie's choice of Cadell to accompany him mirrors his own earlier role as young assistant (then aged 24) to Murchison (then aged 68) on his West Highland traverses made in August and September, 1860. This Murchison-Geikie trip started a close relationship that was mutually very beneficial. When Cadell left the survey he did continue to update the detailed maps of the Lothians, based on his continuing involvement with coal and oil shale mines. However, his geological work related to the Northwest Highlands virtually ceased and some of his last areas mapped (e.g. Cailleach Head—Scoraig area) still lack clean copies.

Butler has also hinted at a 'possible feud' between Cadell and Lionel Hinxman, who joined the survey in Spring 1883 and subsequently mapped large parts of the Northern and Grampian Highlands. This is based on Cadell's sketch of two 'leaping' elephants against a backdrop of Suilven and Canisp, drawn in his field notebook in the summer of 1888. One elephant, labelled 'HMC', is shown leaping from Canisp, a bottle held in its trunk and a glass in its tail. The other, labelled 'Hinxman's elephant', exhibits a more lugubrious expression, its trunk is drooping downwards, and its bottle remains on the top of Suilven. Butler interpreted Hinxman's elephant as disconsolate and falling, but it is clearly leaping and its form may merely reflect Hinxman's features and character. Beneath the sketch is written 'From peak to peak the mighty elephant leaps with delirious bound'. This is one of very few geologically unrelated sketches in Cadell's notebooks. It was drawn when undertaking field work in the Assynt—Ullapool area, probably in early July, 1888, when Cadell mapped Ben More Coigach, a 'Torridonian' mountain that lies within a larger area mapped by Hinxman.

Several questions are posed by the 'Elephant cartoon'. What is its significance? To what does the 'Elephant' quote refer? What was Hinxman's relationship with Cadell?



Cadell's elephant cartoon – "From peak to peak the mighty elephant leaps with delirious bound": x Hinxman's elephant, xx HMC's elt. BGS image P612785b.

Some background is necessary to put the sketch in context. Lionel W. Hinxman was born in 1855 at Dunmore, Stirlingshire where his father was private chaplain to Charles Adolphus Murray, 7th Earl of Dunmore. The family returned to England in 1862 where Hinxman attended Marlborough School, Cheltenham College and then entered Christ's College, Cambridge, graduating in 1877. He was appointed to the Geological Survey in 1883 as a Temporary Assistant Geologist, becoming Geologist in 1901 and District Geologist in 1905. He retired in 1919 after 37 years work, mostly taken up with mapping in relatively remote Highland terrain e.g. Quinag, Cul Mor, Ben Wyvis, Cairngorm. In his obituary in 1936 Murray Macgregor described him as 'A man of an unassuming and retiring nature, he had none the less many friends in all walks of life, drawn to him by his innate courtesy and kindliness, his sincerity of purpose, and his loyalty to the traditions he inherited.' He also noted that Hinxman had a pronounced stammer making him reluctant to deliver addresses or take part in debates. Hinxman's reticence was obviously no bar to his outdoor accomplishments; he was an authority on bird life in Scotland and a noted mountaineer in his youth. The Scottish Mountaineering Club (SMC) Journal records that he was one of the team (with Brown, Douglas and Raeburn) that in April 1896 first climbed the 230m-high Douglas Boulder, part of Tower Ridge on Ben Nevis.

A lengthy account of an E-W traverse of Suilven written by Hinxman for the SMC Journal of 1890 is pertinent to the 'Elephant cartoon'. Hinxman recorded that he undertook this vertiginous scramble with his friends H--- and C---, all three being recorded as pipe smokers. The traverse was undertaken on a clear and sunny early June day starting from field survey accommodation at Achamore Farm by Inchnadamph. This was a clandestine expedition as the incumbent lessee of the Glen Canisp deer forest on the Assynt estate shunned unwanted visitors and had deemed geologists 'of no use but to frighten the deer and upset the Bible'. Luckily, the Suilven area had already been geologically mapped by Peach. The traverse went reasonably well except for a strong gusting wind along parts of the Suilven ridge. Hinxman noted that C--- was left sketching on the summit while he and H--- looked for a way to descend the very steep western face. In the event the party all descended a gully to the north and returned to Achamore Farm via Suileag and Little Assynt. The record of this climb, undoubtedly undertaken by Hinxman,

***The precipitous summit ridge of Suilven.** BGS image P512775a*
***… and as sketched by Cadell in June 1888.** BGS image P612787a.*

