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No. 24 Spring 1990

Incorporating the Proceedings of the Edinburgh Geological Society

155th Session 1988-1989

The Ochil Fault at Stirling

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Acknowledgements

Cover Illustration

Upper Carboniferous sedimentary rocks, downfaulted by the Ochil Fault against Lower Devonian volcanics of the Ochil Hills near Stirling. BGS photograph D 1938, reproduced by permission of the Director, British Geological Survey, NERC copyright reserved.

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Editorial

The current issue includes the Proceedings of the Society (for the 1988-1989) Session and four articles that I hope will stir the interest of members, particularly those who are fascinated by geological enigmas. The life and work of James Neilson is reviewed, by Alistair Sutherland of the Royal Museum of Scotland. Neilson was a prominent Scottish Geologist at the turn of the century, about whom significant facts (including his place and date of birth) remain unknown.

Bill Baird comments on two more geological curiosities: the Stone-Spheres of Central America, that are thought to be giant spherulites, but which were originally described as artifacts, carved by members of an unknown early race that inhabited the region, and the discovery in 1972, of naturally occurring nuclear reactors in Proterozoic rocks of Gabon in SW Africa. Arlëne Hunter's article describes geological mapping in the Lahnalhti area of Finland, supported in part, by a grant from the Society's Clough Fund.

I must apologise to David Gould, regarding the erroneous caption to Figure 2 of his article on the EGS Shetland Excursion, published in issue 23. The photograph showed the agglomerate at Esha Ness, not the Rova Head Conglomerate as indicated in the caption.

Clive Auton

June 1990

James Neilson

Alistair Sutherland
Royal Museum of Scotland, Edinburgh

Introduction

Whilst the author was revising "A Catalogue of Carboniferous Corals in the Royal Scottish Museum, Edinburgh" (Sime, 1972), an entry under the heading "Collections mentioned by name ....." seemed rather incongruous.

It read:- "NEILSON James. before 1872- after 1909. Collection purchased in 1909".

It was rather strange that Ian Sime had not included the actual dates of birth and death for such a prominent Scottish geologist. A search of the R.M.S. library and several phone calls quickly showed how little was known of Neilson, and the difficulty Sime must have encountered when attempting to include the correct dates. It was known that Neilson had been an active member and at one time, Vice-President of Glasgow Geological Society, therefore the Proceedings of that Society seemed a logical place to start. So began a long and tortuous search to track down one of the last of Scotland's "gentleman" geologists.

The first problem to be encountered was that three people named James Neilson had been members of Glasgow Geological Society between 1860 and 1930, and to confuse matters even further, two James Neilsons had been elected Vice-Presidents simultaneously at the Annual General Meeting in 1897! There appeared to be no Obituary notice in the Proceedings of the Society, and apart from a small anonymous note in the Glasgow Herald of 1925, there is nothing to record his passing. It seems a great pity that the death of such an eminent geologist had gone almost unnoticed and that virtually nothing is known about the man. The following notes therefore, offer what has been discovered by the author so far and I would be pleased to receive any further information, or corrections to the text in order to make a more complete biographical sketch of James Neilson.

It is still not known when James Neilson was born, or where. Register House holds his death certificate, but his date and place of birth are not recorded.

James Neilson 1848/49-1925

Parish records would need to be consulted to discover this information, and of course knowing his place of birth is a prerequisite for the appropriate records to be found.

Neilson was elected to membership of Glasgow Geological Society on 3.11.1870 whilst residing at 49 Whitevale Street. His father, also James, who resided at 16 Whitevale Street, was elected at the same meeting. He read his first paper to the Society two years later (12.12.1872). This paper "On some sections of Carboniferous Limestone near Busby" was the first of many and what I hope is a complete list can be found at the end of this note.

By 1874 Neilson had moved to 641 Duke Street, Glasgow, and he had moved again to 122 Finlay Drive, Dennistoun by 1876. His name is not recorded on the role of members of the Glasgow Society for 1882-83. It appears that he allowed his membership to lapse until 1891, when he is recorded as re-joining the Society, living at High Cross Hill, Rutherglen. By 1896 Neilson had moved to Milnbank House, Dennistoun and on the roll for 1891, his address is given as The Alma Boiler Works, Crownpoint Road, which was the family boiler making business. In 1911 he was admitted to membership of Glasgow Archaeological Society when his address was shown as "Rosecliff" 53 Wellshot Drive, Cambuslang, where he remained until his death from bronchitis on 13.4.1925.

The only residence still in existence is 53 Wellshot Drive, the remainder have been demolished.

Nothing is known of Neilson's education apart from what can be inferred from the papers he published. These indicate a clever, careful, perceptive man, with a somewhat dry sense of humour. That he was held in high regard by his contemporary professional geologists there is no doubt. In the 1911 Memoir of the Geological Survey of Scotland: The Geology of the Glasgow District, on page 57, we find the following: "Very little of these sections is now visible, but they have fortunately been described in great detail in the valuable paper contributed by Mr James Neilson to the Transactions of the Geological Society of Glasgow in 1875, and to which the reader is referred for further information". And when for instance, Carruthers, in Clough and others (1911, ibid.) proposed an erroneous correlation of the Carboniferous strata of the Glasgow district, Neilson (1911) pointed out its shortcomings. Carruthers was man enough to acknowledge the errors and as a result, named the Neilson Shell Bed in his honour.

Neilson's mischievous humour shows through in the introduction to his 1911 paper when he complains: "This fact (hand colouring of maps) has been taken advantage of to add an enormous amount of detail, which is often of such a minute character, that after study one feels inclined to wish that he were gifted with microscopic eyes or that the map had been drawn to a larger scale........ It will be observed that the long way of the map is from North to South. This has doubtless been adopted for good and sufficient reasons, if only we knew them." and again later: "I know of no other class of writing in which so much good work is compressed into so little space and sold at such a low price, certainly not the cheap novels which are so popular nowadays: but why it should be issued in such trashy paper covers is one of these things no fellow can understand."

Neilson was a contemporary of, and known to, such eminent geologists as Peach, Horne, Geikie, Traquair, Clough, Dunlop, Craig, Cadell and Macnair. His paper of 1893 "On the Calderwood Limestone and Cement-stone" was the first in the Transactions of the Society to contain half-tone illustrations and "These illustrations were not printed on the special plate paper now used, but appeared in the text" (History of the Geological Society of Glasgow 1858-1908).

He was elected a Vice-President of Glasgow Geological Society for one year during the 1896-97 session and at the Annual General Meeting in November 1897 was re-elected Vice-President for a further 3 years. (He was again elected a Vice-President in 1908). At various times, he served on sub-committees of the Society including those concerned with Publishing, Excursions, Photography and the Boulder Committee. He led several excursions to localities in the West of Scotland, including visits to Arran and Ailsa Craig with the Andersonian Naturalists Society, to Murroch and Auchencorth Glens, in a joint excursion with the Edinburgh Geological Society and to Tory Glen with the Glasgow Natural History Society. During the meeting of the British Association in Glasgow in 1901, he lead the excursion to the fossil grove in Whiteinch.

