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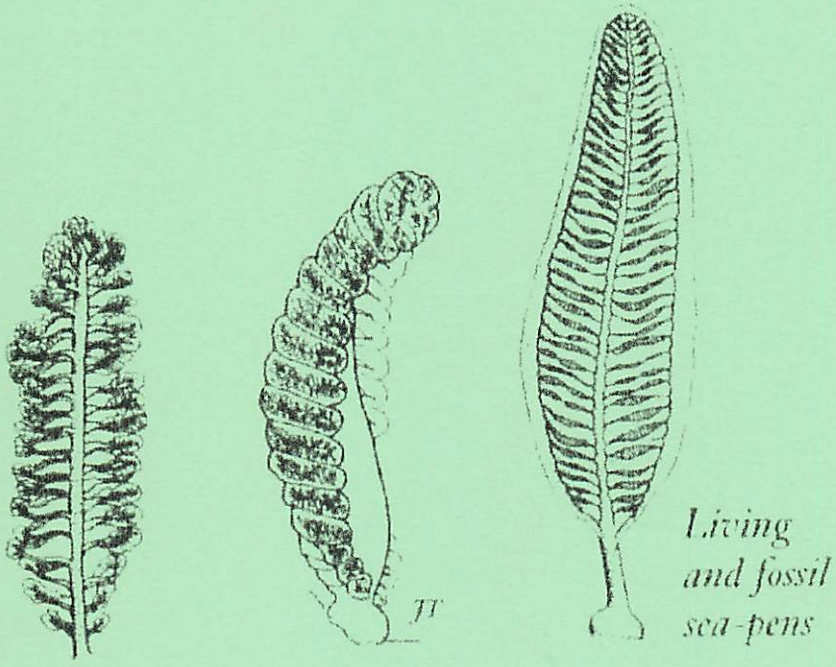

Living and fossil sea-pens

Incorporating the Proceedings of the Edinburgh Geological Society for the 165th Session 1998-1999

THE EDINBURGH GEOLOGIST
Issue No. 34 Spring 2000

Cover Illustration

The cover shows a group of living and fossil sea pens. The illustration is taken from the book *Fossils of the Flinders and Mount Lofty Ranges* by Neville S. Pledge. This book is one of several recommended by Angus Harkness in his bibliographic tour of Australia on page 16 of this issue of THE EDINBURGH GEOLOGIST.

The illustration is published with kind permission of the South Australian Museum.

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Editorial

by Alan Fyfe

It took some time to get here, but here we are, now in the year 2000. Welcome to the Spring issue of THE EDINBURGH GEOLOGIST, in which I think you will find a good deal of interesting reading. The issue has a distinctly international flavour, so if anyone has not yet made holiday plans for this year, you may find some inspiration in these pages.

Just before the last issue was sent to press, I received an article by meteorologist and climatologist, Marjory Roy, on the nineteenth century gentleman scientist, David Milne-Home, who had the distinction of being seven times President of the Edinburgh Geological Society. Marjory's article was accompanied by some notes on Milne-Home's geological work by David Land, and I have interleaved them into one article. It is a fascinating read.

I received some months later an e-mail from Kenneth Aitken. Some of you may remember him as being a staunch supporter of the Society's excursions. He is now working in Freiburg and he tells us something of the geological scene there.

On a fittingly related theme, the subject of WHAT'S IN A NAME? is the stages of the Jurassic. Most of these are named after locations in Germany, France and England. It may not escape your notice that once again I have written this article myself. It is something that interests me, but I would be more than happy for someone else to contribute something for the Autumn issue!

For those planning a trip further afield than Europe, we have three contributions on Australia. The first two are by Angus Harkness, based on his own holiday there last year. One is a bibliographic guide for geologists touring the island continent and is essentially a review of publications that he discovered and found useful during his visit. The other is a reflection on evolution that was stimulated by his visit to Western Australia and South Australia. He unveils some interesting ideas on evolution related to genetics and the development of DNA. Finally, on the Australian theme, Ian Selby has sent me a brief article on the search for diamonds offshore northwestern Australia, based on the lecture that he gave to the Society last year.

The main article this month is by Mike Taylor of the National Museums of Scotland, again based on a lecture that he gave to the Society. He tells the story of three nineteenth century fossil collectors: Mary Anning, Thomas Hawkins and

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Hugh Miller. Their backgrounds and histories are quite different and the contrast between them makes this an entertaining read. A conference to celebrate Mary Anning's bicentenary was held last June in Lyme Regis. It will be Hugh Miller's bicentenary in two years time. I am sure we shall hear more about him then.

POET'S CORNER for this issue features two poems by Colin Will. The first is on Kimmeridge, which ties in well with the earlier article on Jurassic stage names. The second was inspired by his standing at the Plate Boundary at Thingvellir, Iceland. Those who attended the talk by Aubrey Manning in January may remember the picture of the BBC film team standing on that very spot.

There are two book reviews this month, both on new BGS holiday publications, one on the Peak District and one on the Lake District. They are reviewed by the Yorkshire-born geologist and climber, Tony Crosby.

Finally, for those of you who want to expand your cerebral capability, we have Angela's third Rocksword puzzle.

This issue also contains the Proceedings of the Society for last session, 1998 - 1999, including a summary of the accounts.

As always, I would be happy to receive any articles or contributions for future issues of THE EDINBURGH GEOLOGIST. Does anybody know anything about the ancient British *Ordovices* and *Silures* tribes for WHAT'S IN A NAME? or have any other ideas that would interest readers? The copy date for the Autumn 2000 edition is 31st August, so please get scribbling, especially if you want to make the last issue of this Millennium...

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David Milne-Home

a biographical sketch by Marjory Roy
with notes on his geological work by David Land

David Milne-Home (1805 – 1890), Scottish advocate, landowner geologist and meteorologist, was President of the Edinburgh Geological Society from 1874 to 1889, the longest tenure in the history of the Society. He published pioneer work on the geology of Berwickshire, Mid and East Lothian and Roxburghshire between 1834 and 1844, after which his chief geological interests were in boulder clay and particularly in erratics. He was born as David Milne on 22nd January 1805 at Inveresk, near Musselburgh. His father was Admiral Sir David Milne, GCB and his mother was Grace (baptised Grissel) Purves, a daughter of Sir Alexander Purves of Purves Hall, Berwickshire. In 1814, when the young David was only 9, Grace Milne died of consumption in Bordeaux, and in 1817, Sir David took up an appointment of Commander-in-chief of the North American station, taking his two sons David and Alexander with him, and living in Bermuda and Halifax. The family returned to Britain in 1819 and Sir David married Agnes Stephen, who had been a friend of his first wife.

The young David Milne was educated at home, at Musselburgh Grammar School and at the High School in Edinburgh. He showed high intellectual capacity from an early age and, when he was still a schoolboy, developed an interest in science, most notably in geology. However, he decided to follow a legal career and, after graduating MA at Edinburgh University in 1825, he studied law and was called to the Scottish Bar in 1826. Among his university friends were John Forbes, later Sir John Forbes of Fettercairn, and his brother James, later professor of Natural Philosophy at Edinburgh University and Principal of St Andrews University. In 1827, Sir David bought a house at 10 York Place in Edinburgh's New Town and this became the normal place of residence in Edinburgh for his two sons. David Milne quickly became established as a leading advocate and in December 1828 he was much disturbed by his involvement in the notorious case of Burke and Hare, who committed murder in order to provide subjects for anatomy dissection in Edinburgh. He was junior counsel for Burke, whom he had to interview in prison.

From early in his life, religion was of great importance to him and he was an active member of the Established Church of Scotland. He was ordained an elder at the parish church of Inveresk in 1828 and was also a member of the kirk-session of St Andrew's in Edinburgh and at Hutton and Coldstream in Berwickshire. From 1829 to 1879 he was to speak each year in the General Assembly of the Church of

Scotland. He was concerned at the abuse of patronage but he did not join the seceeders in 1843. However, in 1874, he voted for the abolition of patronage in the Established Church. He also attended episcopal church services, mainly when he was in England. He considered that the Scottish system of provision for the poor lacked Christian generosity and genuine charity and was looked upon purely as a tax by those who had to pay. He deplored the establishment of large poorhouses.

David Milne-Home in a picture provided by Marjory Roy

The large part that religion played in his life had an impact on his acceptance of new geological theories. During the time that he was becoming interested in geology, glacial deposits were ascribed to the action of Noah's flood (the Diluvial Theory). In 1840, Agassiz put forward the ice-sheet hypothesis which at first was widely rejected, but gradually gained acceptance until by 1865 very few geologists still held to the diluvial theory, but among them was David Milne-Home, who never accepted the ice-sheet theory, and used every opportunity to combat it. He believed that the facts (erratics, striae, boulder-clay) could be explained by a 2,500-feet deep flood, which, however improbable, at least had scriptural warrant. The very idea of an immense ice sheet was to him a non-starter. Regardless of theories though, he never ceased to urge the collection of facts, of unbiased accurate description, as a necessity to advancing geological knowledge. This makes his papers valuable even today.

In 1829 he became engaged to Jean Forman Home of Paxton in Berwickshire and by July 1832, his income as an advocate was sufficient for him to marry her. There had been a long-term friendship between the two families, with frequent visits being paid by the Milnes to Paxton. He was appointed Advocate-Depute for a few months in 1835 and again from 1841 to 1845. Despite his heavy workload as an advocate, he maintained an interest in science and he became a Fellow of the Royal Society of Edinburgh as early as 1828.

His first geological paper (1837), on the geology of Berwickshire, was followed in 1840 by one on the Midlothian and East Lothian coalfields. This is a generally accurate account of the region, illustrated by a map and cross-sections produced 20 years before the Geological Survey started work in Scotland. These papers were followed by one on Roxburghshire (1844), completed like the others when not only was he a busy advocate in Edinburgh, but travelling was difficult (the railway to Hawick was not opened until 1849). He recognised and mapped greywacke, Old Red Sandstone, Lower Carboniferous coal measures and igneous rocks, and described them as well as the Quaternary deposits. For some parts of Roxburghshire, this paper is still the most up-to-date description.

On 5 May 1845 his father died and he succeeded to the estate of Milne-Graden, near Coldstream, in Berwickshire, which his father had purchased in 1821. This gave him the opportunity to give up legal practice. He spent the rest of a very active

life as a country gentleman, managing and improving his and his wife's estates and devoting as much time as possible to scientific pursuits. He was a prominent member of the Highland and Agricultural Society of Scotland. His investigations of the parallel roads in Glen Roy in 1847 convinced him that these had been formed by lakes at different levels and were not raised beaches proposed by Charles Darwin, with whom he had corresponded.

In 1852, when his wife inherited from her father the properties of Wedderburn, Billie and Paxton, they took the name of Milne-Home, and it was with this designation that he was to develop his reputation in the scientific world. His contribution to the development of meteorology in Scotland was primarily as a facilitator, although in 1840 he published in the Transactions of the RSE a paper on two storms which had crossed the British Isles in 1838. In 1855 his old university friend, Sir John Forbes of Fettercairn and he drew up a prospectus for a meteorological association in Scotland, which received wide support, including that of Pitt Dundas, the newly appointed Registrar-General for Scotland. Following a public meeting on 11 July 1855 a society was set up, which became the Scottish Meteorological Society. Milne-Home was a member of the Provisional Council and from 1858 to 1883 he was chairman of the Council of the Scottish Meteorological Society, before becoming the Vice-President from 1884 until his death in 1890.

He found in Alexander Buchan, who was appointed as Meteorological Secretary in December 1860, someone who combined scientific ability with great diligence in his work and Milne-Home gave him every support. For example, when Buchan was nominated as one of the British representatives to the international meteorological congresses in Leipzig in 1872 and Vienna in 1873 the British Government refused to pay his expenses, but it was agreed that the members of the Scottish Meteorological Society Council would pay the cost out of their own pockets.

