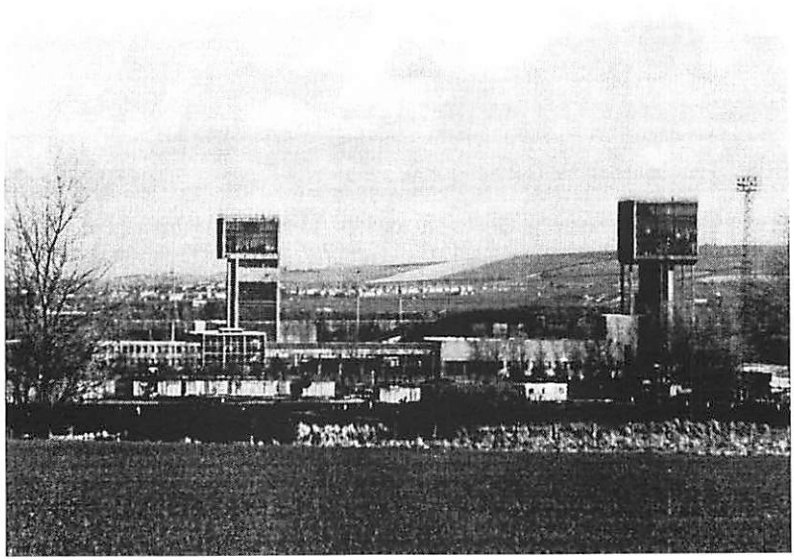
The Edinburgh Geologist



Issue No. 30 Autumn/Winter 1997

THE EDINBURGH GEOLOGIST

Issue No.30 for 1997

Cover Illustration

Pit-head gear and colliery buildings of the former Monktonhall Colliery, Newcraighall, Midlothian (now demolished). Photograph, Alice Walker, BGS, Edinburgh.

Acknowledgments

Publication of *The Edinburgh Geologist* is supported by grants from The Peach and Horne Memorial Fund and the Sime Bequest.

Published November 1997 by
The Edinburgh Geological Society

Contributions and letters to:
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c/o British Geological Survey
Murchison House
Edinburgh
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ISSN 0265-7244
Price £1.50 net

Editorial

Welcome to the thirtieth issue of the Edinburgh Geologist. In our lead article, Norman Butcher examines the lives of two men who are regarded as the founders of our modern geological thinking, Charles Lyell and James Hutton, and their links with the Society. The lives and works of these great men have been given some prominence during 1997, with the bicentennial celebrations of Lyell's birth and Hutton's death. Lyell was a great populiser of geology during Victorian times and his work brought forward the development of the science as we know it today in Great Britain. He acquired the reputation of being an 'English' geologist, although he was in fact a Scot by birth. In contrast, Hutton's prominence in geological thinking waned rapidly following his death. This plunge into obscurity seems remarkable today given Hutton's role as the architect of granite plutonism.

I am indebted to David Land in passing on a most interesting article by Ellis Yochelson, recounting the visit to Scotland of Charles Walcott. Walcott was one of the worlds leading experts in Cambrian fauna at the beginning of this century, going on to become Director of the USGS. He will be best remembered for his discovery of the Burgess Shale. However, his friendship with Andrew Carnegie was probably instrumental in the founding of the Smithsonian Institute in Washington, DC.

Coming nearer to home, John Lovell and David Galloway of BGS present the results of the investigation into the unusual seismic activity that befell the Musselburgh area in late 1996. This, it was established, was linked to deep mining activity from the Monktonhall pit at Newcraighall. Since then we have been witnesses to the gallant fight to keep the pit operational, but which was finally conceded this year. Our cover photograph portrays the colliery workings as they were at the time of the earthquake activity, but which are no longer a feature of the part of the Midlothian sky-line. On a more light-hearted note, Phil Stone weaves a tale of the cannibalism along the Ayrshire coast during the early 1600's into a 'potted' description of the geology of the area around Ballantrae. Scott Johnstone's article continues are them from Issue 29, on the role of conservation in Scotland. Here through the meritous activities of the National Trust for Scotland.

We round of this issue a peek into the personal 'diaries' of David McAdam and Mike Browne, and their involvement in the inaugural events of Scottish Geology Week. David McAdam also provides some interesting snippets into the background organisation.

JAMES HUTTON, CHARLES LYELL AND THE EDINBURGH GEOLOGICAL SOCIETY

Norman E Butcher

The Bicentenary in 1997 of the death of James Hutton (1726-1797) and the birth of Charles Lyell (1797-1875) gave a unique opportunity for the earth science community generally and the Edinburgh Geological Society articularly to mark this important event in the history and development of geology. The links between Hutton, the founder of modern geology, Lyell, the great Victorian populariser if the science, and the Society are worth a brief explanation.

As is well known, the Society was founded in 1834 and is in fact the fourth oldest geological society in the British isles. Its origins can be precisely dated to a meeting on Thursday 4 December in that year in Robertson's Tavern in Milne's Close off the: Lawnmarket of eleven members of a class in mineralogy. These even Edinburgh citizens whose names are all recorded, resolved to start a society for ' discussion an d Mutual Instruction, to meet in the Mr Rose's house, 2 Drummond Street, every Monday evening at half past eight'. Alexander Rose (1781-1860), a wood turner and mineral dealer, conducted classes in mineralogy in Edinburgh under the auspices of Queen's College, a teaching association existing in the city at that time. Later, as the Society developed, it came to occupy rooms first at 5 St Andrew Square and then in the Synod Hall in Castle Terrace (Butcher, 1991) before the present arrangements came into being in the 1960's.

Born at Kinnordy outside Kirriemuir in what was then Forfarshire on 14 November 1797, Charles Lyell moved with his parents to Bartley Lodge in Hampshire near Southampton where he was brought up and this explains why he is often referred to as an English geologist. having entered Exeter College in Oxford in 1816, he made the first of several visits to Edinburgh the following year. He was a elected a fellow of the Geological Society of London in 1819 and it was with that Society that his geological activities were conducted. Lyell certainly visited Edinburgh in the 1830's, after the publication between 1830 and 1838 of the three volumes of his ***Principles of Geology*** in London, though there is no evidence that he had any involvement with the Edinburgh Geological Society in its early years. It is, however, worth recording that Sir Charles Lyell of Kinnordy, then resident in London at 73 Harley Street, was elected Patron of the Society in 1871, a position held until his death in 1875. He died on 22 February and is buried in the nave of Westminster Abbey in London. At the end of the Lyell Meeting in London as part of the bicentennial Conference in 1997, organised jointly by the Geological Society and Royal Society of Edinburgh, delegates visited Lyell's home in Harley Street on Saturday 2 August. The visit was

led by Professor Gerald Friedman from the USA and was followed by a wreath laying ceremony at Westminster Abbey in which both Lady Lyell and her son Lord Lyell, participated.

In contrast to the prominence enjoyed by Charles Lyell, in both his life and death, James Hutton fell into some obscurity on his death in Edinburgh in 1797. Of course, John Playfair (1748-1819) promoted Hutton's life and work after Hutton's death, but in a sense he did Hutton a disservice in that later authors, including Lyell, relied on Playfair's account of Hutton and did not read the original texts for themselves. Dennis Dean (1992, p. 229) has made the interesting observation that 'the Edinburgh Geological Society .... was so obviously Huttonian that it effectively superseded the almost moribund Wernerian Society.' However, the Wernerian Natural History Society, founded in Edinburgh by Robert Jameson (1774-1854) in 1808, catered for a different membership to that of the Edinburgh Geological Society in its early years.

Recognition of Hutton as the founder of modern geology was only really advanced by Archibald Geikie (1835-1924) in 1871 of his Scottish School of Geology of which he acknowledged Hutton to be the founder. Interestingly, under Geikie's presidency, the Edinburgh Geological Society established a link with Hutton by electing his descendant, John Hutton Balfour (1808-1884), Regius Keeper, Queen's Botanist and Professor of Botany in the University of Edinburgh, as an Honorary Fellow in 1863.

Despite Geikie's efforts, the obscurity conferred on Hutton in Edinburgh was only finally reviewed by a lecture given by Professor Sergei Tomkieff of Newcastle-upon-Tyne to the Edinburgh Geological Society on 19 March 1947. Entitled 'James Hutton and the Philosophy of Geology', the text was published in the Society's *Transactions* in 1948 and later reprinted, with other papers on Hutton by Murray MacGregor, Sir Edward Bailey, G W Tyrrell and V A Eyles in the *Proceedings of the Royal Society of Edinburgh*, a Commemoration of the 150th Anniversary of Hutton's death, published in 1950. On 3 November 1947, the Lord Provost Sir John Falconer unveiled a memorial tablet to Hutton in the Greyfriars Churchyard (Plate 1), *The Scotsman*'s photograph published the next day showing the Mister of Greyfriars, Rev D W P Strang, and Mr A H Balfour, a family descendant, in attendance. This tablet recording Hutton as the Founder of Modern Geology was placed on the east wall of that part of the churchyard known as the Covenanters Prison, in the lair of the Balfour family to whom Hutton was related through his mother, Sarah Balfour.

