PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF GLASGOW

Sessions 138 and 139 1995/97

Frontispiece - Siccar Point - Vertical Silurian greywackes overlaid by Upper Devonian sandstones form this spectacular scene noted by Hutton in 1788.

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PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF GLASGOW

Sessions 138 and 137

1995/96 and 1996/97

CONTENTS

MEMBERSHIP

The membership of the Society for sessions 138 and 139 was as follows

	Session 138	Session 139
Honorary Life Members	3	2
Life Members	1	1
Ordinary	350	340
Associate	60	61
Junior	9	4
Totals	423	408
New members	16	26
Deletions	34	25

J Willing

LIBRARY REPORT

Session 138

The major item for this season concerns the location of the library. This summer a fundamental upheaval took place within the building, occasioned by the entry of the Department of Archaeology, with which the Department of Geology & Applied Geology will, henceforth, share the facilities. This meant that we had to give up the room we have used for twenty years. The libraries of both the Society and the Department having, thus, to be relocated and, since we have no single room of equivalent size, have had to be split between three localities.

Library 1 (Conference Room/Room320A, Floor 3) consists of the general and specialist book collection, the restricted loan collection, catalogues and study facilities. Library 1 is open as follows:-

Meetings evenings 7.00 pm - 9.00 pm.

Weekdays 9.00 am - 5.00 pm - at any time when the room is not booked for teaching or meetings. Always consult the timetable by the door before entering.

Library 2 (Room 215, Floor 2) consists of the reports, memoirs and other publications of the British Geological Survey, and of other geological surveys worldwide. Library 2 is open as follows:-

Meeting evenings 7.00 pm - 9.00 pm

Weekdays 9.00 am - 5.00 pm.

Library 3 (Staff Room/ Room 204, Floor 2) contains the journal collection, including current-awareness scientific periodicals and the major geological journals. It is open as follows:-
Meetings evenings 7.00 pm - 9.00 pm.
Daily, except during staff tea and lunch times (i.e. 10.30 - 11.00 am, 12.30 - 1.30 pm, 3.30 - 4.00 pm)
Note that Libraries 1 and 2 are now open, BUT that Library 3 is still being reorganised and will not be available before 01/01/97.
The current rules and regulations will apply for each of the libraries and the usual loan book is to be found in Library 1. The Society's book and journal collection remain intact, and further additions to stock will be made in the course of the coming session.
Sales of old stock continue and it is hoped that the remainder of these out of date books and journals will be disposed of by March 1997. Details of the money raised thus far will be found in the Society's balance sheet for the session.

Session 139

This session has been a very difficult one for the Society's library. In the report for last session it was noted that, while the library had to be removed from the room it had formerly occupied, new rooms had been found to accommodate the stock. At this point our library occupied three rooms (204, 215 and 320A), with reserve stock held in 217, and it was anticipated that all the current stock would be shelved and available for this session. However the Principal decided, at very short notice, that Archaeology should be given rooms 204 and 217, thus depriving us of half our library space at a blow, and imposing a huge amount of extra work, work that had to be accomplished extremely rapidly.
We could not hope to keep all our stock under such circumstances, and the following measures were taken:

1. **Reserve Stock.** The Council had already authorised the sale or removal of this stock, and it was decided to sort the stock, retaining items of interest, selling all of the remainder that was saleable and dumping the rest. Accordingly a considerable number of items were stored, while a large selection of books were sold to Jay Books Ltd. of Edinburgh for a considerable sum (see Society's balance sheet for details) which, added to previous sales, put the total income well into four figures. Sadly much material had to be dumped.

2. **Current Journals.** All the Society's current stock of journals were retained and, together with the Department's journals, were put into store in a variety of rooms in the basement. There is, at present no space to

allow this stock to be shelved and used, and it must remain in store until such space becomes available.

3. **Geological Survey Collections.** These were housed in Room 215, but the situation required that the Department's collection of foreign geological survey collections had to be sent to the University library, in order to free space to house boxes of journals.