He played a leading role in the Edinburgh Geological Society, being elected as Vice-President in 1871 and President in 1874, which office he held until 1889. He was Vice-President of the Royal Society of Edinburgh more than once and in 1870 he was awarded the honorary degree of LLD by the University of Edinburgh for his services to science.

> *While he was almost the last geologist in Scotland to cling to the diluvial theory, he published, in 1869, his paper on boulder clay of Europe. This contains a masterly defence of the old theory, which it would take a whole article to summarise. Two years later (1871) he published a small book on the Forth estuary, describing in fair detail the Quaternary*

deposits. In the same year, he put forward his proposal for recording notable erratic boulders in Scotland. Thus he found himself Convenor of the Boulder Committee, which over the next twelve years issued ten reports from all over Scotland, totalling 555 pages with a final 18-page summary and conclusions. Despite his opinion that the observations supported the diluvial theory, the reports remain a body of factual data as relevant today as when it was published. Incidentally the largest boulder noted was one at Loch Killesport, estimated to weigh 2770 tons.

In 1877, Milne-Home proposed the setting up of a meteorological observatory on the summit of Ben Nevis. In 1878, at the age of 73, he climbed the mountain himself and reported to the Council that the project was feasible. An attempt was made to obtain Government support, but none was forthcoming and a successful public appeal was launched early in 1883. At the dinner in Fort William to celebrate the opening on 17th October 1883, Milne-Home said that he was glad that they had not received help from the Government, because it was most probable that the Government would have imposed conditions that might have interfered with the Scottish management of the institution and he for one was in favour of local Scottish management of local affairs.

In politics, Milne-Home was a Conservative, but if he had stood for Parliament it would have been as an Independent, since he would have felt unable to vote according to party policy if that were contrary to his conscience. He was much involved in matters affecting Berwickshire, serving as Convenor of the County Council from 1876 to 1889 and as Convenor he was the chief promoter of a fund that raised £26,000 to provide help for the widows and orphans of the Eyemouth fishermen who were lost in the terrible gale of 14th October 1881.

He was a tall, dignified, somewhat autocratic man, who could appear severe and unbending in public, but was said to be much less so in private and throughout his life he believed that "what was worth doing at all, is worth doing well." (Grace Milne-Home, 1891, page 145). His wife died in April 1876 and in 1885 he suffered a blocked vein in his head from which he never fully recovered. He died on 19th September 1890 at Milne-Graden from epithelioma and pneumonia and was buried in Hutton Churchyard.

These accompanying notes on the geological aspects of Milne-Home's work cannot do justice to his indefatigable pursuit of factual observation, from which further progress may be made. With hindsight we may think he was mistaken to cling for so long to the outmoded

diluvial theory, but he was ever as gracious to his opponents as they were to him, and based his position on solid facts which have perennial value, whatever their interpretation. Let his friend Ralph Richardson, who wrote his obituary, have the last word: 'He was one of the true aristocrats - not merely a possessor of position, wealth and lands, but of knowledge, public spirit, ability and intellect.'

Material used in the preparation of this biographical sketch

1891 G.M. Home, *Biographical sketch of David Milne-Home*

1890 R. Richardson, Obituary notice of David Milne-Home, Esq. of Wedderburn and Milnegraden, President of the Society, *Transactions of the Geological Society of Edinburgh*, Vol. 6, pp. 119-127.

1859-1881 MSS Minute Books of the Council of the Scottish Meteorological Society.

1856-1890 Reports of the Council to the General Meeting of the Scottish Meteorological Society, *Proceedings of the Scottish Meteorological Society* (until 1863) and *Journal of the Scottish Meteorological Society* v. 1-9 (from 1864).

1911 A. Watt, The early days of the Society, *Journal of the Scottish Meteorological Society* Vol. 15, pp. 304-312.

1883 Reports of the opening of the Ben Nevis Observatory in *The Scotsman* and *The Glasgow Herald* (18 October 1883).

1890 Obituary in *The Scotsman* (22 September 1890).

Significant geological papers by David Milne-Home

He published mostly in the Proceedings of the Royal Society of Edinburgh (PRSE), and the Transactions of the Edinburgh Geological Society (TEGS) and the Transactions of the Royal Society of Edinburgh (TRSE).

1837 Geological survey of Berwickshire, *Transactions of the Highland Society*, Vol. 5, pp. 171-253.

1840 On the Mid-Lothian and East Lothian coalfields, *TRSE*, Vol. 14, pp. 253-358.

1844 Geological account of Roxburghshire, *TRSE*, Vol. 15, pp. 433-502.

1849 On the parallel roads of Lochaber, with remarks on the change on relative levels of sea and land in Scotland, and on the detrital deposits of that county, *TRSE*, Vol. 16, pp. 395-418.

1869 On the boulder clay of Europe, *TRSE*, Vol. 25, pp. 655-691.

1871 *The estuary of the Forth and adjoining districts viewed geologically*, Edinburgh, Edmonton and Douglas, ix and 126p.

1871 Scheme for the conservation of remarkable boulders in Scotland, and for the indication of their positions on maps, *PRSE*, Vol. 7, pp. 475-488.

1872-1884 Reports of the Boulder Committee, ten reports in *PRSE*, Vol. 7-12.

1872-1884 Presidential addresses, in *TEGS*, Vol. 2-5.

1876 Notice of high water marks on the banks of the River Tweed and some of its tributaries; and also of drift deposits in the valley of the Tweed, *TRSE*, Vol. 27, pp. 513-582.

Marjory Roy graduated B.Sc. in Physics from Edinburgh University before joining the Meteorological Office in 1961. After 20 years in a variety of Met Office posts in England she returned to Edinburgh as head of the climatological office for Scotland. She took early retirement in 1990 and then completed an M Phil degree at Edinburgh University on 'orographic rainfall in Scotland'.

David Land has been a regular contributor to The Edinburgh Geologist and an active member of the Society, having held the post of President from 1995 to 1997. He is currently Sales Secretary on Council, and looks after our stock of publications. He retired from the staff of the British Geological Survey in 1987.

Rocking around the Rhine

by Kenneth Aitken

It is always good to hear from members of the Society that have moved overseas, but who still keep their oar in. The Editor was delighted to receive an e-mail from Kenneth Aitken, now living in Freiburg. Are there any others of you out there with a story to tell?

When I arrived here to live, several years ago, I thought that there would be little chance for me to go regularly on geological excursions. Slowly, as I had time, I acquainted myself with the geology around Freiburg. By chance, I looked into the brochure of the city community school, or *Volkshochschule*, and discovered that it offered geological excursions. I have now been on many excursions and I can say that the rocks here, in many ways, rival those of the Edinburgh area. Freiburg is located far south-west in Germany and is on the edge of the Rhine Graben, a rift valley that opened up during the Cenozoic, and is now a flat valley about 50 km wide, extending from Basel almost to the North Sea. The Black Forest spreads to the south and east of Freiburg and is a hilly and mountainous region.

As it may interest some of you, I shall describe the local geology. Apart from basement gneisses and granites, there are no rocks older than Carboniferous age in this region. Directly to the east of Freiburg is a large outcrop of gneissic rock, which looks similar to that in the Hebrides but is much younger (900 Ma and in parts 460 Ma). A valley near Freiburg, called Münstertal, contains the remains of a quartz-porphyry ignimbrite tuff of Permo-Carboniferous age. Because the valley was rich in metal ores, such as silver, lead and copper, it was extensively mined from the early Middle Ages up to the present century.

In geological time one must now jump forward to the Triassic. Because of extensive faulting along the eastern edge of the Rhine Graben, there are varied formations of Mesozoic age. For example, north of Freiburg, there are areas of Lower Triassic (Bunter) rock, which consists of dark red sandstone, and Middle Triassic (Muschelkalk) rock which is a heavily fossilized limestone. There are also a number of Jurassic inliers in the Rhine Graben and some of these are close to Freiburg. A beautiful wooded hill, Schönberg, which overlooks Freiburg, consists mainly of Middle Jurassic oölitic limestone. Schönberg and other hills that are made of this limestone are now used for wine-growing. For this reason, if for no other, the wine here is excellent.

Lastly, in relatively recent geological time (15 Ma), there was a massive volcanic eruption, which accompanied the rifting of the Rhine valley. One can now see a number of hills collectively called Kaiserstuhl (Emperor's Seat) situated about 30 km northwest of Freiburg in the middle of the Rhine valley. They are the remains of a number of volcanoes that spewed out phonolitic and basaltic lavas and tuffs. One can find rocks there such as tephrite, phonolyte, essexite and carbonatite. In the region of a small village near Kaiserstuhl, called Limburg, I collected samples of limburgite, which is a black, glassy, often vesicular, basalt lava. Those that I obtained had vesicles up to 3 cm in size which were lined with a white crystalline mineral. My geological dictionary describes limburgite as a basalt glass containing olivine and augite phenocrysts. In some places, one could see little phenocrysts in the rock, which were rust-coloured, because the iron in them had weathered.

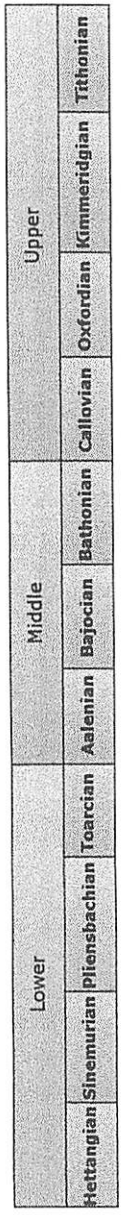
In Freiburg itself, I come across geology all the time, because, like in Edinburgh, one can look at buildings and see fine examples of many types of rock. For instance, a department store uses polished limestone blocks and, in them traces of sponges, crinoids, and molluscs are visible. Many of the Freiburg fountains are made of Muschelkalk, and it is easy to see the characteristic tiny little shellfish all sandwiched together. Some buildings, particularly of Freiburg University, are made of dark red Bunter Sandstone, which contains many examples of cross-bedding. There are several buildings in the city centre that are made of polished gneiss, and one can see in places how the greiss melted, under tremendous pressure, into granite.

Lastly, I should like to say that at many geoligical sites in the region of Freiburg, there are boards that give a detailed explanation of the geology of that locality. As a result of this, perhaps, the excursions offered by the Freiburg community school are very well attended. However, I have yet to come across a Freiburg Geological Society!

Kenneth Aitken has been a member of the Society since 1994 and, when he was in Edinburgh, enjoyed going on many excursions and attending numerous talks. Even though he moved to Germany in 1996, he has remained a member. Kenneth says that in remaining a member of the Society, he is able to stay in touch with so many of the members who know him. His present address is Kartaeuserstrasse 86, D-79102 Freiburg, Germany.

What's in a Name?

In the third in this series, the Editor has the pleasure of publishing another of his own contributions!



The Stages of the Jurassic: What do they have to do with grasshoppers?

If anyone is planning this year's holidays in western Europe or the south of England, they might like to visit some of the type areas of the Jurassic. I once planned a trip of my own around the sites but, for reasons that I shall not explain, ended up climbing in Ireland. MacGillycuddy's Reeks are a long cry from the Jura Mountains, after which Humboldt in 1795 chose to name the Jurassic stratigraphic system, now reckoned to span 195 Ma to 135 Ma, a period of some sixty million years.

The Jurassic is divided into three parts, the Lower, Middle and Upper. Strangely, in England, each of these has its own nickname, namely the **Lias**, **Dogger** and **Malm**. Though Lias may seem like a simple contraction, it was probably originally a word used by quarrymen of southwestern England, corresponding to the type of limestone found in the Lower Jurassic of Somerset. Doggers are calcareous or ironstone concretions that form in Jurassic sediments and are particularly prevalent on the Yorkshire coast, where they often seed around ammonites and are the source of many splendid fossil specimens. Finally, Malm was the name for calcareous loam, once used for making bricks and comes from the Old English word *mealm*, meaning 'soft'.