Plate 1. The memorial tablet to James Hutton, Greyfriars Kirk, Edinburgh

The Lecture by Professor Tomkieff in 1947 had a profound effect on a young Edinburgh graduate who attended, Donald B McIntyre, and who was then on the Society's Council. Fifty years later, on the exact bicentenary of Hutton's death, 26 March 1997, Professor McIntyre delivered the following eulogy of Hutton at an informal wreath-laying ceremony in the Greyfriars Churchyard during a walk from the National Museums of Scotland in Chambers Street organised by Christine Thompson as part of the Edinburgh International Science Festival programme:

> "In 1797 people still believed that the Earth was only 6000 years old, but James Hutton showed the age was far more than that. Measurements possible today prove the age of the Earth is a million times greater.
>
> Hutton asked: *'How shall we acquire the knowledge of a system calculated for millions, not of years only, nor the ages of Man, but of the races of men, and the successions of empires?'* And he answered: *'We must read the transactions of time past in the present state of natural bodies'*. We acknowledge the silent testimony of the rocks, knowing as Hutton taught, that the Present is the Key to the Past.
>
> Hume, Scott, and Hutton were the three great thinkers of the Enlightenment born and bred in this city. Yet Hutton, beloved by all who knew him, lay here for 150 years in an unmarked grave. Fifty years ago Arthur Holmes, the most distinguished geologist of his time, said: *'To the*

geologists a rock is a page in the Earth's autobiography with a story to unfold'. Hutton showed how to read it; doing so he disclosed the marvel of deep time: '*We perceive*', he said '*a fabric, erected in wisdom*'.

Playfair wrote of his friend: '*With his exquisite relish for whatever is beautiful and sublime in science, we may easily conceive what pleasure he derived form his own geological speculations. The novelty and grandeur of the objects offered to them to the imagination, the simple and uniform order given to the whole natural history of the Earth, and, above all, the views opened of the wisdom that governs nature, are things to which hardly any man could be insensible; but to him they were the matter, not of transient delight, but of solid and permanent happiness.*'

Today we have come to know that living creatures evolve, that continental drift, the stars, and galaxies born, mature, grow old and die. We salute the memory of James Hutton, who opened our minds to these wondrous possibilities."

After the laying of the wreath by Donald McIntyre and the writer, the Minister of Greyfriars, Rev David M Beckett, offered thanks for Hutton's life and the party proceeded to St John's Hill via Drummond Street where the writer outlined plans to marl the site of Hutton's house and garden in Edinburgh (Butcher, 1997).

Later in 1997, during the International Bicentennial Hutton Meeting organised by The Royal Society of Edinburgh at the Royal College of Physicians in Edinburgh, a patinated bronze plaque to James Hutton made by Charles Laing & Sons Limited was unveiled on 6 August at St John's Hill by Professor Stewart Sutherland, Principal of the University of Edinburgh, and Councillor Brian Weddell, Chairman Housing Committee, City of Edinburgh Council. The brief ceremony was hosted by the Society's President, David Land, and Fraser Morrison CBE, Executive Chairman of the Morrison Construction Group plc and Professor Malcolm Jeeves CBE, President of the Royal Society of Edinburgh also participated. The 200 or so onlookers included the two sons of Mr A H Balfour present at the 1947 unveiling of the Hutton tablet in Greyfriars Churchyard, Mr Iain R Balfour and Mr Ralph A Balfour, together with Mrs Persis Aglen, another Hutton family descendant.

The plaque mounted on a single block of Clashach stone on which was carved the famous quotation from Hutton's 1788 paper: '..... *we find no vestige of a beginning, - no prospect of an end.*' Surrounding this were placed boulders showing granite veins from the exact locality discovered by James Hutton in September 1785 in Glen Tilt, together with other boulders of conglomerate from Barbush on the edge of Dunblane.

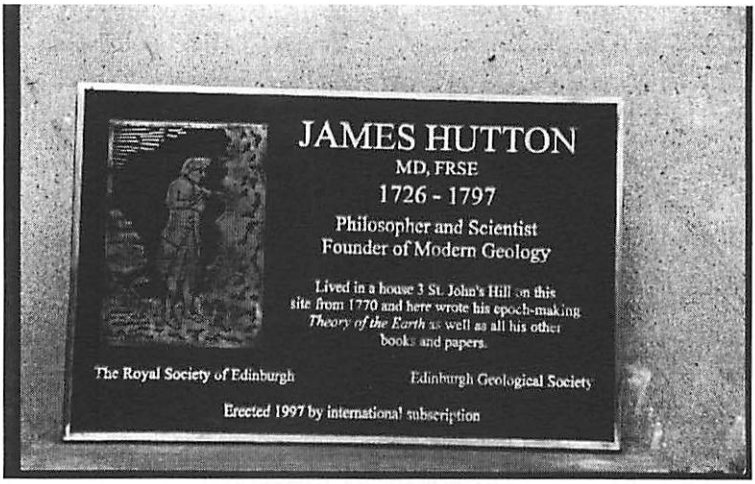

Plate 2 Memorial plaque commemorating the bicentenary of the death of James Hutton, unveiled at the site of his former home in St John's Hill, Edinburgh.

The cost of the plaque was met from a fund launched through the Edinburgh Geological Society to which individuals contributed. many organisations contributed to the whole project, especially the Morrison Construction Group who are developing the adjacent area of St John's Hill. The actual site of Hutton's house and garden has been acquired from the City Council by the University of Edinburgh who will undertake its long-term maintenance. After the ceremony, the stone bearing the plaque and the other boulders were removed for safe keeping to the BGS store at Loanhead pending the construction of a James Hutton Memorial Garden on the site. A replica of the plaque was commissioned by BGS who will undertake its safe storage. A leaflet to accompany the unveiling ceremony was produced through a generous grant from the Curry Fund of the Geologist's Association. Accounts of the ceremony were published in the *Scots Magazine* for October 1997 and in several newsletters of other societies in addition to the *Scotsman* and *Daily Mail* reports on the day following the ceremony.

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WALCOTT IN SCOTLAND

Ellis L Yochelson
National Museum of Natural History, Washington, USA

Charles D Walcott (1850-1927) was one of the worlds leading geologists in the late 19th and early 20th centuries, being Director of the US Geological Survey fro 1894 to 1907, and then Secretary of the Smithsonian Institution. Walcott is probably best remembered for his discovery near Mount Field, British Columbia, in 1909, of the Middle Cambrian Burgess Shale with its unique fauna. His studies of the thousands of beautifully preserved Burgess fossils, as well as Cambrian fossils worldwide, were pursued assiduously, despite heavy administrative duties, and represent his main contribution to geological literature.

In furthering his studies, he visited Scotland in 1909 to examine the Cambrian in Wester Ross. Through his diary, we can follow his journeying day by day.

CAREER

Firstly though, a brief summer of Walcott's career will set the scene and context for his work in Scotland.

Born at New York Mills, some 300km NW of New York City, he became interested in fossils as a boy. Although he never attended college and had no formal geological training, he was appointed, at the age of 26, as assistant to James Hall, the New York State geologist. Three years later, he joined the US Geological Survey. In 1893 he was appointed to the post of Chief Palaeontologist and became its Director of the Survey in 1894. This latter position he held until when he was chosen to be Secretary of the Smithsonian Institution (Anon, 1919). Walcott first met Andrew Carnegie in 1901. Carnegie had just retired, and with his immense wealth had the idea (among his many other munificent benefactions) of funding a national school of research which would not be under government control. In short, Walcott persuaded Carnegie to found the Carnegie Institution in Washington DC with, in particular, its Geophysical Laboratory which was to become a world centre for research in that field (Yochelson and Yoder, 1994).

For the the last 20 years of his life, Walcott held the post of Secretary of the Smithsonian Institution. This was founded in 1846, from a bequest by the English mineralogist James Smithson (1765-1829), to be an establishment "for the increase and diffusion of knowledge among men". Its full-time research scientists are, and have been, active and eminent in many fields. Before Walcott died these included art, anthropology, astronomy, geology, history, meteorology, natural history and technology, together with the running of a major museum. All this he supervised

as secretary and still found time to research his beloved Cambrian fossils, especially the brachiopods and trilobites.

THE SCOTTISH VISIT

In 1909, Walcott decided to visit Scotland. Thus on the 4 June he cleared his desk and left Washington for New York, accompanied by his wife Helena. The the next morning they boarded the White Star liner SS *Celtic*, and at 11am were on their way.

At 7 pm on Sunday 13 June they landed in Liverpool, and Walcott noted 'Our trip across form New York has been a very pleasant one'. Apart from two hours going over a manuscript on the early Cambrian trilobite *Olenellus*, Walcott seemed to have relaxed for on of the few times in his life.

