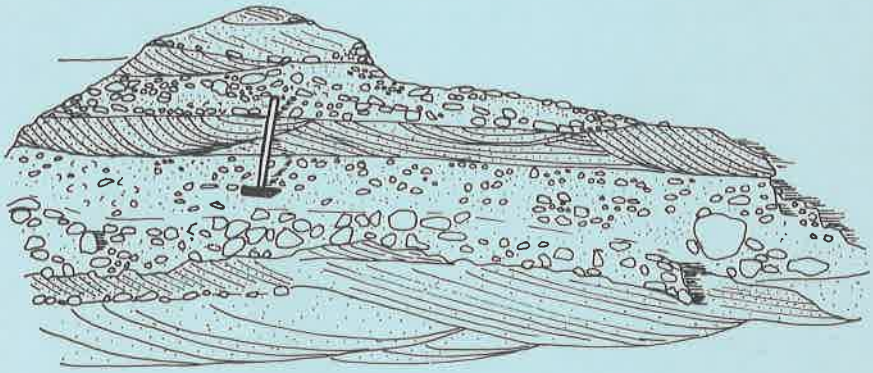
PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF GLASGOW



Sessions 121/122 1979/1980

EDITORIAL

In order to bring the Proceedings of the Geological Society of Glasgow up to date this volume reports on both sessions 121 and 122 with the exception that the annual reports and some of the later field excursion reports will be covered by the next issue.

SESSION 121

MEMBERSHIP

The Membership of the Society for Session 121 was as follows:

Honorary Life Members	4
Ordinary Members	389
Junior Members	17
Life Members	3
Associate Members	19

During the session 19 Members were deleted. The membership of the Society was increased by the addition of 34 new Members.

J. R. Thomson

LIBRARY REPORT

The session was moderately successful, the usual small group of Members using the library consistently. The 23 Members who comprise this group made 161 loans between them, over three times last year's total — a notable effort. Some new books are being, or have been, acquired. Field guides figure largely together with dinosaurs, the oceans and a social history of British Naturalists.

The usual periodical exchanges have been effected and binding of back numbers will soon commence. The long-promised catalogue of books in the Society's library is now available to those Members who require a personal copy and a catalogue of the Society's extensive collection of journals will appear shortly.

The financial transactions of the library appear in the Society's Accounts for the session.

Since Members appear reluctant to venture up to the library it is appropriate to mention once again the facilities available both in our library (Room 403, Geology Dept.) and in the University Library. Our own library offers a wide range of books and journals from introductory texts to advanced works and includes many geological guides, encyclopaedias, books of general interest and such journals as "Nature", "Science", "Scientific American" etc. The library opens from 9 a.m.-5 p.m. Monday to Friday and from 7 p.m.-10 p.m. on Society meeting nights. Members may also use the extensive facilities of the University Library including borrowing facilities for up to 12 books. Any Members contemplating using the University Library should apply first to the Society Librarian for details.

Furthermore the Geology Department's large collection of maps is

available to Members on a consultation basis only, at any of the above mentioned times. Please apply to the Departmental Librarians (Dr C. J. Burton and Mrs B. Mackenzie) for use of this facility.

The Society Librarian will also be glad to help with enquiries from any Member for specific geological material or references, and in this connection a start has been made on a series of pamphlets on "Holiday Geology" giving maps, references and brief details on the geology of the more popular holiday areas in Britain and Europe. (See Librarian for details).

C. J. Burton

NEW BOOKS IN THE SOCIETY'S LIBRARY

This year's list contains a mixture which I hope will provide for the varying interests of members in an attractive and informative way. The mixture contains geological excursion guides, books on the more general aspects of field geology, introductory texts to a number of fields, encyclopaedias and a few more specialist works for those members who want to penetrate more deeply into the subject.

The year's crop of guides for Scottish localities includes **Geologists' Association Guide No. 21** by **A. J. Barber et al** on the **Lewisian and Torridonian Rocks of N.W. Scotland** with excursions and an account of what may be seen on the coast and inland in Sutherland. For addicts of the Inner Hebrides **C. H. Emeleus** and **R. M. Forster** provide a **Field Guide to the Tertiary Igneous Rocks of Rhum,** while on the other side of the country **D. C. Grant's** guide to the **Bass Rock** gives details of the geology, botany and ornithology of the islet. Back on the mainland the glacial deposits in and around Glasgow are fully explained in a **Quaternary Research Association** guide edited by **W. G. Jardine.** Moving to the Borders **D. A. Robson's Guide to the Geology of the Cheviot Hills** deals with the granites of the Cheviot itself and with the Old Red Sandstone lavas and pyroclastics of the area between Jedburgh and Alnwick. Worthy of note outside Scotland is **Rudolf Trümpy's Geology of Switzerland: A Guide Book** which combines a geological description of the country with the most comprehensive excursion guide I have yet seen, including some trips which appear to be purely vertical.

Winter appears to have set in during early June this year and of course the Society has a number of excellent introductory books for the necessary fireside reading. For dinosaur-watchers there are **Alan Charig's A new look at the dinosaurs** and **L. B. Halstead's The evolution and ecology of the dinosaurs,** contrasting and beautifully illustrated approaches to their subject. These could be followed by **Halstead's The evolution of the mammals,** a clear guide to a rather complex field. What Darwin himself said about evolution is convincingly interpreted and appropriately displayed by **Richard Leakey** in **The Illustrated Origin of Species,** while for those more interested in providing their own illustrations there is **Alfred Blaker's Field Photography: Beginning and Advanced Techniques.** The rest of palaeontology, bag and baggage may be found at length and in detail in **Fairbridge and Jablonski's Encyclopaedia of Paleontology.**

A topical field is covered in an absorbing and informative fashion by **Williams** and **McBirney's Volcanology,** a clear and concise rendering of

much modern research. Finally the latest word on Scotland is to be found in **Harris, Holland and Leake's** massive compendium **The Caledonides of the British Isles Reviewed.** This book contains a large section of the formation and development of the late Precambrian and Lower Palaeozoic rocks of this country, conflicting hypotheses thereon and much valuable debate. Not an easy read but a very rewarding one, nevertheless.

C. J. Burton

REPORT OF THE EDITORIAL BOARD

Volume 14 of the **Scottish Journal of Geology** comprised 362 pages, published in 4 parts. The delays in publication have gradually been shortened during 1979 with the issue of Volume 15, and part 4 will be sent to subscribers at the end of November. Volume 15 will total 342 pages. There has been a healthy supply of papers during the year, but the excessive publication delay of the last year or two has been lowered to an acceptable level by stricter controls on the length of individual papers, since there is no possibility at present of increasing the size of the **Journal.** The Board has decided, with the approval of the two Societies, to increase the commercial subscription rate from £20 to £30 from Volume 16 onwards to meet increased printing costs.

D. K. Smythe

PUBLICATION SALES

The sale of publications this session has gone extremely well. The number of Arran and Glasgow Guides sold has increased as a result of two unusually large orders. Sales through the Society Bookshop both to Members and to students in the Department also continue to be a good source of income, especially with new publications. These books are bought by the Society at a discount and provide a useful additional source of funds. Therefore suggestions of other books for sale at the Bookshop would be welcome.

Stocks of Arran Guides now stand at 1378 and of Glasgow Guides at 1826. We should now obviously start thinking about reprinting the Arran Guide, since on this session's sales our stocks will be exhausted in about two years.

C. J. Farrow

GEOLOGICAL HOWLERS

This is the Society's latest (and lightest) publication, comprising fifty pages of geological howlers gathered together by Dr W. D. I. Rolfe (price £1). A Freudian slip may explain "Mountains are formed in erogenous zones" but our merriment must be tinged with feelings of disquiet when we read that "The first law of geology is the law of supposition".

