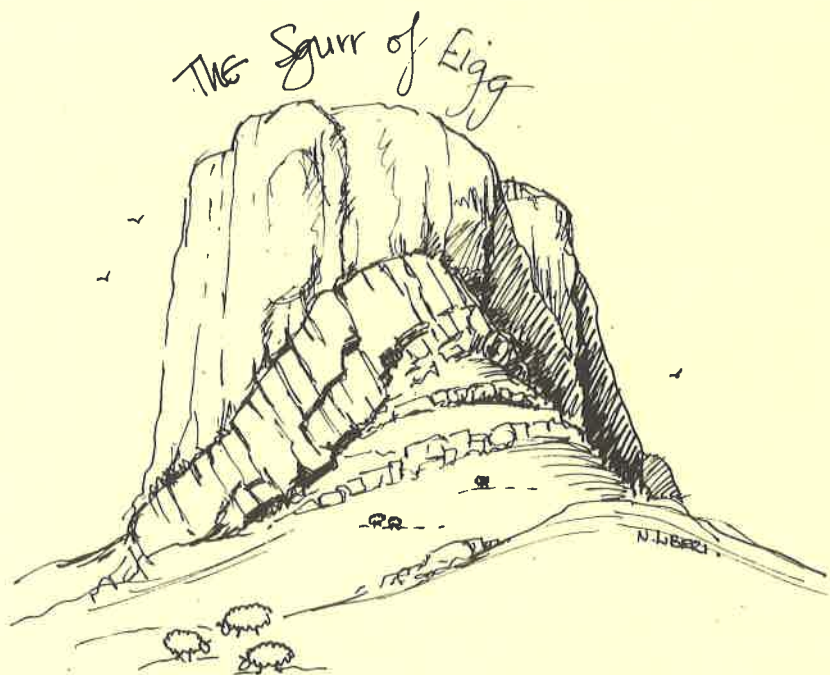


**PROCEEDINGS
OF THE
GEOLOGICAL SOCIETY
OF
GLASGOW**



Sessions 127 and 128

1984/1986



MEMBERSHIP

The membership of the Society for Sessions 127 and 128 was as follows:

Honorary Life Members	5	5
Life Members	2	2
Ordinary Members	401	411
Associate Members	42	40
Junior Members	15	20
	<hr/>	<hr/>
	465	478
	<hr/>	<hr/>
New Members	42	47
Deletions	20	34

Alison Lawson

LIBRARY REPORT (Session 127)

Society and departmental purchases of books in the 127th session have again added up to a wide range of subjects. Of general interest are books on amber, the Krakatau eruption of 1883 and field geology. More detailed and specialist books include an introduction to palaeontology, an atlas of photographs of (mostly) British fossils, the climate of the ice age, oil geology, a history of the Geological Survey's work in Ireland, the geology of the terrestrial planets and much else. Guides to various field areas are, as always, to the fore and this session includes a general look at countryside access and the law, (in England/Wales — Scotland coming soon) the geology of the Seychelles, excursions in central Spain, and in East Germany.

A major journal acquisition for the Society is the new Journal "Geology Today", produced by the Geological Society of London/Geologists' Association, as a magazine for both amateur and professional geologists. All issues to date of this highly interesting publication are now available in our library.

The leaflet describing the Society's library has been produced and distributed to all members.

This session 21 borrowers (31 last session) took out 163 items (137 last session) covering a very wide range of subjects, although there was as always a strong bias towards field guides and the geology of particular areas.

C. J. Burton

LIBRARY REPORT (Session 128)

Once again this session has seen numerous additions to the library on a variety of subjects. Field guides purchased include the Nature Conservancy's excursion guide to new sites in the eastern Mendips of Somerset, an excursion series for Powys (Wales), two volumes on the French Alps, as well as a very detailed itinerary by Ager and others for the same region, and a guide to Crete and Thera produced by Jim Macdonald of the Society. Other books received include "Ben Peach's Scotland" — a catalogue and explanation of water-colour painting done by Peach in the course of his geological field work. Books on structural geology, continental evolution and an interesting geological detective story "Seven clues to the origin of Life" by Cairns-Smith complete the list.

Library services include a flourishing holiday geology business, the librarian having supplied numerous geological travellers with guides, maps, collecting sites, etc for their holiday destinations. Other members requiring information on sites within Scotland have also been provided with details from our extensive stock.

This session 24 borrowers (21 last session) took out 177 items (163 last session) covering the usual vast range of subjects — most of which testify the keen interest in field geology shared by them. However 24 dedicated borrowers is not a great number in a society with over 400 members — so perhaps the rest should come and browse in the library sometime soon!

C. J. Burton

EDITORS REPORT (Session 127)

Volume 20 (1984) was published in three parts totalling 413 pages (35 papers and 1 letter). The lead time from the date of acceptance of a paper to that of its publication varied through Volume 20 in the range 3 to 9 months. The cost to the Society of Volume 20 was about £630.

Volume 21 will be larger still, in four parts, including a special part on Orcadian geology and one celebrating the 150th anniversary of the Edinburgh Geological Society, this latter part being financed by some additional support from outside sponsors.

The institutional subscription will be held at £50 for Volume 22 (1986).

J. Hall

EDITORS REPORT (Session 128)

Volume 21 (1985) was published in four parts totalling 574 pages (38 papers and 3 letters). One part was devoted to papers on Orcadian geology. Another special part celebrated the 150th anniversary of the Edinburgh Geological Society with a series of invited papers on a wide variety of aspects of the geology of Scotland and the surrounding continental shelf. This part was supported by financial contributions from several external sponsors.

The lead time from the date of acceptance of a paper to that of its publication varied through Volume 21 in the range of 2 to 8 months, except for a longer lead time for some papers for the Edinburgh Geological Society special part.

Thus Volume 21 became the largest ever volume of the Journal. It is worthy of note that this volume also made no demand on the purse of the membership, the costs of publication being met wholly by sponsors and institutional subscribers.

Because of the healthy financial position of the Journal, it has been decided to hold the institutional subscription at £50 for Vol. 23 (1987). An increase for Vol. 24 will be needed to maintain the Journal's modest cost to members.

The Volume (22) for the current year will be in the three parts now the norm and is likely to extend to over 400pp.

J. Hall

PUBLICATION SALES OFFICER REPORT (Session 127)

Sales Record 1984/85

Arran Guide 3rd ed.	314
Glasgow Guide	136
Building Stones	107
Dalradian Guides	136
Other Publications	342

The sale of publications this session has been a reasonably successful one. The Arran Guides are still selling well at 314 for 84/85. There has been a downward trend in the sale of the Glasgow Guides, but the Building Stones still has a steady sale.

The sales from the Bookshop and Extra Mural Classes still continue to be successful.

I am pleased to announce that the publication of "An Excursion Guide to the Geology of Skye", Dr B. R. Bell and Dr J. W. Harris, will be on sale at the beginning of March 1986.

I wish to thank all the people who have assisted me in the selling of books throughout the year.

Helen Paton

PUBLICATION/SALES REPORT

Sales Figures

Skye Guide	449	Britain Before Man	53
(+ 11 review/presentation copies)		Story of the Earth	57
Glasgow Guide	217	Earthquakes	28
Arran Guide	410	Volcanoes	58
Dob's Linn Guide	13	British Fossils	13
Building Stones	52	Moon, Mars & Meteorites	12
Dalradian Guides	34	Age of the Earth	13
Knockan Cliff Guide	8	Geological Maps	10
Rhum Guide	2	Plants Invade the Land	5
Ardnamurchan Guide	3	Welsh Minerals	1
Crete Guide	2	Scottish Men of Science	7
Starfish Bed Guide	3	Loch Lomond Quaternary	3
Assynt Guide	3	Miscellaneous	3
Geology Explained	21	Parallel Roads Guide	5
Lothians Guide	1	History of the Society	13
		Mull Guide	2

I had the sad task of taking temporary charge of Publication Sales after the death of Helen Paton, whose meticulous work in the past made my task all the easier. The session included the very successful, if delayed launch of the Skye Guide, nearly 450 of which have been sold to date. The guide has proved to be very popular both with individuals and with commercial outlets and seems set to emulate the perennial success of the Arran Guide. Sales of the latter and of the Glasgow Guide have risen as have those of the Geological Museum Booklets. Interest in the Dalradian Guides has waned, as have sales of a number of the other guides. I can report, on Helen's behalf as well as my own, a successful year.

C. J. Burton

LECTURES 1984-85 (Session 127)

The first meeting of the 127th session was held on Thursday 11 October 1984, when **Professor M. R. House** (University of Hull) was presented with the T. Neville George Medal. The oration given by Professor Leake on the presentation of the medal is quoted in full later in these proceedings.

Following the presentation, Professor House delivered a lecture entitled **Perturbations in Evolution**. Popular theoretical discussions on the process of evolution have been enlivened in recent years by postulates that evolution is controlled by certain phenomena and that these supply the key to interpretation of the fossil record. Such speculations include punctuated equilibria, vicariance, allopatric speciation, mode of macroevolution, bolide events, temperature control, regular periodic extinction events, and the effects of companion stars. Clearly, evolution is the sum of a number of different influences upon any given environment, but most important amongst these is change of that environment.

In November **Dr Stephen Sparks** (University of Cambridge) gave a most interesting talk entitled **Volcanic eruptions 3,000 million years ago**.

As has been the practice in recent years, the **Annual General Meeting** took place in December. It was followed by a short talk by **Dr Judith Lawson** (Paisley College of Technology) on **Old Glasgow Quarries**, during which she described the history of quarrying in Glasgow and related this to the history of the city itself. The annual social followed Dr Lawson's talk.

The new year started with a talk by **Dr John Taylor** (British Museum, Natural History) on the **Diet and Evolution of Predatory Gasteropods**. He discussed the feeding habits of these organisms, and their diet, ranging from invertebrates to fish! He also demonstrated their important influence upon benthic faunas which occurred as a result of the explosive radiation of the gasteropods in the late Cretaceous.

The annual **Members' Night** took place in February. Seven talks were presented. **David Banks** demonstrated that worms had been able to live in hydrothermal vents since at least the Carboniferous, with a presentation on **Worms from hydrothermal vents in the Irish Carboniferous**. This was followed by **Colin Davenport** who discussed the famous **Nazca Lines of Peru**. **Dr G. E. Farrow** gave a fascinating introduction to the **Geology of Menorca**, and **I. H. Forsyth** discussed **Environmental Geology Maps of Glasgow** prepared by the Institute of Geological Sciences for the Scottish Development Department, demonstrating some of the many ways in which these new maps may be utilised. **Alec Herriot** tried once again to obtain converts to **Amateur Petrography**, with a demonstration of the techniques involved and the beauty of otherwise plain looking rocks when viewed in thin section. **Mrs J. E. MacDougall**, in a talk entitled **Grottoes, Tales of 'Gold', Globigerina Ooze — Glimpses of the Geology of Gozo** gave a most entertaining account of the Society's field trip to Gozo the previous year. Finally, **Philip Ringrose** showed recent examples of **Earthquake faulting in Scotland**.