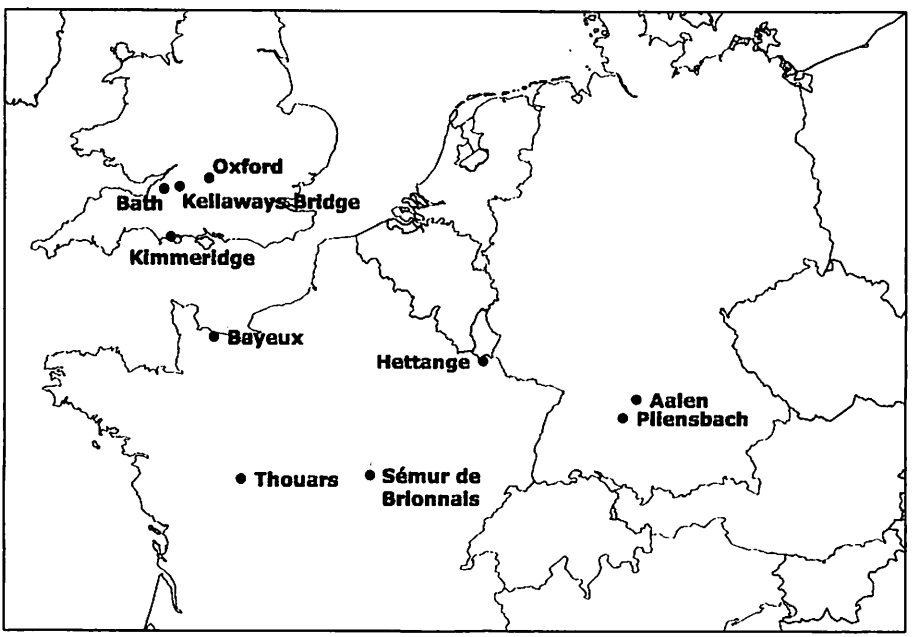
The type areas for the lower stages of the Jurassic are scattered throughout France and Germany, while in the upper stages, the nomenclature is derived from towns and cities in England. The uppermost stage is where the grasshopper comes in.

Starting at the base of the stratigraphic column, **Hettangian** is named after the town of Hettange in northern France, just south of the border with Luxembourg. Apart from being the inspiration for the geological age, the town seems to offer little for the geo-tourist, being on the main road from Luxembourg city to Metz.

The **Sinemurian** is named after the town of Sémur en Brionnais, near to Sancerre in the upper reaches of the Loire Valley. The River Loire provides much more interest for the traveller, principally because the region is full of chateaux and vineyards. It is the latter that are of most interest near Sémur en Brionnais. Sancerre and Pouilly are of particular note, producing some of the most spectacular wines in France. This, of course, owes its character to the calcareous soil formed from the Jurassic limestone of the region.

Skipping across the border into Germany, the **Pliensbachian** is named after the Pliensbach, some thirty kilometres east of Stuttgart. The picturesque village that gives its name to this stage is well known as the heart of the fruit-growing area in the Schwabian Jura and minerals and fossils from the region are displayed in the natural history museum in nearby Göppingen.

The **Toarcian** takes its name from the town of Thouars, just south of Saumur, which lies on a most attractive part of the River Loire and is well worth a visit. Thouars itself has a fine architectural inheritance. My guide tells me that it is worth visiting the seventeenth century chateau of Marie de la Tour d'Auvergne. Of particular interest as well might be the eleventh century church of St. Laon which contains a vault commemorating St. Margaret, queen of Malcolm Canmore.



What's in a Name?

Passing up into the Middle Jurassic, the **Aalenian** is named after the German town of Aalen, some hundred kilometres east of Stuttgart. The town is part of the industrial heartland of Germany and an unlikely tourist destination, though, to its credit, Aalen lies close to the southwestern end of the mountain range known as the *Frankischer Jura.*

The **Bajocian** is named after the town of Bayeux in Normandy. This is another place that is well worth a visit, if only to see the famous tapestry. This amazing work of art was probably one of the first propaganda statements of Europe, and recent evidence shows that the story of Harold being killed by an arrow in the eye is probably the work of some mediaeval spin doctor. Every evening in the summer, there is also a *son-et-lumiere* at the cathedral, celebrating, among other things, the fact that Bayeux was the first city to be liberated after the D-day landings.

We now pass into England for the remainder of the Jurassic stratigraphy. The **Bathonian**, maybe rather obviously, takes its name from Bath. This spa town, whose waters have been famous since the Romans were in Britain, is founded on the Jurassic limestone, which is, of course, what gives it its healing powers. The city itself is largely built of Bath Stone, a bright white oölitic limestone that is quarried nearby. Dorothy Rayner commented that 'it is one of the great historic building stones and justifiably gives its name to the entire stage'.

Into the Upper Jurassic, which is where the **Callovian** now belongs. I say 'now belongs' because the boundary between the Middle and Upper Jurassic has moved around over the past few decades. The stratigraphic commission has agreed that the Callovian is now Upper Jurassic and the name comes the old spelling of Kellaways Bridge, 2 miles north-east of Chippenham in Wiltshire.

The **Oxfordian** is clearly named after the city of Oxford, about which I have little to say. It has a university of some antiquity that boasts a famous library and a passable rowing tradition.

The **Kimmeridgian** is named after the town of Kimmeridge on the Dorset coast, which is the location of one of the first commercial onshore oil fields in the country. It also gives its name to the Kimmeridge Clay Formation, the main oil source rock in the North Sea petroleum province. The beach at Kimmeridge Bay is a great place for fossil hunting, which means that, if you are indeed planning a holiday around this Jurassic itinerary, here at least the younger members of the family can glean some pleasure from your geological pilgrimage.

The uppermost stage of the Jurassic derives its name not from any geographical location but from Greek mythology. Tithon was the son of Laomedon of Troy, who fell in love with Eos, Greek goddess of the dawn. He finds his place in this stratigraphical story because this stage, the **Tithonian**, finds itself hand in hand with the dawn of the Cretaceous.

But the story does not end there, for there are a few stages of the Jurassic that have somehow dropped into oblivion. Of these, perhaps the most famous is the **Portlandian**, once following the Kimmeridgian and now in part amalgamated with it and in part replaced by the Tithonian. Portland Stone, like Bath Stone, is another of England's great building materials.

Another Upper Jurassic age to go was the **Volgian**, named after the River Volga, which runs from central Russia to the Caspian Sea, much of its course being through long, narrow lakes, which are navigable to the heart of the country, thus making it famous for its boatmen and their songs.

Another lost stage is the **Corallian**, named not after any location but, rather obviously, after the fossils that are found therein. It is famous in England not only for its colonial corals but also for the reef talus of broken fragments. Where they are found together, the rock is known as Coral Rag. It is now included as part of the Oxfordian.

Two English Lower Jurassic stages to have vanished in favour of continental ones are the **Yeovilian** and the **Whitbian**. The latter is notable because it was the only stage to have been named after somewhere in Yorkshire, despite the fact that there is a pretty good succession there.

There is a sad end to the story of Tithon, for although Eos managed to secure immortality for her human lover, she omitted to ask the gods that he remain young. As a result, he became very old and very wrinkled and was eventually, at his goddess lover's request, turned into a grasshopper.

When I first started working for BGS in 1975, it was on the Jurassic of the North Sea. The peripheral has always fascinated me, which is why I found an interest in the stage nomenclature. Holidays to mountainous parts of Europe, as well as wine-growing regions have also interested me for a while. In my earlier years, I also had a pet grasshopper called Tithon.

An Amateur's Bibliographic Guide to Australia

by Angus Harkness

Australia is a paradise for the geologist as well as the biologist. On the same land mass as the stromatolite colonies of micro-organisms are also the Ediacarian multicellular fossils. The separate paths that evolution can take are all around you in Australia. The local but very successful eucalypts are a dominant flora and even more localised Western Australian flowers are a marvellous part of any perceptive tourist's enjoyment.

I thought that readers might be interested in the details of many of the publications and maps that I have found useful. I have not generalised; I do not know whether my local experiences may or may not be generally applicable. I doubt whether all local land resources and survey offices are as good as the one I visited in Atherton, Queensland.

For the tourist, the guide books are good and, as in the series of Lonely Planet State Guides, are very detailed where necessary. In Western Australia with, in many cases, at least 100 km between very small 'towns', any food, water and fuel stops are important. There are plenty of good articles on the geography, food and wines with which I shall not try to compete. The problems for me have been in obtaining geological information. This is an acknowledged problem, also shared by a professional palaeontologist and a geochemist with whom I have walked around Canberra. Perhaps I have little competition in my chosen niche!

This article is, therefore, mainly about literature for the amateur geologist - literature that I have obtained and may be useful to others. I find lists of books or other references in hard copy or electronic form are useful but often not very informative unless I can assess the relevance of the contents from at least an abstract. I have tried here to put the bibliography in context and my references are very full, containing many addresses and ISBN numbers so that these scattered sources can be contacted and publications ordered.

An excellent overall view of Australian geology, *The Face of Australia*,[1] would be worth your while to seek out. It is certainly available from libraries, is short and very readable and is exemplary in its avoidance of jargon. There is a University level textbook on Australian Landforms.[2] The authors are both from the University of Adelaide; the book itself is well illustrated with black and white photographs and line diagrams, and is well referenced. However, many references could be difficult to obtain outside Australia.

Overall maps of Australian geology, land use and forestry are produced generally under the NATMAP title.[3] The majority of geological and topographical maps are produced by the individual States; even the road atlases and maps tend to be divided by States. Contours, shading or colouring are little used to denote relief because the country is, in general, amazingly flat. The existing excellent contoured topographical maps are difficult to obtain except locally where hill walking is a popular activity. For topographical maps, the Lonely Planet State Guides have addresses and some generalisations for the supply of maps which I have to confess to not having used. European assumptions as to what the maps contain can be misleading. Some topographical sheets show very little in areas that are nevertheless geologically interesting. Geological maps are also available locally at some visitor centres, at least in the National Parks in Victoria and New South Wales. A land resources and survey office in Atherton, Queensland also had a good stock. For Western Australia, I used the central office in Perth.[4]

The situation with regional guides for each State is varied. The *WA Statistical Year Book* contained a useful chapter on geology from which I emerged understanding the explanation for an earthquake in the middle of the very ancient Yilgarn block that has been tilted tectonically and then cracked. Other such statistical year books may exist for other States and could be used from libraries.

There are many booklets of about 50 pages on local specialised topics. The WA Museum has booklets, well illustrated in colour, on stromatolites,[5] meteor craters,[6] and tektites.[7] Another organisation, CALM, has a colour illustrated booklet on the Kimberley,[4] and the Department of Minerals and Geology Survey Office does publish some detailed maps.