OBITUARY NOTICE

Emeritus Professor Thomas Neville George, M.Sc.(Wales), Ph.D.(Cantab), D.Sc.(Wales), Sc.D.(Cantab), Hon.Ll.D.(Wales), Hon.D.-ès-Sc.(Rennes), F.R.S.E., F.R.S. (1904-1980) died at his home in Glasgow on June 18, 1980. For the last three years he had borne incapacitating illness with courage and dignity, and with the devoted help of his wife Dr Sarah Davies, he had continued to study, to write, and to visit the Department of Geology to teach.

He was born on the outskirts of Swansea, South Wales. His father, a schoolmaster, was deeply involved in helping the community in which he lived. Neville George also held the belief that academics should have educational commitments beyond their formal university duties. This guiding principle was expressed, among other things, as active support of extra-mural courses. During his early career at Swansea he gave time generously to the Workers Educational Association, and served as Chairman of the Extramural Committee of University College, Swansea.

Later, he played a vital role as Committee Chairman, in developing the work of the Extra-Mural Department of Glasgow. Other formal commit ments included service as Chairman of Newbattle Abbey College Executive Committee, and of the Scottish Field Studies Association, and as a Governor of Coleg Harlech. He took a continuous interest in the British Association, which links the interests of amateur and professional geologists, and served as President of its Geology Section in 1953. He was both an amateur and a professional geologist, himself. His concern for the well-being of our Society was particularly strong, since it caters for both interests. He gave it much service and support, and was President during its Centenary Year. He was elected an Honorary Life Member in 1974.

Geology was at the core of his life and interests, but he was not over-specialised as a geologist or a man. At Swansea he gave extra-mural courses of lectures on a wide range of subjects, including music, philosophy and art. He was a highly qualified musician — a pianist of quality and versatility. He was a master of the art of conversation. The well-phrased pithy comment came readily to him, and he could listen with a care that stimulated his companion. He enjoyed dialectic and took an interest in politics. He retained an Edwardian optimism about rationalism, the good intentions of most men (even politicians), and the probability of social progress. Some of his wider concerns found an outlet in the Association of University Teachers which he served as national President in 1959-60, and as a member of the National Broadcasting Council for Scotland.

He did not categorise individuals by class or race, but nevertheless remained intrinsically a "Gower man" himself. After an early sense of strangeness when he arrived in Glasgow (a strangeness compounded of customs, novel to him, such as Christmas being a working day) he developed a strong loyalty to south-west Scotland and its ancient university. His knowledge of, and his pride in, its history surpassed that of most graduates, and he was a stout defender of the traditional breadth of

Scottish education. In a humorous rationalisation of his joint loyalties to Wales and Glasgow, he would remind listeners that Strathclyde had been a Welsh-speaking kingdom until the 10th century.

His career in geology was encouraged by personal contact at University College Swansea with two notable geologists. T. F. Sibly was Principal of the College. Professor (later Sir Arthur) Trueman was Head of the Department of Geology. Neville George had intended to read chemistry, and had to attend a course of geology in his first year. He fell under the spell of the subject and his teacher. His respect and liking for A. E. Trueman were reciprocated, and the bond between them remained strong until Trueman's death.

He succeeded Trueman to the Chair of Geology in Swansea in 1933 (when still only 29), and to the Chair in Glasgow in 1947. After his first degree at Swansea (1924), and two years of research under Trueman, he spent two years (1926-28) at St John's College, Cambridge. He was an outstanding post-graduate student. He was elected a Fellow of the University of Wales in 1926, and was awarded the Bonney Prize for field geology at St John's in 1927. He returned to Swansea as a Demonstrator (1928-30) and then in 1930 won a post as Geologist in the Geological Survey G.B. Whilst in London, his private research and teaching interests were in part sustained by service at Birkbeck College in the evenings. Then in 1933 he became an unusually young professor when he was appointed to the Chair at Swansea. He remained there until he came to Glasgow in 1947.

Many of his interests in, and his contributions to, geology stemmed from his early field work on the Carboniferous Limestone of South Wales. From it developed his interest in rocks of similar age throughout the British Isles. He, and his research students, were particularly active in Ireland, and to a lesser extent in the Midland Valley and South Wales. His early professional interest in the fossils of the Carboniferous Limestone was stratigraphic. One early project was to extend the zoning of the Avonian rocks along the North Crop of the South Wales Coalfield. This was followed by monographic accounts of brachipods (the reticulate Spirifera). He contributed increasingly to evolutionary theory, both on the scale of studying changes within a fossil genus, and by reviews and other publications on the synthetic theory of evolution. A separate branch of enquiry prompted him towards early work on carbonate sedimentology (though he long preferred the word 'stratigraphy' to the new term). Another major field of interest, geomorphology, was sparked by the land-forms of South Wales. His early study of the coast-lines of Glamorgan was followed by later work on the evolution of drainage systems in Wales and in the Southern Uplands, and on the ancient levels in western Scotland. He was a prolific author and his publication list is itself a publication. Among them are his book, *Evolution in Outline* (1951), The Regional Guides on North Wales (1961) and South Wales (1969), and his contributions to *Aspects of the Variscan Fold Belt* (1962), *The British Caledonides* (1963), *The Geology of Scotland* (1964), *University Instruction in Geology* (a UNESCO report) (1965), and *The Upper Palaeozoic Rocks of Wales* (1974).

His distinction in geology was recognised by office, and by awards. He was President of the Palaeontological Association (1962-64), of the Geological Society of London (1968-70) and of the UNESCO Commission on the teaching of geology in universities. He was Vice-President of the Royal Society of Edinburgh (1959-61). He became a Fellow of the Royal Society in 1963.

He was Chairman of the Geological Conservation Council, and of the Minerals Resources Panel of the Scottish Council. He served on several NERC committees. He received honorary degrees from the Universities of Wales and of Rennes. He was awarded the Lyell Medal of the Geological Society of London ("One who deserved well of the science") in 1963, the Neill Prize of the Royal Society of Edinburgh in 1973, and the Kelvin Prize of the Royal Philosophical Society in 1975. He was Woodward Lecturer at Yale in 1956, Senior Foreign Fellow at Northwestern University in 1964, Visiting Professor at the Universities of Witwatersrand, Cape Town and Natal in 1967, and Distinguished Visiting Lecturer at the University of Saskatchewan in 1974. After retiral, his research was supported by the award of a Leverhulme Emeritus Fellowship (1977-79).

This commitment to scholarship was combined with his enthusiasm for teaching. He carried a heavy lecturing load, which at one time included half of the Glasgow first year course . . . "in the Scottish tradition". He was a fluent and lucid lecturer who quickly established a rapport with his audience. A rowdy class of 300 first year students in the post-war years could be a challenge. They were never rowdy for long, if at all, with Neville George. His charm and authority are still remembered by grey-haired men and women, who can no longer recall precisely what a strike-line is. He had *gravitas* and humour. He combined a quiet manner with inner certainty, and seemed devoid of the doubts and fits of pessimism that plague others. His death leaves a gap.

He married in 1932. His wife, Dr Sarah Davies survives him. His memory will be kept alive by many friends and by hundreds of students who were influenced by him.

A. C. McLean

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Mary Lawson Martin (**née Monteath**) was born on July 25, 1903 in Glasgow but her home was in Bonnybridge and it was there that her childhood was spent, her father being the proprietor of the Royal Hotel.

She was educated at the local village school and later by tutor before moving to Glasgow to begin her apprenticeship as a pharmacist. She attended evening classes in the Intermediate and Qualifying stages at the old Royal Technical College from 1924-27 while working as an apprentice pharmacist during the day. In 1929 she married Alexander Martin, a bank manager.

During the Second World War she served with the WVS Civil Defence as an ambulance driver and was involved with the Kilmun Street (Maryhill) blitz). She also served with the ARP. She was a keen motorist all her life and in August 1979 was awarded the meritorious 50 year badge by the Council of Veteran Motorists.

Her interests were many and varied and her appreciation of music and art was extensive. She was a keen photographer, liked to travel and above all she loved nature in all its forms. In her young days she was an enthusiastic hill walker and in later years never went into the country without binoculars for bird watching and a camera to capture some aspect of nature.