DIARY

June 14 'Left Liverpool 9.30 am. Stopped at Melrose and visited Melrose Abbey, drove to Abbotsford, the home of Sir Walter Scott. At 6.10pm took train and arrived at 8pm in Edinburgh. Put up at the North British Ry hotel. A bright, enjoyable day.'

June 15 ' Helena shopping. I called on James Geikie, Univ Edinburgh, Dr Horne, Director Scottish Geol. Survey and Dr Peach. Looked around a little and at 4.25pm we left for the north accompanied by Dr Peach and Mr H Brantwood Muff (Maufe), geologist. We stopped for the night at Blair Atholl. Passed through Pert.'

June 16 'Left Blair Atholl 7.10am. A half hour at Inverness and via Dingwall went to Achnasheen by railway, then stage 10 miles to Kinlochewe where we put up. After lunch drove out and up Glen Logan to look at Cambria rocks - above the head of Loch Maree. Light enough to read out of doors up to 10pm.

June 17 'We drove down along Loch Maree am and at noon climbed 1500 feet up the side of Meall a' Ghuibhais to the Olenellus bed of the Lower Cambrian. Collected a few fossils and at 6.30pm returned to the hotel wet and tired. Cloudy - mist and fine rain at intervals.'

[The climb was to the dolomitic shale of the Fucoid Beds, and is the type locality for several species of the trilobite *Olenellus* described by Peach. Western Scotland was along way to go for a brief look at fossils, but even a short time on the outcrop helped to put the Cambrian of Scotland into perspective]

June 18 'We left Kinlochewe 10am and drove to Achnasheen. Took train to Dingwall and thence to Bonar Bridge. Met by motorcar and at 5.50pm arrived at

Skibo Castle where we met by Mr and Mrs Andrew Carnegie and Miss Whitfield. After dinner looked about a little and visited.'

June 19 'With Mr and Mrs Carnegie looking about the Skibo Castle grounds during the morning. After luncheon all the party went to Dornoch to service in the cathedral on account of the new organ given by Carnegie. At 6pm left Skibo with Helena and Dr peach. Took train to Bonar Bridge. Put up at the Royal Hotel Inverness at 10pm.

[June 19 was a Saturday, not Sunday, but no doubt the organ called for a special service. Like Carnegie, Walcott was a Presbyterian]

June 20 'We left Inverness at 10.10am. Passed Nairn, Kingussie, Blair Atholl, Perth and to Edinburgh. Put up at the North British Hotel at 5.45pm. Dr Peach went to his home.'

June 21 'Dr Peach called for me at 10am. We visited the Geol. Survey rooms [then at 33 George Square] and Edinburgh Royal Scottish Museum. Met Prof. James Geikie and Dr Horne. Looked over a lot of Lower Cambrian fossils etc.. Dined with Dr peach. Met his boys Benj. and Angus. At 11pm left on sleeping car for Cambridge.'

The Walcotts went on to Cambridge where they stayed with Professor and Mrs John Marr. At the convocation commemorating the 50th anniversary of the publication of Darwin's *Origin of Species*, Walcott received the honorary degree of ScD. The scarlet gown became his favourite academic robe.

On the afternoon of the 24th they went to London and attended a reception at the Royal Society. While Helena went shopping the next day, in the afternoon Wlacott 'visited the South Kensington Museum. Met Drs Woodward and Bather. We dined with Prof. E J Garwood and Mrs Nuniyre [?] and went to the Grand Opera with them.'

On June 26 the Walcotts left London in the afternoon 'boarded the SS *Minnewaska* at 5pm and soon after started the long trip for New York. We have had a strenuous but as a whole interesting and pleasant trip.' The weather on the return journey was unpleasant until the last day. On the morning of 5th July they disembarked in New York city, ending their second and final trip abroad. By July 11th they were on their way west from Washington for a field season of more than two months, which included the first discovery and collection of the Burgess Shale fossils.

SCIENTIFIC RESULTS

Short as the Scottish trip was, it still paid scientific dividends.
'Dr B N Peach most kindly guided me to the Loch Maree localities in northwestern Scotland and, by permission of the Director of the Geological Survey of Great Britain, Dr J Horne, in charge of the Scottish Survey, sent me material in the collections of the Geological Survey and the Royal Scottish Museum in Edinburgh.' (Walcott, 1910; p223).

In his monograph on the trilobite family Mesonacidae, Walcott (1910) added little new information on *Olenellus gigas* Peach, but questioned the assignment of this species to the genus. With *O. lapworthi* Peach, he placed a subspecies and a separate species, both described by Peach, in synonymy. The types were re-figured and plaster casts made for the collections of the United States National Museum. Walcott added little more to *O. reticulatus* Peach but did emphasise the validity of the species, and commented on the small size of the eye for the species.

Added to the literature was the genus *Peachella*, the 'generic name given in honour of B N Peach of the geological Survey of Scotland' (Wlacott, 1910; p342). Walcott also discussed *Olenelloides* Peach and its type species *O. armatus* Peach. 'Through the courtesy of the Director General of the Geological Survey the specimens studied by Dr Peach and a number collected since were sent to me by Director Horne of the Scottish Survey' (Walcott, 1910; p347). As with the other species, the types were re-illustrated and plaster casts made for the Washington collections. Finally, Walcott, who was a careful observer, found a tiny form which he illustrated as *Olenellus* sp. indet. Ever since his early work on trilobites, more than three decades earlier, Walcott had been interested in their ontogeny and did not neglect the opportunity to add a morsel of knowledge.

There may have been more indirect results from his trip. While at Cambridge with Marr, Walcott visited the Sedgwick Museum. They must have spoken of Walcott's Lower Cambrian studies. *Callavia cartlandi* Raw *in* Walcott (1910; p282) was based on 'MSS received from Mr Frank Raw, University of Birmingham, England, December 17, 1909'. Whether the word of Walcott's latest efforts drifted south from Edinburgh, or north from Cambridge, it must have reached Charles Lapworth at Birmingham. Lapworth and Walcott had met in 1888 at the International Geological Congress, and maintained their friendship. A few comments and re-illustration of *C. callavei* Lapworth are included and the plaster cast is credited to Raw.

Walcott's paper on this Lower Cambrian family was well advanced when he and Helena left Washington. In the autumn, after his field season in western Canada, he was able to incorporate the new material from Scotland, as well as some Canadian material. He stuck to his self-assigned chore of finishing this work, despite the

tantalising and dramatic new fossils he had discovered in the Burgess Shale. Walcott was a remarkably competent palaeontologist, yet he was also a fast worker, for the paper was distributed by 12 August, 1910.

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THE RECENT MUSSELBURGH EARTHQUAKES

John Lovell and David Galloway
British Geological Survey, Edinburgh EH9 3LA.

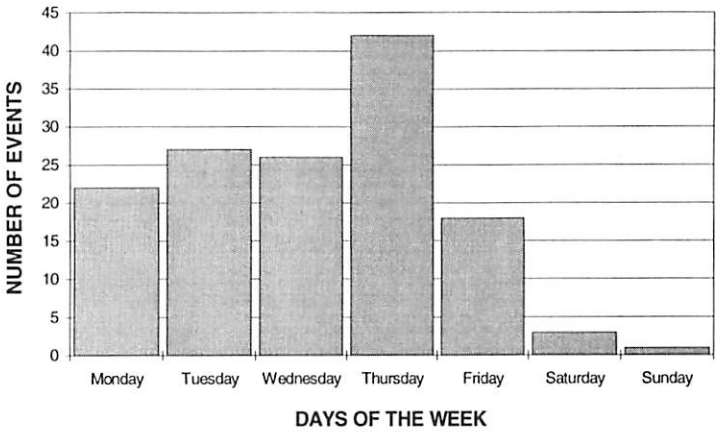
Between October 1996 and early March 1997, an outburst of seismic activity occurred around Musselburgh and Newcraighall, in the Midlothian coalfield just east of Edinburgh. Similar outbreaks in other UK coalfields have been observed in the past, for example in the Clackmannan, Staffordshire, and Yorkshire/Nottinghamshire coalfields, and also locally over the past 20 years in Newbattle Abbey, Roslin, Rosewell, Loanhead, and Polton. Many of these outbreaks have been studied by the British Geological Survey and other workers, either by using closely spaced networks of seismometers in the epicentral area or by conducting macroseismic surveys which gather residents' impressions of the surface effects of the earthquakes.

The Musselburgh event sequence started on 2 October 1996, and reached a peak in late October/early November when up to 12 events per day were being recorded. This was followed by a period of relative quiescence, but activity resumed on 7 January 1997, continued through February and showed a dramatic reduction in March, with only thirteen small events, none of which were felt, being detected in that month. No events have been detected since. A total of 139 events ranging in magnitude up to 2.0 ML occurred; 26 of these were felt at the surface and some underground.

These events caused considerable local alarm, with residents reporting 'bangs and rumbles', and 'houses and windows shaking'. There was also much media interest, and questions were directed to BGS by residents and local and central government. Reports to civil engineers and the National Trust were also prepared by BGS. In order to investigate the cause of the events and to allay public fears, BGS installed three additional seismic monitoring instruments in the epicentral area, and undertook macroseismic surveys on the effects of these earthquakes using questionnaires printed in local newspapers.