For New South Wales, there is a geological guide book,[8] as well as detailed coverage of the Blue Mountains tourist area.[9] I was also able to get a copy of a primary article on the Barrington Tops area[10] from the Barrington Tops Guest House in the National Park. I have not consulted the current geological literature databases for primary articles or reviews, regarding this professional approach as usually supplying too detailed material for a transient visitor, and relying on the advice of my Canberra friends. Australia is covered in a world mineralogical atlas.[11]

Queensland has private and public service sources of readable material. In Queensland around Cairns, a visit to the Great Barrier Reef and to the wet tropical rain forest illuminated for me and others the conditions that might have obtained

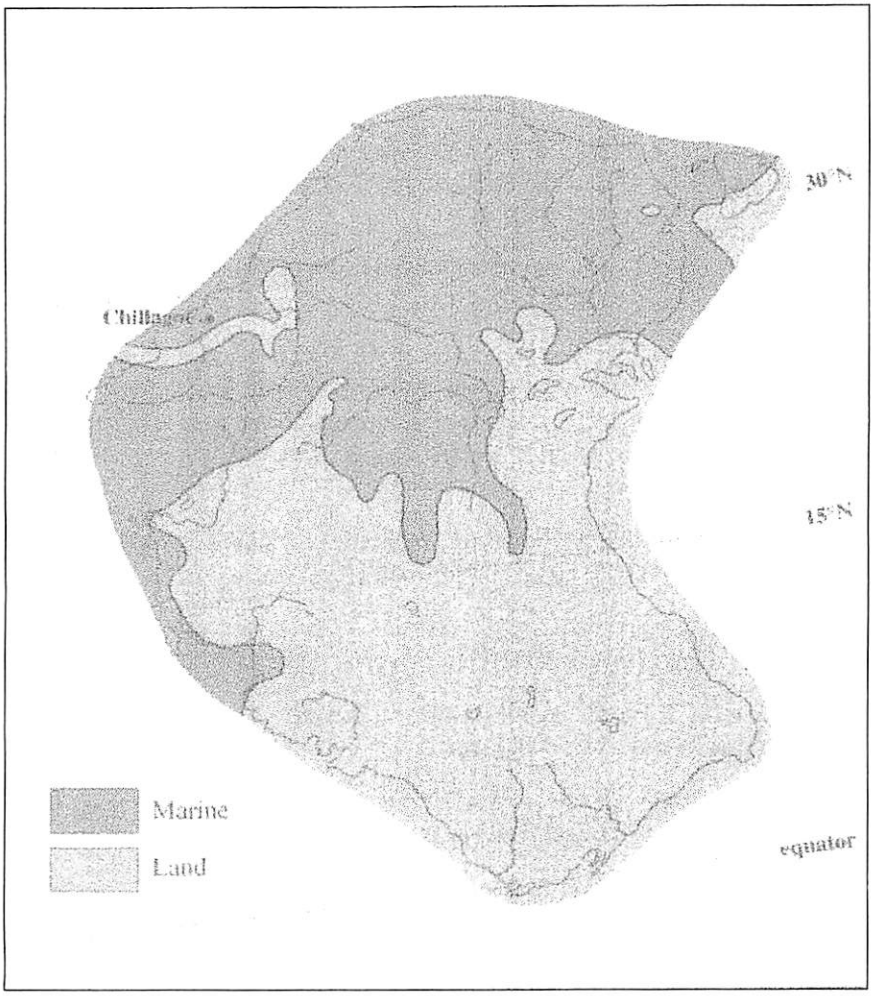
during the Carboniferous. The rainforest is well documented[12, 13]; the Great Barrier Reef is beautifully documented in a Readers Digest publication.[14] The spectacular Undara lava tubes and the Einasleigh gemstone/goldrush area are well described.[15, 16] The Chillagoe district is described in a concise booklet,[17] and in a book with extensive treatment of the mineralisation by Ian Plimer;[18] this book also contains useful material on the general geology of Australia, for example its inundations and northward migration (see figure opposite).

At the southwestern end of the Great Dividing Range, some of the beauties of Victoria can be geologically explored, including the Grampians area;[19] there is a locally well-documented volcano trail on the recent basalt plains to the south of the Grampians. For my limited time in South Australia, I found their newly-published *Fossils* booklet useful.[20]

In summary, for this very old, arid, flat and fascinating island continent there is a wide range of published material but it is not coordinated or spread widely to retail outlets; I failed to secure useful published lists. In contrast, the botanical literature is widely available, cross-referenced and at many levels. On eucalypts, for example, there is a short review on eucalypts,[21] a tourist field guide,[22] local niche descriptions for eucalypts and descriptions of wild flower regions,[23] and other CSIRO monographs. An outstation of the Sydney Botanic Garden in the Blue Mountains has a Gondwana flora trail.[24] The Flecker Botanic Garden in Cairns, Queensland, has a series of shorter trails covering tropical plants with an excellent geologically-relevant locally available guide publication.[13] These botanical trails go some way to fulfilling a request by Bill Baird in the last issue of THE EDINBURGH GEOLOGIST (*Living Fossils*, vol. 33, p. 3).

I hope that this catalogue may help any readers who plan to visit Australia and who would, as I did, like to know something about the geology of the areas visited.

Angus Harkness is a biochemist with an amateur interest in geology. He has been a member of the Society since 1993 and is a member of Council. He admits that his visits to Australia have prejudiced him in favour of the country. This bibliography and the article that follows have been prompted by his most recent tour there in 1999.



The Australian continent 500 million years ago - an example of the palaeogeographical maps in A journey through stone[18]*, here reproduced with kind permission of Reed New Holland, New South Wales.*

Note: the quality of this scanned image does not match that of the original published figure.

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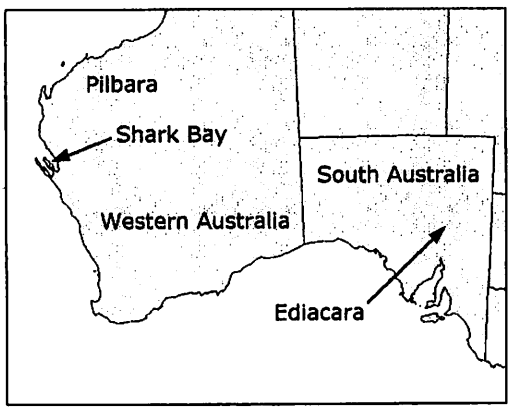
Evolutionary problems in Australia

by Angus Harkness

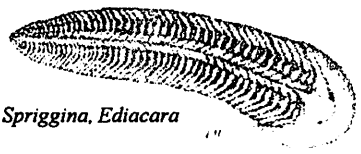
On my recent visit to Australia, I visited Western Australia (WA) and, briefly, South Australia. I was stimulated by the existence of early stromatolite fossils in the Museum in Perth and living stromatolites in, amongst other places, Shark Bay, WA, to consider some evolutionary problems that, to a biochemist, seemed unavoidable.

Australia is a single large wandering continent which has been the site of evolutionary change. It seems from the 'geological' unity of Australia that evolution was possibly continuous. The present-day biological success of the eucalypts is a formidable achievement by any standard, even relative to that of insects (Turnbull & Boland, 1984). These plants have spread throughout the continent and there are both continent-wide and very localised species. Can geology be used, speculatively, to further help biology? I would suggest the answer is that yes, possibly it can.



In the WA Museum in Perth you can see fossils from the Pilbara region of 3,500 Ma old marine stromatolites. These are simple unicellular colonial organisms. Living stromatolite colonies are still present at several sites in WA, both offshore and onshore (McNamara, 1997), the most famous of which are at Shark Bay (see map). The present-day desert photosynthetic blue-green algae (cyanobacteria) that form stromatolites and desert varnish are versatile. They use self-regulating sunshades of calcium carbonate and can concentrate iron and manganese oxides up to 10,000 times (Painter, 1996). If the early 3,500 Ma old cyanobacteria were similarly skilled they could not be described as primitive.

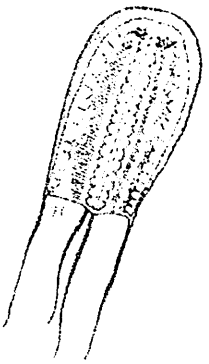
Across the Nullarbor Plain in South Australia, at Ediacara, substantially more advanced impression fossils of 540 Ma were found (Clarkson, 1993; Pledge, 1999). At keast 48 species have been described; these include jellyfish, some worms and rarer animals including a 'brachiopod' and an 'echinoderm'. It seems to me that



Spriggina, Ediacara

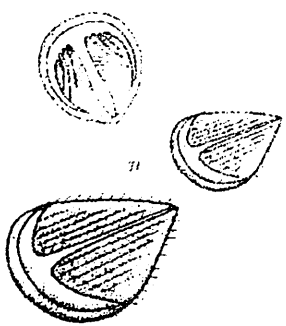
present evidence separates by 3,000 Ma the simple, colonial, non-nucleated cyanobacteria of stromatolites from the highly-organised, nucleated, multicellular organisms from Ediacara. This argument assumes that morphological evidence of biological stability as in cyanobacteria is some reflection of stability at the molecular DNA level.

The environment changed during this period, not least in the evolution of the atmosphere. The evolution of living systems may be related to increased oxygen availability and more efficient energy generation of living cells. These changes were built upon the foundations of existing mechanisms in an anaerobic cell (one that does not use oxygen).



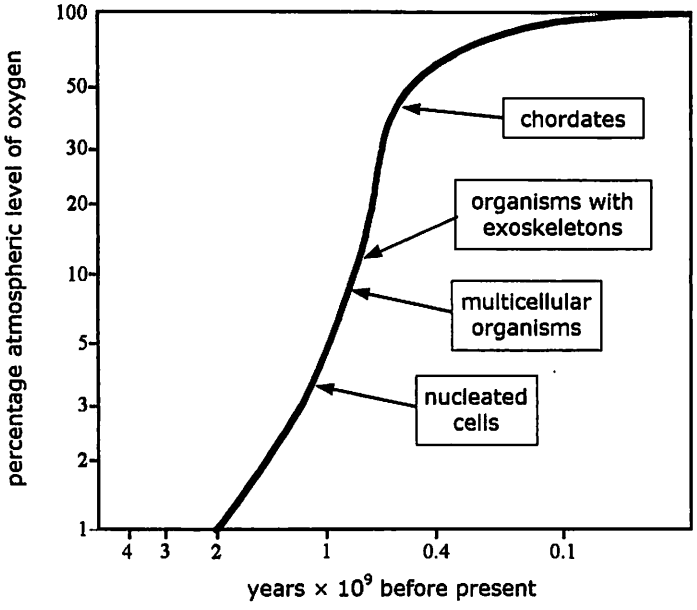
Kimberella, Ediacara

Oxygen concentration in the Earth's atmosphere increased gradually over the period from 2,000 Ma to 100 Ma (see graph on p. 24). Relative to the present concentration of oxygen in the atmosphere, nucleated cells appeared at around 3% (1,000 Ma), multicellular organisms like those at Ediacara at about 8% (800 Ma), organisms with exoskeletons at 10% (700 Ma), and chordates, animals with spine-like axial structures (notochords), about 40% (500 Ma) (Bryant, 1993). The generation of oxygen using sunlight involves subcellular organelles, which look something like micro-organisms and may be related to the cyanobacteria but are incorporated into larger cells; these are called chloroplasts. The production of energy from the oxygen is largely carried out by other subcellular organelles called mitochondria.



Parvancorina, Ediacara

In cells living at the present time, the amount of genetic instructions can be measured by the number of purine—pyrimide base pairs in the DNA (deoxyribonucleic acid). Simple, non-nucleated micro-organisms have between 0.5 and 5.0 million base pairs in their DNA. Single nucleated cells, yeasts, have 13 million base pairs. Multicellular, nucleated organisms have 70 - 3000 million base pairs. It seems that the move in complexity of genetic instructions in living cells from about 1 million base pairs to about 70 million base pairs took about 3,000 Ma. In other words, the early steps in organisation were difficult.