She joined the Geological Society of Glasgow in 1957, was elected a member of council in 1959 and also acted as assistant librarian from 1962 to 1971. She was an active member of the Society, joining in all the excursions till ill health forced her to become less active. In spite of this she continued to help the Society, dealing with the folding and despatch of billets for the meetings until a final heart attack caused her death on November 1, 1979.

Her unfailing thought and concern for other people and her kindness to many will long be remembered by those who knew her and will miss her.

E. M. Anderson

PERSONALIA

Dr B. J. Bluck has been awarded the Keith Prize (including a medal) by the Royal Society of Edinburgh. This prize is awarded biennially for the outstanding communication to the Society.

Dr G. Durant organised a very successful meeting of the Volcanic Studies Group of the Geological Society of London in the department during May 1980.

Drs A. C. McLean and C. D. Gribble have produced **"Geology for Civil Engineers"** (Allen and Unwin), which is already a best seller.

Dr R. Anderton is one of the authors of **"A Dynamic Stratigraphy of the British Isles"**, a book which attempts to inject vitality into a subject which can often become tedious. It has met with wide acclaim.

LECTURES 1978-79 (SESSION 121)

The first lecture of the season **"Basement rocks of the British Isles"** was given by **Mr F. W. Dunning** (Curator, the Geological Museum, London) who gave a summary of knowledge of the Variscan, Caledonian and Precambrian basement rocks of the British Isles. Special reference was made to areas of controversy and the lecture was copiously illustrated.

The November lecture was given by **Dr R. J. Price** (University of Glasgow) on the topic of **"Ice-marginal environments in Alaska, Iceland and Scotland"**. It was fully illustrated with superb photographs of Alaska and Iceland and finished with showing some of the features seen there are also well demonstrated much nearer home.

The **Annual General Meeting** in December followed a rather different

pattern from previous years. After a brief A.G.M. **Dr G. Farrow** talked about the great variety of marine creatures living on rocky areas of the Scottish continental shelf.

He showed that some spectacular animals like starfish, make no recognisable contribution to the calcareous sediments while others, relatively insignificant, such as worms, snails and barnacles are more durable and survive attack by boring and grazing animals better than their neighbours. After the lecture there was a well attended wine and cheese party to round off an enjoyable evening.

In January **Dr R. Bradshaw** (University of Bristol) talked on **"The Geology of Leonardo da Vinci"**. Da Vinci's geology, as found amongst the several thousand pages of his notebooks, included observations on erosion and sedimentation, sedimentary rocks and their fossils, on changes in the distribution of land and sea, on the origin of springs and rivers and on internal processes.

The February members night included the following short talks:—

The Oines Conglomerate, Nordland, N. Norway. **Dr Colin Farrow.**

Further thoughts on the Bennan Sill, Arran. **Mr A. Herriot.**

Minor intrusions and other geological features of Great Cumbrae. **Dr R. Hill.**

Fossil fish from the Middle Devonian of Orkney. **Dr A. G. Dore.**

Early geological maps of John McCulloch. **Mr D. A. Cumming.**

Honours projects. Selected students.

The following exhibits were on display:—

The Garrel Burn area, Kilsyth. **Mr J. McK. Allan.**

The Brandon Flint Knapping Industry. **Mr J. Davies.**

Geological specimens from the Milngavie-Baldernock area. **Mr J. Carrick and Mrs A. Lawson.**

Mineralisation in basalt from Loanhead Quarry, Beith. **Dr J. G. MacDonald** and **Dr E. M. Patterson.**

A Central Highland Root Zone — 'New Evidence'. **Dr P. R. Thomas.**

Recent acquisitions in the Hunterian Museum.

In the March meeting of the session **Dr M. F. Ridd** (B.N.O.C.) gave a lecture on **"Oil Exploration to the west of Scotland"**. His talk covered the recent geological discoveries about the sections from Raasay to the deeper water of the Rockall Trough, the Wyville Thomson Ridge and the Faroes Shetland Trough, using recent seismic reflection sections.

The Celebrity Lecture — the final meeting of the session in conjunction with the Edinburgh Geological Society — took place on Thursday, March 15. **Professor John Haller** (Harvard University) lectured on **"The East Greenland Caledonides"**.

Illustrated by colour slides he showed that rocks from the Archean shield up to thick stacks of Tertiary basalts occurred. The Caledonian fold belt, although of uniform northerly trend has embodied a complexity of Proterozoic vintage. Central East Greenland, the site of multiferous rifting events, was subject to mountain building until Carboniferous rifting initiated the evolution of the Proto-Atlantic. The Mesozoic seaboard

largely followed the present coast, but in the Paleocene the shelf was raised, exhumed and flooded by subaerial basalt.

EXCURSION PROGRAMME (SESSION 121)

21st April. Hunterston ..... Dr E. M. Patterson
5th May. The A82 and Cruachan ..... Dr J. G. MacDonald
18th-23rd May. Raasay Weekend ..... Dr C. D. Gribble
3rd June. Lang Craigs ..... Dr B. J. Bluck
16th June. Kilbirnie ..... Mr M. Yuill
7th July. Garrell Burn, Kilsyth ..... Mr J. McK. Allan
18th August. Glenbuck ..... Dr D. W. Powell
1st September. Loch Doon ..... Mr R. Cornish

LECTURES 1979-80 (SESSION 122)

The first lecture of the session took place on 11th October and was given by **Dr Jim Brooks** (B.N.O.C. Glasgow) on **"Scientific Views of the Origin of Life"**. He talked about the rapid increase in the study, in chemistry, geology, physics and biology, and in the understanding of the origin of life in the last ten years.

The Presidential Address, by the retiring president **Mr A. J. Herriott,** on **"The Minor Intrusions of South Arran"**, described how, over more than thirty years, he has investigated the numerous minor intrusions which can be seen in Arran. His particular interest was in the relationships of and variations in the 'crinanite' and quartz-dolerite/felsite sills and dykes of the south-eastern quadrant of Arran.

The A.G.M. in December was followed by two films "Geysir Valley" about Yellowstone Park and "Heartbeat of a Volcano" about Hawaiian volcanic activity. After this there was a wine and cheese party.

In January **Dr P. R. Thomas** (Paisley College of Technology) lectured on **"A Geologist in the West Central Highlands"**. In a talk beautifully illustrated by colour slides he described the geology, particularly of the Moine rocks in the area between the A.9 and Black Mount, so that a cross-section could be constructed from the Highland Border to the Great Glen.

Members night, in February included short talks on "The Longtown (Carlisle) Earthquake of 26th Dec. 1979". **Dr A. C. McLean.** "Geology of Tenerife". **Dr B. G. Cooksey.** "McCulloch at Addiscombe". **Mr D. A. Cumming.** "A camp in Kolyma, N.E. Siberia". **Dr J. D. Lawson.** "Amateur thin section making". **Mr A. Herriot.**

The following exhibits were on display: "16th-19th century geological books in the collections of the Geological Society of Glasgow". **Dr C. J. Burton.** "The Silvermines lead-zinc ore body, Tipperary, Eire". **Mr G. Gray.** "The Coal Measures of Northumberland and Durham". **Mr S. Hazeltine.** "Raasay Igneous rocks, with thin sections". **Mr A. Herriot.** "Jurassic oolitic limestones from Oxfordshire and Yorkshire". **Dr M. C. Keen.**

The March lecture was given by **Dr C. J. Talbot** (University of Dundee)

on **"New Aspects of Evaporite Deformation"** in which he discussed evidence from one of the salt glaciers in Iran which suggests that some evaporites are so weak that they circulate by thermal convection in response to the regional heat flow rather than being entirely due to loading by the overlying cover.