Neilson combined his interest in geology with his passion for archaeology in the papers on Flint Jack (1892), the Clyde Cranogs (1903) and the Auld Wives' Lifts (1917). He also travelled extensively, producing papers on Egypt (1902), Syria and Palestine (1902) and the Swiss glaciers (1907).

Neilson is listed as one of the platform party, when in 1909, the Glasgow Geological Society held a special meeting to celebrate its Jubilee. He is also a signatory to the illuminated address given by the Society to Lord Kelvin as part of the celebrations. He produced biographical notes on prominent members of the society in "The History of the Geological Society of Glasgow 1858-1908", but modesty obviously precluded him adding notes on himself; no one else appears to have thought to do it for him! Even in the paper "The Geological Society of Glasgow 1858-1958" by Macgregor (1958), no mention is made of Neilson. In 1919, Macnair proposed Neilson for Honorary Membership which he turned down, accepting Life Membership instead.

In the latter years of his membership of the Society he appears to have had several disagreements with prominent members. The proceedings record him opposing the views of Cadell, Traquair, Macnair and Carruthers, mainly on questions of correlation of Scottish Carboniferous strata.

One particular disagreement seems to have been about the Auld Wives' Lifts on Craigmaddie Moor, Stirlingshire. Neilson (1917) published a paper on the structure, attributing it to a Megalithic origin, contrary to the belief held at that time, that it was of glacial origin. He proposed that the Society finance an excavation of the site, a suggestion that appears to have had a less than warm reception. As a result he proposed a joint meeting with the Geological Society, the Glagow Archaeological Society and the Glasgow Natural History Society, in an effort to create a joint venture to finance an investigation; this meeting took place in 1921. When no progress appeared to be made, apparently in frustration, Neilson suggested that he and James Stark would finance the operation. However, the proceedings record: "Mr Stark did not think anything important was to be learned by excavation". Stark (1917) had published a paper with a beautiful illustration of the mechanism of formation by glaciation! There is no further record in the Proceedings of what eventually transpired; presumably no further action was taken.

The joint meeting held on 13th January 1921 appears to have been the last one Neilson attended and nothing further is heard of him until in November 1923, when he wrote a letter to the Society offering a collection of books to the library. Whereas a previous offer of books in 1915, was not only gratefully accepted, and the list of books published in the proceedings, on this occasion only the offer is recorded, with no note of acknowledgement or acceptance appearing.

During his long life, Neilson amassed a large and comprehensive collection of some 20,000 geological specimens. These included a large proportion, if not all, of the Craig Collection of fossil fish, parts of the Braidwood Collection and several other smaller but none-the-less important collections. The collection contains many figured and type specimens, including as a contemporary newspaper report states ".... the remarkable *Cladodus neilsoni* discovered by Mr Neilson, and named after him by Dr R H Traquair ...." (Glasgow Herald 12.10.1909).

When Neilson indicated that he wished to dispose of his collection, Macnair who was at that time Keeper of Geology at the Kelvingrove Museum no doubt hoped it would go there. Some time before this, however, the

Museum had been involved in a controversy over the sale of some coins by the then keeper Professor John Young. Potential donors were therefore wary about depositing material there. Whether this had any bearing or not, on Neilson's decision to "sell to the East" is not known. There would no doubt have been some disppointment that the collection had gone to Edinburgh, rather than Glasgow (which would have been the more relevant repository), and whether this had any bearing on Neilsons eventual "obscurity" can only be speculation. However, a contemporary newspaper report states "It was a great loss to the West of Scotland when his collection was removed to The Royal Scottish Museum, Edinburgh". (The Glasgow Herald, 1925). The sale of the collection to Edinburgh almost never happened, as Rolfe (1988) reports from the R.M.S. Archive, "Thus in 1909 Traquair attempted to buy James Neilson's collection ..... for £100 less than the £500 asked. This brought a spirited reposte from Neilson: 'I have never hesitated to buy up any collections that were in the market and, large as the collection is, every specimen is a picked specimen, or else is very rare ..... I have rejected at least 10 specimens for every one I have chosen ... the collection was cheap at £1000, only I considered that the price was more than you could afford ..... £500 is the very least I would take for it.' Traquair immediately recommended the purchase".

Conclusion

James Neilson was undoubtedly a remarkable man and while his geological achievements are well recorded, if somewhat widely scattered, we still know very little about the man himself. He was married twice, to Jane Baird Moffat and Joanna Stewart. His father was James Neilson and his mother was Euphemia Neilson m.s. Wood. Of his immediate family we know little. His death was registered by a nephew, James Neilson, and an entry in the Glasgow Herald of 20.4.1925 reads "Miss Neilson and the grandchildren of the late James Neilson return sincere thanks for enquiries and sympathy. Rosecliff, Cambuslang".

Perhaps the greatest mystery is why his death went apparently unrecorded by his geological contemporaries. No mention of his death appears in the Proceedings of the Glasgow Geological Society, nor in the Proceedings of The Glasgow Archaeological Society. It seems a great pity that such a man should receive so much recognition during his life and so little attention on his death.

Acknowledgement

I am indebted to Helen Adamson, Keeper of Archaeology, Glasgow Art Gallery and Museum, who provided the vital link in tracking down the correct James Neilson.

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1904. Notes on fossiliferous shales underlying the Arden Limestone at Davieland near the new Rouken Park, Thornliebank. *Ibid.* Vol. 12, p. 294.

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Geological Mapping of Lahnalahti, Southeast Finland

Arlëne G Hunter
Aberdeen University

Introduction

As part of my Honours degree in Geology and Mineralogy at Aberdeen University, I was required during the summer of 1989 to complete a mapping report on an area of my own choice. I decided to base myself in Finland, with the idea of involving metamorphic petrology and ore mineralogy in my work. One of the problems that I encountered initially was that there were few people in Scotland with a detailed knowledge of Finnish geology. Obtaining references was also a problem, with most only describing the geology at a regional scale.

After some research, the district around Outokumpu in eastern Finland appeared to be a promising area to map, because much has been written about its ore deposits and the general geology of the area. Unfortunately, it was not until I contacted Heikki Puustjärvi, an exploration geologist working for the Eastern Division of the Outokumpu Mining Company, that I discovered that exposures of bedrock in the area were minimal; most geological information being obtained from underground workings. Luckily, Heikki was able to suggest an alternative area to map; after 8 months trying to locate a suitable mapping area, I finally had a destination.

Location and General Geology

My mapping area was based around Lahnalahti in SE Finland (28° 20'E 62° 10'N), which is situated between the cities of Mikkeli and Varkaus. The area is part of a major shear zone which bisects Finland, running NW/SE forming a tectono-stratigraphic divide between the Svecofennides and Karelides (Figure–1).