Accumulation of atmospheric oxygen through time (after Bryant, 1993)

The basic inorganic chemistry of evolution (Williams, 1996) with an eventual increase in and use of oxygen to generate more energy is believed to be relevant to the increase in DNA. For example, the subcellular organelles, the chloroplasts and mitochondria, are complex structures; their extensive structures, communications and related controls must involve large amounts of nuclear DNA to control the proteins. However, mitochondrial components such as the respiratory protein, cytochrome C, appeared early in evolution and changed little; many of the housekeeping and structural proteins do not change rapidly with evolution. To me, this seems to leave a large amount of DNA still unexplained. Some of it may be related to the temporal control of development, the determination of biological position and the control systems and communication. We have yet to find functions for massive amounts of the human genome (Dunham *et al.*, 1999)

In nucleated organisms, DNA provides a set of separate structures, chromosomes, which are collectively the genome. After a long evolution of cells with very large genomes, pruning of the genome seems to have occurred and been rapid in the plants and, to a lesser extent, amphibia. The common-sense need for a mobile

organism not to carry unnecessary weight (Atkinson, 1977) is seen at most or all levels in biochemistry and probably provided most or all of the evolutionary drive leading to the removal of much DNA. The plants migrated on to dry land slightly before animals, 430 Ma ago, which may be an indication of the success of their DNA at that time.

Overall, the evidence seems to suggest that evolution may have required billions of years to develop the large amounts of DNA needed to control multicellular organisms, although the slow increase in oxygen concentration may have limited the rate of change. It may be a difficult problem to understand the apparently silent parts of our own human genome.

My journey from the outback of Western Australia to South Australia leaves me humbled and baffled. I wish other travellers success and equal enjoyment.

Further reading

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Acknowledgement

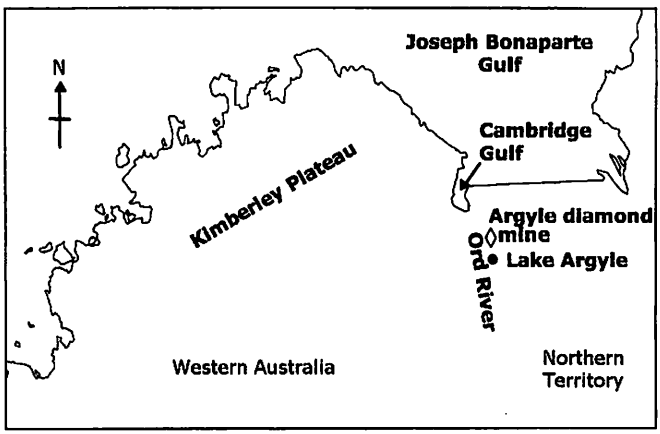
The illustrations of the Ediacarian fossils on p. 23 are taken from the book *Fossils of the Flinders and Mount Lofty Ranges* by Neville S. Pledge, reproduced here with kind permission of the South Australian Museum, Adelaide.

Diamonds in them thar' Sands and Gravels?

by Ian Selby

The third of the Australian feature articles is a contribution by Ian Selby, based on the talk that he presented in this winter's lecture programme. As those that attended the talk will have heard, offshore sand and gravels provide an abundant mineral resource and potential host for diamonds...

I spent a brief time working in Australia in a search for offshore diamonds. Much of the mountainous area of the Kimberley Plateau in northwestern Australia has been explored for diamonds following the discovery of olivine lamproite kimberlite near Lake Argyle. During the early to mid 1990s, Argyle was the world's largest producer of diamonds, although the majority of these were of industrial rather than gem quality. Diamonds have also been mined in the alluvial sheet flow gravel deposits adjacent to the mine, although no alluvial deposits have been discovered in significant quantities down the Ord River to the sea. Despite intensive exploration, no other major diamond source has been located in or around the Ord catchment or in NW Australia.



Although Argyle lies 200 km from the coast it was considered likely that diamonds had been transported out to the north into Joseph Bonaparte Gulf. Today the Ord River carries only a fine grained (silt and clay) load. However, it was thought that enhanced preciptation in the Mesozoic and Tertiary may have lead to episodic seaward transport of diamonds, with concentration occuring during colder episodes in the Quaternary. Its worth remembering that Australia differs from the UK in that the landscape is so old and stable that virtually the same rivers had been flowing northwards for hundreds of millions of years.

In 1993 an offshore diamond rush was started by Cambridge Gulf Exploration through a report of six gem-quality diamond from tenements in Cambridge Gulf. This seemed to confirm the notion that long-term erosion had indeed resulted in transfer of diamonds down the Ord River and the exploration was centred around the mouth of the Ord River. Cambridge Gulf consists of a central deep channel maintained by strong tidal currents (up to 2.5 ms^{-1}). On the other hand, the waves, which have been so important in concentrating the Southern Africa offshore diamonds, are not large.

The initial objective was to locate and test targets. The targets were sediments (gravels) deposited in high-energy depositional settings where heavy particles may have been concentrated. Diamonds are dense and are typically trapped in gravel lags and at the sediment/bedrock interface. Seismic and sonar exploration identified three targets of coarse-grained sediments including the shoreline apron deposited on the western side of the submarine channel and facing seawards. This was shown to be a simple prograding succession with a classic high-energy geometry forming a linear deposit in 15 to 40 m of water, which meant that it could be simply extracted by current dredging technology.

The geophysical surveys were followed by geological exploration. Drilling was undertaken using reverse circulation in wide diameter bit and casing. This method is used to ensure that the coarse fraction is recovered and, using it, we certainly did recover sands and gravels. Unfortunately, they were perfect beach deposits: gravels largely composed of locally formed carbonate with a minor proportion of distal rock fragments. Only four holes were drilled before the barge grounded on a sandbank and the project was abandoned.

So, in the end, no diamonds were recovered. The story does not end there, however. Only small volumes of sediment (a few cubic metres) were sampled and further exploration may have revealed other sediments in other areas of the bank. In my view, diamonds probably are present in Cambridge Gulf but their concentration remains a question that remains to be answered.

Ian Selby was a research student with the British Geological Survey and contributed to the offshore mapping programme west of Scotland. He has since worked on offshore sediments around Britain, as well as in Hong Kong, where he contributed to the building of the new airport at Chek Lap Kok and off Australia. He now works for Hanson Aggregates Marine Ltd. in Southampton.

Mary Anning, Thomas Hawkins and Hugh Miller, and the realities of being a provincial fossil collector

by Mike Taylor

Mary Anning junior (1799-1847) of Lyme Regis, Thomas Hawkins (1810-1889) of Street in Somerset, and Hugh Miller (1802-1856) of Cromarty are three of the most important fossil collectors of the golden age of British palaeontology during 1820 to 1850. Yet they were on the fringes, intellectually, socially and geographically. What realities and constraints affected their lives and their contributions to geology?

In *The Great Devonian Controversy*, Martin Rudwick shows how 'in the early nineteenth century, geology was a new, exciting and fashionable science', a formal science concentrated in the Geological Society of London - an austere intellectual version of a gentleman's club, with curators instead of cooks. Beyond London, there were local societies and professional men. But there were also the people who provided the raw material. Mining engineers and mineral surveyors such as William Smith and John Farey produced the raw data on rock, coal and mineral distribution on which the Victorian economy ran. Likewise, palaeontology relied on collectors of fossils to find the basic material for the science. These provincial collectors generated the basic data for the metropolitan gents and filled museums with astonishing finds. Apart from these surveyors and commercial collectors, and a few meanly paid curators, almost all geology was a spare-time activity until the rise of the Survey and the later Victorian growth in science teaching.

Who were these gentlemanly geologists of the Geological Society? According to Rudwick, the hallmark of a gentleman was that he did not have to work, but could give himself up to a life of leisure. He (usually he) was an independent man, sustained by wealth that was often inherited or acquired through marriage (or perhaps a 'gentlemanly' profession such as the Church, or a university fellowship). This social status could be summed up as not having to worry about money.

Anning had no choice. She was a working class woman making her money in the fossil trade. The known portraits show an interesting contrast. In formal dress, she is entirely respectable. But her outdoor dress is that of a working countrywoman, not a middle-class lady collector. One collector spoke of 'Mary Anning, a dealer, Miss Congrieve, and Miss Philpots'.

Thomas Hawkins aspired to be a gentleman. Instead his life was a tragicomedy.

Born in 1810, the son of a Somerset farmer and cattle dealer, he inherited at 20, and spent the rest of his life collecting marine reptiles, harassing the great and good and *The Times* with crank letters, and generally being the sort of nasty and disruptive person one does not want for a neighbour. He became insane, or at best very profoundly disturbed.

The Geological Society stalwart William Conybeare commented:

> What capital fun Hawkins' book is. I only wish it had been published before Walter Scott died. It might have furnished him a new character, a Geological bore...

Hawkins unwisely tried to overawe Edward Charlesworth, the combative editor of the *Annals and Magazine of Natural History*, who publicly retaliated with:

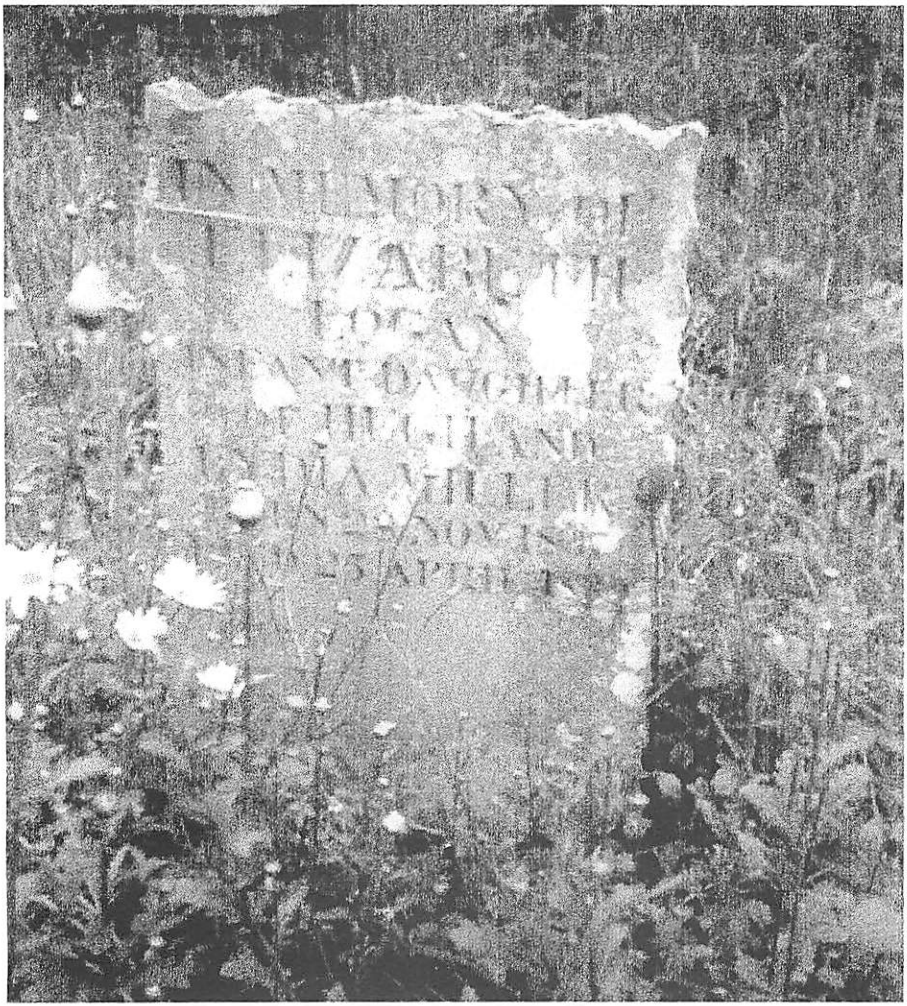
> Mr Hawkins could adopt the language of cringing adulation, as well as that of the coarsest bullying, just as it chanced to suit his purpose.

And this is how Hawkins dedicated a book to no less than Professor William Buckland of Oxford:

> You have ever since given me a thousand flattering testimonies of Friendship, and tightened all the Chords of that Sentiment, by which man is bound to man.