The final meeting of the session, in April, was given by **Dr Roger Anderton** (University of Strathclyde) who lectured on **"The Sedimentary and Tectonic Evolution of the Dalradian Basin"**. By applying sedimentological techniques the detailed depositional and palaeogeographical history of the late Precambrian to lower Palaeozoic Dalradian metasediments is being worked out. The various Dalradian facies were described, the palaeogeographic evolution reviewed and the sedimentation considered in the light of plate tectonic models for the evolution of the Caledonian belt.

EXCURSIONS 1980 (SESSION 122)

Great Cumbrae (Leader: Professor W. E. Caldwell)
by J. Rigby Mirtle

About 45 people, including a number of youngsters, gathered at Largs and travelled to Great Cumbrae by ferry on 26th April. On Cumbrae the party was welcomed by Professor Caldwell who gave a résumé of the geology to be seen. Thereafter the island was circumnavigated, partly by bus and partly on foot. Splendid exposures of Old Red Sandstone and Lower Carboniferous sediments, along with minor intrusions of Carboniferous, Permo-Carboniferous and Tertiary age were seen. At each exposure an explanation was given of the geology, and members were then able to examine the rocks in detail.

A most interesting and enjoyable day was had by all who attended. The weather, in spite of the weather forecast, was superb. Many members of the party found that not only were the geology and weather excellent, but so also was the ice cream both in Largs and on Cumbrae.

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River Endrick and Balmaha (Leader: Dr B. J. Bluck)
by Lawrence G. Jubb

The second meeting of the 1980 season took place on 10th May when a party of 19, including three young people, met Dr B. J. Bluck at the River Endrick near Drymen. The purpose was to examine the sedimentary structures in a typical meandering river. Dr Bluck described the dynamics of current bedding and demonstrated the different types of point bars and evolution of the river pattern. The interpretation of fossil sedimentary structures was discussed. The low state of the river flow following the recent dry weather enabled the river to be crossed easily although at least one member proved the presence of unconsolidated sediment at the tail of a point bar by a practical test! Lunch was enjoyed sitting on the bank of the river in the warm sunshine watching the flight of sandpipers.

After lunch the party proceeded to Balmaha to examine the Old Red Sandstone coarse conglomerates adjacent to the Highland Boundary fault.

The provenance of the clasts in the contrasting units and the probable movements of the fault were discussed. The excursion continued with an examination of the carbonated serpentine exposed on the shore of Loch Lomond and in a nearby quarry. Dr Bluck concluded the meeting with a description of the tectonics of the region. The leadership, the subject matter and the perfect weather combined to make this a most interesting and enjoyable occasion.

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The Ben Alder Excursion (Sat. 24th May-Mon. 26th May 1980 — Leader: Dr P. R. Thomas)
by Brian G. Cooksey

Eleven members met in North Frederick Street and drove in the mini-bus to the first exposure in Glen Garry where we met the last five members of the party. In the river section there we examined inverted flaser bedding and mullion structures.

We reached the Ben Alder Estate and after an argument with a drunken fisherman intent on poaching, who demanded we leave the gate open, we drove alongside Loch Ericht and then abandoned the cars. With each member carrying a pack and a bag of provisions we walked the remaining three miles to the bothy (Cluny Lodge). This was a handsome structure of asbestos sheets with a wooden floor and (what luxury) running cold water. We had a meal and then visited lancet edge and examined D3 folds and graded bedding. We returned quite ready for sleep after a six mile hike.

On Sunday the hard wooden floor contributed to an early rise and by 9 a.m. we were on our way to examine the Geal Charn steep belt. We saw some very impressive exposures of isoclinal folds and M-folds and had lunch surrounded by snow. Several members now deserted the leader in order to collect Munroes. The remainder went on to examine the slides in Coire Sgoire and Coire Cheap with their strongly sheared rocks and prominent S1 cleavage. We also saw the Kinlochlaggan syncline with its clear repetition of the lower Dalradian sequence including limestones and a kyanite schist. On the return journey many members collected pine logs from the peat bog and after dinner (corned beef hash and home made wine) we sat around a blazing fire drinking Drambuie and singing to tunes played by Dr Macdonald on a tin whistle.

The final day was devoted to Ben Alder and was much less energetic than Sunday owing to the two members who had worn out their feet on the previous day. The open Ben Alder folds (D3) were seen in several places in Coire Labhair to fold the tighter earlier folds. There were also several good examples of crenulation cleavage. We had lunch on the summit of Ben Alder and on our return via Sron Bealach Beithe were able to examine very large open folds in the Ben Alder Moine rocks (10 miles).

After returning to the bothy for a meal and carrying our equipment back

the remaining 3 miles, exhausted but satisfied members lay about on the grass prone, waiting for the mini-bus to carry us back to Glasgow. This was the end of a memorable excursion.

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Dobb's Linn (Leaders: Dr E. N. K. Clarkson and Mr S. H. Williams)
by William T. Coffield

A small but enthusiastic party left Glasgow by coach for Dobb's Linn on Saturday at 9.30 a.m. On the outskirts of Moffat going towards Dobb's Linn we could clearly see patches of New Red Sandstone giving fertile fields.

At Dobb's Linn Mr S. H. Williams (Glasgow University) and Dr E. N. K. Clarkson (Edinburgh University) distributed well illustrated and detailed handouts explaining the Ordovician/Silurian boundary. The Upper Ordovician and Lower Silurian is here represented by only 250ft of black graptolitic shales. In general graptolites, being widely distributed and having evolved rapidly, made ideal time-indicators.

Both Mr Williams and Dr Clarkson explained the zonation of the graptolites and their relation to subduction in an extremely lucid manner. The graptolites were rich both in abundance and variety; the find of the day was a beautiful specimen of *Dicranograptus ramosus,* found in the Longburn section.

Unfortunately it was raining most of the time and Dobb's Linn reminded me of Walter Scott's vivid description of the hills around Moffat — "A deep, black, blackguard-looking hole of an abyss — at the bottom there is a small bit of a brook, that you would think could hardly find its way out from the hills that are so closely jammed about it."

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Lesmahagow Inlier (Leader: Mr A. D. McAdam)
by James K. Archibald

On 28th June under the leadership of Mr A. D. McAdam (I.G.S.) some nineteen members of the Society took part in a bus excursion to the Lesmahagow Silurian Inlier as exposed in the Greenock Water north of Muirkirk.the stratigraphy of the area was first generally explained by Mr McAdam; the party then spent the rest of the day carefully examining the succession at six different localities from the lower marine greywackes, through shallow water silt and mudstones to the terrestial conglomerate and sandstone formations.

A rapid alteration of colour and lithology of the formations aided in their identification. In the greywackes of the Priesthill Group ripplemarks and scouring were evident. A very well exposed fault with local crushing of the siltstone was seen near Waterhead Farm. Other features noted were mud flakes and cracks in the Dippal Burn sandstones, a large NW-SE basic Tertiary dyke and, later, red desert sandstones with rounded grains.

Fossil collectors in the party had a tantalising day for although silty mudstones gave up plentiful ostracods, the well known Dippal Burn and

Slot Burn fish beds yielded not even a fish scale, only some tentative plant remains.

Excursions were also planned for 16th August - Campsies and Finn Glen (Dr J. G. MacDonald); 30th Aug. — N.C.B. drilling rig and Glen Devon (R. Beveridge); 27th/28th Sept. — Quaternary features north of Glasgow (Dr Rose).

AN EXCURSION GUIDE TO DOB'S* LINN

S. Henry Williams

It is over a century since Lapworth published his classic work on the Moffat Shale in 1878. Since then, although Dob's Linn has been visited by countless geologists, very little thorough research has been done and many problems still require elucidation. The succession consists predominantly of upper Ordovician and lower Silurian black, graptolitic shales overlain by upper Llandovery greywackes.

The black shales were probably deposited in relatively deep water far from land. It is thought that they were formed in the Iapetus Ocean which separated England from Scotland before closing late in the Silurian. The complex structure of the area, composed of many thrust slices, is considered to represent the remnant of an accretionary prism formed over a northerly dipping subduction zone (McKerrow *et al,* 1977).