The results showed that the earthquakes were located at a depth of about 1km in the vicinity of active mining. Because of the shallow focus, the events were strongly felt over quite small areas but were below the damaging intensity, and only minor damage to plaster and door frames was reported. The reports of strong shaking emanated from south-west Musselburgh, Newcraighall, Portobello and Joppa, all within 2 to 3km of the epicentres.

MUSSELBURGH TREMORS



Deep mining throughout the period of seismic activity took place from the Monktonhall pit south of Newcraighall. Coal extraction was by longwall methods, i.e. 'complete', with progressive collapse allowed behind the 240m wide advancing face, at a depth of about 1000m. The seam mined was the 1.2m thick Peacocktail, one of the lowest in the Limestone Coal Group; mining was in a north-westerly direction from the flat-lying central part of the Midlothian Coalfield syncline towards and into its steeply-dipping western limb.

A histogram of the cumulative number of earthquakes per day plotted against days of the week (above) shows marked highs during the working week and lows during the weekends when mining did not take place. This strong correlation between event frequency and mining operations has been studied several times before in the Midlothian and other coalfields when local monitoring networks have been used to study similar outbursts of seismicity, for example around Roslin and in Staffordshire. A further correlation was noted between the opening of a new coal face on September 23 1996 and the onset of the earthquakes on October 2 1996; between the two-week Christmas and New Year holiday period during which there was a complete absence of seismicity; and between the fall-off of event frequency during March 1997 and the winding down of mining because of flooding during that month.

From the results quoted above and from previous BGS seismic monitoring work and experience in this and other coalfields, we conclude that these earthquakes were induced as a result of deep mining in the Monktonhall pit. They showed the

characteristic small felt areas but high intensities typical of shallow earthquakes, and strong correlation with mining operations. Although many of the larger events caused considerable alarm, only very minor damage, to plaster and door frames, occurred, and there was no danger to the public. As the mine will now never produce again it is unlikely that similar seismicity will recur.

GEOLOGY FOR CANNIBALS

Phil Stone

In 1604 a military force dispatched by King James 6th rooted out the cannibal tribe led by Sawney Bean from its lair on the Ayrshire coast. There are some claims that the King took personal command of the expedition but this seems unlikely since James had moved his Court to London in the previous year, when he became James 1st of England on the death of Queen Elizabeth. The cannibal's base was an inaccessible sea cave and a consensus view, plus the authority of the Ordnance Survey, places this in Balcreuchan Port, a small cove surrounded by steep cliffs about 5 km north of Ballantrae and about 15 km south-west of Girvan. In geological terms the cave lies in the heart of the Ballantrae Complex, an assemblage of early Ordovician basaltic lavas and ultramafic rock. The complex is regarded as an "ophiolite", a fragment of oceanic crust which was pushed up onto a continental margin (obducted) rather than being drawn back down and destroyed at the adjacent ocean trench (subducted). In this respect Sawney made an inspired choice of geological habitat, since it is the fate of almost all ocean crust to be consumed at a subduction zone. Only rare examples evade the voracity of the plate tectonic process and one such is the Ballantrae Complex. About 480 million years ago it escaped over the edge of the geovorous plate boundary at which the early Palaeozoic Iapetus Ocean was largely swallowed-up.

Sawney Bean's cave lies on the north side of Balcreuchan Port (Figure 1). It was eroded along a fault zone cutting through a thick sequence of basaltic pillow lavas. The distinctive pillow shapes show that the lava was erupted under water and the best age estimates suggest that this happened about 500 million years ago. The chemical composition of the lavas gives an insight to the type of oceanic environment in which they were erupted; possibilities would be a mid-ocean spreading ridge, a Hawaiian-type within-plate island or an island arc formed above an intra-oceanic subduction zone. The latter proves to be the source of the Balcreuchan Port lavas but even here Sawney's refined geological taste (as opposed to his eating habits) came to the fore since his chosen cave nestles amongst lavas of very unusual composition. They are highly enriched in nickel and chromium but, surprisingly, also have more silica than most basalt. Such compositions in recent lavas are only found in primitive oceanic island arcs, typically those in the western Pacific Ocean such as the Bonin Islands, from which the lithology is named as *boninite*. A pity really since it could otherwise have been named *beaninite* after Sawney.

So, from his subterranean haunt amongst the unusual island-arc pillow lavas Sawney could look out across Balcreuchan Port and perhaps ponder on the variety of rocks to be seen. In some ways the view presents a microcosm of the Ballantrae Complex with lavas and ultramafic rocks faulted together and cut by later intrusions. The geology is

summarised in Figure 1. At the foot of the cliff containing the cave entrance is another fault separating the lavas from highly altered ultramafic rock, now a mass of quartz and dolomite veins. The fault trends almost north-south and is part of a plexus marking the eastern margin of a large offshore Permian basin. This means that the demonstrable downthrow on the fault is to the west and so at some time the ultramafic rocks must have been at a higher structural level than the boninite lavas. Originally of course the ultramafic rocks formed part of the mantle whereas the lavas built up the upper crust and so a major reversal is evident. This situation hints at imbrication by thrusting during obduction and certainly the upper surface of the ultramafic rock does appear to be a sub-horizontal plane since all of the cliffs, right the way round the cove, consist of lavas; the ultramafic rock is only seen at beach level.

An interpretation based on low angle thrusting is supported by the outcrop relationship on the south-west side of Balcreuchan Port where, in contrast to the steep fault at the north-east side, the lavas overlie the ultramafic rock with a very gently dipping contact plane projecting around the foot of the cliffs beneath the raised beach. This plane is then abruptly cut off by the Permian fault at the foot of Sawney Bean's cliff. A pre-Permian lithological sandwich is thus established with two layers of island arc lava separated by a layer of ultramafic rock. The degree of alteration of the latter reduces across its present outcrop from the grey, quartz-dolomite mass beneath the cave entrance to dark green and fine-grained serpentinised dunite (originally almost 100% olivine) at the opposite, south-west end of the beach. It is common for serpentinised ultramafic bodies to show such alteration towards their margins; indeed it is an almost inevitable side-effect of serpentinisation which tends to create excess silica and magnesia. Serpentinisation is generally a fairly early process in ophiolites, occurring during obduction when sea water gets at the ultramafic rock via the developing thrust fault network. However, in Balcreuchan Port, the margin adjacent to the most intense alteration is formed by the Permian fault; perhaps coincidence, or did it have a previous, pre-Permian history of movement ?

Whilst snacking contentedly on a tasty morsel from the latest victim Sawney is unlikely to have mulled over these problems but he cannot have failed to notice one geological feature of Balcreuchan Port. Near the foot of his cliff a Tertiary dyke cuts through the altered ultramafic rock and heads north-north-east, across the Permian fault and the lava sequence forming the northern headland of the bay, towards its ultimate source in the Arran volcanic centre. It also draws the eye outwards to Ailsa Craig, the spectacular offshore island of Tertiary microgranite. Back on the foreshore, erosion has left the dyke standing proud as a wall of basalt almost a metre across and striped by zones of amygdales parallel to its margins. Children playing on the beach today love to run along the dyke as the tide comes in on both sides, and it's not difficult to imagine the ragged Bean urchins doing just the same thing.

As they scrambled southwards around the southern headland of the bay they might also have noticed another geological phenomenon. Across a gulley eroded into a second north -south Permian fault, the lava lithology changes abruptly. Large, reddened pillows contain stubby phenocrysts of feldspar up to 1 cm across and the lava flows are interbedded with much chert and clastic sedimentary rock. This volcanic assemblage is very different to that seen in Balcreuchan Port and also proves to have a very different chemical composition; it is indicative of eruption from a Hawaiian-type, ocean-island volcano rather than from an island arc. Bearing in mind the westward downthrow of the Permian faults, these ocean-island lavas may therefore represent a still higher slice in the structural sandwich deduced from Balcreuchan Port. A sandwich which provides a geological feast for the intellect far surpassing the more macabre version enjoyed by Sawney Bean. No surprise therefore, that the whole area is part of a geological Site of Special Scientific Interest.

Back in 1604, King James' force was not constrained by conservation issues and reportedly used gunpowder to blow up the entrance to the cave. Viewed across Balcreuchan Port the entrance area is clearly seen to have collapsed, so what is left today is only the inner recess of the original cave. The huge blocks of lava which must be negotiated to gain access would once have formed the roof of a much more commodious chamber. And therein lies the present danger of Balcreuchan Port. If you do decide to follow in the footsteps of Sawney Bean go very carefully and wear solid boots. The cliffs are steep, the water is deep, and you could just end up as a meal for the fishes.

Further reading:

STONE, P. and SMELLIE, J.L. 1988. *The Ballantrae area: a description of the solid geology of parts of 1:25 000 sheets NX08, 18 and 19.* Classical areas of British Geology. HMSO for British Geological Survey.