Both before and after the lectures, the following exhibits were on display:-

David Banks — Worms from hydrothermal vents in the Irish Carboniferous; **Dr C. J. Burton** — A Silurian Coral Reef; **I. H. Forsyth** — Environmental Geology Maps of Glasgow; **Dr M. C. Keen** — Rocks,

photographs and microfossils from Gozo; Mrs J. E. MacDougall — Minerals from the Artist's Palette, and Miss Katryna Jozyfowycz — Illustrations of the Geology of St Andrews.

The following acquisitions from the Hunterian Museum were also on display:-

Strontianite, from Steiermark in Austria;

Doplerite from Darvel in Ayrshire;

Agates and silicified wood from the island of Rhum;

Carboniferous Crustaceans from Bear Gulch, Michigan, USA;

Fossil Tertiary insects;

Eurypterids from Lesmahagow;

Trilobites from Lugton;

Serial sections through palaeocharinid arthropods from the Devonian Rhynie Chert; and

Bothriolepis mimia, from the Upper Devonian of Gogo, Western Australia.

March saw a lecture by Dr James Jackson (University of Cambridge) on **Earthquakes and faulting in Greece, and their implications for the North Sea**. In it he demonstrated the benefits of the study of active normal faults, and what this can add to our knowledge of the geometry and geomorphology of "dead" fault systems, such as those responsible for the formation of the North Sea.

After the Easter break, Dr Donald Hutton (University of Durham), addressed the Society on **Granite Tectonics**.

In June it was the Society's turn to host the Joint celebrity Lecture, when Professor J. M. Coleman addressed us on **Variability of World Deltas**. He discussed the controls upon delta shape, and emphasised the processes of sedimentation and resulting stratigraphic sequences. His talk was lavishly illustrated with photographs, core samples and geophysical records from his worldwide experience of his subject.

At the June meeting members had the opportunity of inspecting the rosebowl given by the Society to Miss Elizabeth R. Brock to commemorate the twin anniversaries of her 90th birthday on May 28 1985 and 60 years of Society membership.

LECTURES 1985-86 (Session 128)

The start of this session saw the presentation of the T. Neville George Medal, to Sir Alwyn Williams. The citation read by Professor Leake appears elsewhere in these proceedings. Following the presentation of the Medal, Dr Graham Williams (University College of Cardiff) got the lecture programme off to a fine start with a talk on **Sedimentation and Tectonics in the Pyrenees**.

The next meeting was addressed by that great communicator Dr L. Beverly Halstead (University of Reading) on the **Life and Times of the Dinosaurs**. Dr Halstead demonstrated the life habits of a wide range of these fascinating creatures, even crawling about upon table-tops himself to show their modes of locomotion.

November also contained two lectures. The first was by Dr A. S. Batchelor (Camborne School of Mines) on the **Cornish Hot Dry Rock**

Geothermal Experiment. He told the Society of the drilling of boreholes to a depth of 2500m and the results of injecting water into them: Significant water rock interaction has been found.

Alan Hodgkinson (a Glasgow jeweller) delivered an intriguingly title talk — **Keep the Moth in the Diamond.** The “moth” of the title was a fracture halo, shaped like a moth. Mr Hodgkinson showed his encyclopaedic knowledge of diamonds, gained from a lifetime of study.

Sandwiched between the December **Annual General Meeting** and the annual social, **Dr W. E. Tremlett** (University of Glasgow) delivered his presidential address on **Changing Views on North Wales Geology.** Dr Tremlett summarised changing thought upon the Precambrian rocks of Anglesey, Ordovician volcanic rocks and the Caledonian deformation of the region. Both plate tectonics and some surprising field evidence have given rise to extensive reinterpretation of this “Classic” area of British geology.

February saw what for many is the highlight of the year — **Members' Night.** This year was no exception to the normal high standard of presentations. First to speak was **Neil Clark** on **Shrimps from the Bearsden Shark Locality.** Members' attention was directed to the exquisitely preserved shrimps from the famous Hunterian Museum “dig”. The shrimps had hitherto been overshadowed by the publicity given to the fish remains found at the site. Many of the shrimps in the Hunterian collection were found by the late James Carrick, for long a member of the society, not long before his death. He has left us a most interesting legacy. **J. Jocelyn** told us about **J. B. Hannay's Experiments on Siliceous Fossilisation,** and **Dr Michael Keen** showed slides, many of geological interest, of a **Walk up Mount Fuji.** **R. McNicol** told us about the **Section at Knockan Cliff, Loch Assynt,** which has become better exposed as a result of road-widening. Finally, **Professor Mike J. Russell** addressed us on **Precambrian Weathering of the Lewisian to Agalmatolite.**

The following exhibits were on display:-

Neil Clark and Sheila Pierce — Shrimps from the Bearsden Shark Locality;

J. Jocelyn — Specimens of J. B. Hannay;

Dr Michael Keen — Samples from Mount Fuji;

Mrs Alison Roberts — Arctic Marine Shells from Rhu;

H. Mabon and Dr W. D. I. Rolfe — First Fossils from the Coal Measures of Knockentiber, Kilmarnock since the 1860's.

A number of recent acquisitions from the **Hunterian Museum** were also on display.

In March **Dr G. S. Boulton** (University of East Anglia) spoke on **Sedimentation on Polar Continental Shelves.** He told us of the dramatic activity to be found on modern polar shelves, from large sediment discharges from active glaciers to disruption by the bases of large icebergs.

The **Celebrity Lecture** took place in Edinburgh. Regrettably few Glasgow members ventured through to hear **Dr B. P. Hageman** (Director of the Netherlands Geological Survey) give a fascinating lecture on **Quaternary Research and its application to Land Use Planning** wherein he showed the (literal) pitfalls for civil engineers who did not have adequate

information upon the unconsolidated sediments beneath their constructions.

The final meeting of the regular programme for the session was addressed by Professor **R. K. O'Nions** (University of Cambridge) on **Fluids in the Continents**. He showed that fluids of mantle derivation can be shown to escape through the crust in some tectonically active areas, particularly rifting zones.

As a bonus, an extra lecture was arranged, when **Dr Brian Bell** (University of Strathclyde) gave an illustrated general introduction to the **Geology of the Isle of Skye**, to mark the publication of the Guide to the Geology of the Isle of Skye.

OBITUARIES

HELEN CHRISTINA PATON

Helen Christina Paton (née Wallace) was born and brought up in Rutherglen where she received her secondary education at Rutherglen Academy (now Stonelaw High School). In 1938 she married Daniel Paton, a pharmacist, by whom she had a daughter and a son. Ever active she found time to do duty as part-time almoner at Belvidere Hospital and to participate in amateur dramatics as a member of Unity Theatre Group. Shortly after being widowed in 1965 Helen moved from Kings Park to East Kilbride. Having studied for and obtained a qualification in Social Work, she was employed at the Hunter Health Centre until retirement in 1981. Even then she found ways of serving the community when not acting as an obviously much loved parent and grandparent.

Helen joined the Society in 1981, was elected to Council in 1983 and took up duty as Publications Sales Officer in 1984, filling the appointment with enthusiasm. Her interest in geology was general, although latterly the beauty of rock sections in polarised light was proving an attraction for her. Her activity and popularity were such that when it was unexpectedly discovered that she was terminally ill no-one could quite believe it. After the initial shock, Helen came to terms with her fate. She was not, however, to be accorded the few months estimated by the doctors, and died peacefully at home on June 10 1986, aged 70. She is survived by a brother and her children.

A.H.

PROFESSOR BASIL CHARLES KING

Professor Basil Charles King, who died on 11th September 1985 was a member of the Society for years. He came to Glasgow in the session 1947-48 and was so attracted to the country that he always continued his interest in and finally retired to Scotland. Professor King was born in 1915 and was educated at King Edward VI School, Bury St Edmunds, Suffolk and Durham University where he graduated with 1st Class Honours in 1936 and also met his future wife Peggy whom he married in 1939. he worked as a demonstrator at Bedford College before moving to the

Uganda Geology Survey as chemist and petrologist. It was here that he began his life-long interest in the geology of the East African rift, more particularly in the volcanic and other igneous rocks. It was marvellous to hear him talk so enthusiastically about this area (and to see his photographs — some 300 slides in a single wet Dolgelley evening that I recall!) After a short spell in Nigeria he returned to the UK as Senior Lecturer at Glasgow University.

In Glasgow he lectured to honours students on volcanic rocks and petrogenesis and had to take his turn with the 300 strong Ordinary class, a task he later confessed to finding rather daunting at first. He was a careful, precise lecturer with vast amounts of information packed into each lecture. It was a lively time with many ex-service men returning to study. He was encouraged by Prof T. N. George to begin field work with Nick Rast in the Braemar region although unfortunately his work was never published.

In 1956 he moved back to Bedford College as Professor and built up the department in numbers of both staff and students and also saw the change to admitting male students. His geological interest in Africa and Scotland continued with research students working both areas. He was very involved with the development of African Universities and was an external examiner in East Africa and Nigeria and later also the West Indies and Bergen. He often led student trips to Scotland (I well remember my first impression of Glasgow, the party arriving at St Enoch's Station after a night on the train and being taken for a tram ride before breakfast — we didn't realise that trams were about to depart forever from Glasgow!)

In 1977 he and his wife decided to retire a few years early to Catacol on Arran where he continued to take an interest in the local geology as much as his failing health would allow. His wife died before him and he is survived by three of his children.

He was made a FRSE in 1950 and received the Bigsby Medal (1959) and Murchison Medal (1971) from the London Geological Society, the André Dumont Medal from the Société Géologique de Belgique (1967) and the Clough Medal (1978) from the Geological Society of Edinburgh.

He will be remembered with affection by his former students, friends and colleagues.

J.L.

Presentation of the Third Thomas Neville George Silver Medal

Professor B. E. Leake gave the citation on the award of the 1984 Thomas Neville George medal to Professor Michael R. House saying:-

“Professor House, I have great pleasure in presenting you for the award of the 1984 Thomas Neville George Silver Medal.

Professor House was born in 1930, attended Weymouth Grammar School and Downing College, Cambridge, graduating in 1954 with First Class Honours. He was appointed to the staff at Durham University and simultaneously taught and studied for his Ph.D. which he obtained in 1958 for a thesis entitled The Devonian goniatites of Devon and Cornwall. This was to set the direction for his life's research work — Devonian ammonoids and Devonian stratigraphy.

After leaving Durham in 1963, he became Lecturer in Palaeontology at

Oxford and then in 1967 Professor of Geology at the University of Hull where he has since been both Dean of the Faculty of Science and Pro-Vice Chancellor.