Hugh Miller is a refreshing contrast to Hawkins' 'cringing adulation'. He would have scorned worrying about being a gentleman, as befitted his independent-minded burgher ancestry. Born in 1802, the son of a shipmaster, Miller was plunged into poverty with his father's death. He could still have worked his way up the Scots educational system to become an educated professional, but as his splendid autobiography, ironically titled *My schools and schoolmasters*, relates, he dropped out to become an itinerant stonemason and write poetry in the winter close season. A stonemason's life was grim, working in all weathers and lodged in appalling bothies, but he found deep pride in his workmanship. He came home with lung disease to quieter, more settled work as a monumental mason and then a bank clerk. The poetry was hopeless, but his prose showed genius.

By then he had become fascinated by the fossils he'd first noticed as a youth, and came to discover the local Old Red Sandstone fishes. But Miller also clove to the Kirk of his fathers, and in 1839-40 he moved to Edinburgh to become editor of *The Witness*, the newspaper of the Evangelical wing of the Church of Scotland which formed the Free Church in 1843. In Edinburgh, he famously eschewed urban dress



The last gravestone Hugh Miller ever carved, that of his first daughter Elizabeth, who died in infancy. St Regulas' Kirk, Cromarty

in favour of the outdoor gear of the Lowlander countryman. In tweeds, overwrapping 'maud' and tackety buits, he was always ready for some collecting on the way home to the suburbs or Portobello.

How and what they collected

'Collector' is an ambiguous word. It can include anything from actually discovering a fossil, through excavating and preparing it, and housing it with others. But it can also include the act of making a collection, of amassing specimens. Thus it extends to buying or swapping specimens already collected by others, and maybe selling them or giving them to museums.

Miller collected mostly middling fossils in his free time for his own satisfaction. He scorned being patronised. His collection, perhaps the best general collection of Scots fossils ever made, is now one of our great national treasures in the NMS.

Anning found fossils, but did not 'collect' them in the second sense - she sold them to survive. She sold whatever she could. But she would also have paid workmen to help collect large reptiles, and tipped the sea-quarriers to tell her of finds that they made when digging for stone on the beach.

Hawkins was a big game hunter, going only for showy reptiles partly perhaps for social status. He could afford it. But marine reptiles are very rare. Rather than spending vast amounts of time searching, he paid folk to tell him about finds on the shore at Lyme and in quarries at Street. He then collected the finds himself, and then took them home to prepare himself, not always without a certain degree of 'improvement'.

What impresses me above all is how impossible it is to understand the provincial collectors outside their contexts, both geologically and socially. It's no accident that visiting Cromarty for the first time, after reading Miller's writings about the Black Isle, feels almost an exercise in déja vu. The best collectors are provincial by definition, with an intense localism. Anning delightfully ends one letter, 'The tide warns me I must leave of scribilling,' and she was indeed well known for the regularity and persistence with which she spent time on the beach looking for fossils. It was, and remains, vital to put in enough time on outcrop to make rare finds statistically probable. This puts a high premium on living on the spot, especially before the days of cheap and fast personal transport, and especially on coastal exposures intemittently covered by the tide. One modern collector I know walked his dog morning and evening along a beach that is a classic dinosaur locality. It was vital to build up familiarity with every rock layer, and every quarry and quarrier. Miller found his Cromarty Old Red fossil fish by systematic exploration of the rocks, testing a hypothesis about local geology that turned out to be gloriously wrong! He was in fact looking for Jurassic fossils, predicting an

outcrop symmetrical to that at Eathie on the other side of the south Sutor headland.

The local person can also take advantage of special events and time windows. Wet weather saturates the ground and causes landslips around Lyme, bringing down fresh fossils just as they did for Anning. Storms sweep beaches clear of seaweed and mud, giving a window of opportunity before the weed regrows or the mud settles again. Even quarries had to be monitored. The quarriers that Hawkins patronized might hit an ichthyosaur, at which Hawkins had to move instantly before the quarrymen moved on, or before the specimen was damaged.

Who published the specimens?

All three had specimens published by others, revealing an anomaly which seems very odd to modern eyes. Miller naturally had his finds named after him, as convention dictated, such as the placoderms *Coccosteus milleri* and *Pterichthys milleri* by Louis Agassiz (now *Coccosteus cuspidatus* and *Pterichthyodes milleri*). Yet contemporary British palaeontologists named Anning's finds not after her, but often after the people who bought them and gave them to museums. The one exception was Louis Agassiz who being a Swiss and a foreigner didn't know how to play cricket, let alone the distinction between Gentlemen and Players. Anning was in Trade: she sold her fossils, and that extinguished any social obligation.

Richard Owen named *Plesiosaurus hawkinsi* after Hawkins, which seems rather unfair. Hawkins had sold his two main collections of marine reptiles to the British Museum for £3110 5s. Perhaps the facts that Hawkins was, or at any rate purported to be, a gentleman, and that he had formed 'amateur' collections, and wasn't in Trade, were seen to justify this genteel hypocrisy, at the time anyway.

Even if one had the inclination, time and ability to write up one's research, there were still problems for provincials at that time. The worst was paying for current literature and relevant society memberships (to get the journal, but also to gain access to books and periodicals in the society library and specimens in the collection too, maybe). The literature might have been refreshingly small compared to today's, but the prices were horrendous. At one time in the early 19th century the Geological Society of London charged a one-off admission fee of £6 6s, and an annual sub of £3 3s, plus an extra three or four pounds for a volume of *Transactions* every few years. Lyell's *Principles of Geology* was £2 5s, Murchison's *Silurian System* £8 8s, and John Parkinson's *Organic remains of a former world* £5 5s. Not bad on first sight – except that one has to multiply these by 200 or so to allow for inflation (an exact comparison is impossible because of fiscal

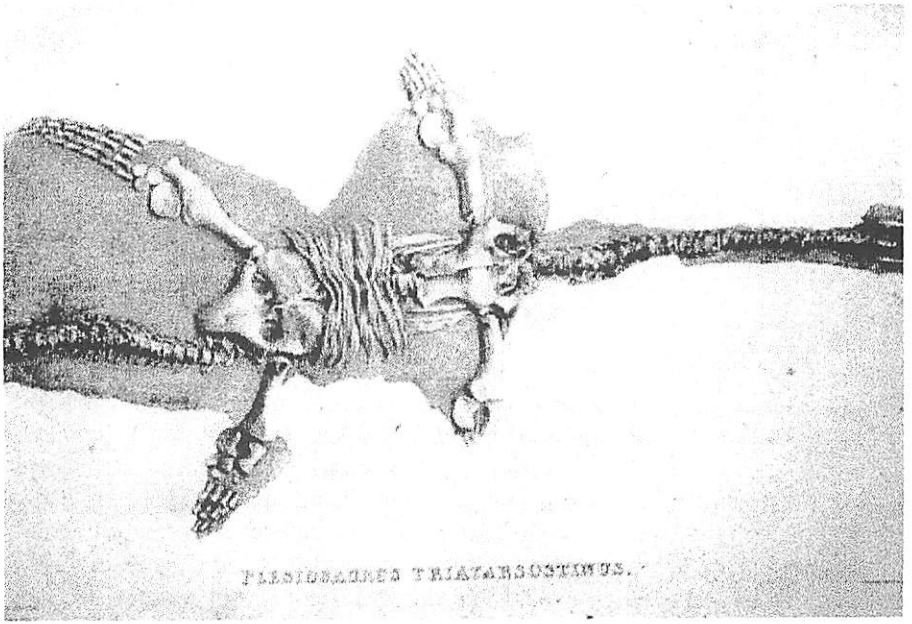
and social changes, such as progressive taxation and the replacement of the live-in maid by central heating and a washing machine, but this seems about right certainly at the Anning and Miller end of the social scale). Imagine, today, paying more than £1000 for a copy of *The Geology of Scotland*!

Not surprisingly, Thomas Hawkins was the only FGS of our three, for he did well out of his reptiles. The BM's £3110 5s (around £600 000 today) compares well with the roughly £20 annual income of a Dorset farm labourer's family half-starved on the then equivalent of Income Support. An 1820s gent on £300+ pa slipping down to Lyme for a spot of collecting reminds me of nothing so much as a Western tourist in a really poor Third World country today.

On top of that, imagine a world with no photocopiers, no useful libraries outside a few big cities except perhaps a few widely scattered Institutions and Museums (the nearest to Miller being that at Elgin), and hardly any specialist colleagues. This was in the early stages of the growth of local museums and societies, before books became cheaper with mass production and steam presses, and well before the later development of the Geologists' Association. So to be a fully active geologist needed enough money not to worry too much about it – and here we come back to the definition of a gentleman. Hugh Miller was even more right than he perhaps realized in *The Old Red Sandstone*: 'Geology in a peculiar manner supplies to the intellect an exercise of this ennobling character. But it has also its cash value'.

The next problem was where to publish. Society journals were hazardous, for the great and the good geologists did not hesitate to sit on or even quietly suppress papers they didn't like, as Miller's friend John Malcolmson found. Anning published nothing: she had to earn a living. Hawkins tried, with pathetic results. He privately published two huge volumes, *Memoirs on Ichthyosauri and Plesiosauri* (1834) and *The Great Sea Dragons* (1840). Despite sumptuous plates of fossils, and a frontispiece to *Sea Dragons* by John Martin that is perhaps the first and still the finest image of battling saurians, these monuments of vanity publishing were scientifically negligible. As Hawkins' mental state deteriorated, the second one also gained a fantastical subtheme of the 'Gedolim Taninim of Moses'. He soon relapsed into sub-Miltonian epic verse such as *The wars of Jehovah in heaven, earth and hell* (1844).

Miller reminds us that there are other ways of contributing to science than finding data and writing papers for the academic elite. He made no major intellectual contribution to geology, as David Oldroyd has pointed out (Shortland, 1996). As a newspaper editor and writer, he was too busy to do much serious research. Indeed, as Michael Shortland shows, geology was a small part of his output. But as the boss



The type skeleton of Thalassiodracon hawkensi *(Owen, 1840), one of the plates from Thomas Hawkins' lavish* Great Sea Dragons *of 1840.*

he had the perfect opportunity to create his own slot in the paper, making a massive contribution to popularizing geology. One might compare him to Stephen Jay Gould - except that *The Witness* was not a special interest magazine like *Natural History*, but a mainstream national newspaper. His articles were repackaged into best-selling books, for Miller hit the spirit of the time perfectly. Archibald Geikie, his friend and disciple, recalled how Miller's 'books were to be found in the remotest log-cabins of the Far West, and on both sides of the Atlantic ideas of the nature and scope of geology were largely drawn from them'.

Miller became the leading popular expounder of geology in the 1840s and 1850s, helping make respectable what was once a dodgy and infidel science. Even if his mix of religion and science was no longer acceptable in elite scientific debate, the public loved it. He followed the Reverend Paley in using functional morphology to extol the works of the Lord in, for instance, the fine design of a single fossil fish scale. He went on to interpret the Creation story in Genesis as an extended metaphor of historical geology (showing that he was no literalist). Miller, as a good journalist, also went straight for the big question, launching with bared teeth into

the dogfights over pre-Darwinian evolutionary theories, notably that of fellow-Scot Robert Chambers in *Vestiges of the Natural History of Creation*.