The bedrock of the Lahnalahti district (Figure 2) comprises a suite of of meta-igneous and metasedimentary rocks (amphibolite metamorphism), between 2100-1800 million years old, that are thought to be characteristic of ancient calc-alkaline island arc and its adjacent shelf deposits. The meta-igneous sequence is derived from intrusive, extrusive and pyroclastic rocks

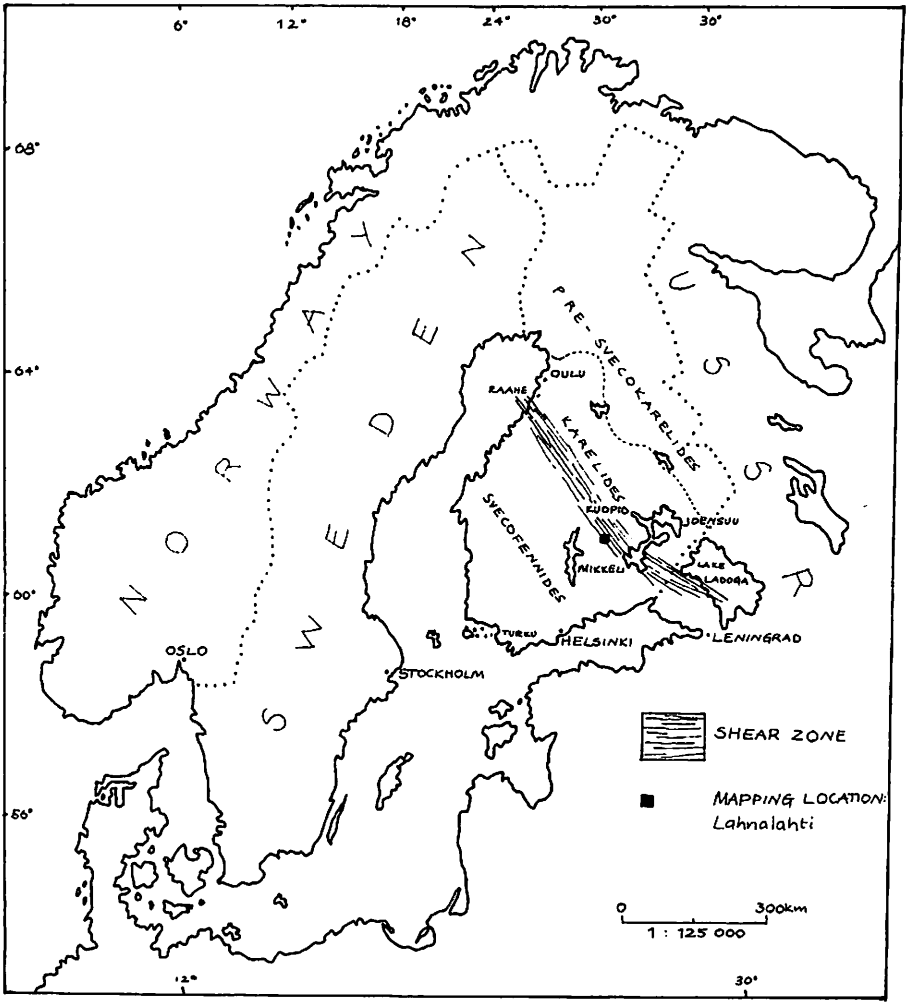

Figure 1. Map of Finland showing the location of the Lahnalhti area

that ranged from basic to acid in composition; many have been highly migmatised. The metasediments are principally metagraywakes and quartz-feldspar schists, with subordinate conglomerate and skarn limestone. The metamorphic rocks are intruded by bodies of synorogenic granite, granodiorite and quartz-diorite.

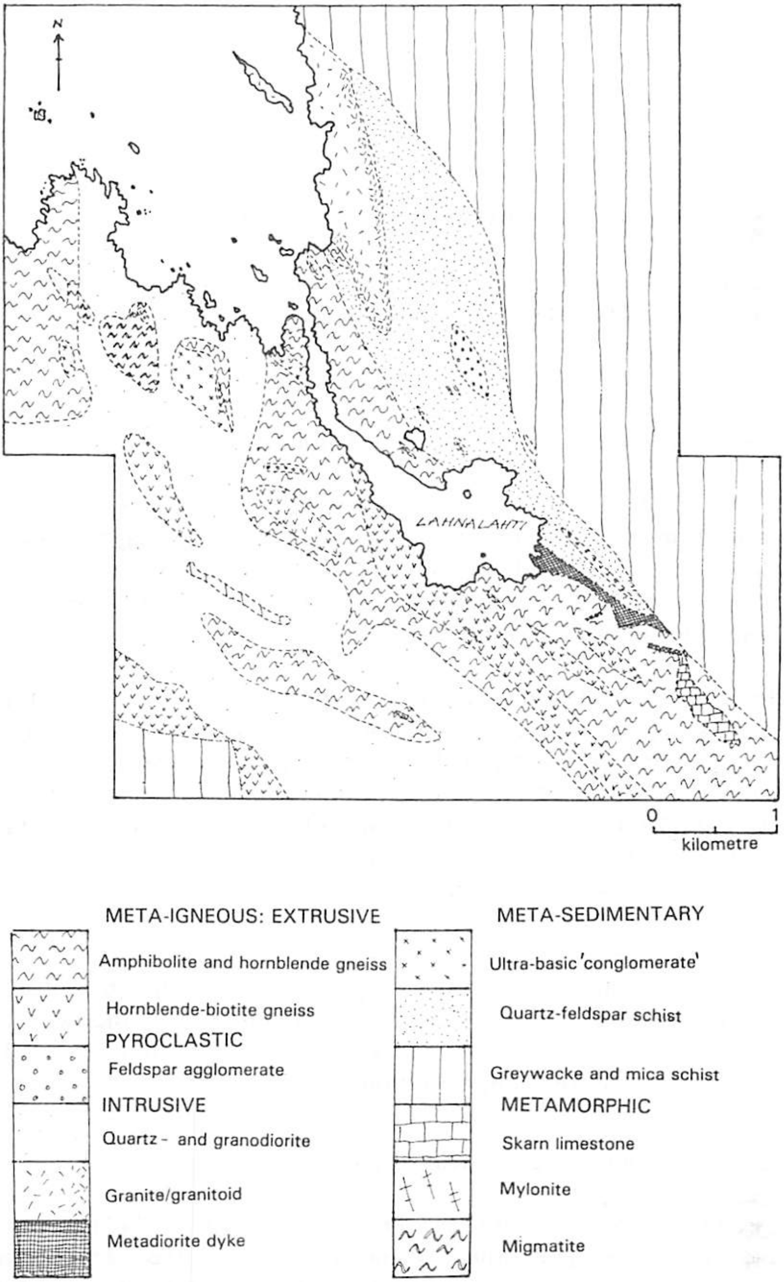

Figure 2. Geological sketch-map of the Lahnalahti area

Structure

The structure of the Lahnalahti area is dominated by the major NW/SE trending shear zone.

Field evidence indicates three phases of isoclinal folding:

(1) Large, kilometre scale, folds (F1) with decimetre to metre scale parasitic folds and mullions in the hinge zone.

(2) Medium, decimetre to metre scale folds (F2)

(3) Small, millimetre to centimetre scale folds (F3)

The F1 folds trend NW-SE and are attributed to NE-SW compression, resulting from the convergence of ancient plate-margins against the calc-alkaline sequence. F2 folds are a result of N-S compression. In places, 'hook interference patterns' are produced by F2 refolding of F1 structures. The F3 folds are a result of E-W compression.