In 1957, Professor House was awarded the Daniel Pidgeon Fund of the Geological Society of London; in 1958-9 he was a Commonwealth Fund Fellow in the United States, in 1962 Darwin Lecturer at the British Association, and he also received the best paper award of the Society of Economic Palaeontologists and Mineralogists in 1962; in 1964 he was awarded the Wollaston Fund, Geological Society of London and in 1970 the William Bolitho Gold Medal of the Royal Geological Society of Cornwall. He has been President of the Yorkshire Geological Society, The Palaeontological Association, The Systematics Association and of Section C of the British Association for the Advancement of Science.

Professor House — your personal research into the palaeontological, palaeogeographical, palaeoecological, tectonic and stratigraphical events of the Devonian has involved a global programme of field and museum study: in New York State (1964, 1965, 1966, 1981 etc), Poland (1960, 1968, 1977), Siberia and the Ukraine (1968), W. Canada (1967), Nevada (1970), Belgium (1970 and several other times), Morocco (1975), W. Australia (1976), Tien Shan Mountains of Uzbekistan (1978), Spain and Brittany (1979), California (1980), Carnic Alps (1980, 1981) and the Montagne Noire (1982, 1983). In addition to this kaleidoscopic programme you have collaborated and published with others on Devonian ammonoids from Ohio, Alaska and Germany; you have contributed to the geology of Malta and to the Mesozoic rocks of Dorset and East Devon, you have made a massive contribution to our understanding of the origin, classification and evolution of the early ammonoidea, to our understanding of evolution, and of the history of events in the Devonian system. You have also set many researchers off on sound lines such as the investigation of periodicity structures and their palaeoecological use in the Mollusca (including our former colleague George Farrow), microfossil investigations of Devonian carbonates using conodonts, central Mediterranean Miocene carbonates and general cephalopod studies.

Most of this activity, which has resulted in nearly 100 publications, has taken place while you simultaneously were building up and ably leading the Department of Geology at Hull University and you have built a reputation for being a good head of Department. I am sure that this award would have particularly pleased Professor George as the fields of your activities are so closely allied to many of the areas of his own interests.

Professor House, you have made a most distinguished and quite outstanding contribution to our knowledge of Devonian stratigraphy and ammonoids, sustained over many years, and I have much pleasure in asking the President of the Geological Society of Glasgow to make the presentation of the 1984 Thomas Neville George Silver Medal to you."

Professor House, in accepting the medal and thanking the Society and the Department of Geology recalled with pleasure his association and admiration of Professor George, and the encyclopaedic nature of Professor George's publication record.

Presentation to Sir Alwyn Williams of the T. Neville George Memorial Medal

Professor Leake read the citation, saying:-

“Mr President, Ladies and Gentlemen:

Sir Alwyn Williams is known to most people in Glasgow as Principal and Vice-Chancellor of the University of Glasgow and to most of the academic community in connection with the work of the Court, the Senate, the Finance Committee and the multitudinous aspects of University administration. However to those of us in the Geological Society of Glasgow and the Department of Geology, he is known as a very distinguished scientist. This is not surprising because he was a member of staff in the Department here under Professor T. Neville George in the early 1950s and has kept active connections while he spent time elsewhere. From 1954 to 1974 he was Professor of Geology at Queen's University, Belfast (where he also became Pro-Vice Chancellor) and from 1974 to 1976 he was Lapworth-Professor of Geology at the University of Birmingham. But in 1976 he returned to Glasgow mainly to occupy the position for which he is best known, but also to continue his researches in the fields of palaeontology and stratigraphy.

During the period he was away from Glasgow, many of us saw him on his not infrequent visits and many of us shared time in the field with him in the Girvan district where his researches led to major contributions to knowledge of Ordovician faunas and stratigraphy. This work was linked to studies of Ordovician palaeobiogeography in Wales, Ireland and N. America and an appreciation of the importance of a valid statistical basis for taxa and faunal assemblages. On the way to achieving this his structural work at Girvan indicated to those who think of themselves as structural geologists just how much could be done when field relations were thoroughly investigated and really understood.

Sir Alwyn's interest in faunas led to investigations of ultrastructure, particularly of brachiopods and many here will remember the remarkable lecture given to the Society in the Gregory Lecture Room in the East Quadrangle when the lights went out. Only someone who had pioneered the use of the scanning electron microscope to illuminate growth mechanisms of brachiopod shells and who had developed the transmission electron microscope as a means of throwing light onto the nature of the tissue of living brachiopods could have used darkness so effectively. It could be that the darkness brought to Sir Alwyn's mind the then state of knowledge in the field of palaeo-biology, because he subsequently became a prime innovator in this field making major advances in our understanding of skeletal secretions from cells and applying the results to the fossil record.

Like the late Professor George, Sir Alwyn is an acknowledged expert on brachiopods and on evolutionary history. A culmination of this expertise was the preparation of the Brachiopod volumes in the *Treatise on Invertebrate Paleontology* series with Sir Alwyn a major author. His standing in this field is reflected by his recent appointment as Honorary President of the First International Brachiopod conference. This is only

one of the many accolades bestowed on this year's recipient of the T. Neville George Memorial Medal.

It seems fitting that not only should this award be presented in the building that Professor George did so much to bring into existence, but to someone he examined in 'A' level Geology, had on his staff here in Glasgow and helped and influenced in his scientific career.

Sir Alwyn Williams, it gives me great pleasure to ask the President of the Geological Society of Glasgow to present to you the 1985 T. Neville George Memorial Medal for your distinguished contributions to geology, particularly in the fields of stratigraphy and palaeontology."

EXCURSIONS 1985 (SESSION 127)

KINCRAIG AND ELIE, FIFE: 27th April 1985 (Leader: Dr MacGregor)
by Robert McNicol

The first field excursion of the session is always a bit special, coming as it does after the winter hibernation, so it was with keen anticipation and the usual enthusiasm that the bus party sped towards the East Neuk of Fife.

On arrival at Elie Dr MacGregor described the day's task as we stood in the sun and cold wind, a combination which was later complicated by hailstones (traditionally it is perhaps unfair to hold the Excursion Secretary responsible for the weather, nevertheless, Rosemary McCusker made a fine debut!)

The main objective of the day was to examine evidence of past volcanic activity resulting in the Craighforth and Kincaig Necks. Dr MacGregor's vivid description of the vulcanism — disrupted country rocks, ash plumes, bombs, multi-centre extrusion then quiescence followed by further explosions with magmatic steam causing dyke shredding and high pressure ash-borne penetrating columnar jointing of the basaltic plug of the Kincaig Neck — brought the static scene to life. Ejecta included a massive block of columnar basalt embedded high in an ash cliff face. Scrambling was necessary, but this was made easier by the fixed chains on the cliff faces, dangling from which was a first for many of the members. Crossing wave-lashed gullies was an added adventure, so there was much laughter (of the nervous sort).

This part of the excursion ended with the examination of four raised beaches, which suggested much less destructive geological events, in contrast to the previous volcanic features.

Finally, the party successfully searched the tuffs at Elie Ness Neck for "Elie Rubies" (pyrope garnets) which, though small, indicated deep crustal origins, followed by transport to the upper crust in upward moving extrusive mantle material. It was with quiet relief that the excursion reporter confirmed that all sixteen members who had started out had completed the course.

On conclusion of the excursion, the party thanked Dr MacGregor for a thoroughly enjoyable day.

**BUILDING STONES OF THE GLASGOW UNIVERSITY AREA: 30th
May 1985 (Leader: Dr Judith Lawson)
by Rosemary McCusker**

On a pleasant spring evening seventeen members set out to go walkabout with Dr Judith Lawson looking at the stones used in the University buildings, and those of the surrounding area.

We saw a wide range of stone in the main buildings — a selection of cream Carboniferous sandstones, red sandstone of Old Red Sandstone age and Ross of Mull granite. Some of the sandstones had weathered better than others.

The other buildings are of Portland Limestone and sandstones from England. Even the newest buildings were of interest as the precast units contained pebbles of flint. We also examined the road cobbles.

On leaving the University grounds we looked at some fine tenements now free of their grime and showing a wide variety of colours.

We finished with a walk along Byres Road studying the more exotic shop fronts, notably the larvikite on the butchers.

Those who attended this most enjoyable outing will no doubt be grateful to Dr Lawson for the continuing pleasure they will have stone spotting as they go about their everyday business but hopefully taking care not to trip as they examine the felspar crystals in a kerbstone or attract the attention of a watchful police officer as they look at the xenolith in the entrance to a bank!

**LESMAHAGOW BYPASS (M 74): 8th June 1985 (Leader: Dr Peter Thomas)
by Dr Ian Allison**

Nine society members attended this excursion led by Dr Peter Thomas of Paisley College who took them by minibus to the site office at Lesmahagow. Here Robert Caginard, the resident engineer for Lanark Division of Strathclyde Regional Council, described the project mentioning the large volumes of rock and soil which must be excavated from cuttings or built up into embankments, and the group gained some impression of why this section of 8km of motorway would cost some £12 million to construct. Afterwards Jim Hare of the Geotechnical Division talked about a particular stability problem with the rock in Wellburn cutting and of the techniques, developed at the Transport and Road Research Laboratories at Livingston, which were applied here. Dr Thomas rounded off the talks by describing how an engineering geologist is not so concerned with the age of the rocks and their fossils but rather with their physical properties, for example their suitability to be used for filling an embankment or as a base layer for a road. A project such as this was a fine balance between the volumes of rock and soil removed from cuttings and the volumes required to construct embankments.

The group then visited Wellburn cut where a small rockface had occurred in moderately dipping rocks of Old Red Sandstone age where blocks slipped along bedding surfaces into the cutting. Analysis of existing geological information, especially from an abandoned railway cutting nearby, would have predicted such a failure on that side of the cut. The

group visited a number of other localities and saw a particularly stiff boulder clay (a lodgement till) which had been excavated from this section and a trial section of the road surface which is to be a continuous concrete pavement with steel reinforcement. This will be the first of its kind in Scotland. The final locality was where a culvert had been constructed to take a stream prior to its valley being filled to form an embankment. Here we saw a natural exposure in the valley sides where shales and a thin coal seam were visible and where the fossil hunters could forget about engineering geology for a while.

From here the group returned to Glasgow and as the M8 was joined, Dr Thomas mentioned that the Baillieston Interchange is the largest road project in Scotland and because of the complexity of the geology and the superficial deposits it required some three hundred boreholes to be drilled during the site investigation. The group had an enjoyable day examining one aspect of the application of geology.

LINN GLEN, DALRY, AYRSHIRE: 22nd June 1985 (Leaders Dr W. D. Ian Rolfe and Matt Yule)
by A. M. Stott

A group of seventeen members assembled at Linn Bridge car park where we were met by Dr Rolfe and Mr Matt Yule who led the visit. Our visit was a repeat almost 64 years to the day of a visit by John Smith the famous Ayrshire geologist and a group from Dalry. Dr Rolfe read out a newspaper record of the earlier visit and at various localities along the way he produced fossils from John Smith's collection. Mr Matt Yule gave a fascinating account of the industrial history of the area.