The following description results from a study of the upper Ordovician graptolite fauna of Dob's Linn by the author over the past two years, supervised by Drs J. K. Ingham of Glasgow and R. B. Rickards of Cambridge. The itinerary largely follows that of a Glasgow Geological Society excursion led by Dr E. N. K. Clarkson and the author (see separate report). The map and range chart include work by Drs J. K. Ingham and J. D. Lawson. Information from all these researchers is gratefully acknowledged. For additional descriptions and a more detailed plan of the Linn Branch see Lawson & Lawson, 1976 (Chapter 7, pp. 127-136).

To get to Dob's Linn travel to Moffat via the A74 then take the A708 Selkirk road from the town centre. Proceed ½ mile beyond the Grey Mare's Tail car park (10 miles from Moffat) to a double lay-by on the left hand side of the road, from where the gorge in black shale and greywacke is clearly visible. If time allows it is worth making a 'pilgrimage' to Birkhill Cottage, another ¼ mile beyond at the highest point of the road. This is where Lapworth stayed during his fieldwork and a plaque commemorating his work has been erected on the cottage wall.

From the lay-by follow the poorly-defined sheep track into the bottom of the valley then northwards for about 150 yards. The first black shale scree slope traversed is derived from faulted Birkhill Shale. Proceed to a small but prominent bluff which the track crosses after splitting; just to the left of this, under a thin cover of scree, is the only fair-sized exposure of Glenkiln Shale at Dob's Linn (Loc. 1).

* "This is the orthographic version as used on O.S. maps: Lapworth's original spelling is incorrect."

FIG 1

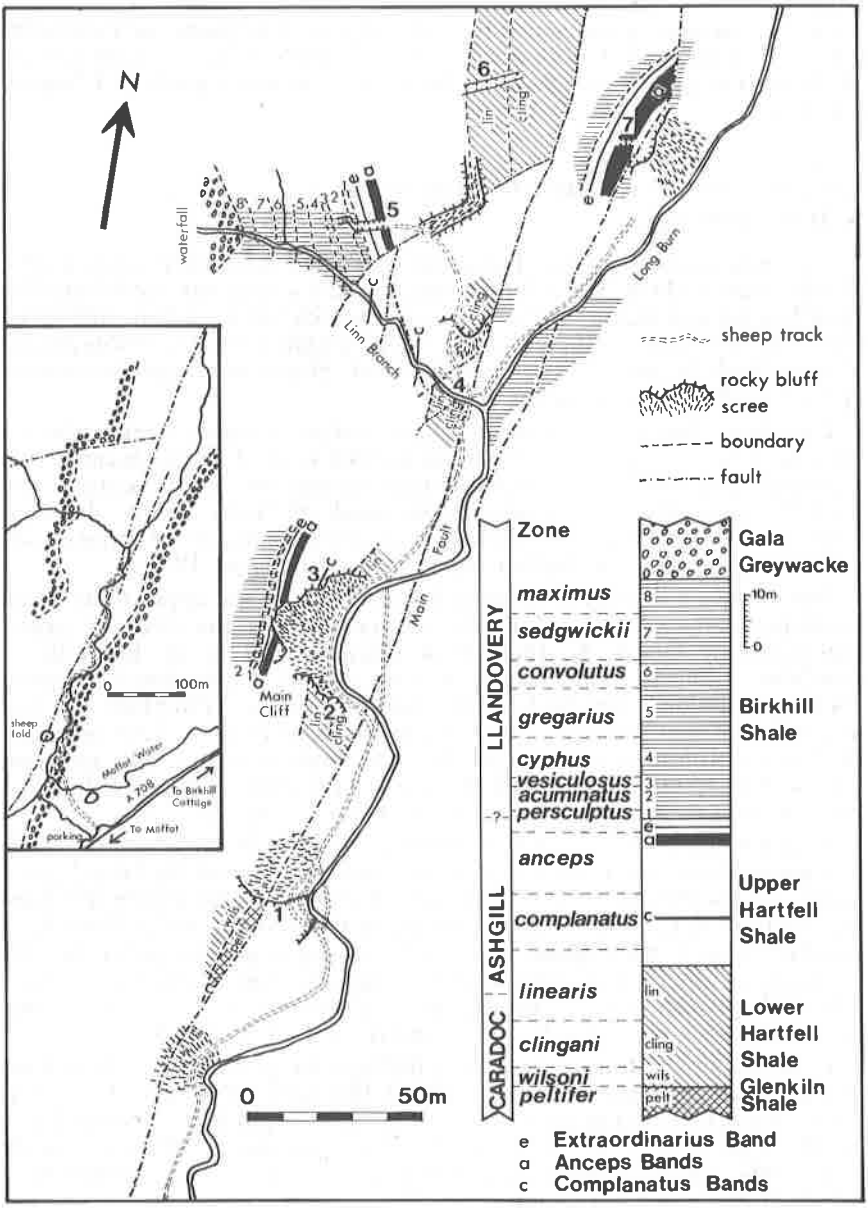

Fig. 1. Locality map and geological succession of Dob's Linn.

It is not however recommended to stop here before seeing the other localities as the graptolites are difficult to find and poorly preserved in the rather cherty shale. It may be worth collecting from this locality after seeing the other outcrops, when specimens of early *Dicellograptus, Dicranograptus, Climacograptus* and *Orthograptus* species may be found.

The first recommended stop is at the Main Cliff (Locs. 2 and 3). Before studying the shales in detail follow the track on to the right hand bank of the stream and look across to the exposure, largely hidden by scree on the lower slopes. Observe how the black Lower Hartfell Shale at the base and the Birkhill Shale at the top are separated by the pale grey Upper Hartfell Shale. At this locality the strata are dipping at about 45° and are the correct way up while at all other parts of Dob's Linn the strata are dipping at a high angle and are overturned (e.g. Linn Branch). The explanation is that the whole of the Main Cliff slumped and rotated during the Pleistocene: it is not a tectonic feature as assumed by early workers. The succession is heavily faulted so detailed sections may only be constructed with extreme care. Now proceed to the lowest bluff just above the stream (Loc. 2). This belongs to the *Dicranograptus clingani* Zone of the Lower Hartfell Shale and contains a fauna including *Dicellograptus (D. moffatensis, D. forchhammeri, D. caduceus), Dicranograptus (D. clingani, D. nicholsoni, D. ramosus), Climacograptus (C. tubuliferous, C. minimus, C. bicornis)* and *Orthograptus (O. intermedius, O. calcaratus).*

Just above this is a second, slightly hollowed out exposure. This is the upper part of the *Pleurograptus linearis* Zone and contains *P. linearis, Leptograptus (L. flaccidus macer, L. capillaris), Dicellograptus (D. morrisi, D. pumilis, D. elegans, D. carruthersi), Climacograptus (C. tubuliferus, C. caudatus, C. styloideus), Orthograptus (O. amplexicaulis, O. quadrimucronatus, O. calcaratus basilicus)* and *Plegmatograptus nebula* but no *Dicranograptus.*

Climb the scree to the exposure of black shale bands and cream bentonites in the top of the Upper Hartfell Shale. These are the five Anceps Bands and contain abundant *Dicellograptus (D. anceps, D. complexus, D. minor), Climacograptus (C. supernus, C. miserablis, C. latus), Orthograptus (O. abbreviatus, O. fastigatus)* and a descendant of *Plegmatograptus.* In the top three bands rare specimens of *Paraorthograptus pacificus* are found while the top band occasionally yields *Dicellograptus ornatus* with extremely long spines, which together with the occurrence of *Dicellograptus complexus* allows accurate correlation of the late Ordovician succession with that of Russia, North America, China and Australia. The presence of bentonites indicates vulcanism possibly related to the northerly dipping subduction zone. The top bands are repeated by strike-faulting before the Birkhill Shale is entered. Only the *Glyptograptus persculptus* and *Orthograptus? acuminatus* Zones are easily accessible on the Main Cliff.