Horne and Cadell, coincided with a period of geological mapping in southern Assynt in June 1888. This agrees with a date of the 6th June, 1888 (a Wednesday), recorded by Cadell on his notebook sketch of the summit ridge of Suilven. Thus, the elephant cartoon likely refers to incidents and/or discussions that occurred during this traverse of Suilven. The source of the quote is not known though there is considerable literature on the possibility of elephants' 'leaping'. In his book 'The Wild Elephant (1867), Sir J E Tennent stated 'I am disposed to think that the elephant is too weighty and unwieldy to leap'. He also noted that an elephant cannot 'gallop' but 'shuffles'. Subsequent research has confirmed the elephant's inability to 'leap', despite anecdotes to the contrary[1]. Whether this was a subject of discussion by Hinxman and companions during the day or whether the elephant was an allegory for the Survey or for another geologist

remains unclear. During June and July 1888, Cadell assisted Peach, Horne and Hinxman in mapping the remaining unsurveyed areas on 1 inch Sheet 107 (Ullapool), probably after he had officially resigned from the survey. Geikie recorded that the mapping of Sheets 101 (Lochinver) and 107 (Ullapool) was finally completed in that year. Perhaps Cadell enjoyed his freedom carrying out this work, despite his new responsibilities as head of the family's affairs. This period may also have been a 'stag' interval prior to his marriage to Eleanor Simson, which took place in August the following year.

In conclusion, rather than animosity or acrimony between Cadell and Hinxman, there seems to be evidence of mutual assistance and friendship, despite their contrasting personalities. This would tally with a note of an address for Hinxman at Brading in the Isle of Wight in one of Cadell's notebooks (1884-5), possibly Hinxman's parents' residence, and with Cadell's attendance at Hinxman's retirement dinner in 1919.

[1] And the debate continues. I see that the latest *New Scientist* book inspired by its 'Last Word' question and answer page is entitled "Why can't elephants jump?" – Ed.

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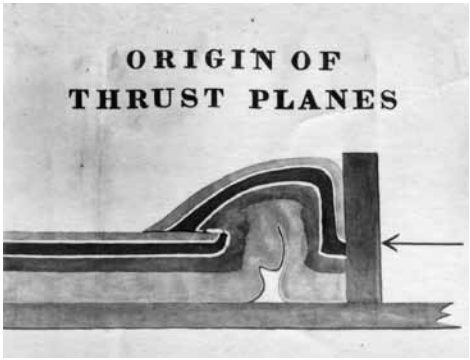


The Stockbridge local geodiversity site

by Dr Beverly P Bergman

After several days of heavy rain, the evening of 9th June 2010 was uncharacteristically dry and sunny, ideal for a walk along the Water of Leith upstream from Stockbridge [NT 246 743] to look at the local geology. This stretch of river is one of the proposed new Local Geodiversity Sites (LGS) (formerly known as RIGS—Regionally Important Geological/Geomorphological Sites) which have been identified in Edinburgh. The local biodiversity was soon illustrated by a magnificent grey heron, followed by the first geomorphological feature; the raised beach which marks the former position of the shoreline. Now some 30 m above mean sea level, it bears witness to how far the land has risen following the end of the last glaciation.

Further upstream along the attractively landscaped footpath which runs through the deep gorge cut by glacial meltwater is a structure in the form of a Doric temple, built in 1789 to a design by the artist Alexander Nasmyth and modelled on the Sybils' Temple at Tivoli. This houses St Bernard's Well, a sulphurous spring once used for medicinal purposes but closed since 1940. Discovered by three schoolboys in 1760, the spring became a popular venue in the

The statue of the godess Hygieia within the temple surmounting St Bernard's well-house.

early days of Edinburgh's New Town although the water was said to taste like "the washings of foul gun-barrels". One can only speculate on the experience on which the anonymous commentator was able to base the comparison! It is reported that the sulphurous odour disappeared some years ago, and today the water has only a bland taste.

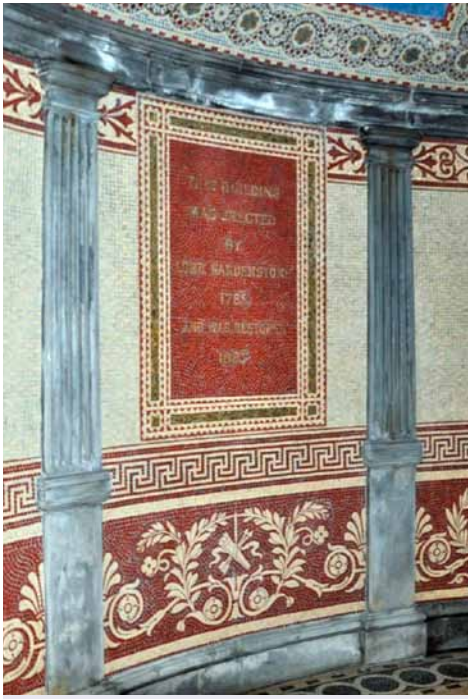
The well-house was built of the local Craigleith sandstone, some blocks showing the fine ripple marks characteristic of the higher beds in the quarry. The statue of the goddess Hygieia within the temple surmounting the well-house is constructed not of white marble, as it appears at first glance, but of Coade stone, a ceramic material invented by Eleanor Coade (1733–1821) and at one time widely used for statuary. It is a highly durable material but James Grant comments, in about 1880[1], that it was 'so battered by stones as to be a perfect wreck'. It is likely therefore that the present figure is a restoration. The plinth on which it stands is hollow and acts as the ventilation shaft for the well-house. A chimney is built into the stonework of

[1] Grant J. *Old and New Edinburgh,* Vol III (pub. Cassell & Co.)