Tectonic fabrics developed during each phase of deformation, although these are less pronounced in the plutonic rocks. Plate collision resulted in a primary penetrative foliation (S1) overprinting the fold structures. The S1 foliation, which is parallel to the strike of the rock units, trends NW-SE and dips steeply (70-90°). Dextral NW-SE shear led to the development of L and LS fabrics, particularly within the mafic lithologies. As well as ductile shearing, brittle deformation has occurred, resulting in the formation of cataclasites.

All of the intrusions were emplaced passively. The intrusion of quartz-diorite and granodiorite was synorogenic as indicated by the penetrative tectonic fabrics. The granite, however, is late-orogenic and is related to a phase of granitisation and migmitisation, that destroyed many of the original structures.

Orogenic Development/Geological History

The Lahnalahti-Varkaus area has been compared by Eskola (1961) to a eugeosyncline. Sedimentation commenced with the deposition of proximally-derived volcanogenic material by turbidity currents flowing down a continental slope. These turbidites are now represented by sequences of meta-greywacke and mica-schist. Quartzofeldspathic sandstones were deposited on the continental shelf, before extensive calc-alkaline volcanic activity took place. Subduction or plate-collision occured and the resulting metamorphism, which produced temperatures of 450-700 and pressures of 2-10 kb (Klein and Hulbert, 1986), altered the rocks to amphibolite grade. The earliest phases of folding and the passive intrusion of bodies of granodiorite and quartz-dolerite were associated with the amphibolite metamorphism.

Polyphase deformation commenced c. 1,900 MA (Bowes, et al., 1984), and dextral movement took place along the shear-zone, followed by the partial melting and migmitisation of the metamorphic rocks. A later phase of migmitisation, associated with the emplacement of the granite pluton, resulted in the liberation of saline fluids which formed the skarn deposits and aplitic veins.

Crustal relaxation followed the emplacement of the granite and hypabyssal rocks were intruded within the shear zone. Sericitisation of feldspathic material and chloritisation of much of the mafic material took place subsequently. The Svecofennian orogenic activity in the Baltic Sheild is thought to have taken place over a period of c. 100 MA (Park, 1985), implying that most of the structures in the Lahnalahti district were formed 1900-1800 million years ago.

Economic Geology

No commercially viable ore deposits have yet been found in the area, although surveys are being carried out at present, by the Outokumpu Exploration Oy., at the eastern end of Lahnalahti Bay.

Conclusion

Overall, my time in Finland proved a most enjoyable experience. It was my first solo attempt at geological mapping, which might have proved a daunting challenge, as I had little prior knowledge of the mapping area, Finnish geology, the language, the landscape or the Finns themselves. I found however, that with even the few words of badly spoken Finnish that I was able to learn, I could communicate with the local inhabitants, who were most friendly and helpful.

I was able to travel where I pleased, but the dense forests and lakes that cover much of the country proved a severe obstacle to detailed geological mapping when compared to the areas of Scotland with which I am familiar. This inability to "see the rocks for trees", may explain why the Finnish Geological Survey relies so heavily on aero-magnetic data and sub-surface information to compile its geological maps. Field mapping in the traditional manner is possible however, in places such as the Lahnalahti area where although bedrock exposures are sparse, a wide variety of spectacular igneous and metamorphic rocks can be seen, making it an obvious location for anyone interested in metamorphic petrology.

Acknowledgements

I would like to thank the Geological Survey of Finland and the Outokumpu Exploration Oy., especially Heikki Puustjärvi who helped me to choose my mapping area, and supplied the necessary base maps.

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Strange Earth, No. 9: Stone Spheres

Bill Baird
Royal Museum of Scotland

Until recently, the stone spheres of Central America were regarded as the mysterious vestiges of an unknown culture. Ranging in diameter from less than 1 inch to over 11 feet and almost perfectly spherical, their mode of construction was an enigma. The precision with which these spheres had been shaped was incredible. A sphere from Costa Rica, 7.03 feet in diameter with an estimated weight of 16 tons, for example, was measured as being within one quarter of an inch of a perfect sphere.

Apart from those found in Costa Rica, precisely rounded stone spheres were also known from Honduras, Belize and Mexico. It was not until 1967 however, when Matthew Stirling and his colleagues saw hundreds of spheres littering the ground at Agua Blanca, near Guadalajara, in Mexico, did they suspect that the origin of the spheres was a geological rather than archaeological problem. Sterling's report to the National Geographic Committee for Research and Exploration resulted in a joint National Geographic – Smithsonian Institution – United States Geological Survey expedition to the Agua Blanca area in 1968. The members of the expedition concluded that the spheres were indeed of geological origin and had probably formed by the nucliation, at high temperature, of glassy material around individual, widely spaced glass shards, within the matrix of an ash-fall tuff. The tuff was formed during an episode of Tertiary volcanism. Hot gases were released as the glass solidified, permiating the rock in all directions and remelting the surrounding material to form the spheres. The process of sphere growth continued until, either the rock had cooled sufficiently, or the spheres coalesced.

Spheroidal structures are not uncommon in rocks, especially those of volcanic origin, but most are the intermediate products of weathering processes and not normally perfectly round. Many geologists will have seen examples of onion skin weathering in the dolerite exposures of Scotland's Midland Valley and structures of this type within igneous rocks appear in the literature, from as far afield as the Karro, of South Africa and Klondyke, Arizona. What is uncommon about the stones of Central America is the near perfection of their spherical form. Perhaps the master stonemasons of that unknown culture first credited with making them, simply honed to perfection the spheres they liked best?

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Strange Earth, No. 10: Ancient Nuclear Reactors

Bill Baird

Radioactive minerals are subject to natural processes of decay, during which unstable isotopes give off fission products such as alpha and beta particles, gamma rays and radon gas. Eventually the process of decay is complete, a more stable daughter element having been formed.

It will probably come as a considerable surprise to the general public to know that there is naturally occurring radioactive material in thin bands disseminated throughout the Middle Old Red Sandstone rocks of Caithness and Orkney. Uranium is commonly present in the range 100-1,000 ppm (0.01-0.1%) in thin phosphatic horizons and fringing dolomitic conglomerates. Indeed concentrations within some small fossil fish remains in shales can reach 3,000 ppm. Radioactive minerals are widespread around the world, at low concentrations, especially in rocks such as granite. In places, geological processes have greatly concentrated uranium, as at Cigar Lake, Saskatchewan, Canada, for example, and at Morro do Ferro, Minas Gerais, Brazil. In rarer circumstances, the concentration of uranium has been enriched to such an extent that fission reactions have occurred similar to those which take place in nuclear power stations.

Between 1,800 and 2,000 million years ago, during the Proterozoic, a concentration of uranium occurred in a region of the African continent now known as the Republic of Gabon. The amount of uranium ore concentrated in the Oklo area of south-east Gabon amounted to at least 800 cubic metres and was of such richness, that it sustained one or more naturally initiated fission type reactions, over a period in excess of 500,000 years and possibly as long as 2 million years.

This site was discovered in 1972 and it is thought that the conditions necessary for the reaction process included, not only an unusual concentration of uranium, but also ample ground water and the natural containment conditions provided by the surrounding rocks. It has been calculated that the minimum amount of energy produced during the lifetime of the ancient reactor exceeded 16,500 megawatt years. Temperatures of the reactor, while active, were between 280 and 400 degrees celsius. Although naturally occurring large-scale fission reactions are a rare process, the Oklo example is not unique, as a further reaction site has been found at Okelobondo, about 1km south of Oklo.