We set off upstream from the Thrawcrook Bridge which carries the road over the Caff Water, the burn which flows through Linn Glen. A few yards upstream from the bridge a tertiary dyke is seen. We moved up the succession from this point starting at the top of the Lower Linn Limestone. Productid brachiopods can be found in the shale beds between the limestones, but not in the limestone itself unless it has been silicified. John Smith collected bivalve lamellibranchs from the shales in this part of the glen. The shales are fissile and laminated with slight cross-bedding and probably represent delta top deposits. Trace fossils such as worm burrows and carbon plant remains are also found.

After climbing a steep slope we reached an old quarry in the Upper Linn Limestone. John Smith collected brachiopods here and also discovered a coal seam about one foot thick. This was known as Paddy Doyle's Mine and the locals who knew of its location helped themselves in hard times. After further climbing we reached the Linn which lies on a fault plane. Above the Linn the limestone is very thick and must have been laid down under stable conditions.

Continuing upstream, the path was bordered by thick cross-bedded sandstones, which showed faulting and some slickensiding. At one point the cross-bedding was on a large scale, and possibly represents a large river bank sand bar. Shales were seen underneath the sandstone at one location.

By a small wooden bridge where we ate lunch there is a large fault in the sandstone and on the down throw side the Douglas Fire Clay, interbedded

with thin bands of shaley coal, could be seen. This belongs to the Namurian Passage Group Coal Measures. The Douglas Fire Clay is possibly derived by weathering from the Castle Cary Limestone, as the limestone is absent here. Upstream, sandstone of a different type from that on the other side of the fault is seen to overlie the fire clay.

The day ended with a return to Dr Rolfe's house where a delicious afternoon tea was awaiting us, prepared by Mrs Rolfe. Exhibits of John Smith's records and drawings were also available for examination.

VISIT TO BRITOIL PLC PREMISES: 27th June 1985

by Dr Ian Allison

Society members met at Britoil's Gordon Street, Glasgow office where two groups were formed to tour the different offices. In the Gordon Street office we were shown the very sophisticated computer system, Landmark, which allows a geologist or geophysicist to interpret seismic reflection sections and to display successive sections of a three dimensional seismic survey. We were shown how computers plotted structure contour maps of different strata based on information from seismic sections and boreholes and how geologists could adjust the position of the countours using their geological knowledge rather than relying on an arbitrary algorithm of the computer.

The cartography office was next on the agenda. For those of us who still use india ink and stencils or Letraset it was an eye opener. Again the typesetting and production of text for figures is all computer controlled and the typeface can be changed at the press of a button. All of Britoil's high quality publications are produced here.

In one of the St Vincent Street offices the acquisition of seismic sections and their processing was described. The final venue was the company's core store where we were able to examine cores of oil-impregnated sandstone taken from the deep beneath the North Sea. In this store all cores drilled for the company are kept and there are facilities for cutting and photographing the core and for taking samples for further analysis of permeability and porosity, for example.

Although we were rather rushed to see the few departments which we did, we gained an impression of the multitude of activities that a large oil company is engaged in.

QUATERNARY GEOLOGY AROUND THE CLYDE ESTUARY AND LOCH LOMOND: 17th August 1985 (Leader: Dr D. A. Davidson)

by Alexander Hall

At our first site, near Allender Toll in the Bearsden/Milngavie area Dr Davidson introduced himself to our party of about fifteen by saying that he is not a geologist but a geographer and soil scientist, and his task was to give us a fresh look at the land forms resulting mainly from glaciation during part of the Quaternary period. At this first site we looked at the drumlins formed during the Main Devensian Glaciation (maximum c. 18,000 B.P.) and noted the poor drainage of the soils in the valley drained by the Allender River.

From Milngavie the minibus took us to Cardross where, after an assault

course through the nettles and across the Geilston Burn, well filled by recent heavy rains, we studied the Gielston section (as reproduced in the Quaternary Research Association's 1980 Field Guide to Glasgow). Unfortunately the poor summer weather had caused the burn to erode the section, causing slumping. The upper Flandrian beach deposits of bedded sands and gravels were clearly seen, but samples of lower Clyde Beds and tills had to be dug from behind the slumped soil.

We then went to Ardmore Point where we investigated a raised beach shoreline on the northern side. This appeared to have a classic wave worn cliff but, as Dr Davidson pointed out, this was not exposed to the Clyde estuary, but formed the southern boundary of a channel less than 2km wide. It was difficult to imagine sufficient wave action to form the cliff under these circumstances, and it has been suggested that "freeze/thaw" erosion could have been responsible. The possibility of a frozen ice sheet on the sea being forced along the channel was also discussed, but "not proven" seemed the best verdict. However, it set a few people thinking.

Our next stop, after a picnic at Ardmore in beautiful sunshine (almost unique for the summer of 1985) was at Rhu where we walked around the point to the Gareloch shore to look at a section showing raised beach gravels, till, Rhu Gravels and Clyde Beds which in place occur in separated clasts. Although this is a classic site it does not appear to have been investigated thoroughly and could repay further study, especially if it could be related to the Clyde Beds elsewhere. It was the limit of the Gare Glacier in the Loch Lomond readvance. A worrying feature is that much of the section is being destroyed, either by erosion or by efforts to prevent erosion by covering it with stones.

We proceeded to Glen Fruin where, near the B832 Helensburgh to Loch Lomond road we saw an excellent example of a terminal moraine. The clear distinction between the rough hummocks below the ice and the smoother rounded landform around the glacier were noted. The unusual feature here is that the glacier was moving up Glen Fruin, being an off-shoot of the Loch Lomond glacier.

A little further North we stopped beside Muirlands Primary School (on the B832) and looked at a good example of an esker formation, now cut through by the road and a river.

Dr Davidson gave us an excellent overview of the quaternary geology of the area and pointed to several objects which had not been fully explored by geographers and geologists.

JOINT EXCURSION WITH THE EDINBURGH GEOLOGICAL SOCIETY TO BRAIDWOOD, NEW LANARK, THE FALLS OF CLYDE AND CARMICHAEL QUARRY: 31st August 1985 (Leader Dr Norman E. Butcher)
by Harry Young

The two parties met at Carluke with the thirty nine members from Edinburgh outnumbering the twenty two from Glasgow. Our first stop was Daleville House, known as the Dales, near Braidwood, to commemorate the joint excursion of July 1882 to the same house which was then owned by Dr J. R. S. Hunter-Selkirk (1835-1898). Our party gratefully received

tea and biscuits from the household of Mr Tom Shephed. We then split into groups to see the old coal mine buildings on the banks of the Braidwood Burn, or the pre-glacial valley of the River Clyde. The Tower of Hallbar was also open to view and was manned by members of the Carluke Parish Historical Society. The climb to the top afforded a view over the Clyde valley. At the house we were able to see carved stones from the Old College of Glasgow before the move to Gilmourhill to become the University of Glasgow. Also on view were maps of the area, memorabilia of J. R. S. Hunter-Selkirk and some of his Carboniferous fossils and examples of the Silurian fossils found at "Camp Siluria" near Lesmahagow.

After an all too brief visit to such an interesting locality we crossed the lower Clyde at Crossford and continued upstream to New Lanark where lunch was taken in sunshine in the new picnic area. All around one can see the results of the considerable efforts to restore and renovate the buildings of the 200 years old model mill village established by David Dale and Robert Owen. Here we saw an outcrop of the lower Old Red Sandstone, fine grained, with horizontal bedding which is the result of dominantly terrestrial fluvial deposition. Further upstream we were shown the weir and the start of the mill lade tunnel which is hacked out of solid rock. All enjoyed the fine views of both Corra Linn and Bonnington Linn which were both spilling flows more like November than August after so much summer rain. It became easier to appreciate how the tremendous forces of the glacial meltwaters might carve out such a ravine during the last 10,000 years. Right angled bends in the river show how the Clyde has captured old streams which originally ran into the Tweed system.

The next stop was at the disused Carmichael Quarry where we saw an excellent example of a felsite sill, with top and base exposed, cutting into the earlier Old Red Sandstone. At the far end of the quarry there is an even younger hydrothermal vein of bladed barite which is heavily brecciated and runs in a north-west/south-east direction.

Late afternoon tea was enjoyed at the Tinto Hotel in Symington. There Dr Rolfe gave a vote of thanks to Dr Butcher and countered the pieces of friendly rivalry written into the excellent handout for the day with his own witty stories and remarks. This gave the Glasgow Society the last word on what had been a most enjoyable and instructive excursion.

THE WHANGIE: 14th September 1985 (Leaders: Dr James MacDonald and Mr Anthony E. Stevens)
by Mrs E. Henderson

A stalwart band of enthusiasts braved the elements to study a local landmark, the Whangie. Met by the excursion leaders at the Queen's View car park, the party proceeded directly uphill under sweeping rain and threatening skies, stopping briefly mid-slope to view the Campsie Fault and consider the relationships between the Campsies and the Kilpatricks. On locating the ashy base of the Kilpatrick lavas, we were reminded of their relatively alkaline character and high water content, the latter being responsible for late stage alteration and the common occurrence of calcite,

haematite and zeolites. The Whangie, dramatic under "lowering" skies was duly "conquered", and we were grateful for its shelter as we examined the matching and curiously curved surfaces of the narrowing crevasse. We discussed the problems posed by these and the apparent lack of downthrow, and the guided consensus was that earthquake shock (rather than ice leverage) might have been responsible.

After exploring a nearby area of slipped and rotated rock, we were blown back to base by gusting winds. A picnic lunch, taken mainly inside the cars, restored us sufficiently to contemplate the visit to Catythirsty as planned for the afternoon. Here Dr MacDonalld helped us to interpret the details of lava and agglomerates in this small Calciferous Sandstone vent, pointing out tell-tale patches of foundered cementstone.

The final test of our stamina, if not our enthusiasm, was a patch of blanket bog, separating us from the beautifully fresh basic dyke which penetrates a nearby vent. We made dry land, the wellies stealing a march (or was it a marsh?) on the walking boots at this point. A memorable day on all counts!

THE BALLANTRAE COMPLEX: 21st September 1985 (Leader: Dr Brian J. Bluck)

by Rosemary McCusker

This, the last excursion of the 1985 season took place at the end of what must have been the wettest week in many years, with the radio reporting landslips and flooding in the Ballantrae area. This no doubt accounted for only thirteen members attending out of the thirty two who originally booked.

Our bus driver had a quick role change to boatman as he sailed our gallant little bus through desperate flooding en route to Downan Point, our first stop.

At Downan we saw the excellent pillow lavas younging seawards, with calcite filled vesicles demonstrating that the pillows had been extruded into relatively shallow water. Dr Bluck pointed out that we must not expect all pillows to be such good examples as those at Downan.