The well-house fire-place.

the well-house and vents a fireplace with an ingenious cup and spigot, originally used for heating the waters for clients in the winter months! The interior of the well-house is open to visitors on Sundays during August (and was viewed later on one of the open days); it is highly ornate and features a magnificent marble and brass well-head.

Close to St Bernard's Well, the riverbed provides one of the few exposures to be found in the city of



The ornate interior of the well-house.

The marble and brass well-head.

the Lower Carboniferous, Granton Sandstone, the beds dipping to the west in one limb of the 'St Andrew Square anticline'. A short distance upstream, a second well-house, dating from 1810, marks St George's Well, another long-abandoned medicinal spring, and here a well-defined quartz-dolerite dyke cuts the sandstone beds,

Gently dipping beds of Granton Sandstone exposed in the Water of Leith.

one of a number of such dykes in Edinburgh.

The massive structure of the Dean Bridge (designed by Thomas Telford and built in 1832) dominates the valley just beyond this point, and on the cliff at the left-hand side of the path, shale beds overlain by sandstone are exposed. The shale beds are rumoured to contain fish fossils but on this occasion an enthusiastic hunt among the loose material at the foot of the cliff turned up only a few plant fragments. Some of the sandstone blocks in the Dean Bridge show clear cross-bedding, inverted where occasional blocks have been placed upside down. Beyond the Dean Bridge, three millstones from a mill which formerly stood on the site have been placed in an ornamental setting. An information board notes that they were imported from France and are made of 'very hard stone'! No surprise there, but no consensus was reached as to their lithology, perhaps a chert, a quartzite or a limestone. Subsequently a Dean Village Association guide confirmed that they consisted of orthoquartzite from the locality of Caen.

This short but highly instructive walk was one of the Edinburgh Geological Society's evening excursions. The excursion programme offers something for everyone, whether experienced geologist or beginner, and can be thoroughly recommended.

Is the earliest animal Scottish?

by Martin Litherland

Recently there have been reports claiming that the earliest animal life is manifested by pre-Ediacaran 'sponges' from the Flinders Range of South Australia dated at 650 to 630 Ma (e.g. Maloof *et al*. 2010). These have encouraged me to reassess a fossil animal that I found in the Easdale Slates in 1967, and described in *Scottish Journal of Geology* (Litherland 1975, 1980). At the time I suggested an early Cambrian age but this should now be revised downwards, thus making Scotland the home of one of the earliest known animals.

The rocks in question form a series of breccias that crop out at Benderloch. Although the regional stratigraphy is complex, these breccias undoubtedly lie within the Easdale Subgroup, part of the Dalradian Argyll Group; the sequence is capped by the 600 Ma Tayvallich Lavas. The Easdale Slates are underlain by the Portaskaig Tillite, whose age and correlation have been much debated. Although formerly interpreted as equivalent to the Varanger Tillite (c. 635 Ma), recent correlations based on Sr and C isotope patterns have suggested that association with the Sturtian glacial event is more probable (e.g. Prave *et al*. 2009). The Sturtian event is thought to have been diachronous, extending from c. 720 Ma to 650 Ma (Kendall *et al*. 2006).

The Benderloch breccias were originally interpreted by the Geological Survey as a crush conglomerate. I re-interpreted them as a series of sedimentary slide tilloids and wrote a detailed account of the outcrops in my PhD thesis (1970). I reproduce a geological sketch map from this (Figure 1)—with apologies for the imperial units! The sedimentary interpretation has been upheld in subsequent work by Dr Geoff Tanner.

The Dalradian rocks along the Benderloch shore at Port Selma are low grade (greenschist facies) black slates, with slump folds, passing up through turbiditic 'pebbly mudstones' into a series of five breccias and interbreccia units that contain quartzites and laminated siltstones. The rocks are folded into a monocline that plunges gently to the NE and has an associated, steeply dipping, axial planar slaty cleavage.