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SMELLIE, J.L., STONE, P. and EVANS, J.A. 1995. Petrogenesis of boninites in the Ordovician Ballantrae Complex ophiolite, S.W. Scotland. *Journal of Volcanology and Geothermal Research*, **69**, 323-342.

GEOLOGY IN TRUST

G Scott Johnstone

Although the National Trust for Scotland was confirmed by Act of Parliament in 1935 "For places of Historic Interest and Natural Beauty". It is recognised that this involves the conservation of the Natural Environment in all its aspects, and to this end the Trust has set up a 'Countryside and Nature Conservation Committee'.

Geology forms the basis of the scenic landscape of the country, there are a few localities within which the primary reason for the acquisition of the property by the NTS is for conservation in its own right. Nonetheless out of more than 200 NTS properties, I can count at least 23 within which Geological features are of importance to the Society's members. These include several which, if properly displayed and documented, would enhance the experience of the more general visitor. On this latter matter, the NTS are becoming better informed and are taking action.

Probably the only property within which Geology is the primary feature of interest is the Island of Staffa. Its obvious features of basalt columns and Fingal's Cave are of international renown. To the more adventurous visitor, MacCulloch's Tree on the Burg of Mull is an outstanding feature meriting NTS protection. To geologists, however, the remanié chalk and fine mineral crystals found in the nearby cliff foot are also an important feature, and thankfully only accessible to the more dedicated (and agile!!).

Probably the general public are well-satisfied with the sheer spectacle of Corrieshalloch Gorge. Its importance as the largest post-Glacial 'slot' gorge in the country (showing remarkable joint control) is to be demonstrated with the siting of an explanatory board. Of course Botanists are not without a claim to be represented there as well!

Society members will hardly need reminding of the geomorphological, glaciological and palaeontological interest of the Grey Mare's Tail and Dobb's Linn property, which is much used (one might argue over-used) by school parties. There, the NTS has expended a great deal of effort and money in the control of erosion and path maintenance, although the latter will always require a circumspect approach by visitors.

The geological basis of the major spectacle of Glen Coe is probably not appreciated by most of the thousands of people using the A82, but is fully treated for the more discerning in the Trust's handbook. It is hoped to demonstrate the geological make-up of the property in the proposed new Visitor Centre, the siting of which included consideration of this aspect.

In the NTS properties of Torridon and Kintail-West Affric-Glomach, the geology is of less general interest. Of course it forms the basis to the magnificent scenery and provides many sections in both Foreland and Moine rocks at the western margin of the Caledonian Mountain Belt. To the specialist, however, the late-glacial landslips on Beinn Alligin and Beinn Fhada for features of great interest, while the famous Falls of Glomach is not only a spectacle but a remarkable example of a 'hanging' gorge cut by diverted melt-waters. The Kintail property holds important exposures of the Sgurr Beag Slide; its remoteness should ensure its protection from the ravages of geological parties. Other properties whose significance to geologists need not be detailed here, include: Fair Isle, Glenfinnan, Iona, Killiecrankie, Linn of Tummel, St Abb's Head, St Kilda, the Hermitage at Dunkeld, Balmacarra, Brodick and Goat Fell, Dollar Glen and Canna.

On Ben Lomond the NTS has had to contend with serious problem of erosion. Damage has been caused by visitor pressure both by the public at large and hill-walkers in particular. The Trust is spending a great deal of effort and money to control and rectify this. The best-known feature of geological interest is of course the superb views from the upper slopes over the Highland Boundary. A more specialist attraction is, however, the demonstration of close parallel vertical jointing in the Eastern corrie walls. This type of joint pattern, widespread over the SW Highlands, is an important control of the geomorphology.

On the Ben Lawers property there is the problem of erosion for the NTS. For geologists there is, however, a special problem. The mountain forms major part of a National Nature reserve and is especially conserved for its unique botanical interest. It also forms the upper part of a very important geological section through the Loch Tay 'Inversion'. Here exposures lie in the same burn sections whose walls are much cherished for their content of rare plants, preserved by their inaccessibility to nibbling animals. This is also the case with certain of the cliff outcrops. Geological examination can certainly cause some concern to the Reserve's Rangers, and it is well to discuss and give notice of any visit. Indeed it is correct to notification and permission to be sought by any party leader intending to visit any of the Trust's properties. As a someone who has been an active member of the NTS Countryside and Nature Conservation Committee, I have become more aware that there are other sciences than Geology. The Rangers themselves are generally interested in the scientific aspects of their beat, and always helpful. Contact numbers are given in the Trust's 'Guide to Properties', published each year.

Finally, of course, Geologists will all wish to pay their respects to the NTS property at Cromarty - Hugh Miller's Cottage. Do not, however, doff your hard hats..... The lintels are low!!!

SCOTTISH GEOLOGY WEEK 1997 - ONE PERSPECTIVE

David McAdam

There have been successful Irish Geological Weeks, Welsh Geology Weeks, even a Yorkshire Geology Week - why not a Scottish Geology Week? The bicentenary of James Hutton and the celebratory conference in Edinburgh, 5 - 9 August 1997 provided the trigger for Scottish Natural Heritage to arrange the first Scottish Geology Week.

Last winter SNH invited Scottish geologists and organisations to arrange geological events, large or small, local or national, during a Scottish Geology Week to follow the Hutton Conference from 11 to 18 August. Response was slow though the British Geological Survey was early in the frame with proposed Open Days on Sunday 10th and Monday 11th. Surely as EGS Excursion Secretary and having a wealth of experience in Edinburgh and the Lothians I should do my part: Volcanic rocks on the North Berwick shore - tide would need to be right, Blackford Hill walks linked to BGS Open Days could take in the magnificent views and Agassiz Rock, Corstorphine Hill the glaciated sill on my own doorstep, a fossil foray at the best fossil locality in the Lothians - need to persuade Euan Clarkson to come and identify the fossils. That will do for a start - sent off eight event forms. My caring wife thinks I may have overstretched myself, but the walks are not particularly strenuous - the main commitment is time, and they are well spaced out.

Advertising is the key to successful events. SNH promised an events brochure in mid-June. Arrange for EGS to do a mailing to members. SGW presents a unique opportunity to attract new members to the Society. Caroline Paterson designs and has printed in double quick time a thousand new membership leaflet / application forms. The promised SNH brochure does not appear till mid -July, less than a month to go, but it is worth waiting for: eye-catching turquoise & orange, well-laid-out, small turquoise type a bit difficult for the hard-of-seeing. Check my details are correct - relief - they are.

Phone call from the *East Lothian Courier*; they have a space, albeit a week early. What is the purpose of the North Berwick walks? Does one need to know any geology? No. Good! Design a small poster come leaflet - a colleague agrees to hand them in to North Berwick Museum and Tourist Office. Prepare a handout based on my SNH landscape booklet on *East Lothian and the Borders.*

Saturday 9th. Up early and drive to North Berwick, find a space in the car park with half an hour to prepare handout material before the 1030 start. How am I to gather people, there is a spare poster which could be pinned to the tube it came in. These look like likely participants - surely not this early; they were - the *Courier* advertised the wrong time - at least it advertised. They seem happy with the handouts, and they

provide a nucleus. A good crowd is forming. Important to be punctual, so I move to the preselected vantage point to address the party while Valerie, my wife, distributes handouts and directs latecomers - an extra helper is clearly valuable. Nice to see Rob Threadgould of SNH, the overall organiser supporting the first SGW event in his home town - he counts 48, a third children and a few dogs. Nice, too, to see EGS amateur members taking up the invite of the Society mailshot.

It's a lovely day for a walk by the sea, the tide out, and the three lava flows round the harbour are great text book examples. Remember to keep to basics - these are not geologists. Down on to the beach to see the red volcanic ash. Half way along the beach is the prominent Yellow Craig dyke; the children climb the rocks, while the dogs nose among the seaweed, leaving the adults to look convinced about intrusive contacts. Finally a quick stride to the Partan Craig Vent with its spectacular agglomerate blocks. One and a half hours have turned into two; pleasingly the group has stuck it to the end and parts after mutual thanks.

Walk back to the car for a quick lunch, dangling our feet over the sea wall. Hear bagpipes tuning up in the distance - learn we have competition from the North Berwick Highland Games; and there is a raft race at 5.00. Approaching 2.00 and a good crowd of adults, children and dogs gathering, only half the morning's number. Nice to see John Arum of Rockwatch with his handouts for children; pity he missed the ones in the morning. Valerie again proves her worth at the hectic start, before going off for her reward - exploring a new retail park at Fenton Barns with her Mastercard. Less tension and adrenalin the second time round, but still an interested party. Time to return home and prepare for the Open Days, reflecting that over seventy people thought it worthwhile to come on a shore walk and learn about volcanoes at North Berwick.