Our next stop was at Bennane Head, but first we had to cross the flood again, and it was now even deeper!

Here we looked at some of the sediments associated with the Ballantrae Complex — radiolarian cherts interbedded with tuffs and conglomerate with large clasts. These sediments again suggest shallow water with land and a volcano close by. Some of the cherts showed soft sediment deformation.

We proceeded to our next stop just South of Pinbain where we investigated a gabbro sheet in serpentine with very large crystals of diallage.

Our last stop was at Stockenray to look at the hyalotuff delta. Lava was extruded into shallow water which chilled it rapidly causing fracturing and the production of large amounts of sediment. The next lava flow then advanced over these sediments.

Dr Bluck did much to clarify this most complicated area pointing out

that when the ophiolite was thrust over the land a movement of at least 15km and possibly as great as 45km was involved, i.e. it is the biggest thrust in Scotland. He also said that this area demonstrated the importance of regarding field evidence and not relying entirely on geochemical evidence.

EXCURSIONS 1986 (SESSION 128)

ISLE OF SKYE: 30th May-2nd June (Leaders: Drs B. Bell and G. Harris)
by *M. C. Keen*.

Members travelled independently to Skye on Friday, 30th May and most were accommodated in the Hebridean Hotel, Broadford. It had been hoped to use the new Skye Guide to be published by the Society, but unfortunately it was not ready in time, appearing in June 1986. However, our leaders were the authors of the guide, so we were able to benefit from their vast experience of the terrain.

Saturday 31st was spent examining the Outer Granite of the Eastern Red Hills Centre and the surrounding country rocks (Excursion 4 of the Skye Guide). Our Convoy of cars headed for Camas Malag, where we parked on the grass-covered "25-foot" raised beach (5826 1928) and examined the porphyritic granite exposed on the wave-cut platform. Our next stop on our southwards traverse was to study marble formed by the intrusion of the granite into Cambro-Ordovician carbonates at the southern end of Camas Malag (5822 1886). Minor Tertiary dykes were also intruded into the carbonates and well-developed chilled margins to boudin structures within the dykes suggested cooling was contemporaneous with deformation. A brisk walk then took us to the Jurassic strata; en route we noticed a very deep swallow hole developed at the contact of the Jurassic and Cambro-Ordovician limestones, lying directly on the path! The Lower Jurassic Broadford Beds at the mouth of the Allt nan Leac (0582 1832) lie unconformably upon the Cambro-Ordovician. The contact was examined and small neptunian dykes observed cutting into the Lower Palaeozoic strata and filled with Jurassic sediment. The Broadford Beds were found to be very fossiliferous with abundant *Gryphaea* and pectenid bivalves, and rarer ammonites and belemnites. Trace fossils, probably *Arenicolites*, are also well developed. The basal beds consist of limestones and shales, the sequence coarsening upwards into sandy shales and finally sandstones. The latter show good ripple-drift bedding and 30cm thick cross bedded units.

Lunch was taken at the headland south of the Allt nan Leac, members either sitting on, or examining, the olivine-gabbro dyke from which it is formed. After lunch the party proceeded up the Allt nan Leac, but the deteriorating weather, together with the roughness of the terrain, caused about half of the party to return to the cars. The remainder disappeared uphill into the mists to examine Triassic alluvial fan conglomerates (6000 1816), Lower Cambrian quartzites, and Torridonian sandstones of the Applecross Group. The Torridonian and Cambrian rocks have been thrust over the topographically lower Cambro-Ordovician carbonates, but by this stage the mist was so thick that little could be observed. We were fortunate in having two leaders who knew the country, but even so they had to use their compasses for guidance. No one unfamiliar with the area should

attempt these excursions if there is even a hint of mist in the hills. We next examined the Strath Suardal Dolostones and their contact with the granite of Beinn an Dubhaich where they have been metamorphosed to a white marble. The going had now become very rough, across boggy ground with visibility down to a few yards. However, the party was much impressed (and relieved!) by the fact that we eventually descended out of the mists only 100 yards from our next destination. This final exposure was skarn developed at the contact between the granite and the Ben Suardal Dolostones (5902 1984) where magnetite and diopsides were collected.

Sunday 1st June was occupied by a visit to Camasunary Bay (Excursion 10 of the Skye Guide). After parking the cars the party set off at a brisk pace, vaguely examining Jurassic shales and Tertiary lavas en route to our first stop, the large doleritic dyke at Arn Mam (5250 1800). From there we descended to Camasunary Bay (Excursion 10 of the Skye Guide). After parking the cars the party set off at a brisk pace, vaguely examining Jurassic shales and Tertiary lavas en route to our first stop, the large doleritic dyke at Arn Mam (5250 1800). From there we descended to Camasunary Bay in a thin mist which restricted visibility, especially of topographic features associated with the Camasunary Fault. The party examined Torridonian rocks at the bridge over the Abhainn nan Loac (5182 1864). The mist by now was changing into fine rain, so some members turned back at Camasunary Cottage while others forded streams to reach the rocks of the Cuillin Complex and lunch. The margin of the gabbro was examined in detail (5110 1934), especially the cross-cutting relationships between dykes and veins. After lengthy discussion the remnants of the party decided to ford the very wide, and deep-looking, Abhainn Camas Fhionnairigh. This proved very worth while, for a very wet party was able to examine the contact between the Coire Uaignoich Granite and the Tertiary basalts it has intruded (5094 1874). Magnificent xenoliths of basalt and Torridonian rocks could be observed. Unfortunately we still had to recross the river to get back to the cars!

Monday morning saw the mists clearing a little, so those who wished were able to tour the island and see the Cuillins at last. The weather had been disappointing, but it could not spoil the magnificent geology nor mar the enthusiasm of our leaders.

BATHGATE HILLS: 14th June 1986 (Leader Dr. Chris J. Burton)
by Neil D. L. Clark

On one of the better days of a poor summer Dr C. Burton led us on an excursion into the Carboniferous of the Bathgate Hills. The first stop was Mr Stan P. Wood's quarry at East Kirkton, where he has obtained some marvellous complete amphibians. We were not as successful and were content with a few ostracods, a coprolite, brachiopods from a marine limestone which tops the exposure, and sedimentary structures. The only amphibians we saw were at the Peter's Hill reservoirs, and they were still alive.

On next to see the overall geology of the area from the top of a dolerite still looking towards Knock. This was plainly seen to be a set of ridges and hollows representing the igneous and sedimentary rocks respectively.

Then at the highlight of the day, the Peter's Hill reservoirs, we collected a vast number of fossils. This locality is soon to be a nature trail. The fossils found included corals, *Gigantoproductus*, *Composita*, *Krotovia*, and other brachiopods, encrusting bryozoa, crinoids, bivalves, bellerophonitids, and high spiral gasteropods. Elsa Henderson brought our attention to what turned out to be a large number of ostracods (*Myodocopida*) which are rarer than the more common *Podocopida*.

The next stop was at Knock where we walked down to the "silver mine". The cliff on the left as we descended exhibited a small intermittent rootlet bed. We did not strike it rich at the mine, but more fossils were found near to the old lime kilns. Part of the limestone here was silicified although the fossils were still carbonate.

We finished off the trip with a visit to the Bronze Age Cairnpapple Cairn which provided much needed relief, as it was cool inside the cairn while the sun outside was still very hot.

This was a very successful trip, and most instructive to all who went on it.

GIRVAN: 28th June 1986 (Leader: Dr J. Keith Ingham)
by C. C. Jamieson

On Saturday 28th June a party of 24 travelled to Girvan on a warm, hazy morning with the promise of a hot day to come. The first stop was at Kennedy's Pass where Dr Ingham explained the basic structural relationships of the rocks which would be seen during the day, and outlined their significance in the wider scene of the major tectonic events which took place in the Ordovician to early Silurian periods. The party examined the rocks on the foreshore which were seen to be roughly graded conglomerates, (Kilranny Conglomerate) with spilite, gabbro, granite and quartz pebbles and boulders in a sandy matrix. The sediments had been deposited from both low and high density turbidity currents in a pro-deltaic or submarine fan environment. Some beds showed evidence of slumping and other instability. As the party proceeded along the Ardwell shore, we observed some impressive complex folds in the flaggy siltstones, and noted the effects of late Silurian tectonism resulting in steeply dipping beds.

The excursion had been well planned with regard to the tide, which was at dead low water as the party crossed Ardwell Bay to the Whitehouse foreshore. We examined rocks of the Ardwell group, striped graptolitic shales and siltstones, with thick sandstone beds. It was observed that the junction with the Lower Whitehouse group is partly faulted, with calcareous breccia overlying the upper Ardwell group strata. These calcareous flysch turbidite sequences contained shelly debris and coral fragments, and were succeeded by fine grained sandstone with greyish green shaly mudstones, showing a pronounced "ribbon" appearance. A few yards west a large thrust fault was observed which cuts off the uppermost division of the Lower Whitehouse group and shows strongly coloured red and green mudstones. The mudstones contained trilobites, mainly cyclopygids, and graptolites, indicative of deep water conditions. At this point it was decided to stop for lunch, and everyone was glad to relax and enjoy the heat, but unfortunately the haze prevented any views of Ailsa Craig or further afield.

After lunch the party continued along the shore to Woodland Bay where we studied the Shalloch formation, a turbiditic sequence of sandstone and mudstones. An interesting example of a sandstone dyke was observed, winnowed into the strata. The shore section of the excursion was completed at Myoch Bay, where we saw the basal beds of the Upper Whitehouse Group. A variety of sandstone and mudstone sequences with black shales was suggestive of an environment of deposition associated with the subsiding unstable slopes of a submarine fan. After a short walk to the bus, and very welcome cold drinks and ice cream at the car park, we drove to Ardwell farmhouse where we climbed up the track on the Ardmillan Braes to a point just off the main ridge running up to Byne Hill, and geologically near the base of the Ardwell Group above the Benan Conglomerate.

A reverse thrust cut out the Kilranny Conglomerate and the Infra Kilranny greywackes. The heat was intense at this time in the late afternoon, and only the most dedicated seekers after knowledge struggled up a dry stream bed among thick gorse bushes, to search for trilobites, brachiopods and other lower Ordovician fossils.

This marked the end of the excursion and when everyone gathered at the bus Dr Ingham was thanked for a very enjoyable and informative day.

JOINT EXCURSION WITH THE EDINBURGH GEOLOGICAL SOCIETY TO EDINBURGH: 6th September 1986 (Leader: Dr Ian Bunyan)

Fourteen of us travelled to Edinburgh by train to join with the Edinburgh Geological Society in order to follow (roughly) in the footsteps of the first joint excursion of our two Societies which took place 120 years ago — on the 20th June 1866.