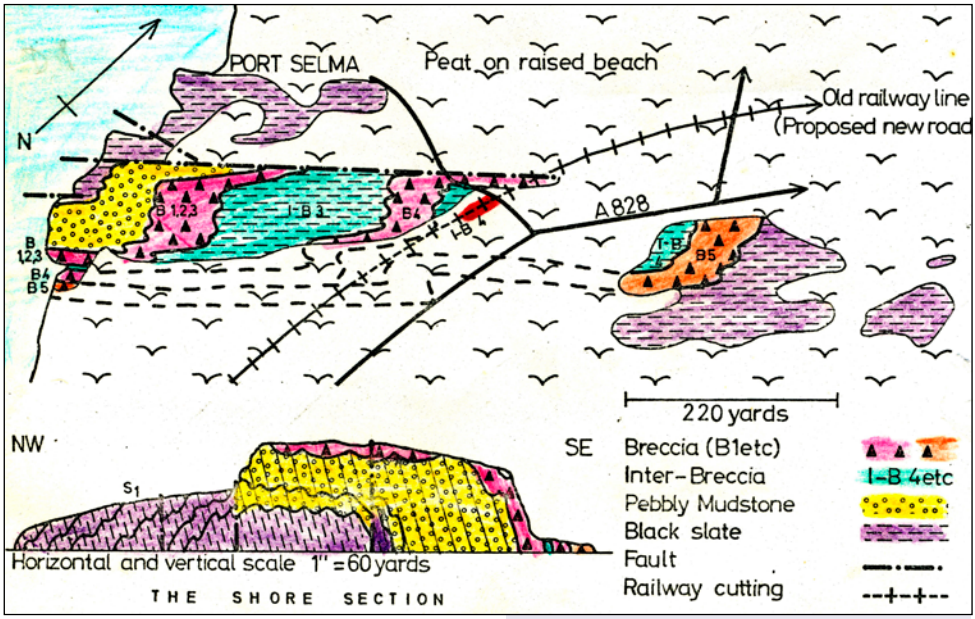


Figure 1 Dalradian outcrops at Benderloch.

Breccias 1 to 4, which range from one to eight metres in thickness, are essentially made up of locally derived clasts: quartzite (60%), laminated siltstone (25%), dark shale (7%), pebbly mudstone (5%) and limestone (3%). The clasts have been tectonically flattened and range up to three metres in length. Breccia 5, however, contains about 60% of limestone clasts; many of these are 'exotic' and show less deformation. Their truncated margins strongly suggest that they were lithified prior to slumping. These limestones are either rusty weathering, banded dolostones with grey laminae, or 'oolitic' varieties with individual oolites up to one centimetre across.

The top of Breccia 5 can be traced inland from the shore to the sea cliffs of a raised island.

The 'oolites' turned out to be both oncolites and catagraphs; the oncolites showing cyanobacterial growth rings the catagraphs containing internal microcysts. In 1969 I gave a sample to a visiting scientific authority, Mme M E Raaben, who subsequently wrote from Moscow to say that her colleague, Dr V E Zabrodin, had found (with my additions in parentheses):

"The (Benderloch) microfossils belong to the form-genera Osagia (oncolite) and Vesicularites (catagraph). The former is represented by *Osagia svalbardica* milst. and the latter by *Vesicularites bothrydioformis* Krasnopeeva. The assemblage is characteristic of parts of the Vendian, i.e. the uppermost part of the late Precambrian. The same assemblage is present in the Hecla-Hoek succession of Spitzbergen, namely in the Eldobreen Formation of the Polarisbreen Group of Central North Spitzbergen, that is in levels underlying the main tillite."

This 'main tillite' appears to be equivalent to the Varanger tillite (c 650-635 Ma) of north Norway, which would support the revised age of the Dalradian Benderloch rocks. My suggestion in 1975 that the oolitic clasts could have been derived from the Cambrian Durness Limestone is now clearly inadmissible.

Interesting as these biota are, (and I also reported some algal bores in the oncolites), the most important discovery came, not from the shore section, but from the railway cutting inland. Here I noticed some small pits up to 2 mm across in the pebbly black slates of what was interpreted as Interbreccia 4. These pits proved to have formed by dissolution of calcareous pebbles which, in thin section, showed differing stages of recrystallisation. Many are completely recrystallised, but some contain relics or 'ghosts' of original organic structures whilst a few exhibit unrecrystallised areas. In most of

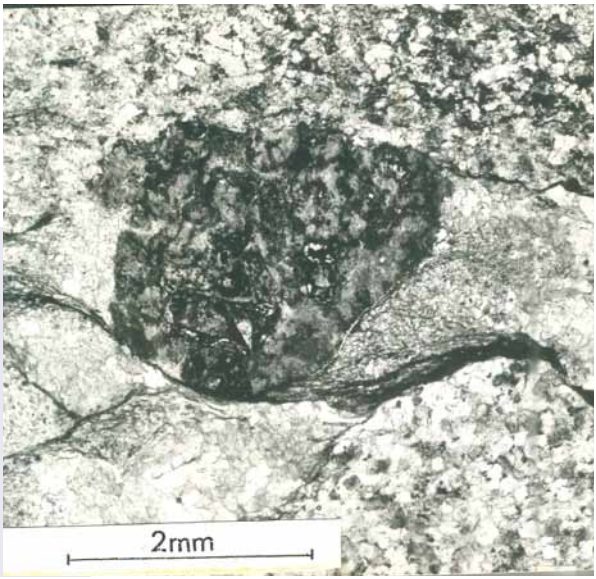


Figure 2 Thin section of a ?Bryozoa pebble showing internal U-shaped and V-shaped structures in the unrecrystallised area passing through the partially recrystallised area and truncated at the pebble margin.

these there are circular or elliptical cells, about 0.4 mm across, separated by calcareous walls; descriptions of these and acetate peel 3-D studies can be found in my PhD thesis.