If natural reactors were present in ancient ecosystems, there are clear palaeontological implications – even the process of evolution may have been affected. There may also be very practical lessons to be learned from studies of ancient reactors by engineers and others involved in the de-commissioning of nuclear power stations.

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Proceedings of the

EDINBURGH

GEOLOGICAL SOCIETY

155th Session

1988-1989

No. 19 **January 1990**

INTRODUCTION

This the nineteenth issue of the *Proceedings* covers the 155th Session, 1988-1989. Abstracts of the lectures delivered to the Society are included.

MEMBERSHIP

The total membership of the Society at 30 September 1989 was (with last year's figures in brackets 580 (570), consisting of:

Honorary Fellows	10 (11)	Senior Fellows	15 (15)
Corresponding Fellows	8 (8)	Family Fellows	33 (31)
Life Fellows	27 (27)	Glasgow Associates	9 (10)
Ordinary Fellows	465 (457)	Junior Associates	13 (11)

Numbers of Fellows and Associates elected, deceased, resigned, removed and transferred during the 155th Session, 1988-1989.

Honorary Fellow deceased	1
Ordinary Fellows elected	32
Ordinary Fellows reinstated	5
Ordinary Fellow deceased	1
Ordinary Fellows resigned	7
Ordinary Fellows removed	21
Ordinary Fellow transferred to Senior Fellowship	1
Senior Fellow resigned	1
Family Fellows elected	4
Ordinary Fellow reinstated and transferred to Family Fellowship	1
Family Fellows resigned	2
Family Fellow removed	1
Glasgow Associate transferred to Ordinary Fellowship	1
Junior Associates elected	3
Junior Associate removed	1

PUBLICATIONS

Three parts of the *Scottish Journal of Geology* were published during this session.

1988	Volume 24 Part 3
1989	Volume 25 Parts 1 and 2

Issues 22 and 23 of the Societies informal magazine, *The Edinburgh Geologist*, were published, the latter incorporating the *Proceedings of the Edinburgh Geological Society* No. 18, covering the activities of the Society during the 154th Session, 1987-1988.

A new Membership Roll, correct up to 1988, was also published and the *Geological Excursion Guide to the Assynt District of Sutherland* was reprinted.

CLOUGH MEMORIAL MEDAL

The Clough Memorial Medal for 1988-1989 was awarded in January 1990 to Professor A L Harris of Liverpool University for his distinguished research throughout the Highlands that includes studies of the stratigraphy of the Moine and the Dalradian, the evolution of the Tay Nappe and correlation of Caledonian Orogen.

CLOUGH AWARD

The Clough Award was made to Dr T Dempster for his studies on the orogenic evolution of the Dalradian rocks of Scotland.

CLOUGH FUND

Awards in aid of field work, from the Clough Fund, were made to Miss A Hunter for geological mapping and mineralogical studies in central Finland; to Miss Y Najaman and party, for geological and geophysical work on the Tertiary plutonic rocks in the Austurhorn and Geitafell areas of Iceland and to Miss R McGill and party, for mapping igneous and metamorphic rocks in the Narsaq region of southern Greenland.

WALTER MYKURA MEMORIAL FUND

This fund, in memory of Wally Mykura was established in the summer of 1988, with the aim of supporting and encouraging geological field work in Scotland. Applications for support from the fund should be made by letter to the Honorary Secretary of the Society.

FIRST EDINBURGH INTERNATIONAL FESTIVAL OF SCIENCE

The Society made two contributions to Edinburgh's First Science Festival. The International Exhibition of Geological Maps of the World was held in the Geography Department of Edinburgh University and a guided walk through Holyrood Park on 8 April (led by Dr R Cheeney, Mr M Browne and Mr D Land) was attended by some 250 members of the public.

OBITUARY

SIR ANDREW MEIKLE BRYAN, DSc, LLD, FRSE, FIMinE, Honorary Fellow of the Edinburgh Geological Society. (1893-1988)

Sir Andrew Bryan was a Lanarkshire man, born in Burnbank, Hamilton on 1 March 1893. He died in Hounslow, Middlesex aged 95 on 27 June 1988, having spent a lifetime in the mining industry, where his greatest contribution (for which he will always be remembered) was to health and safety in an inherently dangerous occupation.

He started work at the age of fourteen at a local colliery, first on the screens and later underground. He continued his education by evening classes and in 1912 commenced a degree course at Glasgow University. He graduated in 1919, after an interruption for army service in the first world war, and also obtained his first class Certificate of Competency in Mine Management. His following years were spent in the Lanarkshire Coalfield in a variety of jobs.

In 1926 a most significant aspect of his career began with his appointment as a Junior Inspector of Mines. At 39 years old he was appointed Dixon Professor of Mining at Glasgow University and head of the mining department at the Royal Technical College, posts he held for nearly eight years; following this he became general manager, then managing director of the Shotts Iron Company.

During the war he was group production director of the Scottish Region of the Ministry of Fuel and Power. He became Chief Inspector of Mines in 1947. From 1951 until 1957 he was a member of the National Coal Board with particular responsibility for safety and training and continued to advise on these matters for some years after he retired.

Sir Andrew served on many commissions and committees, too numerous to mention. He was at various times president of the National Association of Colliery Managers, of the Mining Institute of Scotland and of the Institution of Mining Engineers. His achievements were widely recognised, especially in receiving the freedom of his native Hamilton in 1950. He was elected a Fellow of the Royal Society of Edinburgh in 1945 and knighted in 1951. The honorary degrees of DSc (from Durham University) and LLD (from Glasgow University) were conferred on him, as were honorary fellowships of the Institution of Mining Engineers and of our own Society, which he joined as an ordinary fellow in 1943.

D.H.L.

RECORD OF MEETINGS

12th October 1988
How a fault grows, and grows and grows
Dr J Watterson, University of Liverpool

Geological faults occur in strata which have been strained beyond breaking point, and their study is vital in mining and mineral exploration, in engineering applications and in stratigraphical and structural geology. Outcrops yield only limited data in considering the behaviour of faults, their growth, variations and limits. Much more can be discovered by looking at faults in three dimensions. But where is this 3-D information to be found? Some data has been available from mine plans of coalfields where several seams have been worked and the position and displacement across a fault are recorded. A different type of 3-D information has become available more recently from seismic reflection surveys of oilfields; several hundred seismic sections may be available for a single oilfield, with the between-line spacing as little as 25m. For the first time the geologists' dream of a real 3-D view of the crust is being realised.

When faults are examined in 3-D they are surpringly systematic. Displacement can be mapped over the fault surface and displacement contours drawn. In ideal cases these show fault surfaces to be elliptical in shape, with the maximum displacement at the centre reducing to the zero displacement contour, which is the boundary of the fault. There is a relationship between the maximum displacement on a fault surface and the dimensions of the surface; a fault with a maximum displacement one hundred times greater than that of another fault will have a maximum dimension only ten times greater than that of the smaller fault. These and other systematic relationships can be used to demonstrate that faults grow in a predictable manner, with each growth step represented by an earthquake event. If good 3-D information were available for other types of geological structures it might be seen that their formation may also be related to surprisingly simple systematics and growth laws.