Sunday 10th. Make Murchison House just before the opening at 11.00. Plenty of staff, but where are the crowds? What is this in my in-tray? - a Scottish Geology Week T-shirt, extra large, it fits! A select production of 120 - it may become a collector's item. That's what one is to use as a gathering point at the start - good thinking!

Spend time making leaflets for the walk up Blackford Hill at 2.00; gather all the notices and adverts for SGW into an exhibit. Maybe the walk will cause a conflict of interest with visitors to the Open Day - 3.30 might have been a better time. One or two people enquire; yes, the start is at the car park opposite the Observatory. More concerned about the gathering mist - after all the main attraction of the hill is its panoramic views of Edinburgh, and the Midland Valley from the Southern Uplands to the Highlands.

At the car park in plenty of time, lots of handouts, not all needed as the party totals nine. Arthur's Seat and The Castle volcanoes are clear, can just make out the East Lothian volcanoes, but not going to see any more from the summit. Sit down by Corbie Craig,

a mini crag-and-tail to tell the glacial story, and examine the fine-grained andesite lava. Then pay pilgrimage to Agassiz Rock and read the plaque unveiled by Magnus Magnusson, chief of SNH - 'This is the work of ice'. Return, on the way contrasting walls of andesite with those of Old Red Sandstone, finishing by a feature made out of dolerite erratics carried by ice from sills to the west. Back to the office - the Open Day had not been swamped by visitors either.

Monday 11th. The Office seems more like a working day than an Open Day. Blackford Hill is disappearing into the mist and fog. A lady asks `Can she bring a 10-year-old boy and a dog? Yes. In the event they are joined only by a young student and a keen amateur from Boston. The American, over for a family wedding in Peebles, had been given a SGW brochure at the local Tourist Office: he couldn't have picked a better week to visit Scotland - pity about the views!

Hear that some had thought the walk would be off because of the weather. Mike Browne had even worse weather for his evening trip to East Lomond Hill. The six participants readily agreed to an alternative walk up a glen where rocks were visible and the trees afforded shelter from the rain. Think about the need to state in the brochure that events WILL TAKE PLACE REGARDLESS, though may be varied due to adverse conditions. Not too good either for David Land doing Arthur's Seat and Norman Butcher in Torphin Quarry.

Tuesday 12th. ***The Scotsman*** carries a half back page feature on the official SGW launch at Loch Lomond - a bit of good publicity should boost numbers. No! ***The Scotsman*** latches on to a new-fossil-find and sex story, and then dutifully reports that geologists will be busy doing their own thing at 110 events throughout Scotland. Nowhere does it indicate to the reader that the 110 geological events are **Fascinating**, - **Fun**, - **Free**, - **For YOU**; - look out for an event happening **near you**. Ah, well! Better carry on as before - take leaflets advertising the next Blackford Hill walk to the local library and the Hermitage Visitor Centre.

Wednesday 13th. Took in two afternoon lectures by Ingval Maxwell and Andrew McMillan on Building Stones; the 30+ audience nicely filled the small lecture theatre. The rain had returned by the time we emerged to the light, not auguring well for the follow-up walk round the New Town; by coincidence, Valerie and I were inside the St Andrew and St George Church at the Festival Fringe *Strictly Scottish* while Ingval was demonstrating the effects of rainwater on the outside stonework to the handful of excursionists. Comments were made through the week about the wisdom of holding SGW during the Festival.

Norman Butcher must have had a wet walk round Dreghorn, too.

Thursday 14th. At least the rain cleared the mist with the prospect of good panoramas from Blackford Hill. The extra bit of advertising, too, could help the turn-out. In the event it was again only a handful; Valerie's assistance was not needed. She took our dog for a walk and returned with the car to give the less able a lift back up the hill.

Friday 15th. A welcome day off - just time to produce enough handouts for the weekend events. Resurrect leaflets for an earlier Corstorphine Hill excursion - 60 should be enough.

Saturday 16th. Doing my bit for my local community; extra advertising in the Corstorphine Trust and the Library should help. Up in the car park half an hour early, Valerie's arrival is needed as 27 turn up. First, superb glaciated pavements on the dip-slope of Corstorphine Hill. Best locality has archaeological cup markings on glaciated surface. Stroke of luck, the gentleman who first notified these was in the party and gives a brief account. Difficult to find viewpoints on Corstorphine Hill because of the tree cover; best view to the west is disappearing into the mist. The marine sedimentary rocks below the sill show the dip; produce the fossil mussels - collected earlier. Climb back to Corstorphine Hill Tower - the other Scott Monument - for closing words. A good two hours; participants can do the east part of the hill we did not have time for by following the handout on their own some time. Back home for lunch and a rest before the afternoon walk.

Give Colin MacFadyen of SNH a lift up the hill. Mike Paul of EGS promised a party of ten, one aged 83, and there are half a dozen more. Seems to prove that mornings produce greater turn-outs. Heard later that Rosalind Garton was delighted at the enthusiastic group of 36 who turned out for her evening walk round the building stones of St Andrews.

Sunday 17th. Dunbar for a `fossil foray'. Local advertising and the ***Courier*** may help; heard later ***Scotland on Sunday*** listed it. An hour drive from Edinburgh and half an hour to prepare. Two tourists from the south had picked up a leaflet in the Tourist Office, but not many more. Panic! no sign of Euan Clarkson - need him to identify fossils. There is another car park, quick look over the hill, relief! There's Euan with a small crowd, and Cecilia Taylor to help too. Cars are streaming in, Rob Threadgould from SNH is here again, he seems to be a lucky mascot - he counts 50, with loads of children who don't stand still long enough to be counted.

Great locality, lots of polished material on the beach, stream of children. What's this? - coral. What are these marks? - trace fossils. What's this fossil? - brachiopod, colonial coral, tree root, bivalve ..... Just as well there are three of us. Call a halt after two hours - quit while you are ahead.

Retire for lunch round the picnic tables, feed-back from some of the participants, mostly complimentary, prompting an interest in geology which may be continued by joining a class or a society. Note the tide is in, so could not have done a repeat this time.

Monday 18th. Last day, chance to go and support Norman Butcher's walk at Sainsbury's store built on the infilled Craigleith Quarry. Mike Browne and Peter Brand with his knowledge of fossils have the same idea. A good dozen turn up and are fascinated by the history as well as the geology. There is comment on the wider discussions prompted by having several professional geologists.

Well! that was the first Scottish Geology Week, that was! Was it a success? Yes, this geologist had a fun week promoting his science. Almost two hundred people were interested enough to turn up, and stay. Some may even continue their interest by joining the EGS, but where were the Society officials to foster this interest? Could the professional members not have given more support to their colleagues? And could not the amateur members have turned out in force to demonstrate to the public how much fun geology can be?

Again, it was the 'old Faithfuls' who responded: David Land, Norman Butcher, Euan Clarkson, Bill Baird, Andrew McMillan, Mike Browne, Rosalind Garton, myself. What held back the others? If every professional geologist in Scotland had used his or her expertise to devise even one local event, what a geological week Scotland could have had. We can learn from, and build on Scottish Geology Week 1997, and all make sure that **Scottish Geology Week 1999** is a resounding success.

SOME FURTHER VIEWS ON SGW 1997

Mike Browne

Saturday 9th. Made my way across the Forth Bridge to Kinghorn on the Fife coast, but only five folk turned up to see the local corals, bone beds, and other goodies such as pillow lavas.

Sunday 10th. Led a party of nine who successfully cut their way through the jungle of Bilston Burn to examine the Lower Limestone Formation rocks. Just as well all the participants had rung me in advance and knew to bring wellingtons and a walking stick for balance in the wet gravel - SNH had managed to omit this advice from the brochure.

Monday 11th. Low visibility and heavy rain `welcomed' six participants to my scheduled walk on East Lomond to look at an old volcano and tropical seas. They readily agreed to my instantly organised excursion up Maspie Glen with its well-exposed section in Old Red

Sandstone rocks. The tree cover sheltered us and the party was finally rewarded by a beautiful undercut waterfall.

Saturday 16th. Back to Fife to the Lochore Meadows Country Park, where Jimmy Connelly of the Fife Ranger Service had arranged an illustrated talk *Look at the Land* introducing the Benarty Hill area. Local advertising paid dividends, as eighteen folk joined us for the follow-up walk and toasted gently in the warm sunshine. The RSPB Vane Farm viewpoint and Blair Quarry Opencast Coal Site were two of the highlights of a delightfully successful day.

Sunday 17th. Join Bill Baird's walk to Roslin Glen and Castle. A group of about 20 learn much about riverbank landslips, old bridges, wild bee honeycombs, horsetail pan scourers, and much more, such as keel-like channel sandstone bases. This trip was well-advertised in the Ranger Service programme and by David McAdam at the BGS Open Days, which was just as well as it was, hopefully, the only SGW event not advertised in the official brochure.

Monday 18th. End SGW helping Norman Butcher out at Craigleith Quarry.