One thin section (Figure 2) showed a typical calcareous pebble within a slaty meta-siltstone matrix that defracted a cleavage. In this section the cut shows U-shaped cells suggesting longitudinal sections of a colonial animal. Although much of the pebble is partially recrystallised, under the microscope one can clearly see the structures running through it and their truncation at the pebble margin. Thus the pebble was interpreted as a fragment of an eroded colonial reef.

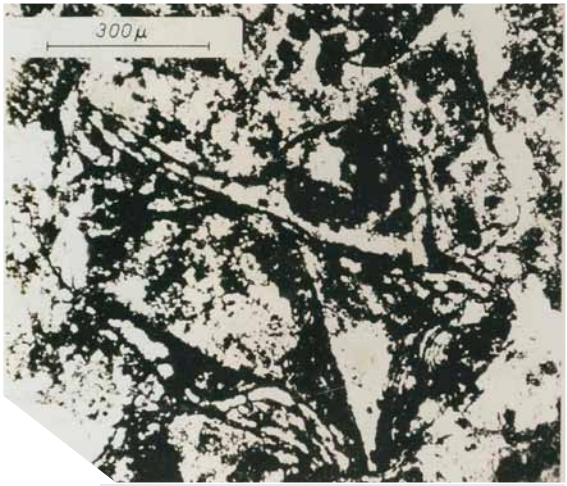


Figure 3 Enlarged image of unrecrystallised part of pebble in Figure 2.

Figure 3 shows details of the unrecrystallised of part of the Figure 2 pebble. The zooids and zooecial walls of an animal structure are very clear. I compared it to Bryozoa and certain palaeontologists at the time remarked on the similarities in dimensions and anatomy. One even labelled up an anatomy (Fig. 4) with diaphragm and alveoli (interzooecial spaces). Thus there seems little doubt that a very early reef-forming animal lived in the shallow Dalradian seas around 630–650 Ma. Peter Gower showed me thin sections of a similar animal in pebbles slumped into the younger Tayvallich Limestone, whose depositional age is now confirmed at around 600 Ma.

As to further research, after a 30 year absence I was unable to trace the samples and thin sections at Liverpool University. I also discovered that the fresh outcrops on the then recently-closed Connell to Ballachulish railway line have become strongly weathered. There is now a footpath with a grassy bank along the old line. Anyone wishing to obtain new samples would need to excavate the SE bank beneath and SW of the bridge to Selma in the area shown heavy red on Figure 1.

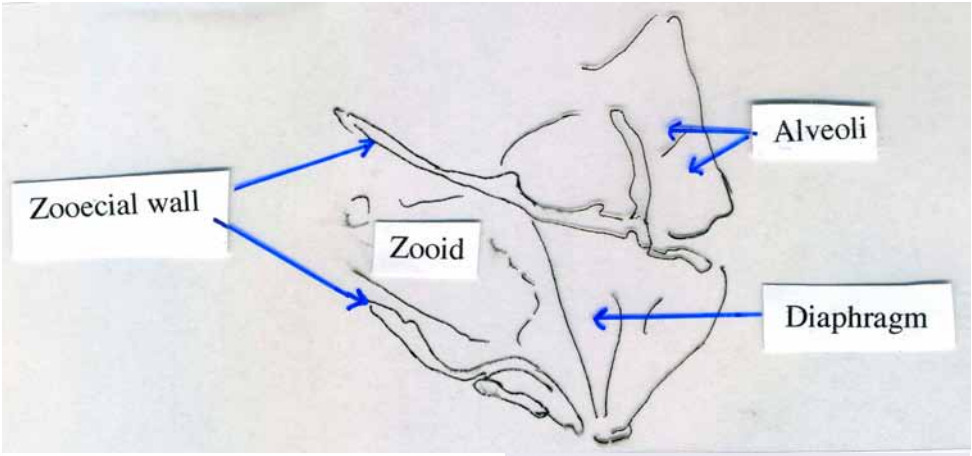


Figure 4 Proposed Bryozoa anatomy of Figure 3 image.

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Welcome to the Anthropocene

Phil Stone wonders when we arrived there

You will probably have noticed the word 'Anthropocene' being increasingly used in both scientific and popular media. It cropped-up in Iain Stewart's 'Men of Rock' BBC TV programme, and also features in the title of one of the Edinburgh Geological Society's lectures scheduled for the end of March. So there's clearly an assumption that we all know what it means—but do we? And do we all have the same understanding of its meaning? That the human species is having a substantial impact on the global environment is beyond doubt, but have we really left one Epoch, the Holocene, and entered another, the Anthropocene. If so, when did it happen?