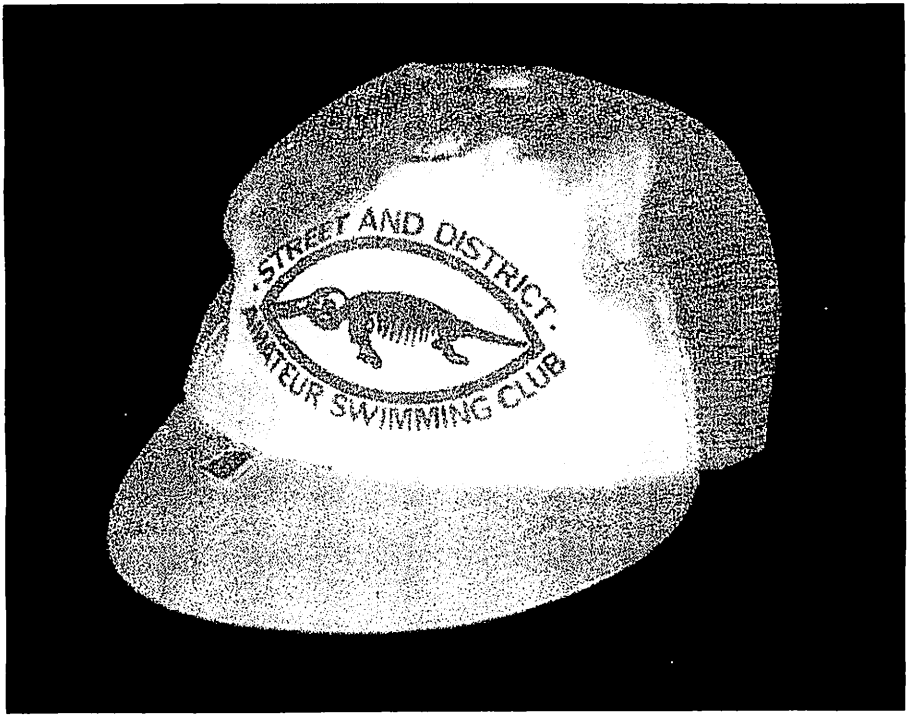
Most fundamentally, collecting fossils was a noble work in itself, a physically and morally improving recreation. As he put it in *My schools and schoolmasters*, a dryly witty classic of 'self-help', another great theme of the day, 'life itself is a school, and Nature always a fresh study'. *The Cruise of the Betsey* (actually, the first of two books in one cover, the second title being *Rambles of a Geologist*) is full of the joys of fossil collecting around Scotland in between pointed observation of the apparent decline of the old Gaelic society, and the consequences of the Disruption of 1843 - the *Betsey*, an ancient and unseaworthy yacht, being all that the Free Kirk minister of the Small Isles had for a manse, thanks to landowners' hostility.

So Miller had a massive if unquantifiable impact on popular support, and for instance its implications for government sponsorship for science and geology, quite on top of his direct contributions such as his collection. We will certainly hear more of him in 2002, his bicentenary year.

The legacy

One irony is that Miller's own publicity for the Cromarty site led to its depletion even in his own time. Today it is a remnant of its former self, protected by SNH. This reminds us that the collections we inherit are not just the accumulated rewards of decades of collecting. They may be the now irreplaceable fruits of post-Devensian erosion. Perhaps, like Miller's Cromarty beach, the sites are almost worked out. Or perhaps, like Hawkins' Street quarries, historical changes such as the coming of the railways and the dominance of imported brick forced their closure. There's little palaeontology to see at Street today beyond the ichthyosaur on the town sign. Only Lyme remains almost as productive as in Anning's time – in some ways more so, because new reptiles are still appearing - and even then the halt to sea-quarrying, vital to prevent the destruction of the town by the sea, would have reduced the sheer amount of material coming out of the limestone.

The collectors' specimens' scientific value is if anything increasing. As well as rarity value, and established value as type and figured specimens, the specimens gain new value by restudy with new technology. For instance, I brought two of Hawkins' *Plesiosaurus hawkinsi* specimens completely out of the rock with acetic acid preparation, allowing Glenn Storrs and myself to reassess them as a new genus, *Thalassiodracon* - Greek for 'sea dragon'.



When quarries were closed, some signs remain: the town symbol of Street remains an ichthyosaur. This is especially appropriate for the swimming club!

These old fossils are also important in popularizing geology, notably in the magnificent redisplay of Anning and Hawkins (and other) marine reptiles at the Natural History Museum, or our own displays in the Museum of Scotland. But on top of that, there is the historic importance of the specimens themselves in our changing perceptions of science and of the world around us. I happened to be reading Hutton and Lyell when working on the Museum of Scotland. We rightly pay tribute to both James Hutton and Hugh Miller, but in the historical section. I was struck by how deeply the geological gallery is (of course) based on Hutton's and Lyell's ideas, but also by how they have, appropriately, been so recycled and modified that they have lost any specifically Huttonian or Lyellian identity in modern scientific work. In contrast, Miller, Anning and Hawkins retain their identities in their specimens as much as in their very different, human stories. Maybe even more so: ideas and concepts can be and are discarded, but the specimens remain as the basic information on which science, to be science at all,

can be tested again and again. Perhaps in endeavouring to reestablish the balance of history we are finding that justice is finally being done to the provincial collectors.

Acknowledgements

This is based on the paper given to the EGS on October 1999 stemming from that at the Anning Bicentenary Conference, Lyme Regis, June 1999, based in part on entries for Thomas Hawkins and Hugh Miller in press in the *New Dictionary of National Biography*. I am very grateful to the conference organizers, and to many colleagues, especially Hugh Torrens, Jehane Melluish, Marian McKenzie Johnston, and Sarah Levitt, for information and discussion.

Some further reading

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Tickell, C. [1995]. *Mary Anning of Lyme Regis.* Booklet available for £3.50 including post and packing from the Lyme Regis Philpot Museum, Lyme Regis, Dorset DT7 3QA.

Torrens, H.S. 1995. Mary Anning (1799-1847) of Lyme; 'the greatest fossilist the world ever knew', *British Journal for the History of Science*, Vol. 28, pp. 257-284.

Mike Taylor is Curator of Vertebrate Palaeontology at the National Museums of Scotland (NMS). After studying Jurassic plesiosaurs at the Oxford University Museum of Natural History, and later working in museums in England, he came home to Scotland and the NMS in 1993. After being Curatorial Co-ordinator for the Beginnings gallery in the Museum of Scotland, he is now working on a major exhibition for the Hugh Miller bicentenary in 2002.

Poet's Corner

The following couple of previously unpublished poems have been contributed by Colin Will.

Kimmeridge

Rocklets patter down the crumbling cliff-face;
at its foot a platform;
a grey floor with curves
that might be fossils.

They probably are, these phosphatic fragments
of emptied bone, pale edges
shadows where ball once met socket
in a reptilian joint.

Cliffs are mirrored by the sea.
Across the watered distance from Dorset to France,
between Arromanches and Lyme Regis,
across the languages, cultures,
these shores are joined by Jurassic time

Kimmeridge, Dorset, 2nd August 1998

Poet's Corner

Rift

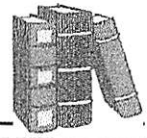
We stood, on the true edge of America,
looked across the sundered ground
at Europe's distant scarp.

In between, light snow flurries
came and went, hazing the short walk
between the continents.

Thingvellir, Iceland, 11th April 1999

Colin Will is a member of the Society, and until 1988 was the Librarian at the British Geological Survey. He now works for the Royal Botanic Garden. Colin has had a collection of poetry (*Thirteen Ways of Looking at the Highlands, and More*) published by Diehard in 1996. His second (*Seven Senses*) is to be published soon.

BOOK REVIEWS



We have two reviews this month, both BGS publications and both designed for the holiday-maker with an interest in geology. They are both from England of course, but members who are going over the border for their holidays this summer might be interested. Both are available from the Book Shop in Murchison House.

HOLIDAY GEOLOGY MAP - PEAK DISTRICT

Tony Crosby

The latest offering by BGS in the Holiday Geology Series is a bright colour production on folded laminated A3 card. On opening the map I was surprised to see a satellite view of the Peak District combined with a simplified geological map, an attractive blend of colours, but no mention of satellite image on the front cover.

Viewing the map upside down, as suggested in the explanation, does improve the perception of 3-D relief. Also orientating the explanation in this way would have helped the reader. With the aid of a magnifying glass I enjoyed identifying features previously visited on the ground.

The geology map shows the outcrops of five major rock types; limestone, sandstone, shale, lavas and dolerites, with a succinct account of their formation and appearance printed on the back. Chronostratigraphic terms are not used, probably simplifying the map for the non-geologist, though, a small outcrop of 'Red Triassic' sandstone is shown. Readers brought up on the volcanic rocks of Edinburgh may be interested to see the occurrence of lavas and dolerites in the Peak District, but to locate and visit these, another map is likely to be needed. Millstone Grit is the local name for the sandstone, we are informed that the crags of this rock provide great sport for rock climbers. Scottish climbers will find the climbs somewhat short compared to those of the Highlands. The major gritstone escarpment, which runs north south for ten miles just west of Sheffield, is not too easily identified from relief on the image but the colour contrasts used for the rock types do help the reader.

The relationship between the drainage pattern of the Wye, Derwent, Dove, and Manifold rivers and the underlying geology is enhanced by the use of a satellite image. For those not familiar with the geography of the district there could be confusion with colours, for example the colour for limestone is very close to the colour used for lakes. The brown of the moorland in the north is not included in the explanation.

The geological structure is explained by including on the back of the card an oblique 3D section and description, which answers the often asked question, why is the limestone of the central part of the Peak District surrounded by valleys of shale and escarpments of sandstone? The map should help to answer other questions posed by visitors to the area who wish to understand more about its geology.

The image and map are printed on hard wearing material and is of a convenient size for use out of doors, though I think it will be mainly carried for reference in the rucksack or car. The pleasant use of colour and shape make it excellent for poster display. For those requiring a map to navigate round the geology of the Peak District, this is not the one to go for, but is worth getting for a fascinating geological overview of an interesting area.

Is this the shape of BGS maps to come? Could there be one for each classic area of British Geology. I wait with interest for more satellite views overprinted with simplified geological maps.

HOLIDAY GEOLOGY MAP - PEAK DISTRICT
Neil Aitkenhead and Anthony Dennis
BGS Earthwise Publications, £1.95
ISBN 0 85272 340 7

HOLIDAY GEOLOGY GUIDE - LAKE DISTRICT **Tony Crosby**

The Lakes District Story is another Holiday Geology Guide published by BGS in the familiar A3 folded laminated card format. The format reminds me of the menu cards in roadside restaurants, they stand neatly on a table and are easy to read.

On the front cover, the impressive picture of Langdale Fell with a superimposed volcanic plume in the sky above, will be noticed by tourists visiting Lake District bookshops on rainy days. If they take the trouble to read the guide, they will learn there is no need to worry, as the volcanic eruption took place 450 million years ago when the Lake District was part of an ocean floor.The 500 million years of the Lake District story is told with colourful illustrations and minimum use of text. The author packs a great deal of information into a limited amount of space.

A graphic colourful stratigraphic column forms the centre piece of the story. There is a small (9 cm by 9 cm) satellite image with superimposed geological map. Rocks have their own colour code on the map which match the colours on the stratigraphic column and the background to the text.

There is a brief introduction to continental drift, illustrated with three globes, to show where the Lake District fits into the global picture at different periods of geological time, as it drifts as part of an ancient continent from the southern hemisphere to the northern hemisphere. The story is divided into eight stages, characterised by different events and environments, from the earliest ocean floor to the more recent glaciation. Rocks formed during each stage, are described to show how they are used as evidence to untangle the complex story.

A small block diagram shows one early stage in the story, when violent volcanic eruptions occured as the ocean floor was forced beneath the continent as it drifted north. Another block diagram shows a later stage, 420 million years ago, when two continents collided, and Scotland (part of the northern continent) and England (part of the southern) met. Proud Scots will be pleased to learn that Scotland came out on top, over-riding England and piling up into a mountain range.