We were met at Waverley Station and conducted to the foot of the Scott Monument where we joined up with 40-50 members of the Edinburgh Geological Society and were welcomed and introduced to our leader for the day, Dr Ian Bunyan of the National Museum of Scotland. He gave us a brief history of the development of the New Town of Edinburgh and the sandstone quarries opened locally to supply the necessary building material, drawing our attention to the fact that the Scott Monument was itself built on the infilled site of a former quarry.

We were conducted the length of Princes Street Gardens pausing at various points on the way, including the board erected by the EGS depicting the formation of the Castle Rock. After a close look at the Castle Rock ourselves we boarded buses which took us to the site of the former Craigleith Quarry. Dr Bunyan showed us an etching of the quarry at its heyday showing the depth to which it descended. It is now totally filled in but we were able to examine some sedimentary structures at one edge of the site.

The buses then took us to Calton Hill which is an outlying part of Arthur's Seat volcano, where Dr Bunyan described the various monuments littered round the hill and we all admired the views of Edinburgh and its surrounds.

A delicious buffet lunch was provided for us by the EGS in Murchison

House and Dr Judith Lawson thanked the Edinburgh Society on our behalf for their hospitality.

To aid digestion the afternoon was spent on a tour of the Arthur's Seat volcano. We started by looking at the impressive Samson's ribs, hexagonal jointed basalt which cooled slowly deep within the volcano, from here we scrambled up to Queens Drive and walked round to the car park below Dunsapie Hill with Dr Bunyan pointing out various volcanic structures on the way.

From the car park we climbed up to an even clearer view over Edinburgh than we had in the morning. We walked round the Lions head vent till we could see the Long Row, a lava flow from the Castle volcano, with 12 other flows stacked up behind it making up Whinny Hill. Dr Bunyan pointed out the Pulpit Rock which is the remains of a later vent and a sill outcropping in a line below the Long Row known as the Dassies. We proceeded along the top of Salisbury Crags — a sill which was intruded after the volcano ceased to be active — its cap of calciferous sandstone can be seen better from the lower road. Finally Dr Bunyan led us to Camstone quarry, a small quarry in the calciferous sandstone, some of which was used in the nearby Palace of Holyroodhouse. Here we saw some well preserved examples of mudcracks and ripple marks.

Finally the buses took us back to Waverley Station thus completing an extremely enjoyable day with much better weather than that excursion of 120 years ago.

BAIRSKAITH QUARRY, BEARSDEN: 21st August 1986 (Leader Dr J. D. Lawson)

by Myles M. Jordan

Fourteen members of the Society met outside this disused brickpit on a drizzling evening.

After entering the quarry, Dr Lawson distributed handouts, and explained the geology of the location, together with the importance of evidence gained from both sedimentary rocks and fossils that would be seen as indicators of the environment of the Lower Limestone group in which the quarry is cut.

First we looked at a block of Blackhall Limestone. This rock displayed flake breccia, mud cracks and small crinoid fragments. It was explained that the crinoids were stunted due to their poor growth environment.

Moving to the other side of the quarry, fish scales and plant fragments including impressions of *Stigmara* were found in a pile of debris from the Blackhall Limestone.

The next two locations visited were on the dip slope of the Blackhall Limestone. The lower part of this slope consisted of limestone containing shell fragments, small crinoid columnals, brachiopods and corals. The brachiopods found included Productids, *Orbiculoidea* and *Crurithyris*. The coral was the solitary horn coral *Zaphrentis*. We also observed the straight nautiloid *Orthoceras*. The limestones here, like the mudstones later encountered, were well weathered.

Further up the dip slope we came to the black mudstone of the Neilson Shell Bed. The mudstone had broken down into mud and iron carbonate

nodules, many of which showed a septarian fracture when split. Few fossils were found in the shell bed, probably due to failing light, but an excellent specimen of a fish head plate was recovered from a pile of debris. So with the light failing and the drizzle still falling we left the quarry and returned to the transport where Dr Lawson showed us a collection of fossils that had been obtained from the quarry on better days. These included gasteropods and brachiopods.

The wet weather did not dampen the enthusiasm of the members visiting the quarry, however it did make collecting fossils difficult. The quarry was most interesting, and is well worth another visit, but preferably in better weather!

INVERKIP, WEMYSS BAY AND THE FIRTH OF CLYDE: 2nd August 1986 (Leader: Mrs Jane MacDougall)
by Evelyn Lennie

A very small party of members set off in a very large luxurious new bus and drove in style to the top of the Lyle Hill in Greenock. There we met a few more members and our leader Mrs MacDougall. She explained that we had assembled at that place because of the truly exceptional views to be had of the surrounding terrain. Unfortunately it was very wet and very windy so we willingly accepted that on a clear day we could have seen Dumbarton Rock, Ben Lomond, a rhyolite quarry and many more features. We did just make out some stepped lava flows in the distance before huddling together to examine the basalt exposures at the side of the road.

On the west side of Gourrock we paused to peer, from the bus, through the greenery at a cliff of graded beds of red sandstones on the left side of the road. Our next stop was a quarry of basalt which was quite breathtaking. All around us was the most fantastic columnar jointing, twisting in all directions. As the rain continued we lunched in the bus at Inverkip before struggling down to the beach. There we studied faults, dykes, cornstones and sandstones as well as, in miniature, how river systems develop, the principles of sedimentation and the cementation which can occur around metal structures in the sea.

At our last stop at Wemyss Bay we traced large dykes and dyke slots through the Old Red Sandstone beds which form the high cliffs as well as the foreshore. We perched precariously, almost within reach of the waves to examine a series of small folds and to study the unconformity between the conglomerate and the sandstone.

In spite of the fact that so many of the stops had been selected because of the views usually obtainable our leader invariably found a smaller scale feature to talk about. She very nobly faced into the gale force wind so that we could face her and hear her with comparative ease in spite of the constant rain and wind.

We returned very wet and dripping all over the bus but having learnt a lot, especially about geological processes. The bus driver was polite but I don't think the society will ever be allocated such a nice new bus again.

THE ULLAPOOL AREA: 20th to 21st September 1986 (Leader: Dr Iain Allison)

The areas around Ullapool and Loch Assynt contain classic aspects of Scottish stratigraphy, sedimentology and structure. Ably led by Iain Allison from the University of Strathclyde, 10 members of the Society were treated to an excellent study in outcrop of the Precambrian and early Palaeozoic geology of northwest Scotland, the Moine Series thrust over onto the relatively undeformed foreland succession sediments resting unconformably on Lewisian Gneiss.

Day 1

Saturday morning was spent walking north from the Lewisian Gneiss along the shore of Loch Assynt, up the lower slopes of Creag Sgiathaig, before turning east to rest and have lunch by the gentle falls of the Allt Sgiathaig. Unconformable on the Lewisian in the A837 roadcut, the pink Torridonian alluvial fan sandstones were unconformably succeeded by the white shallow marine Lower Quartzite and Pipe Rock. Both large and small diameter burrows (pipes) could be found in the Pipe Rock in close proximity, occasionally on rippled bedding surfaces. The Pipe Rock passes up in uniform succession through the Fucoid Beds, Salterella Grit and Durness limestone east along the A837, completing the foreland succession. Just to the north of the A837 and east of the A849, steep dips and faulting in the foreland succession show the affects of thrusting.

An excellent example of a duplex, in the Durness limestone, was viewed on the drive south to Knockan Cliff, where the foreland succession was overridden by Moine Schists, separated by a mylonite zone.

The weather had matched the geology, quite invigorating. The wind had strengthened throughout the day, reaching crescendo at Knockan Cliff. For the geologists and admirers of beautiful scenery it had been a very good day.

Day 2

The weather made Sunday a day to be in church. it was very wet and overcast. The clambering over the hills between Ullapool and Loch Achall, however, had its own religious overtones for geological devotees. The foreland sequence was less well exposed than in the Assynt area, but the relationships between the various structural units bound by the Loch Broom and Moine Thrusts over the foreland succession were of prime interest and studied intently. To place one's hand on the world famous Moine Thrust, rooted deep in the earth's crust and in geologic literature, represented something of a pilgrimage. The day ended early, whereupon part of the group took in one last structural exposure, a roadcut just east of Ullapool, a good example of horse/thrust geometries.

EXCURSION GUIDE TO THE GEOLOGY OF THE ISLE OF EIGG

Introduction

The Isle of Eigg can be reached by boat from both Arisaig and Mallaig. In the summer there is a daily boat from Arisaig weather permitting, (tel 0687-224 or 678) which takes one hour, leaving Arisaig at 12.00, returning from Eigg at 17.00. Calmac sail from Mallaig throughout the year, on Mondays, Wednesdays and Saturdays on a Small Isles round trip, Mallaig 12.30, Eigg 14.00, Mallaig 19.00, (i.e. a five hour return trip). Most of the accommodation is in self catering cottages or the Kildonnan Guest House on the east of the island. Laig Farm Guest House is on the west with a superb view of Rhum. About 4 miles (c.7km) of road leads from the pier across the island to Laig Bay and Singing Sands Bay or Camus Sgotaig. There is also a branch road to Kildonnan House. A landrover taxi service is available (£1 a head 5 minimum) if time is short. The owner of the island, Mr Keith Schellenberg, is usually happy for people to walk over the island with the proviso that nesting birds, particularly the eagles, divers and terns, are not disturbed. Check with the Estate Office or the Scottish Wildlife Trust Warden.

The following maps would be useful: OS:- 1:25000 NM 38/48, 1:50000 Sheet 39, Bartholomew 1:100,000 Sheet 50 B.G.S. 1 mile: 1 inch Rhum and Small Isles.

The Geology

Eigg has outcrops of Jurassic and Cretaceous sediments overlain by Tertiary volcanic rocks and there are numerous small intrusions, see fig. 1. A wide variety of rocks, fossils and sedimentary features can be seen. The geological column is given in fig. 2. Numerous articles have been written about the various aspects of the geology. A delightful introduction is the account of Hugh Miller's visit in 1856 during the "Cruise of the Betsy" when he visited the singing sands, the pitchstone dykes of Rudh 'an Tancaird and of course discovered the famous Reptile Bed. Dr John Hudson worked for his Ph.D on the island and has subsequently published many articles both alone and with others. A good introduction to the Great Estuarine Series is given in his 1962 paper. There has also been much discussion on the nature of the emplacement of the pitchstone of the Sgurr, by Harker (1908, 1914), and Bailey (1914). Selected references are given on p.33. A more complete list of references is given in Hudson (1980).

Itineraries

Two nights on the island using the Arisaig boat for transport allow 2½ days for field work which is enough to give a good general idea of the geology, although, of course, more time would always be better. The itineraries are given from points on the roads, leaving people to make their own way along the roads. This guide is arranged in 3 parts:-

a) Kildonnan shore (about 5km total walking from Kildonnan House — half day) where the variation in facies typical of the Great Estuarine Group can be studied and the contact between the lavas and the sediments on the east can be seen.