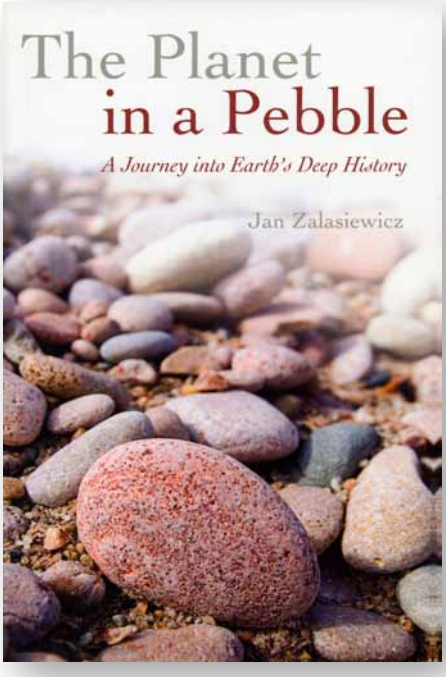
The term has actually been around since at least 2002, when Nobel Prize-winner Paul Crutzen used it in an article in *Nature*. Of course the broad concept has been around for much longer, with several scientists commenting in the late 19th Century on the likely extent of the human influence on planet Earth. Those influences are many and varied and all run to slightly different time-scales, complicating any definition of the Holocene-Anthropocene boundary.

For example, towards the end of the Pleistocene our ancestors set about exterminating the terrestrial megafauna: this was achieved by about 50 000 years ago in Australia, but it took until about 13 000 years ago in the Americas and in Africa we haven't quite managed it yet. What we have done though is extend mass extinction into the oceanic realm, where it is much more likely to provide a strong marker in the future geological record. Meanwhile, Holocene forest clearance and the expansion of agriculture, followed by urbanisation, have all profoundly affected erosion rates and patterns of sedimentation.

But it's probably the Industrial Revolution that really kicked-off the Anthropocene. It allowed the rapid growth of the population, the exploitation of coal and oil radically changed the global carbon cycle, whilst the intensification of agriculture led to a massive influx into the oceans of nitrogen- and phosphate-rich fertilizer. And that's just the tip of the iceberg. So if the Anthropocene started in about 1800 AD, how and where should we define its basal stratotype? Any suggestions?

Book reviews

The Planet in a Pebble by Jan Zalasiewicz. Oxford University Press, Oxford. 2010. Hardback, 234 pp. Price £16.99. ISBN 978-0-19-956970-0



Enthusiasts for a particular style of Scottish geology will be familiar with Jan Zalasiewicz's work on graptolite biostratigraphy in the Southern Uplands; see, for example, *Scottish Journal of Geology*, **39** (1) for 2003. In 'Planet in a Pebble', despite a brief excursion back to the Scottish graptolites in company of Charles Lapworth, his brief is much bigger and much bolder, and it starts with a pebble of Welsh slate. It is a delightful and ingenious device. Pick up a pebble, any pebble. Look at it—really look at it. What can it tell you? Of course, different pebbles may have different tales to tell, but that teased here from the chosen one would take some beating. As we discover, building a pebble is not a simple process.

Our pebble's atoms and elements take us back to the origins of the universe and to distant supernovae, its minerals tell of the formation of our home planet and generation of its geological plates. Some of those mineral grains allow age determinations to be made, others might tell of their unique geological origin. How did the grains come together? Tides and wind, storm surges and turbidity currents are all invoked—and perhaps the grains encountered living organisms. The author's background in palaeontology comes through strongly as we learn of the intricacies of graptolite construction and evolution, of acritarchs and chitinozoa, of symbiotic algae and of seething

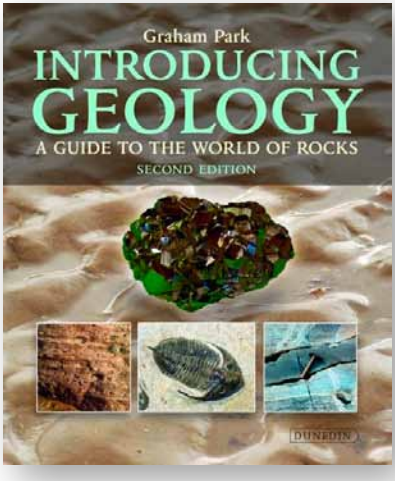
bacterial mats. Where did all this happen? Palaeomagnetism comes into play.

As our proto-pebble is buried and lithified we follow it into realms of elevated temperature and pressure: it passes through the oil window, minerals transform, cleavage is imposed as continents collide, ore-bearing veins are injected. Then it's back to the surface as mountains rise and are eroded, ice covers the land locking our guide into permafrost, before the pounding waves smash it from the cliffs. Even then there's still time for a lesson in cosmogenic dating before a final speculation on our pebble's future prospects. Could the whole story be repeated?