26th October 1988
Natural Hazards and railways around the World
Prof. P.A. Fookes

Certain geological hazards that affect the construction of railways throughout the world can be related to specific combinations of climate and terrain. In temperate areas, especially those which have been recently glaciated, tills, varved clays and periglacial soils are liable to slippage. Unfilled periglacial joints and cavities (gulls) provide hidden zones of weakness in otherwise competent rock strata, often leading to landslides.

Arid desert areas provide a variety of hazards depending on the type of terrain. Piedmont areas suffer from flash floods, which require the construction of banks and culverts along railway lines. In sand dune areas drifting sand may block lines; this may be overcome by ensuring that lines have a flat profile allowing sand to blow across rather than accumulate on them, or by planting vegetation producing turbulent near-ground airflow and preventing drifting. In Sabkha areas, saline ground water reacts with concrete, leading to the weakening of bridges and tunnels.

9th November 1988
The Ocean Drilling Programme – the first few years
Professor R Kidd, University of Wales, Swansea

JOIDES, which stands for Joint Oceanographic Institutes for Deep Earth Sampling, has an annual budget of £39m. 'JOIDES Resolution', the drilling ship of the Ocean Drilling Program (ODP), began its scientific ocean drilling career in 1985 with operations in the Florida Straits. Since then the ship has completed 23 cruises in the Atlantic, Pacific and Indian Oceans. Its specialised high latitude capability has been tested in both the Arctic and Antarctic. Sea-floor spreading and plate tectonics have both been confirmed by deep sea drilling.

ODP has recently completed an Indian Ocean drilling campaign comprising 9 cruises that drilled at over 60 locations. Each of the drilling legs was targeted at specific regional objectives. Taken together with data from the 40 or more drilling locations surveyed during the early 1970's by the Deep Sea Drilling Project, the data from Indian Ocean drilling now offers fertile ground for Ocean Basin Synthesis studies.

More local, but still regional-scale, geology is now being investigated. The evolution of the Mediterranean as an evaporite basin, for example, and the history of glaciation in the North Atlantic, which extends back 20 million years. Evolution of active and passive plate margins, and global changes of all sorts will be studied in future.

23rd November 1988
Borneo adventure – coal geology in a tropical forest
D H Land formerly British Geological Survey

The Borneo coal project was part of the search for alternative energy resources in Indonesia, where oil has a virtual monopoly of domestic energy and a large share of foreign exchange earnings. Coal is mined and quarried, but total output is only about 300,000 tons per year.

During the Tertiary period, NW Borneo was part of a south-eastwardly trending subduction zone. Back-arc cratonic basins formed in eastern Borneo, one of which, the Kutei Basin, contains >10,000m of folded Neogene sediments.

The project involved the mapping and drilling of the Samardia coalfield (of Miocene age) within the Kutei basin. The Miocene Borneo coalfield can be compared with the Carboniferous Midlothian field: both have the same number of workable seams but the Scottish measures are about half as thick. Over 100 million tons of recoverable reserves were proved, suitable for electricity generation; enough to satisfy Indonesia's needs for over 30 years.

7th December 1988
The ancestry of the vertebrates
Dr R P S Jefferies, British Museum, Natural History

The origin of the vertebrates as a group and the separation of the chordates from the echinoderms can be reconstructed on the basis of the carpoid echinoderms, found only as fossils in marine Palaeozoic rocks: (1) the *Soluta* represent the group from which both echinoderms and chordates evolved; (2) the *Cornuta* are part of the chordate stem group of the chordates; and (3) the *Mitrata* indicate how the acraniate tunicates and vertebrates separate from each other.

The solutes, cornutes and mitrates are marine animals, about 20mm across; examples can be found in many Scottish Palaeozoic formations. *Dendrocystoides*, for example, is an Upper Ordovician Solute from Girvan, which is anatomically related to echinoderms; it has gill slits, a head and a tail. *Cothurnocystis*, an Upper Ordovician solute from the Starfish Bed, which has sixteen gill slits on the left side of the head, can be compared with the living acraniate *Amphioxus* in which the larva has gill slits only on the left side: an example of recapitultion. *Ceratocystis*, a middle-Cambrian cornute from Czechoslovakia, has analogous anatomy. *Reticulocarpus* from the Lower Ordovician of Czechoslovakia, is a mud-surface dweller with a pharynx and gill slits on the right. *Microcystella*, a Middle-Ordovician mitrate, has a primitive lateral line, a tail, a notochord and segmented muscles. Some tunicates, eg. *Ciona*, have mitrate-like larvae, and tunicate and mitrate feeding systems are generally similar.

The external calcareous plate skeletons of the early Palaeozoic forms were gradually lost, being replaced first by phosphate, and later by an internal skeleton.

18th January 1989
The periglaciation of upland Scotland
Dr C K Ballantyne, University of St Andrews

The mountains of Scotland support a rich and fascinating variety of periglacial (cold-climate nonglacial) phenomena, some of which were produced under the severe conditions of the Late Pleistocene, when mountain-tops protruded the level of the glaciers, icefields and ice sheets, whilst others formed under the relatively mild maritime periglacial regime of the Holocene and are active at present.

Late Pleistocene periglaciation on the highest parts of Scottish mountains was dominated by frost weathering and the formation of various types of mountain-top detritus, on which developed large-scale patterned ground and mass-movement forms that are nowadays active only in permafrost environments, whilst talus, rock glaciers, protalus ramparts and avalanche landforms developed below steep rockwalls. Under present conditions small-scale patterned ground and solifluction features remain active, aeolian forms are developing on some lithologies, and avalanches and debris flows modify steep slopes.

Research on Scottish mountains has demonstrated a strong lithological control on the distribution of many active and relict phenomena. Relict periglacial phenomena also throw light on the dimensions of Late Quaternary ice masses and on the nature of Late Quaternary mountain climate. Comparison of rates of mass-movement during the Loch Lomond Stadial of 11 to 10 thousand years ago with those of the present day suggests that the former were two orders of magnitude greater, but there is some evidence to indicate a recent acceleration of geomorphic activity on Scottish mountains, triggered possibly by increased storminess during the Little Ice Age of the 16th to 19th centuries AD, or by changed landuse practices on high ground.

15th February 1989
Fellows' Night

The Channel Tunnel

by Mr N Butcher

As early as 1820 it was realsed that the geology along the coasts of England and France matched on either side of the English Channel and about 100 years ago the prospect of tunnelling beneath the channel in the argillaceous Lower Chalk was deemed to be practicable. By the end of 1988 some 4km of the service tunnel had been driven from the English side; the French however, are encountering greater geological difficulties. Ground is being cleared and prepared at Cheriton in Kent for the terminal facilities but there are problems of landslipage.