The 1.6m of *G. persculptus* Zone contain *G. persculptus* and *Climacograptus (C. normalis, C. angustus, C. medius)* but no *Dicellograptus* which last occur in the top Anceps Band, and only rare *Orthograptus*

FIG 2

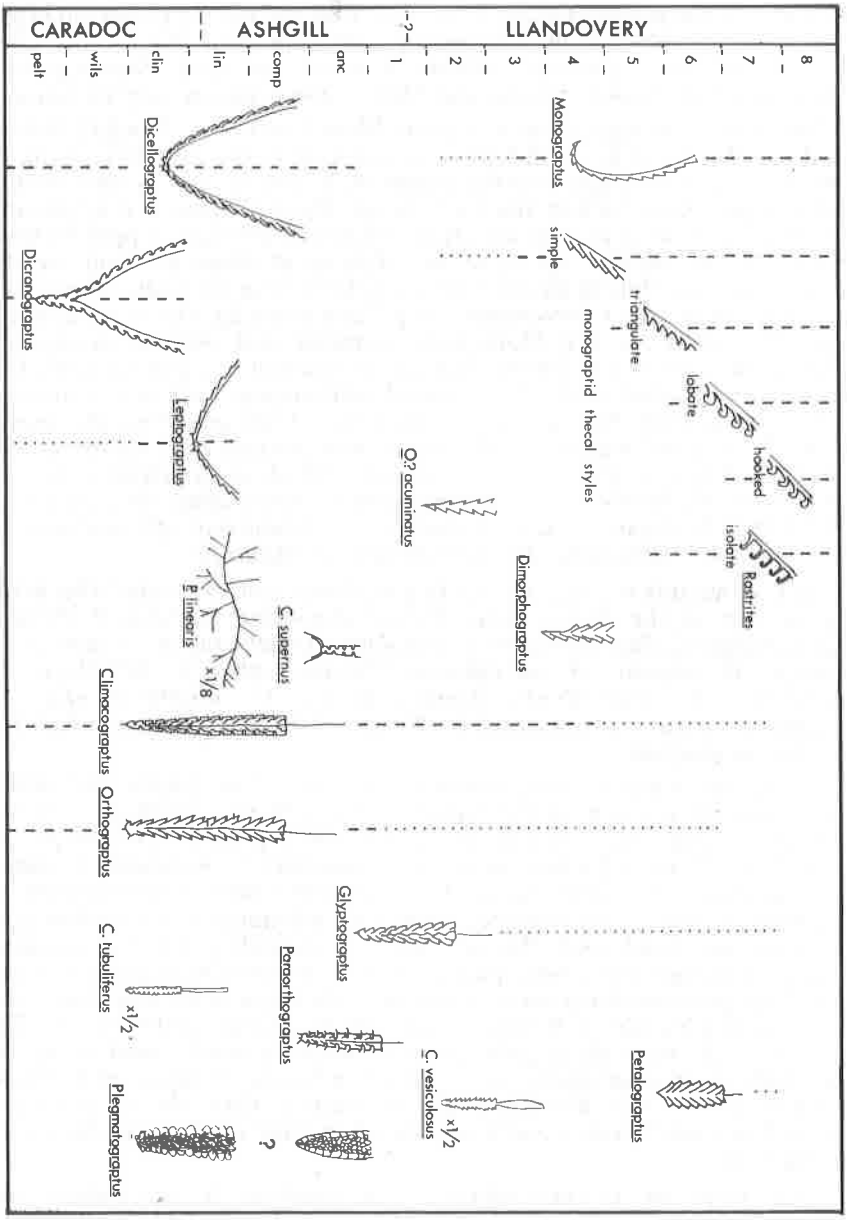

Fig. 2. Ranges of some characteristic graptolite genera and species at Dob's Linn: dotted line indicates rare occurrence (all drawings approx. x2 unless otherwise stated).

abbreviatus. The overlying *O.? acuminatus* Zone contains similar *Glyptograptus* and *Climacograptus* but also contains *O.? acuminatus, Akidograptus ascensus* and early, very small monograptids *(Atavograptus ceryx)*.

In the past the Ordovician/Silurian boundary was always placed at the bottom of the Birkhill Shales; however it is now considered that a more appropriate and usable horizon would be at the base of the *O.? acuminatus* Zone and this is presently the subject of international debate.

Cross the scree of the Main Cliff without descending to the bottom. If a little time is spent it should be possible to find the black lower Complanatus Band bounded by pale shale (Loc. 3); This contains *Dicellograptus complanatus, Orthograptus socialis* and *Climacograptus miserablis* but is more easily seen in the Linn Branch (Loc. 4).

Proceed to Loc. 4 where the main stream divides and turn into the left hand tributary, the Linn Branch. The first exposures of black shale in the hollow on the left bank belong to the *D. clingani* and *P. linearis* Zones and contain the same faunas seen at Loc. 2. Just upstream from this the two Complanatus Bands may be seen at the back of an excavation in the stream bank. These should not be collected from owing to their very limited outcrop. Rare specimens of an inarticulate brachiopod occur in and just above the upper Complanatus Band.

Climb up the track to the trench clearly visible from the junction of the Linn Branch and Long Burn (Loc. 5). This is the least tectonically affected exposure of the Anceps Bands and contains the fauna described for the bands of Loc. 2. Midway between the top Anceps Band and the base of the Birkhill Shale (remember that the beds are inverted and young upstream) is a narrow dark brown band. Rare graptolites have been found on one lamina indicating the presence of the *Climacograptus? extraordinarius* Zone known from Russia. Just below this, in a conchoidally-fracturing calcareous mudstone, rare fragments of a blind dalmanitid trilobite constituting a new genus have been found. The lack of eyes presumably indicates a mode of life in deep water below the photic zone. If the succession is followed along the trench the basal Birkhill Shale containing the *G. persculptus* and *O.? acuminatus* Zones is encountered with faunas as described for Loc. 2.

It is now best to descend to the stream to observe the remaining graptolite zones; full faunal listings for the lower Silurian graptolite zones are given by Toghill (1968) and are summarised here. Common monograptids first appear at the base of the *Cystograptus vesiculosus* Zone and are associated with abundant *Dimorphograptus, Climacograptus, Glyptograptus* and the zone fossil. In the Zone of *Monograptus cyphus* monograptics become far more abundant while *Climacograptus* all but disappears by the top. The *Monograptus gregarius* Zone contains the first *Petalograptus* and is followed by the *Monograptus convolutus* Zone which contains common *Rastrites* and the late *Orthograptus (O. bellulus)*. The Zone of *Monograptus sedgwickii* is the last one to contain *Glyptograptus* while the highest zone at Dob's Linn of *Rastrites maximus* has a fauna con-

sisting almost entirely of monograptids. During this zone the shales become interspersed with greywacke partings which become dominant to give the transitional boundary of the Gala Greywackes. Monograptid thecal style changes throughout the Silurian succession as shown in Fig. 2.

If time (and energy) allow it is worth visiting the final two localities. Locality 6 may be reached by climbing up the gully on the down stream side of the Anceps Bands trench or via the scree and grass slopes above the junction of the Linn Branch and Long Burn. The trench is excavated through the only unfaulted succession in the *P. linearis* and top *D. clingani* Zones and contains abundant well-preserved graptolites typical of these zones. The boundary between the two zones is approximately marked by the line of an old trench excavated along strike, possibly by Lapworth himself.

Loc. 7 is another trench cut through the Anceps Bands and is situated above a scree slope in the Long Burn. At this locality the succession is more than twice as thick as that in the Linn Branch. The apparently rapid thickening is more easily explained when realising that the localities are separated by a major thrust and would have been deposited tens or even hundreds of miles apart. The greater thickness of graptolitic shale means that there is a more abundant and better preserved *D. anceps* Zone fauna than at Locs. 2 or 4.