The faint-hearted potential reader may perhaps be deterred by the conjoured visions of nepheloid plumes, rare-earth-element mobility, quorum sensing in microbial communities, methane clathrates and the like, but there is absolutely no need for concern. Despite its scope and willingness to tackle up-to-the-minute techniques and conundrums, this book is quite remarkably accessible. It is beautifully written, becoming quite lyrical in places, and abounds with gentle humour and humility. There is no pretence that we know all the answers, but 'Planet in a Pebble' provides more than enough to be going on with and does so with verve. It is a skilful celebration of modern geological methods and, what's more, it is excellent entertainment.

By Phil Stone

Introducing Geology: a guide to the world of rocks by Graham Park. Dunedin Academic Press, 2nd Edition, 2010. Paperback, 134 pp. Price £9.99. ISBN 978-1-906716-21-9



As we enter the second decade of the 21st century, increasingly a knowledge of geology is required to allow us to better understand current events in the natural world.

The global repercussions of the recent Icelandic ash clouds, the 'great escape' of the trapped Chilean metal miners, the tragic loss of the 33 New Zealand coal miners and the oil leak from the BP drilling rig in the Gulf of Mexico; these are but a few of the recent events which have filled the media headlines for weeks on end. At the same time, TV programmers and producers are increasingly using the Earth and Planetary sciences as an entertainment vehicle, with a cascade of items by enthusiasts like Professors Iain Stewart and Brian Cox for example, supported by other experts in various specialities.

In 'Introducing Geology', Professor Graham Park offers an excellent primary text on the subject which provides the tyro, amateur or serious student, with a good overview of the basic concepts of the science covering its many different subject areas. The birth and death of oceanic basins, ocean crust subduction, continental collision, mountain building and their associated volcanic episodes are examples of the range of topics presented. When taken together with the numerous geological processes and products involved, it becomes clear that a wide breadth of knowledge is required to master all aspects of the science. To accommodate the size of his subject, the author has divided the text to describe both the rock forming minerals involved and the forces, both internal and crustal, which have played their part in forming our planet from its earliest origins.

The concept of 'deep time' is often difficult to convey to the reader and Professor Park has devoted 3 chapters of his book to an explanation of this aspect of geology. Taking the reader back to the beginning at 4.6 billion years ago, he describes the four great ages of time through which the earth has passed. By an explanation of radiometric dating he explains the concept of absolute age and how it compares with relative age dating as recorded in the fossil record. The principles of superposition and the use of stratigraphy, which led James Hutton to the realisation of the age of the earth, are well illustrated. These ideas on superposition are then allied to a description of the main fossil groups and their evolution over time. The concept of evolving life forms leaving their fossil remains in the rock strata was the first indication that the rocks were laid down layer upon layer, and has allowed correlation of synchronous events across continents, e.g. the Carboniferous limestone strata of Western Europe.

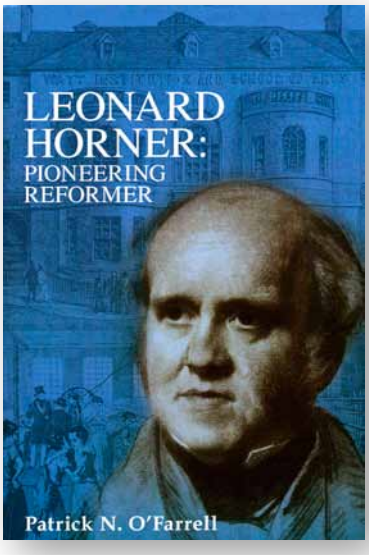
A chapter of the book is devoted to an area of interest which was

once referred to as 'geology in the service of man'. This chapter is an examination of the extractive industries on which mankind depends and in particular the vital fields of oil, gas and coal production. Although much thought is currently being applied to methods of reducing the amount of carbon dioxide being released into the atmosphere, there can be little doubt that as world energy requirements increase, so fossil fuel utilisation will continue to grow. As well as describing structural oil and gas traps, there are also descriptions of the other important extractive processes and a section on hydrogeology and the search for potable water, a vital resource which continues to diminish worldwide through over-abstraction and contamination.

Terms and concepts new to the beginner in any sphere of study require much repetitive checking and cross referencing. This is particularly so for the student working alone in the widening field of 'distance learning'. By highlighting terms/subjects throughout the text and by providing a comprehensive glossary, the author has greatly increased the usefulness of his volume and has made it a reference source of lasting value. The diagrams and illustrations and the increased use of colour when compared with the earlier edition augment the text very well and this little volume, by one of our finest geologists, should prove a real boon to those seeking primary information on Earth science.

By Tony Irving

Leonard Horner: Pioneering Reformer by Patrick O'Farrell. Heriot-Watt University, Edinburgh, 2010. Hardback, 378 pp. Price £20. ISBN 978-0-9566729-0-2.



At the end of 1970 I moved north with my family from Reading to help set up the Open University in Scotland. With a long-standing interest

in the history of geology and having become the Edinburgh Geological Society's Secretary in 1974, I became aware in 1975 that four doors away from the OU's office at 60 Melville Street in Edinburgh's West End, at number 52, there lived in the 1830s the little-known Leonard Horner and his family. Horner's bust, along with that of the goldsmith George Heriot, adorned the front of the Heriot-Watt University building in Chambers Street, now the Crown Office.