Figure 1.
 Sketch map of the Isle of Eigg

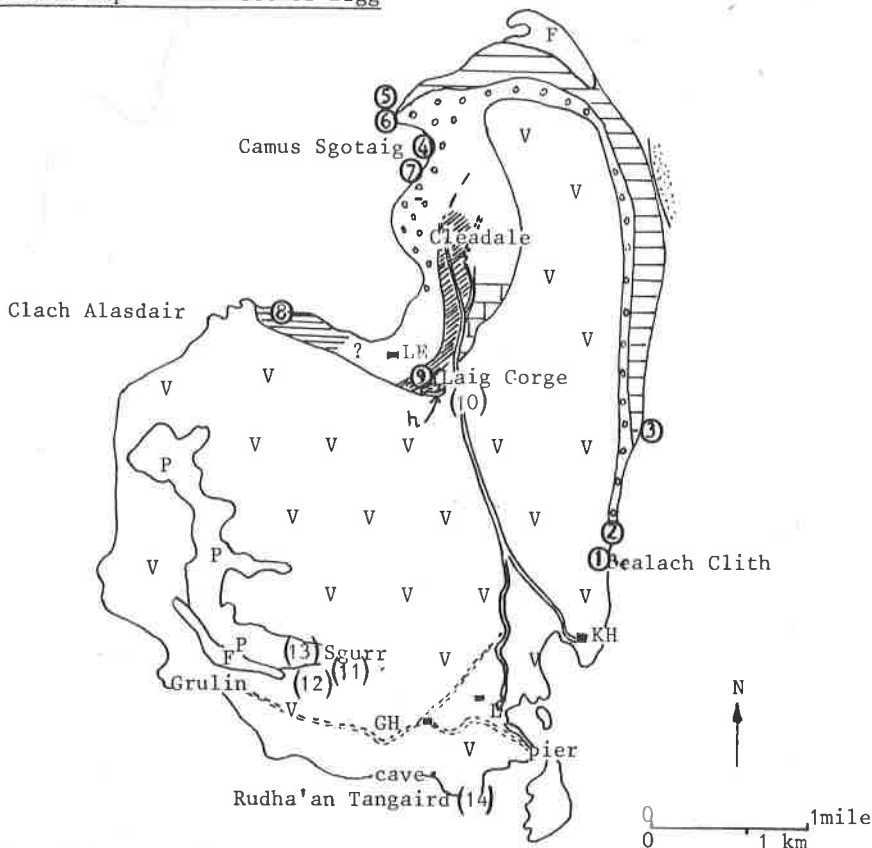


Figure 1 shows the main geological outcrops (for key see below and also figure 2), localities mentioned in the text (numbers 1-14), roads (//). The following abbreviations are used: F = Felsite, P = Pitchstone, V = Basalt lavas, KH = Kildonnann House, LF = Laig Farm, L = The Lodge, GH = Galmisdale House.

b) West Coast and Laig Gorge (about 10km + road - full day) for the upper part of the Great Estuarine Group, the Oxford Clay, two outcrops of the Cretaceous sediments and the base of the lavas in the west.

c) Scurr of Eigg and Rudh 'an Tangaird (about 10km taking $\frac{2}{3}$ of a day) to see evidence for the emplacement of the pitchstone and other igneous features.

The numbered localities are given on the map in fig. 1.

The tide should be low for the Kildonnann shore section and the Oxford Clay near Clach Alasdair. Note that in mist ALL parts of Eigg with its massive inland cliffs should be treated with extreme caution.

As much of the literature uses the old stratigraphical names these will generally be used in this text but new names are listed in fig. 2.

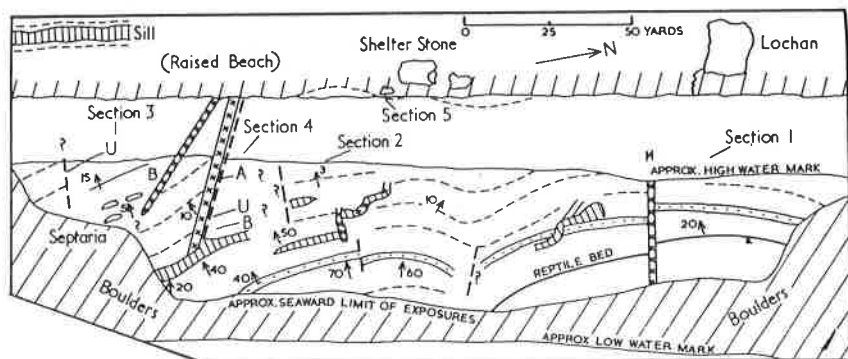
Main divisions	Old names		New names		
TERTIARY U/C CRETACEOUS U/C <u>Stages</u>		V, P, F			c. 5m
	L. Oxfordian U. Callovian	OXFORD CLAY gap	h	Staffin Shale Formation Laig Siltstone Member*	>33m
Bathonian	OSTRACOD LIMESTONE	8	Kilmaluag Formation	6m	
	L. OSTREA BEDS	7b	Duntulm Formation	6m	
	CONCRETIONARY SANDSTONES	7a	Valtos Formation	56m	
	ESTHERIA SHALES MYTILUS SHALES gap	6b	Lealt Shale Formation Lonfearn Member Kildonnán Member*	22m 30m	
Bajocian	'INFERIOR OOLITE'	5	Bearraraig Sandstone Formation	>6m	

*type locality

Figure 2. Stratigraphical horizons of rocks found on Eigg.

a) Kildonnan Shore

This route uses an easy path down through the precipitous cliffs. From Kildonnan House road end (490851) walk north across the fields for about 0.75km to the Bealach Clith (492858), a marshy depression at the edge of the cliff with a wall running to the edge of the cliff. Before going down the path go round the edge of the wall and through an old gate to an outcrop a few metres beyond (locality 1) This outcrop is of mugearite, part of the prominent "Grey Rock" which can be traced round the north of the island. This distinctive rock is a very fine grained pale grey, weathering to grey lava with numerous elongated vesicles and platy joints. This is one of the less common lavas on the island as most are basaltic. The dominant feldspar is oligoclase and Allwright (1980) considers the mugearite to be a differentiate from a more basic magma. Return to the path and walk down in a northerly direction towards the shore. The lower lava flows can be seen to the left of the path (locality 2) and shortly the contact between the lowest lava and the Concretionary Sandstone Series is seen — a sharp junction with no disturbance of either the sediment or the lava. A thin intrusion occurs at the junction. The lavas here lie on lower Jurassic rocks than in the west of the island. The lavas can be seen very well from the path as it goes north. The lowest flow has particularly well formed columns which vary in attitude presumably due to the varying original underlying topography. Several red weathered horizons can be seen on top of the lavas. A fallen block of lava near the path allows closer study of the columns.



KEY TO MAP

— A	Algal Bed	} Mytilus	XXXX	Dykes	} Tertiary Basalt (thicknesses exaggerated)
— U	Unio Bed			Sills	
— B	Bivalve S. Bed		----	----	Faults
- - -	Shales (Bed 5), with strike lines	} Shales			
.....	Complex Bed				
—	Reptile Bed				

Figure 3. Sketch map of the Kildonnan shore, type section of the Mytilus Shales. Reproduced, by kind permission of the editors from J. D. Hudson, 1966. Hugh Miller's Reptile Bed and the Mytilus Shales Middle Jurassic, Isle of Eigg, Scotland. *Scottish Journal of Geology* 2. 265-281.

About 1.5km north of the Bealach Clith, where the path has reached the shore is a very large boulder with excavated sides called the "Shelter Rock" and to the north is a small marshy lochan (495873). On the shore here are outcrops of the *Mytilus* Shales (locality 3) which were mapped in great detail by Dr John Hudson (1966). This is the type section of the *Mytilus* Shales and a low tide is needed. John Hudson's map (fig. 3) indicates good exposure but it should be noted that there are numerous boulders covering the shore and that hard searching is necessary to find the various horizons. Samples should only be collected from the loose blocks. Within the grey shales it should be possible to find a stromatolitic algal bed (hypersaline mud flats), shell beds with *Unio* (freshwater) or *Mytilus* (brackish water) and also the famous Reptile bed — a red weathering horizon. The rapid variations in conditions of deposition are well demonstrated here.

Return by the same route.

b) West Coast

Start at the road end in Cleadale (476901). Cross the fields to the north west and descend the path in Camas Sgotaig (locality 4). When the sand is dry a sharp squeaking noise is made when walking across. This is hardly a song but is a loud and distinct noise. These sands were first described by Hugh Miller. Now walk to the headland north of the bay. On the northern side of the headland (locality 5) numerous sills are intruded into thinly bedded black shales which seem to have allowed the intrusions easy access. On the bedding planes can be found minute *Cyzicus* (*Euestheria*) and also *Unio*. These are nonmarine forms and these "Estheria Shales" are thought to have been almost entirely freshwater. There are no sandstones. Walking south back towards the bay thin sandstones appear (locality 6) often bioturbated and gradually becoming thicker. Some of the sandstones are crossbedded and there are many large calcareous concretions, hence the name of this "Concretionary Sandstone Series". These are interpreted as a series of upwardly coarsening units typical of a delta building out into deeper water. Some of the beds south of the bay (locality 7) are very thick. There are several dykes intruded into the sandstones. The igneous rock is generally more easily eroded than the sandstones. Return to Camus Sgotaig and go back up the cliff path, then walk along the top of the cliffs to Laig Bay. Cross the sand then take the path along the raised beach to the west towards Clach Alasdair (455884). Well hidden under the beach boulders are outcrops of grey clay with occasional prominent cream limestones (locality 8). This is the "Oxford Clay" or Laig Bay Member which contains ammonites and belemnites. The outcrops are probably all blocks slipped under the weight of the overlying lavas. The dip varies from the vertical to the horizontal and it is difficult to piece together the succession. However all divisions from the Oxfordian are present. (Sykes 1975). The easiest way to find good outcrops is to continue to the headland of Clach Alasdair where the lavas reach the sea and work back to where about 50cm of glauconitic sandstone of Cretaceous age overlies good outcrops of the Oxford Clay. The ammonites are concentrated at some horizons and may be quite numerous. They may be pyritised but many are

preserved with their original aragonitic shell. The larger specimens break very easily and if any are collected a large slab of clay should be excavated together with the fossil and carefully wrapped for transport. Cardioceratids are the most common ammonites here.

Retrace the path towards Laig Bay and walk south-east towards Laig Gorge (474875).