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THE CARLISLE AREA EARTHQUAKES, 1979-1980

by Jeremy Hall

Introduction

Members of the Society may have felt the ground movements resulting from the earthquake that occurred early on Boxing Day 1979. This note summarises what is known of the main earthquake and others that are related to it, and speculates on causes. The factual information is based primarily on data collected from temporary arrays of seismometers operated by the University of Cambridge (King 1980) and by the Global Seismology Unit of the Institute of Geological Sciences who also detected and located the main earthquake on its permanent arrays (Neilson 1980).

When

The Carlisle earthquakes consisted of several tens of detected tremors. The main shock occurred at 03.57 GMT on December 26, 1979 and had a magnitude of about 5 on a Richter scale (such scales are logarithmic — a change of magnitude of 1 unit corresponds to a change of about 30 times in the energy released). 4 foreshocks of magnitude 2 or less had been detected by I.G.S. in the preceding 3 months. 12 aftershocks occurred

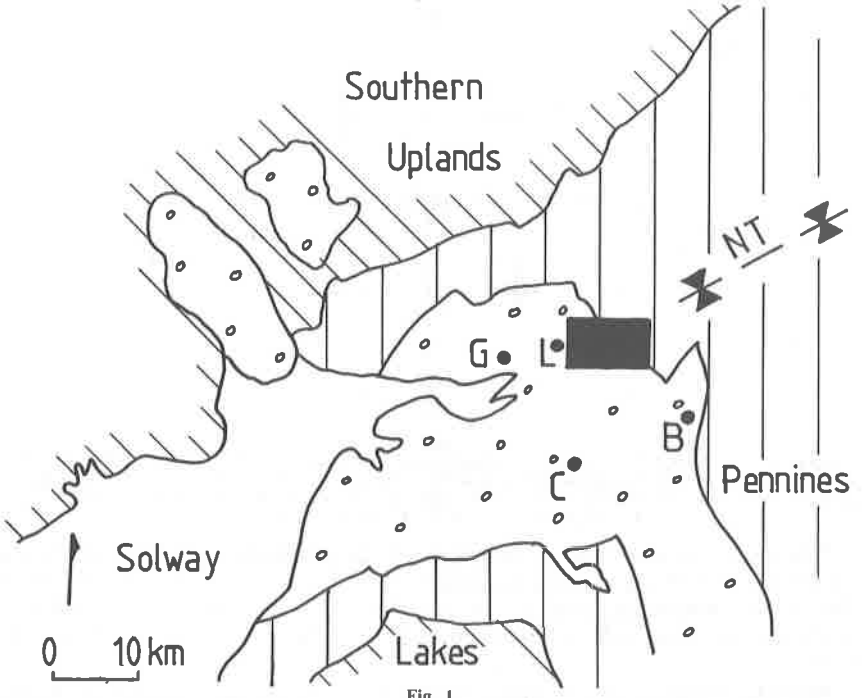

Fig. 1.

Map showing epicentral area (black) of Carlisle earthquakes. Vertical ruling indicates outcrops of Carboniferous rocks, loops indicate younger rocks, and diagonal ruling indicates edge of outcrop of older rocks. G = Gretna, L = Longtown, C = Carlisle, B = Brampton, NT = axis of Northumberland Trough.

within 24 hours of the main event, but none had magnitude greater than 2.1. Several more aftershocks were recorded, of which the most energetic (magnitude 4.1) occurred at 05.05 GMT on January 1, 1980.

Where?

The positions of the sources of the earthquakes (hypocentres) lie at depths ranging over 2-12 km below surface positions (epicentres) distributed in the area shown in Fig. 1, *i.e.* an area, about 10km from east to west and about 5km north to south, centred about 6km east of Longtown, Cumberland. There are uncertainties of 1-2km in epicentral locations.

The main earthquake appears to have been the deepest, at 12km; most of the other shocks occurred at between 3 and 8km. There is no correlation between surface position and depth (which might have suggested movement on a single surface as the cause).

How?

Earthquakes in the shallow crust are produced by rock fracture, usually faulting. A fault is a shear fracture and from the sense of shearing shown in Fig. 2 the first motions of the elastic wave spreading out from the source will be either compressional or extensional, depending on the location in one of four quadrants.

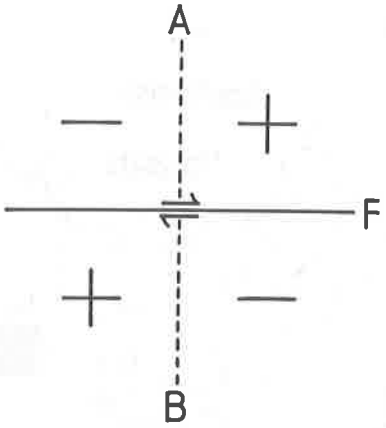

Fig. 2.

F is a fault with a dextral shear producing a compressional first motion (+) in two quadrants and an extensional first motion (−) in the other two quadrants. In experimental seismology, the problem is usually to infer the fault from the quadrant pattern. Two possibilities exist: fault F with dextral shear, and fault AB with sinistral shear. The correct answer has to be inferred from other evidence.

The inspection of seisomograph recordings allows us to determine the orientation of the quadrant boundaries and so to determine the nature of the fault movement and its orientation. The solution is not unique, however, because both quadrant boundaries could be fault plane orientations.

Such techniques have been applied to the Carlisle earthquake. Dr King's interpretation *(loc. cit.)* is that the faults causing the Carlisle earthquakes are thrusts which dip either 35°S or 55°N and strike just south of east. The

resolution is not perfect, though, and the possibility of movement of strike-slip kind (sinistral on faults striking NNE, dextral on faults striking ESE) is only a little less likely than the preferred interpretation. Dr King calculates that the earthquake may have resulted from a slip of some 30cm over a surface of a real diameter 3.5km; the ground over the epicentral area may have risen by about 1cm.

Why?

The simplest answer would be that a regional N-S compression has been relieved in this area. This prompts two questions: is there such a regional stress, and, why relief just here?

To the first question, the answer is that, without independent supporting evidence, we do not know. Local re-orientation of regional stresses can be caused by local inhomogeneities in the crust such as pre-existent fault zones, boundaries of deep sedimentary basins, and major plutons. Not only do such inhomogeneities re-orientate stress, they may also intensify it, thus offering potential answers to the second question. Let us look at the three possibilities mentioned.

Examination of known faulting in the area does not offer much guidance, though a thrust fault (the Goat Island-Lyne thrust) passes through the epicentral area (Geological Survey of Great Britain (England and Wales) Sheet 12). Most of the hypocentres lie in the Lower Palaeozoic basement below about 2km of Upper Palaeozoic cover and the pattern of faulting at depth is unknown. One possibility is that the relevant faults may be part of the Iapetus Suture — the line along which the Proto-Atlantic ocean closed in the 'Caledonian orogeny.'

The most conspicuous geological correlative of the epicentral area is the axis of the Northumberland trough, a zone of exceptionally rapid subsidence and sedimentation in early Carboniferous times. Many hypocentres lie at about the base of the Carboniferous trough, which is where the maximum stress concentration would be (*i.e.* at the downward-pointing tip of such a basin). Of course, this does not explain why the basin developed there. Again, the answer may be found in the Lower Palaeozoic rocks of the basement, as yet unrevealed but to be studied in a deep-seismic refraction experiment in 1982.

The presence of buried granite plutons as a cause is dismissed only for lack of evidence and not because of the superstition that such plutons characterise only uplifted basement blocks.

I would summarise my views on the causes of the earthquakes as follows:

1. The earthquakes are localised by the axis of the Northumberland trough to fractures mainly in the Lower Palaeozoic basement.
2. The regional stresses responsible for the earthquakes are:
   - (i) not likely to be residual stresses from the subduction of the Proto-Atlantic;
   - (ii) possibly associated with the eastward tilting of Britain and the development of the North Sea basin (only 0.02cm/km/1000 years for the last 60 million years);

(iii) probably associated with isostatic readjustment after deglaciation; raised beaches tilt at about 1 cm/km/1000 years for the last 10,000 years (Sissons 1967 p. 187);

(iv) partly unknown; intra-plate stresses are poorly determined as yet.