Book Reviews:

VOLCANOES

Susanna van Rose & Ian F Mercer
HMSO 1997 (£5.95) (ISBN 0-11-310027-2)

The second edition of ***Volcanoes*** makes excellent use of attractive photographs, diagrams and maps interspersed with short, informative blocks of text. A very readable book, it summarises the main areas of volcanism from causes, types, lava flows and rocks, to usefulness and 'coping with an eruption' - backed by a range of examples from Santorini (1645 BC) to Ruiz (1985). The addition of 'contents' and 'index' means that it is now more "user friendly" - an ideal reference for school use, the interested amateur and the professional.

I H Marshall
Principal Teacher of Geography,
The Royal High School, Edinburgh

Earthquakes

Susanna van Rose & Roger Musson
HMSO 1997 (£5.95) (ISBN 0-852722-87-7)

The portrayal of natural disasters has become an increasingly popular subject in the media, whether on television or in the cinema, the interest of our students is enhanced and their thirst for knowledge easily recognisable. Many school geography departments include the study of Earth Forces in their first and second year courses. The impending implementation of 'Higher Still' will extend the teaching of such topics to fifth and sixth year pupils.

This book is a welcome addition to the resources currently available. For many years we have used Susanna van Rose's previous *Earthquakes* book with our more able youngsters. This text is rather dry and has become old fashioned and outmoded.

The new book is more 'user friendly' with topics divided into clearly recognisable sections. The addition of a contents page and an index makes finding specific information easier. The text, too, is well set out in succinct paragraphs. Maps and diagrams are relevant, well drawn and clearly labelled. We would hope to use this text with pupils with a wider ability range.

In this age of information technology, many new resources are video or CD-ROM based. The 'Internet' is also a source of much up to date information. It is refreshing to find a well structured and coherent book that not only provides detailed background knowledge but will stimulate and interest our pupils.

J P Highton
Principal Teacher of Geography
Holy Rood High School, Edinburgh

Proceedings of the
EDINBURGH
GEOLOGICAL SOCIETY

161st Session
1994-95

No. 25 **November 1997**

INTRODUCTION

This, the twenty fifth issue of the *Proceedings*, covers the 161st Session 1994-95 of the *Society.*

MEMBERSHIP

Total membership at 30 September 1995 was 550, which represents a decrease of one from the 1994 figure of 551 members. The membership comprises as follows:

Honorary Fellows	7 (7)	Senior Fellows	18 (13)
Corresponding	7 (8)	Family Fellows	33 (36)
Life Fellows	23 (23)	Glasgow	6 (6)
Ordinary Fellows	453 (455)	Junior Associates	3 (3)

The year has been sadly marked by the deaths of several Fellows, including Ian T Bunyan, Michael J Gallagher and Prudence M Hancock. Ian Bunyan became a fellow of the Society in 1965. He was a popular leader of field excursions and an authority on building stones, being a co-author of the Society guide. Michael Gallagher became a Fellow in 1974 and was the Clough Medallist in 1991-92. An excellent leader of field excursions, he was, at the time of his death, the Society's Lectures Secretary. Pru Hancock was an Honorary Life Fellow; from 1971 to 1976 she was a highly effective Treasurer and acted as Trustee in 1982-83.

COUNCIL

Following nominations at the AGM on 23 November, the elected members of Council for the session were as follows:

President	Mr S I Hogarth
Vice-presidents	Mr J Hull and Mr W J Baird
Secretary	Mr J M Dean

Treasurer	Dr D Gould
Assistant Secretary	Dr C G Smith
Membership Secretary	Dr E R Phillips
Excursion Secretary	Mr A D Mc Adam
Lecture Secretary	Dr M J Gallagher (succeeded by Dr D I J Mallick)
Librarian	Dr W B Heptonstall
Publications Sales Officer	Mis A H Hope
Edinburgh Geologist and Proceedings Editor	Dr A J Highton
Ordinary Members	Dr P M Dryburgh, Dr A C Paterson, Mr N McMahon, Mr K I R Halley, Mrs M M Leitch & Dr M Amstrong
SWT and RIGS representative (co-opted)	Mr M C Smith

Office-bearers not on Council

Trustees	Professor P McL D Duff, Dr WDI Rolfe & Mr W G Harper
Scientific editors	Dr P Stone and Dr D Stephenson
Auditor	Mrs M McLeod

LECTURE MEETINGS

The following open meetings were held during the session:

12 October 1994
British earthquakes
Dr C W A Browitt

26 October
Stabilisation of rock slopes
Mr I Dalgleish

9 November
Gold rush to molybdenum: the story of the Colorado mineral belt
Dr C Rice

23 November
What coal mining does to geology (Presidential address)
Mr S I Hogarth

This lecture was followed by the Annual General Meeting

18 January 1995
Petrography of sandstones
Mr G Strong

1 February
End-Ordovician extinction
Dr A Owen

15 February
Fellows' evening

1 March
Aspects of the geology of Rum
Dr H Emeleus (following the presentation of the Clough Medal)

15 March
Extracting records of recent climate from corals
Dr A Tudhope

19 April
Diamonds and their inclusions: mineralogy of the Earth's interior
Professor B Harte

RECORD OF FIELD EXCURSIONS

20 April 1995	Ochil Hills B Jackson & M Armstrong
10 May	Princes Street gardens and the Castle A D McAdam
20-27 June	Isle of Man T D Ford & D Quirk
3 June	Angus N H Trewin
7 June	Dean C D Waterston
14 June	Salisbury Crags D H Land

21 June	Craigmillar Castle N E Butcher
24 June	Comrie and Glen Lednock A R MacGregor
28 June	Bilston Burn M T Dean & M A E Browne
14-17 July	Vale of Eden S K Monro & E Skipsey
2 September	Kinghorn M A E Browne
30 September	Hartfell Score E N K Clarkson & C E Taylor

In addition, guided walks around Holyrood Park were made as part of the International Science Festival.

PUBLICATIONS

Volume 30 part 2 and Volume 31 part 1 of the *Scottish Journal of Geology* were published this year. Also published was the Inchnadamph booklet *Assynt the geologist' Mecca.*

CLOUGH AND MYKURA FUNDS

The Clough Medal was awarded to Dr Henry Emeleus for his work on the Tertiary volcanics of western Scotland. The Clough Award was given to Dr R W England. Two grants were made from the funds in support of field work.

LOTHIAN AND BORDERS REGIONALLY IMPORTANT GEOLOGICAL SITES GROUP

Two sites have been confirmed: Torphin Quarry and Dreghorn Spur cutting. Others are under negotiation, and a literature search by John Cleland has suggested a further 200 sites that are worth consideration.

INCHNADAMPH

The Inchnadamph Hotel visitors book, which includes the international geological meeting of 1912 led by B N Peach and J Horne, was rebound and presented to the hotel together with a memorial plaque.

PRINCES STREET GARDENS DISPLAY BOARD

A new geological display board was unveiled in Princes Street Gardens, explaining the geology of the gardens and the Castle. Edinburgh City Council and Scottish Natural Heritage gave generous financial support.

SUMMARY OF ACCOUNTS FOR THE YEAR ENDING 30 SEPTEMBER 1995

Revenue Account

	General	*Publ's*	*Clough*	*Mykura*	*Total* 1995	*Total* 1994
INCOME						
Income from Investments	1525	1077	704	195	3510	4020
Net gain on disposal of Investments	131	92	60	17	300	-
Bank Interest	158	111	73	20	362	363
Subscriptions	5779	-	-	-	5785	6054
Tax recoverable on Deeds of Covenant	523	-	-	-	523	486
Donations	41	-	-	-	41	60
Souvenirs	-	-	-	-	-	1
Sale of Publications	-	1542	-	-	1546	767
Total income	**8172**	**2822**	**837**	**232**	**12063**	**11751**
EXPENDITURE						
Administrative Costs	144	11	-	-	155	416
Insurance	266	-	-	-	266	250
Bank Charges	506	-	-	-	506	521
Reception	44	-	-	-	44	(2)
Miscellaneous	29	-	-	-	29	-
Auditor's Remuneration	525	-	-	-	525	600
Depreciation	244	-	-	-	244	-
Total	**1758**	**11**	**-**	**-**	**1769**	**1785**
Charitable Activities						
Lecture costs	950	-	-	-	950	1075
Celebrity lecture	-	-	-	-	-	789
Billets	1307	-	-	-	1307	1978
Award and medal expenses	-	-	300	-	300	136
Excursions	830	-	-	-	830	1059
Scottish Journal of Geology Vol. 31	-	1250	-	-	1250	1500
Edinburgh Geologist	-	-	-	-	-	720
Library/ Leaflets	-	1244	-	-	1244	250
Grants made	-	-	150	200	350	835
Inchnadamph Visitors' Book	383	-	-	-	383	-
Total	**3470**	**2494**	**450**	**200**	**6614**	**8342**
Cost of Publications Sold	-	999	-	-	999	512
Total expenditure	**5228**	**3504**	**450**	**200**	**9382**	**10639**
Surplus (deficit) for year	**2944**	**(632)**	**387**	**32**	**2681**	**1112**

Balance sheet at 30th September 1995

	1995		1994	
	£	£	£	£
Fixed Assets				
Investments at Market Value		74104		67416
Tangible Assets		980		-
		75084		**67416**
Current Assets				
Stock of Publications	4023		4430	
Other Stocks	272		333	
Debtors and prepayments	4162		281	
Taxation Recoverable	373		356	
Bank Accounts	6643		10250	
	15473		**15650**	
Less:				
Creditors due within one year				
Sundry	1057		1311	
Scottish Journal of Geology, Volume 30	1250		1500	
	2307		**2811**	
Net Current Assets		13166		12839
Net Assets		**88250**		**80255**
Representing:				
Permanent Endowment		47916		45187
Unrestricted		40334		35068
		88250		**80255**

A copy of the full accounts may be obtained from the Honorary Treasurer.