Laig Gorge

The upper part of the gorge is in the lavas with the basal columnar flow and the grey mugearite above easily seen. Below the lavas are some interesting exposures (locality 9). In the lower part of the stream are oyster beds — thick beds composed of nothing but thousands of *Liostrea hebridica*. These are the “Lower Ostrea Beds” (lower because for example, in Skye, there are also Upper Ostrea Beds). Higher, there are outcrops of shales and limestones with ostracods crowding some of the surfaces. These are the “Ostracod Limestones”. Above the shales and limestones is a massive bed of sandstone, of Cretaceous age (Hudson 1960). The base of the sandstone is very coarse or even pebbly. The sandstone is about 3 metres thick and a waterfall flows over it. By scrambling up the rocks the next part of the succession can be seen. At the lip of the waterfall is a nodular bed, then the sequence becomes more calcareous and finally is seen as a pure greyish limestone about 2.5 metres thick. Microfossils have been identified in thin section and give the age of the limestone to be Upper Cretaceous. A little way above, the base of the lavas can again be seen (locality 10). Two unconformities can thus be well demonstrated on Eigg, one at the base of the lavas which rest on both Jurassic and Cretaceous rocks (cf.(2),(7)) and another which must occur below the Cretaceous, which has a very irregular distribution. The pre-Tertiary landscape must have been quite varied. It is possible to scramble along the gorge or to return to the bottom and go up a path to the south in order to get back to the road.

(c) Sgurr of Eigg

From the pier, take the drive to the Lodge as it passes along the edge of the fields. Continue straight on at the Lodge gates, then turn left, following the track through the woods. Across the fields can be seen Galmisdale House (about 1.5km from the pier). Here there is a gate through the wall, turn right and after a few metres left up a grassy path. From here there is a clear path up to the Sgurr. The path gradually rises over a succession of lavas showing typical trap scenery with the central portion of the flows forming a series of cliffs (mapped as sills originally!) As the Nose is reached the path continues to the north. Turn left at this point and walk across a steep heathery slope to the pitchstone cliff (locality 11). Here at the Nose a sequence of lavas can be seen. Cutting them is a small dolerite dyke. The dyke does not continue into the pitchstone which here forms a massive cliff towering above. The lower part of the pitchstone has thick regular columnar jointing perpendicular to its base which is here dipping quite steeply to the south (fig. 4). Continue westwards down along the base of the pitchstone, which often forms an overhang. After about 500m is a deep recess (locality 12) just west of Botterill's Crack, a cleft in the cliff. Below

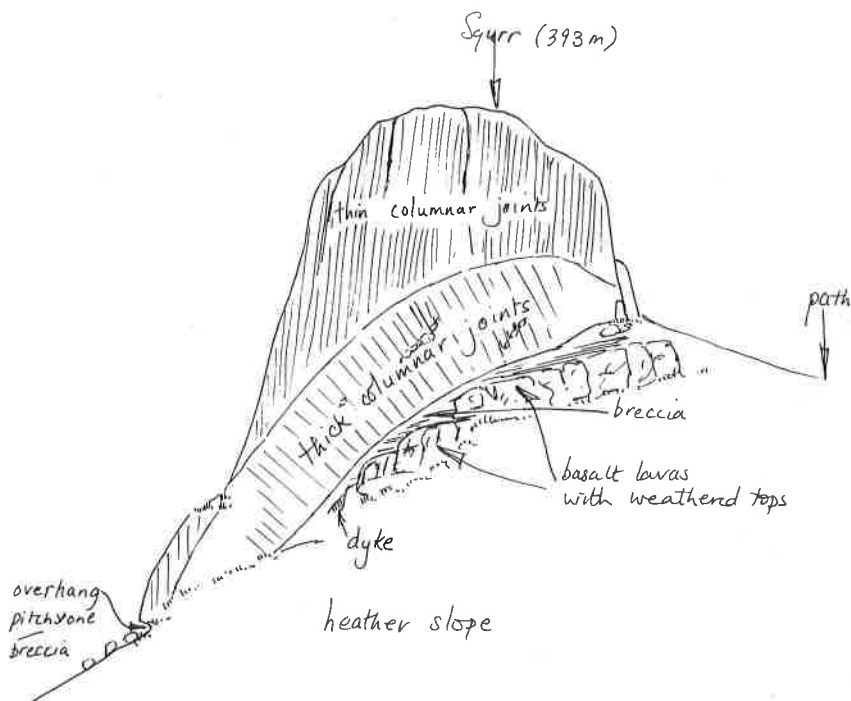


Figure 4. Sketch view of the Nose of the Sgurr of Eigg.

the pitchstone is 2-3m of pitchstone breccia while below this is about 50cm of more rounded pebbles including Torridonian Sandstone. Fossil wood could at one time be collected here.

It is now considered that there was a long period of erosion after the formation of the basalt lavas; time for a major river system to develop and deposit sediments and for trees to grow somewhere in the area. The viscous pitchstone lava then flowed down this valley with the base solidifying and breaking up to give the breccia. Harker, the author of the *Small Isles Memoir*, thought that the pitchstone was intruded into the lavas, but there is little support now for his view.

Return to the Nose and continue along the path. The upper part of the pitchstone can be seen to have much thinner columns which are often at a different angle to those of the lower part. It is thought that this is due to their having been formed perpendicularly to the upper surface of the cooling lava as it came to rest in the valley. These columns can be well seen on the Sgurr itself (locality 13).

Descending the path again, turn right about half way back to Galmisdale House and walk across the heather to the Grulin road. Look back to the Sgurr and note the intrusions of felsite which can be distinguished by their lack of columnar joints.

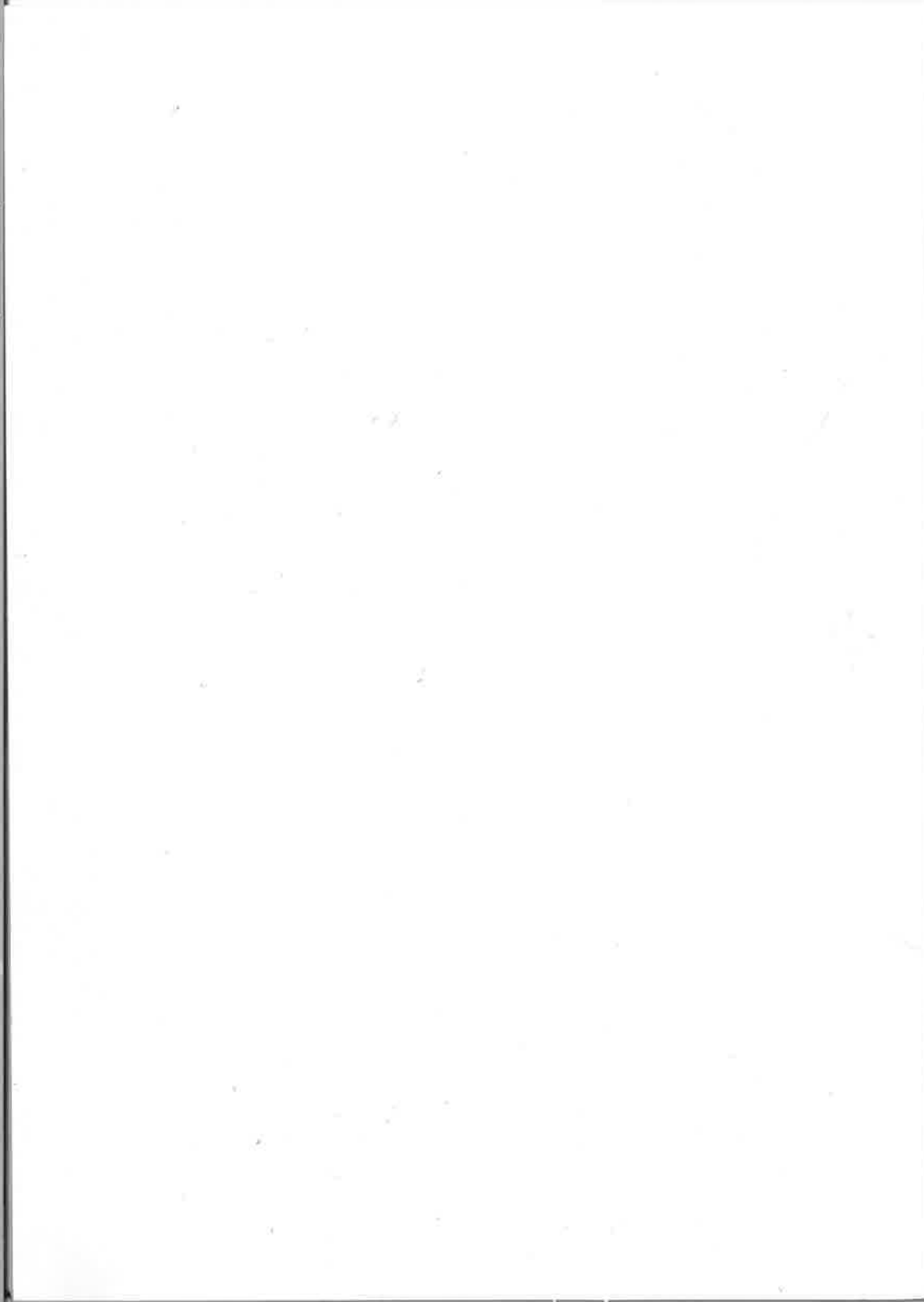
Cross the road and continue to Rubh'an Tangaird (locality 14). Here are

two splendid pitchstone dykes (no hammering!) These are quite irregular as they intrude through the basalt lavas. They show the black shiny appearance of the pitchstone very well. A thin felsite occurs in the centre of the eastern dyke. They are not similar to any of the other pitchstones and so cannot be linked to the other outcrops (Allwright 1980).

From here walk back to the pier and wait for the boat, hopefully in the sun!

REFERENCES

- Allwright, A. E., 1980. The Structure and Petrology of the Tertiary volcanic rocks of Eigg, Muck and Canna, N.W. Scotland M.Sc. Thesis Durham (unpublished).
- Bailey, E. B., 1914. The Sgurr of Eigg. *Geol. Mag.* 51, 296-305.
- Harker, A., 1908. The geology of the Small Isles of Inverness-shire. *Mem. Geol. Surv. Scotland.*
- Harker A., 1914. The Sgurr of Eigg: some comments on Mr Bailey's views *Geol. Mag.* 51, 306-308.
- Hudson, J. D., 1960. The Laig Gorge Beds, Isle of Eigg (with appendix by C. G. Adams) *Geol. Mag.* 97, 313-325.
- Hudson, J. D. 1962. The Stratigraphy of the Great Estuarine Series (Middle Jurassic) of the Inner Hebrides. *Trans. Edinb. Geol. Soc.* 19, 139-165.
- Hudson, J. D., 1966. Hugh Miller's Reptile Bed and the Mytilus Shales, Middle Jurassic, Isle of Eigg, Scotland. *Scott. J. Geol.* 2, 265-281.
- Hudson, J. D., 1980. Aspects of brackish-water facies and faunas from the Jurassic of north-west Scotland *Proc. Geol. Ass.*, 91, 99-105.
- Miller, H., 1858. The Cruise of the Betsy.
- Sykes, R. M., 1975. Jurassic stratigraphy in Northern Scotland. *Scott. J. Geol.* 11, 51-78.





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