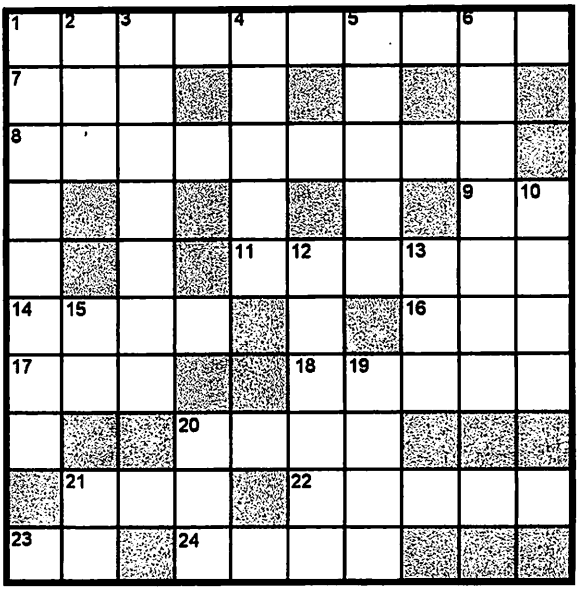
Colourful sketches illustrate the contrasting environments of each of the stages and the type of flora and fauna which populated the Lake District, evidence for which can be found in the fossil record.

To come back to the comparison with a 'menu card', the guide contains plenty of interesting courses, there is much food for thought, and should whet the appetite of those wanting to know more about the geology of the Lake District. An interesting starting point might be to visit the locations of the pictures used to illustrate each of the stages.

HOLIDAY GEOLOGY GUIDE - LAKE DISTRICT
Phil Stone
BGS Earthwise Publications, £1.95
ISBN 0 85272 339 3

Tony Crosby, who lives in Nottingham, is a keen walker and climber. He has spent many long and happy days in both the Peak District and the Lake District, making him ideally placed to review both these publications. Before he took early retirement in 1997, he worked for the Coastal Geology section of BGS in Keyworth.

Rocksword Puzzle No. 3



compiled by Angela Anderson

Clues across

1. Can I do voir after Cambrian (10 letters)
7. Dogs howl and bite in the coast (3)
8. Downfolds (9)
9. Colloquial beg pardon for Edinburgh post code (2)
11. Tertiary new dawn (6)
14. Eye flower (4)
16. One of Samson's, seen in the Queen's Park, Holyrood (3)
17. Electric island in march mode (3)
18. The final frontier (5)
20. Palmed ate in time (4)
21. French here initially a chemical combine (3)
22. see 3 down
23. We took a from America (2)
24. Not whole (4)

Clues down

1 Id bonsai volcanic glass (8)
2. A narrow beamed fish (3)
3,22. A fundamentally moving experience in Holyrood (7,5)
4. Half a lamellibranch (5)
5. Nicco upset shape of ash pile (5)
6. Poisonously rinse ca (7)
10. She being in a shrubby genus (4)
12. Yes rot a bivalvian delicacy (6)
13. Time races in (3)
15. Initially Rolls Royce (2)
19. In lope at boggy stuff (4)
20. - - - and strike (3)
21. Not 'ers (2)

This is Angela's third puzzle, so you should be getting the hang of them by now! The answers (only for readers who are absolutely stumped) are on the next page.

Rocksword Puzzle No. 3

Solution to puzzle on page 43

Clues across

1. ORDOVICIAN
7. BAY
8. SYNCLINES
9. EH
11. EOCENE
14. IRIS
16. RIB
17. ARC
18. SPACE
20. DATE
21. ICI
23. US
24. PART

Clues down

1. OBSIDIAN
2. RAY
3, 22. DYNAMIC EARTH
4. VALVE
5. CONIC
6. ARSENIC
10. HEBE
12. OYSTER
13. ERA
15. RR
19. PEAT
20. DIP
21. IS

Proceedings of the Edinburgh Geological Society for the 165th Session 1998-1999 No. 29

Compiled by David Land

Proceedings of the Edinburgh Geological Society for the 165th Session 1998-1999 No. 29

Membership:
The total membership on 30th September 1999 was (with last year's figures shown in brackets) 586 (583), consisting of:

Honorary Fellows	7 (8)	Senior Fellows	26 (23)
Corresponding Fellows	12 (12)	Family Fellows	34 (36)
Life Fellows	18 (18)	Glasgow Associates	12 (11)
Ordinary Fellows	467 (464)	Junior Associates	10 (11)

With great regret, we record the deaths of **Margaret C Laing** and **David C Greig**. Margaret Laing was Honorary Treasurer of the Society from 1976 to 1982 and Vice-President from 1983 to 1985. David Greig was Honorary Secretary of the Society from 1965 to 1970 and President from 1973 to 1975. He had a distinguished career in the Geological Survey, and was elected a Fellow of the Royal Society of Edinburgh.

Council, elected on 18th November 1998, was as follows:

President	William J Baird
Vice-presidents	Andrew A McMillan Peter M Dryburgh
Secretary	J Michael Dean
Treasurer	David Gould
Membership secretary	Mary M Leitch
Excursions secretary	A David McAdam
Lectures secretary	Donald I J Mallick
Assistant secretary	D Ian Jackson
Assistant secretary (billet)	A Caroline Paterson
Proceedings and Edinburgh Geologist editor	J Alan Fyfe
Librarian	W Barrie Heptonstall
Sales secretary	David H Land
Scientific editors	Philip Stone, Peter G Hill
Ordinary members of Council	William J Coppock, R Angus Harkness, Averil H Hope Smith, Tom S Kerr, Tom McMillan, Suzanne Miller
Trustees (not on Council)	W D Ian Rolfe, William G W Harper, S Ian Hogarth
Independant Examiner	Mrs. M McLeod, C.A.

Proceedings

Lecture meetings were held as follows:

7th October 1998	**Prof. D R Oldroyd** The Character and Work of Archibald Geikie (James Wright Memorial Lecture)
21st October	**Dr. M G Petterson** Colliding ocean plateaus and arc volcanoes of the Solomon Islands
4th November	**Prof. L Wilson** The development of the giant volcanoes on Mars
18th November	**Prof. S S D Foster** Groundwater - hidden asset, threatened resource (followed by A.G.M.).
2nd December	**Prof. D J Breeze** The Stone of Destiny (held in Edinburgh Castle)
13th January 1999	**Dr. S Miller** The Making of Beginnings (held in the Royal Scottish Museum)
27th January	Fellows' night.
10th February	**Dr. J D Hansom** Coasts in crisis
24th February	**Dr. P R Sheldon** Plus ca change: explaining an evolutionary paradox
10th March	**Prof. J B Dawson** Diamond is everybody's best friend (Prof. Dawson was presented with the Clough Medal at this meeting)
24th March	**Prof. I W D Dalziel** The Scottish promontory of Laurentia in the pre-Pangean Earth: some thoughts from the Alamo

Proceedings

Field meetings were held as follows:

1st May 1999	**M A E Browne** Charleston
8th - 15th May	**F May, J D Peacock, D Stephenson** Appin
22nd May	**A Owen, E N K Clarkson, C M Taylor** Wandel Water
26th May	**E N K Clarkson** Wardie shore
5th June	**R Garton** Funnels and fossil forests of Fife
9th June	**N E Butcher** Craiglockhart Hill
18th - 20th June	**S M Ross** Elgin
23rd June	**A A McMillan** Lothian Road
26th June	**C G Smith** Tyndrum
7th July	**D H Land** Middleton Quarry
17th July	**J A Fyfe** Pease Bay to Cove
28th August	**A A McMillan** Braveheart Land
25th September	**B Jackson & W M Baird** Whiteadder minerals

Proceedings

Scottish Journal of Geology: Volume 34 part 2 and Volume 35 part 1 were published during this session.

Clough Medal: The Clough Medal was awarded to Prof. J B Dawson for his work on volcanism.

Publications: a second edition of *Building Stones of Edinburgh* by A A McMillan, R J Gillanders and J A Fairhurst, and a pamphlet on *The Hermitage of Braid and Blackford Hill* by D H Land were both published during the session.

Membership Roll and Laws: revised editions of both of these were distributed to members.

Publication sales: Numbers of Society publications sold during the session were as follows:

Ardnamurchan Guide	90
Assynt Guide	290
Assynt, a Geologist's Mecca	189
Borders Guide	23
Braid — Blackford pamphlet	94
Building Stones of Edinburgh (2nd edition)	319
Discovering Edinburgh's Volcano	956
Fife and Angus Guide	31
Lothians Guide	72
Moine Guide	24
Southwest Scotland Guide	7

Lothian and Borders RIGS: The form was completely redesigned to a more attractive and friendly format.

Scottish Geology Week: Eight members led walks or gave lectures.

Accounts: The summary of the accounts for the year ending 30th September 1999 follows.

EDINBURGH GEOLOGICAL SOCIETY

REVENUE ACCOUNTS FOR THE YEAR ENDED 30th SEPTEMBER 1999

	General	Public-ations	Clough	Mykura	Total	
					1999	1998
INCOME	£	£	£	£	£	£
Gross income from investments	1,890	1,104	711	188	3,893	3,138
Net gain on disposal of investments	61	35	23	6	125	119
Bank interest	280	164	105	28	577	721
Subscriptions	5,395	-	-	-	5,395	5,707
Tax recoverable on Deeds of Covenant	520	-	-	-	520	541
Legacies and donations	217	-	-	-	217	267
Grants for publications	-	2,398	-	-	2,398	-
Miscellaneous	-	-	-	-	-	41
Sale of publications	-	4,815	-	-	4,815	3,269
TOTAL INCOME	8,363	8,516	839	222	17,940	13,803
EXPENDITURE						
Administrative Costs						
Printing, stationery, postage	77	199	-	-	276	191
Insurance	229	-	-	-	229	270
Bank charges	595	-	-	-	595	584
Reception	4	-	-	-	4	56
Miscellaneous	30	-	-	-	30	73
Print Laws, Role, publicity sheet	988	268	-	-	1,256	-
Independant examiner's fee	550	-	-	-	550	550
Depreciation	303	-	-	-	303	303
	2,776	467	-	-	3,243	2,027
Direct Charitable Activities						
Lecture costs	1,693	-	-	-	1,693	1,445
Celebrity lecture	207	-	-	-	207	-
Billets	2,572	-	-	-	2,572	1,640
Award and medal expenses	-	-	206	-	206	518
Excursions	1,057	-	-	-	1,057	991
Scottish Journal of Geology	-	2,000	-	-	2,000	2,000
Edinburgh Geologist	-	1,374	-	-	1,374	513
Special publications	-	586	-	-	586	-
Books for library	198	-	-	-	-	198
Grants made	-	-	-	-	-	850
	5,529	3,960	206	-	9,695	8,155
Cost of Publications Sold	-	3,878	-	-	3,878	876
TOTAL EXPENDITURE	8,305	8,305	206	-	16,816	11,058
SURPLUS (DEFICIT) for year	58	211	633	222	1,124	2,745

EDINBURGH GEOLOGICAL SOCIETY

BALANCE SHEET AT 30th SEPTEMBER 1999

	1999		1998	
	£	£	£	£
FIXED ASSETS				
Investments at market value		79,324		72,585
Tangible		120		423
		79,444		73,008
CURRENT ASSETS				
Stock of publications	27,762		20,853	
Other stocks	830		109	
Debtors and prepayments	17		160	
Taxation recoverable	342		237	
Bank accounts	10,548		16,626	
	39,499		37,985	
Less:				
CREDITORS REPAYABLE WITHIN ONE YEAR				
Sundry	817		993	
Scottish Journal of Geology Vol. 33	2,000		1,500	
	2,817		2,993	
NET CURRENT ASSETS		36,682		34,992
NET ASSETS		116,126		108,000
REPRESENTING				
FUNDS				
Permanent endowment		60,237		55,565
Unrestricted		55,889		52,435
		116,126		108,000

Prepared by David Gould, Treasurer, approved by M McLeod, Independant Examiner, and adopted by Council on 17th November 1999.

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