The Society owns the following items not considered realisable:
Silver snuff box and silver cup presented to Alexander Rose; specimen cabinet and chair made by him; library of geological books; archive held in the University of Edinburgh library; and Hutton manuscript held by the National Library of Scotland.

Proceedings of the
EDINBURGH
GEOLOGICAL SOCIETY

162nd Session
1995-96

No. 26 **November 1997**

INTRODUCTION

This, the twenty sixth issue of the *Proceedings*, covers the 162 nd Session 1995-96 of the *Society*.

MEMBERSHIP

Total membership at 30 September 1996 was 548, which represents a decrease of two from the 1995 figure of 550 members. The membership comprises as follows:

Honorary Fellows	6 (7)	Senior Fellows	21 (18)
Corresponding	6 (7)	Family Fellows	33 (33)
Life Fellows	21 (23)	Glasgow	7 (6)
Ordinary Fellows	450 (453)	Junior Associates	4 (3)

COUNCIL

Following nominations at the AGM on 22 November, the elected members of Council for the session were as follows:

President	Mr D H Land
Vice-presidents	Mr J Hull and Dr A C Paterson
Secretary	Mr J M Dean
Treasurer	Dr D Gould
Assistant Secretary	Dr C G Smith
Membership Secretary	Dr E R Phillips
Excursion Secretary	Mr A D Mc Adam
Lecture Secretary	Dr D I J Mallick
Librarian	Dr W B Heptonstall
Publications Sales Officer	Mis A H Smith
Edinburgh Geologist and Proceedings Editor	Dr A J Highton

Ordinary Members	Dr P M Dryburgh, Dr R A Harkness, Mr W J Baird, Mr K I R Halley, Mrs M M Leitch & Dr M Amstrong
SWT and RIGS representative (co-opted)	Mr M C Smith

Office-bearers not on Council

Trustees	Professor P McL D Duff, Dr WDI Rolfe & Mr W G Harper
Scientific editors	Dr P Stone and Dr P G Hill
Auditor	Mrs M McLeod

LECTURE MEETINGS

The following open meetings were held during the session:

11 October 1995
Ikaite: the disappearing mineral
Prof. A Smith

25 October
Aspects of the history of the Scottish coalfields
Dr P McL D Duff

8 November
3-D seismic surveys at Sellafield
Prof. D Smythe

22 November

Platinum in the Pacific

Dr H Pritchard
This lecture was followed by the AGM

17 January 1996
Black smokers, massive sulphides and unusual vent fauna in the Palaeozoic of the Urals
Dr R Herrington

31 January
Treasures of the Hindu Kush
Dr R Leake

14 February
Fellows' Evening

28 February
The Shetland ophiolite
Prof. Derek Flinn (following the presentation of the Clough Medal)

13 March
Burgess Shale-type fauna and the explosion of Cambrian life

Prof. S Conway Morris
(James Wright Memorial lecture)

17 April
Tectonic plates: a gravimetrist's view
Dr R Hipkin

RECORD OF FIELD EXCURSIONS

20 April 1996	Ratho
	N E Butcher
4 May	Bail Hill and Afton Water
	R A Smith & J D Floyd
18-25 May	Islay
	C G Smith
1 June	Strathblane Hills and Dumgoyne
	J MacDonald
5 June	Arthur's Seat: Lion's Haunch vent
	D H Land
12 June	Pentland Hills: Howden Burn
	D H Land
19 June	Broard Law
	E N Clarkson & D H Land
22 June	St Andrews and St Monans
	A R MacGregor
26 June	Blackford Hill
	D H Land & A D McAdam
20 July	Pentland Hills: Bavelaw
	H F Barron & A D McAdam
31 August	Eyemouth
	P Stone
28 September	Kinnoul Hill and Campsie Linn
	M Taylor & A McKirdy

PUBLICATIONS

Scottish Journal of Geology Vol. 31, part 2 and Vol. 32, part 1 were published. A new geological guide book *Geology in south-west Scotland: an excursion guide* was published by the British Geological Survey in association with the Society. The book is dedicated to the memory of Byron Lintern, who died in January 1993 and who made a significant contribution to the understanding of the Southern Uplands. A full colour broadsheet pamphlet *Discovering Edinburgh's Volcano* was published early in 1996 with assistance from Scottish Natural Heritage and Historic Scotland. The Lothian and Ardnamurchan guides were also reprinted.

CLOUGH AND MYKURA FUNDS

the Clough Medal was awarded to Professor Derek Flinn (University of Liverpool), primarily for his work in Shetland. Two grants were made to assist fieldwork.

LOTHIAN AND BORDERS REGIONALLY IMPORTANT SITES GROUP

Work continued in assessing sites for inclusion, and eighteen were studied in this session. In addition, Norman Butcher has identified the location of Hutton's house in St John's Hill, and a fund has been started to erect a commemorative plaque on the site.

SUMMARY OF ACCOUNTS FOR THE YEAR ENDING 30 SEPTEMBER 1996

Revenue Account

	General	*Pbl's*	*Clough*	*Mykura*	*Total* 1996	*Total* 1995
INCOME						
Income from Investments	1686	1070	733	200	3689	3510
Net gain on disposal of Investments	141	90	61	17	309	300
Bank Interest	147	93	64	17	321	362
Subscriptions	5818	-	-	-	5818	5785
Tax recoverable on Deeds of Covenant	566	-	-	-	566	523
Legacies and donations	226	2500	-	-	2726	41
Grants for publications	-	4359	-	-	4359	-
Miscellaneous	-	8	-	-	8	-
Sale of Publications	-	2050	-	-	2050	1542
Total income	**8584**	**10170**	**858**	**234**	**19846**	**12063**
EXPENDITURE						
Administrative Costs	93	33	-	-	126	155
Insurance	266	-	-	-	266	266
Bank Charges	468	-	-	-	468	506
Reception	38	-	-	-	38	44
Miscellaneous	25	-	-	-	25	29
Auditor's Remuneration	575	-	-	-	575	525
Depreciation	244	-	-	-	244	244
Total	**1709**	**33**	**-**	**-**	**1742**	**1769**
Charitable Activities						
Lecture costs	1225	-	-	-	1225	950
Celebrity lecture	261	-	-	-	261	-
Billets	1498	-	-	-	1498	1307
Award and medal expenses	-	-	216	-	216	300
Excursions	668	-	-	-	668	830
Scottish Journal of Geology Vol. 32	-	1500	-	-	1500	1250
Edinburgh Geologist	-	816	-	-	816	-
Discovering Edinburgh's Volcano	-	4859	-	-	4859	1244
Grants made	-	-	750	-	750	350
Inchnadamph Visitors' Book		-	-	-	-	383
Total	**3652**	**7175**	**966**	**-**	**11793**	**6614**
Cost of Publications Sold	-	1679	-	-	1679	999
Total expenditure	**5361**	**8887**	**966**	**-**	**15214**	**9382**
Surplus (deficit) for year	**3223**	**1283**	**(108)**	**234**	**4632**	**2681**

Balance sheet at 30th September 1996

	1996		1995	
	£	£	£	£
Fixed Assets				
Investments at Market Value		67762		74104
Tangible Assets		736		980
		68498		**75084**
Current Assets				
Stock of Publications	25201		4023	
Other Stocks	217		272	
Debtors and prepayments	278		4162	
Taxation Recoverable	328		373	
Bank Accounts	12485		6643	
	38509		**15473**	
Less:				
Creditors due within one year				
Sundry	8053		1057	
Scottish Journal of Geology, Vol. 32	1500		1250	
	9553		**2307**	
Net Current Assets		28956		13166
Net Assets		**97454**		**88250**
Representing:				
Permanent Endowment funds		51808		47916
Unrestricted funds		45646		40334
		97454		**88250**

A copy of the full accounts may be obtained from the Honorary Treasurer.

The Society owns the following items not considered realisable:
Silver snuff box and silver cup presented to Alexander Rose; specimen cabinet and chair made by him; library of geological books; archive held in the University of Edinburgh library; and Hutton manuscript held by the National Library of Scotland.

The Edinburgh Geologist

Issue No. 30 1997

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ISSN 0265-7244