G B Greenhough's role in the geological mapping of India

by Dr D Cumming

Greenhaugh, one of the leading figures in the early days of the London Geological Society, edited the first geological map of England and Wales. In 1854 he produced a general sketch at a scale of 1:1.8 million of the geology and physiography of India, based on reports of varying accuracy and comprehensiveness provided by largely amateur observations of East India Company officials. Greenhough's map was thus mainly a compilation and in 1851 Thomas Oldham, from Ireland, began the official Survey of India. The final version of Greenhaugh's map was dated 1854 and printed at his own expense, most of the copies being given away. East India Company employees were instructed to send in comments for later updated editions. Greenhaugh died in 1855 and Oldham was asked to prepare a new edition. By 1877 the Indian Geological Survey had produced a new map at a smaller scale of 1:4 million, with simpler but more accurate geology.

Iceland

by Mr J K Oakley

The oldest rocks on Iceland are Tertiary Plateau Basalts and volcanic activity has been almost continuous up to the present day. Both basaltic and rhyolitic lavas have been erupted, as well as large amounts of pyroclastic material. Some eruptions have taken place subglacially producing hylaclastitic palagonite.

Welsh Mines

by Mr M A E Browne

Several disused mined in NW Wales may be visited by the public; the copper mines on Great Orme, for example, where only spoil tips remain and the slate mines (Llechwedd and Gloddfa Ganol) at Blaneau Ffestiniog. In the slate mines slate was extracted from a series of inclined and horizontal chambers which extended over a vertical distance of 1500 feet. At its height, the industry employed about 16000 men in slate quarrying and mining, now there are only about 400.

Sygun copper mine, west of Blaenau, is also open. It was abandoned near the end of the 19th century and since then a remarkable array of stalactites and stalagmites composed of iron oxides, has developed in the old workings. Some old stopes are accessible, showing the methods of working (overhead stoping), ore running and timbering.

Video-film of Peat Working in Germany

by Mr P McLintock

The film, presented by Peter McLintock (Penicuik Peat Co) illustrated the methods of peat working and processing used by Klasmann Co who work a raised peat bog, similar to that worked by Penicuik Peat. Cutting, drying, loading and processing are all highly mechanised. The main products are horiticultural peats, but chemical and pharmaceutical applications are being studied. Products are exported all over the world, including Scotland and Australia! As well as horticultural peat products, peat coke and activated charcoal are also produced.

8th March

The short and varied history of a small basin in South East Spain

Dr P J Brenchley, University of Liverpool

The dissected, arid landscape of south east Spain beautifully exposes the geology of the area and reveals its complex history from the Miocene onwards.

In south east Spain early Miocene nappes were emplaced, uplifted and collapsed to form three small basins separated by "basement" highs. One of these basins, the Sorbas Basin, has a Miocene to Recent history of repeated subsidence and uplift, reflecting the tensional, compressional and strike slip tectonics which affected the region. In its final phase the basin had varied transgressive facies, marginal reefs, widespread Messinian evaporites and then as basin subsidence slowed, varied shoreline and fluvial facies developed. The fluvial facies heralded the final phase of deformation and uplift which produced the present-day relief.

22nd March 1989
Presidential Address

On Geology and Geologists
Professor E K Walton, University of St Andrews

Geological science is not (in general) mathematical; it is an art as much as a science. Who is or who is not a scientist however, is a matter of convention as much as of strict definition. An artist is concerned with the emotions of the viewer but a scientist is not; he aims at expressing truth (as he sees it) with clarity.

Many geological observations cannot be expressed mathematically, but they are none the less valid. Observations lead to theories, some of which may be disproved, but many cannot be proved. Theories are provisional and are, or should be, continually modified; they are analogous to a series of nets of increasingly fine mesh. Both induction and deduction are necessary.

Geology makes great use of models. For example, three different models of the evolution of the Southern Uplands are currently being proposed. They are:

(1) The rocks were deposited in a trench and formed into an accretionary prism during subduction. [McKerrow]

(2) That the accretionary prism formed with an island arc to the south of the Northern belt.

(3) That there was an island arc to the south of the Central Belt, which was subsequently overriden by a foreland basin. [Stone]

Setting up a model is more important than having it accepted. Models may have to be erected on meagre and inadequate data, but rigorous thought is still necessary. Critical experiments may not be possible, but an accumulation of evidence from different sources is impressive.

Several varieties of *'Homo geologensis'* can be recognised:

(1) The macho variety, characterized by the need to suffer hardship in the field.

(2) The scribbler, who never writes up his work which remains unrecognized.

(3) The scribbler who churns out a cascade of papers, many of doubtful value.

(4) The political variety, who spends life attending conferences and committtees.

(5) The instrumental variety, for whom numbers, computers, specimens and data processing are everything, while actual rocks are of little account.

Many people see a relationship between geology and art. Thin sections of rocks for example, can be compared with modern abstract art and an appreciation of the beauty of the landscape is often deepened by understanding its geological structure. To geologists, their work is an integral part of their lives; it is not just a way to earn a living.

5th April 1989
The Caledonian Orogeny and its relations with other Palaeozoic orogenies
Dr W S McKerrow, University of Oxford, Clough Memorial Medalist, 1987-88

The origins of the 'Caledonian Orogeny' as a phase and as a concept are interesting. Suess in his 'Face of the Earth' used the term Caledonian

Mountains; Haug in the Bulletin of the Geological Society of France of 1900 used the term Caledonian Orogeny with reference to Scotland, but did not date it; Stille in 1924 placed the orogeny at the end of the Silurian and considered it to be of world-wide extent; Evans and Stubblefield in 1926 gave the first British mention, again assigning the orogeny to the end-Silurian.

In many places, there is a continuous sequence from the Silurian up into the Devonian without any stratigraphical break; the orogeny is now recognised as not of world-wide extent. It is better understood if its history is examined in the light of plate-tectonics.

The Cambrian-Ordovician Durness Limestone of northern Scotland is a warm water, near tropical deposit. In southern Britain the contemporary strata were formed in a cold-climate and contain different fossils. In early Ordovician time (Tremadoc, about 500 Ma) England was part of Gondwanaland in southern latitudes, while Scotland was part of North America. Rifting had by this time produced the Palaeo- and then Neo-Iapetus oceans, with the Rheic Ocean existing further to the South. On the northwest flank of Iapetus during the Arenig (480–Ma) the Midland Valley became the site of an island arc. Jumbled relict pieces of ocean floor are seen in the Girvan-Ballantrae area.

Further north, Caledonian events reached a climax in the Dalradian terrane with the so-called Grampian event. Further southwest (and now sited across the Atlantic) the geology of New England, though complicated, may be simplified into three sectors: The western part is Grenville (ca. 1000-1100 My) and the central part was a Tremadoc island arc. The eastern sector is termed Avalonia; it contains fossils similar to those found in New Brunswick, Wales and France. Avalonia collided with N–America during the Acadian Orogeny (Middle Devonian) with island arcs colliding earlier in the north (Newfoundland) than the south.

From the Lower Ordovician through to the Silurian, the Iapetus Ocean lay to the south of Scotland, with island arcs and accretionary prisms lying on its northwest margin. Sediment was derived from both NW and NE. Active transcurrent faulting probably took place during both the Upper Ordovician and Silurian, contemporaneous with accretion in the Southern Uplands.

SOCIAL EVENING

2 December 1988	A social evening was held in the Common Room of Murchison House (BGS) and was attended by 97 members and friends.