The wide scatter of British earthquakes (Davison 1924) does not offer much interpretative help. The Carlisle area has had earthquakes before, but to the south of the town. It may be quite a long time before the file of well-recorded earthquakes with epicentres in Britain is extensive enough to permit sound tectonic conclusions to be drawn.

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NEW MOSAIC

by W. D. I. Rolfe

As decoration for the Geology Department in Lilybank Gardens a large mosaic mural has been created in the entrance hall. It is the work of George Garson, Head of the Department of Murals and Stained Glass at Glasgow School of Art, whose mural with Alan Davie at Grangemouth won a recent Saltire Award. An early work by this artist can be seen in the Adam Smith Building of Glasgow University and he has donated a smaller exhibit (included in a recent exhibition) to the Hunterian Museum.

The present work, in which some geologists claim to see a cross-section of the Highlands, is executed in Easdale Slate, Carboniferous sandstones from the Lothians and Old Red Sandstone from Dunbar. Hidden in these larger structures are almost six hundred specimens culled from the Hunterian Museum and Geology Department teaching collections, including trilobites from the Cambrian of Kicking Horse Pass, Alberta; a Jurassic sprat from Bavaria; and pyropes from India (gifted in 1890 by the Maharaj of Oodeypore).

An initial anonymous donation to promote palaeontology provided the impetus to improve the general Geology Department habitat. Departmental funds earned externally under contract rounded out the initial donation. That sum was doubled by a donation from the British National Oil Corporation, with whom the Department already had a strong link. In turn, that total was doubled by a grant from the Scottish Arts Council, who also contributed the fee for an initial maquette, under its 'Art for Public Areas' scheme. In this way, initially modest sums were made adequate for the commission by multiplier effect.

The mosaic was formally opened by Mrs Joan Williams on December 7, 1979. It can be viewed at any time between 9 a.m. and 5 p.m., Monday to Friday, in the entrance hall of the Geology Department, University of Glasgow.

See if you can spot the malachite, the stalactite sections, the Jurassic Solnhofen fish *Leptolepis sprattiformis*, and the rest of the 600 specimens!

GEOLOGY TEACHERS GROUP (STRATHCLYDE)

Bulletin No. 3 was published in May 1979 and includes an excursion guide to the Jurassic of Skye. The editor is J. B. Blair of Airdrie Academy and the Secretary is W. R. B. Crichton, Cathkin High School, Whitlawburn, Cambuslang.

AFOOT IN FIFE, 1950

This excerpt from **T. G. Snoddy: Afoot in Fife, 1950,** p.106 was contributed by **J. Davies.**

" . . . Here on the whole surface were to be seen in clotted masses the fossilised remains of submarine vegetation, the crinites of sea anemones or lilies. These fossils of the ocean gardens of unspeakable ages past are of varying dimension, ranging from less than a match size to three-quarters of an inch in diameter. They are circular rods in which you see the rings of growth, the central core and sometimes the tiny dimples, which perhaps mark lateral leaf rests or breathing pores."

GENERAL NEWS ITEMS

These items are gathered from newspaper cuttings and magazines such as "Open Earth" and "Geotimes". Members are encouraged to send similar items to the editor for the next issue.

Magnetic bacteria

It has been discovered that some bacteria in the mud off the coast of Massachusetts always swim north. Analyses revealed that they contain an unusually high amount of magnetite in the form of about 25 particles strung along the longitudinal axis of the bacterium, evidently serving as a compass. Why should they want to swim north?

New drilling record

Soviet geologists have drilled to a depth of 9,670m on the Kola peninsula and hope to reach 15,000m. The temperature at the depth so far reached was 160°C instead of the expected 90°C.

Dawn ape

The skull and jaws of the small ape-like *Aegyptopithecus zeuxis,* found in the rocks 30 million years old in Egypt, suggest that it could have been the common ancestor of both man and the apes. It was probably an arboreal quadruped, feeding on fruit, and living in complex social groups in which there were a lot more females than males!

Volcanic activity

Many old friends have been active this year — Kratatoa, Soufrière, Etna and Hekla — but special acclaim must be accorded to the previously little-known St Helens volcano in the Cascade Range, Washington, U.S.A. Although it has erupted 15 times in the last 4,500 years it had been extinct since 1857. In 1975, geologists predicted that a renewal of activity might be imminent and in May 1980 the volcano obligingly erupted with an explosion which was heard 300km away. The ash column rose to 20,000m and spread mainly eastwards to be deposited thinly over central U.S.A.

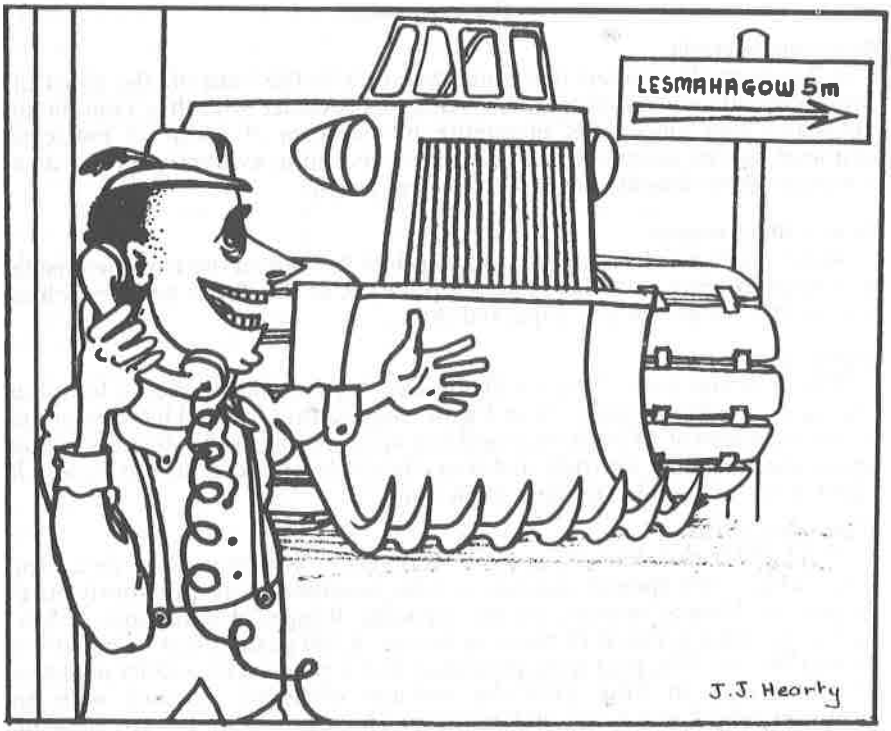
and Canada. Nearly a hundred people were killed. Subsequent eruptions have been less violent. The eruption has been blamed for the poor summer weather in British Columbia but a different scapegoat may be needed to take the blame in Britain.

Stop Continental Drift

Any members possessing evidence which might disprove the theories of continental drift and plate tectonics should communicate immediately with The International Stop Continental Drift Society, Star Route Box 38, Winthrop, WA 98862, U.S.A.

NAMES FOR THE JOB

In "Open Earth" No. 6 (Dec. 1979), Dr J. H. McD. Whitaker of Leicester University records appropriate names for geologists which he has noted. The list includes Jewell J. Glass (minerals), Pearl (gems), Krush (ores), Emery (industrial mineralogy), Gaster (palaeontology), Bugg (ostracodes), Dowse (hydrology), Sparks (vulcanology), Gault (cretaceous), Coke (coalfields), Florer (pollen analysis), Shearman (structural geology), Wigley (annelids), Till (clay weathering), Mudrock and Sandilands (fine-grained lacustrine sediments).



"Oh no Herr Doktor Rolfe . . . Nein, Nein, we do not use pneumatic drills."

Edited by J. A. Lawson, published by the Geological Society of Glasgow, Geology Department, The University, Glasgow G12 8QQ in November 1980. ISSN 0141-1837

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