Leonard Horner's eldest daughter, Mary, married the great Victorian geologist Charles Lyell in 1832. Another daughter nearly married Charles Darwin. So, on 25 August 1975, I put on a small exhibition in the OU office on Lyell in advance of the Scottish Excursion which preceded the main Lyell Centenary Symposium at Imperial College in London that year. During the Scottish Excursion, organised by Gordon Craig, a dinner was held in the Royal Hotel in Forfar on 29 August following a visit earlier that day to the Lyell home at Kinnordy, just outside Kirriemuir in Angus. After the dinner, I got everyone present to sign my copy of the Society's new Excursion Guide, *The Geology of the Lothians and South East Scotland*. The signatures include Lady Lyell and her son, Lord Lyell and also those of George W. White of Urbana, Illinois, North America's leading historian of geology at that time, Leonard G. Wilson who as Lyell's biographer had already published Volume 1 of his now three-volume work on Charles Lyell, Gordon Herries Davies of Trinity College, Dublin, Ireland's leading historian of geology, Martin Rudwick of Cambridge and many others. One signature in this unique copy I have is that of James Greig, retired Professor of Electrical Engineering at King's College, London, then living on the Kinnordy estate. He told me that he was going to write a biography of Leonard Horner. He never did.

At last, we now have the most excellent biography of Leonard Horner, launched in the Edinburgh Business School of Heriot-Watt University at Riccarton on 8 October 2010 in the presence of Lord Lyell who has written the Foreword. The book is written by Patrick O'Farrell, former student of Gordon Herries Davies at Trinity College, Dublin, and now Emeritus Professor of Economics at Heriot-Watt University. It follows his excellent illustrated history of the University published in 2004.

Beautifully illustrated, each of the nine chapters in Patrick's book concludes with an extensive list of the sources quoted and so is an important addition to scholarship.

The book traces the extraordinary life of one of the most important but until now, little-known figures in 19th Century Britain. Any one of Leonard Horner's many achievements would have been a major contribution, but to realise that he covered so much is almost beyond belief. He must have had a formidable intellect and quite extraordinary work rate.

Leonard Horner was born in Edinburgh in 1785, the year in which James Hutton first presented his Theory of the Earth to the infant Royal Society of Edinburgh. His grandmother was friendly with Hutton. Like his older brother, Francis, who became MP for St Ives in Cornwall and died early, in Pisa, in 1817, Leonard attended the High School and University in Edinburgh where he was much influenced by the lectures of Thomas Charles Hope who had succeeded Joseph Black in the Chair of Chemistry. Leonard joined the world's oldest Geological Society, in London, the year after it was founded, in 1808. He became Secretary and was twice President. He retained an amateur interest in geology throughout his life and was instrumental in rescuing Hutton's missing manuscript, eventually put together as Volume 3 of the *Theory of the Earth* in 1899.

In 1821, it was Leonard Horner who founded the Edinburgh School of Arts for the Instruction of Mechanics in the Freemasons' Hall in Niddry Street in Edinburgh, now St Cecilia's Hall, which evolved into today's Heriot-Watt University. With Lord Cockburn of Bonaly he co-founded Edinburgh Academy and then became the first Warden of London University in 1828, a post he held for three years. Because of his pioneering zeal as a reformer, he was appointed the first Inspector of Factories in Britain and held the post for 26 years. Patrick's book details the many tussles he had with the mill-owners in the North of England.

The geological community in Edinburgh and beyond is profoundly grateful to Professor O'Farrell and to Heriot-Watt University for this penetrating and long-overdue biography of Leonard Horner.

By Norman E Butcher

"One of the major figures in 19th Century educational and social reform" Ann Jones, Archivist, Heriot-Watt University.

To see ourselves as others see us

Having introduced Lionel Wordsworth Hinxman earlier in this issue of *Edinburgh Geologist*, it seems appropriate to give the last word to William Wordsworth. This extract is from Book iii of his '*Excursion*'.

He who with pocket hammer smites the edge
Of every luckless rock or stone that stands
Before his sight by weather-stains disguised,
Or crusted o'er with vegetation thin,
Nature's first growth, detaching by the stroke
A chip or splinter—to resolve his doubts;
And with that ready answer satisfied,
Doth to the substance give some barbarous name,
Then hurries on; or from the fragment picks
His specimen, if haply interveined,
With sparkling mineral, or should crystal tube
Be lodged therein—and thinks himself enriched,
Wealthier, and doubtless wiser, than before.

The extract was quoted by Ralph Richardson, President of the Edinburgh Geological Society, 1908-1909, in his Presidential Address on 'Geology and Art', as recorded in *Transactions of the Edinburgh Geological Society*, Volume 9, Part 4.

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