RECORD OF EXCURSIONS 1988

		Attendance
29 April	Charlestown and Roscobie Leaders: Dr N. Pickard and R. Garton	26
6 May	Glencoe: Joint excursion with the Glasgow Geological Society Leaders: Dr G. Durant and Dr D. McGarvie	60
13 May	East Neuk of Fife Leader: Prof. E. K. Walton	29
20-27 May	Long excursion to the Black Isle Leader: Mr S. Ross	24
3 June	Balmaha Leader: Dr B. J. Bluck	34
7 June	Edinburgh Castle Leaders: Mr N. Butcher and Mrs N. Butcher	?
17 June	Glenclova Leaders: Dr J. R. Mendum and Dr C. G. Smith	39
28 June	East Kirkton Leader: Dr W. D. I. Rolfe	40
3 September	Cairngorms Leader: Dr A. M. Hall	?
16-18 September	Aberdeen area Leader: Dr C. Gillen	27

30 September	Lomond Hills Leader: Dr A. R. MacGregor	28

COUNCIL NOTES

The International Exhibition of Geological Maps of the World was sent to the University of Toronto in October, to be part of open-day displays, celebrating the opening of a new Earth Sciences Building.

The Scottish Wildlife Trust has asked the society to provide geological descriptions of its reserves and protected sites. This task has been begun, on the societies behalf, by Mr M C Smith.

At the end of the present session, the Walter Mykura Memorial Fund for supporting and encouraging geological field work in Scotland stood at £2144.

We offer our very grateful thanks to Professor G. S. Boulton for the use of facilities at the Grant Institute, and to Dr R W Gallois and Dr D I J Mallick for the facilities provided for the society at Murchison House.

OFFICE BEARERS 1988-89

President	Prof. E.K. Walton
Vice-presidents	Mr M.A.E. Browne and Dr W.D.I. Rolfe
Secretary	Mr D.H. Land
Assistant secretary	Dr S.S. Brown
Lectures secretary	Mr J.A. Fairhurst
Excursions secretary	Mr J.K. Oakley
Membership secretary	Mr J.L. Laxton
Treasurer	Dr I.R. Basham
Convener of the Editor Board	Dr D. Grant
Proceedings and Edinburgh Geologist editor	Mr C.A. Auton
Librarian	Dr W.B. Heptonstall
Publications sales officer	Mrs C.M. Taylor
Ordinary members	Mrs F. Bowie Mr J.W. Merritt Dr S.K. Monro Dr C.G. Smith Mr H. Wright Dr P.M. Dryburgh Mrs A.F. Mykura
Scottish Wildlife Trust representative	Mr M.C. Smith

Officers not on Council

Trustees	Prof. G.Y. Graig Mr D.C. Greig Dr C.D. Waterston
Scientific editors	Dr G.M. Biggar Dr J.D. Peacock Dr S.S. Brown
Auditor	Mrs M. McLeod

STANDING COMMITTEES 1988-89

Finance	Dr I.R. Basham (Convenor) Prof. E.K. Walton, Mr D.H. Land, Dr F. Grant, Prof. G.Y. Craig, Mr D.C. Greig, Dr C.D. Waterston.
Publications	Dr D. Grant (Convenor) Dr G.M. Biggar, Dr N.H. Trewin, Prof. W.K. Walton, Mr D.H. Land, Dr I.R. Basham, Dr J.D. Peacock
Clough Memorial	Mr D.H. Land (Convenor) Dr D.J. Fettes, Prof. B.G.J. Upton Prof. E.K. Walton, Dr I.R. Basham
Excursions	Mr J.K. Oakley (Convenor) Dr W.D.I. Rolfe, Dr E.K. Clarkson, Mr A.A. McMillan, Mr A.D. McAdam, Mr N.E. Butcher, Prof. E.K. Walton, Mr D.H. Land, Dr. I.R. Basham
Planning	Mr D.H. Land (Convenor) Prof. E.K. Walton, Dr I.R. Basham

Neither the Finance Committee nor the Planning Committee met during this session.

Report of the Auditor to the Members of the Edinburgh Geological Society

I have audited the Accounts in accordance with approved auditing standards. Information supplied by individual Council members has been accepted as being correct when independent confirmation could not be obtained. The valuation of Investments by the Bank of Scotland Investment Services has been accepted.

In my opinion the accounts which have been prepared under the historical cost convention give a true and fair view of the state of the Society's affairs at 30th September 1989 and of the net Revenue for the year ended on that date.

M. McLEOD, CA

74 Colinton Road
EDINBURGH
EH14 1AT

10 November 1989

SUMMARY OF ACCOUNTS

Statement of balances at 30th September, 1989

	1989		1988	
	£	£	£	£
Fixed Assets				
Investments at Market Value		49,144		45,028
Current Assets				
Stock of Publications	7,445		6,660	
Other stocks	179		285	
Debtors	196		257	
Taxation Recoverable	1,072		992	
Bank Deposit Accounts	3,895		3,000	
Current Account	1,152		–	
	13,939		11,194	
Less:				
Creditors due within one year				
Sundry	795		570	
Loan (Necker Map)	700		700	
Bank overdraft	586		348	
	2,081		1,618	
Net Current Assets		11,858		9,576
Net Assets		61,002		54,604
Representing:				
Funds				
at 1 October 1988		54,604		55,588
Donations to Walter Mykura Fund		2,317		–
Increase (decrease) in value of Investments		2,525		(3,152)
Scottish Journal of Geology Allocation		1,500		1,400
Surplus for year		1,561		1,380
		62,507		55,216
Less:				
Specific Expenditure				
(Scottish Journal of Geology Vol 24)		(1,505)		(612)
		61,002		54,604

Revenue Account for the year ended 30 September 1989

Income	*General* £	*Publi-cations* £	*Clough* £	*Wright* £	*Sime* £	*Total* 1989 £	1988 £
Income from quoted investments	1,445	1,853	368	98	123	3,887	3,632
Bank interest	315	–	–	–	–	315	366
Subscriptions	4,649	–	–	–	–	4,649	4,517
Tax recoverable on Deeds of Covenant	21	–	–	–	–	21	48
Profit on sale of publications	–	662	–	–	–	662	793
Other	4	–	–	–	–	4	–
	6,434	2,515	368	98	123	9,538	9,356

Expenditure	*General* £	*Publi-cations* £	*Clough* £	*Wright* £	*Sime* £	*Total* 1989 £	1988 £
Lectures	1,193	–	–	–	–	1,193	1,288
Excursions	752	–	–	–	–	752	428
Audit	400	–	–	–	–	400	380
Print. Post. Stat.	1,855	860	–	–	123	2,838	2,381
Miscellaneous	–	–	333	–	–	333	336
Insurance	100	–	–	–	–	100	75
Reception	67	–	–	–	–	67	46
Library additions	113	–	–	–	–	113	180
Bank Charges	327	–	–	–	–	327	297
Non-recurrent expenditure	354	–	–	–	–	354	1,165
	5,161	860	333	–	123	6,477	6,576
	1,273	1,655	35	98	–	3,061	2,780
Specific allocations	–	(1,500)	–	–	–	(1,500)	(1,400)
Surplus for year	1,273	155	35	98	–	1,561	1,380

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