Thus, at present our book collection is housed in Room 320A, and the collection of British Geological Survey publications in Room 215. Both these collections have been available for consultation and lending throughout the session.

The book collection, housed in a temporary set of cabinets and shelves, in Room 320A will shortly be housed in new purpose-built shelving units, purchased by the Department. It is hoped that the planned increase in the amount of shelving will allow some key journals to be displayed. As for the future, it is not yet possible to allocate enough space to house all the departmental and society journals and other literature. However members interested in consulting current journals are, of course, free to use the University library.

In coping with these upheavals, and the consequent hard and dirty work of hauling our collections around, I had the assistance of a small group of members and departmental colleagues to whom I owe many thanks. Among these are Mr. W. Bodie (Assistant Librarian), and Drs J.J. Doody and A.W. Owen. Furthermore, without the unstinting help of the departmental technical force we should not have succeeded in doing the job at all.

The disruption has meant that reliable statistics on loans, etc. for the session could not be kept, and no new stock purchased. I hope, when the new shelving units arrive, and the Department subsides into normalcy to resume the services that the Society expects of its library and librarian.

C.J.Burton

EDITORIAL REPORT OF THE SCOTTISH JOURNAL OF GEOLOGY
Session 138

The Journal has seen another successful year with the completion of part 2 of volume 32. We have a reasonable number of papers in hand for the first part of volume 33 but are still seeking good manuscripts in order to maintain a flow. Efforts by the editors have now almost eliminated the few long-standing manuscripts and the blame for any continued delays on these now lies almost entirely with the authors. For new manuscripts we can now promise a rapid turn around in review and a speedy publication.

Dr David Stephenson has retired as an editor. Members will remember the difficulties of the Journal some years ago when it became necessary to change publishers. David was one of the leading figures in the survival of the Journal and both Societies owe him a considerable debt. He is replaced on the Board by Dr Peter Hill of the University of Edinburgh.

The Journal now has a page on the World-Wide Web, accessed through the Geological Society and the Publishing House, and there is a feeling that the two Societies should produce their own pages which can be accessed from the journal pages and vice-versa.

The financial position of the Journal remains uncertain in an uncertain world. Whereas our subscriptions over the last few years have shown lower rates of decrease than those of comparable journals, this year we face an 8% fall. The reasons for this are not immediately obvious but are under investigation by the Publishing House. It appears that the number of citations which we receive fell dramatically, although it now seems to be rising, and this may have discouraged Librarians. However, the statistics which back this are open to argument and it would be premature to attribute too much to them. There is concern on the part of our Treasurer that this situation may require subscriptions/subventions to be raised in the future but we await further investigations. In the coming year income may increase by the withdrawal of discounts from intermediate agents. This follows actions by other Journals but its effects are uncertain.

Finally, as a result of impending retirements at the typesetters and attempts by the Printers to dramatically increase costs, both of these functions will move to new operators for volume 33. Allied to this there will be changes in the way in which both text and diagrams are prepared for publication which will reduce intermediate stages and should also improve image quality. It will also open the way for both text and images to be available electronically if we wish to go down this road in the future. If we were to choose to do this it would entail a small additional charge and it is not clear how Journals published electronically would be able to charge subscribers. Until these issues are resolved we need take no action, but members will be interested to know that the Scottish Journal will be one of the first in which this style of publishing will be possible.

Session 139

The Journal has continued to be produced in 96 page issues and to appear on time. There have been minor problems with typesetting which have resulted in a small number of printing errors escaping the editorial net but otherwise the standard of production remains high. Volume 33 is complete and issued to members and preparations for volume 34 are well in hand. There has been a slight reduction in the number of papers being submitted but coupled with a more active policy on papers which had been on our books for a number of years but which authors have failed to revise, the delays between submission and publication are now enviably short. Provided that there are adequate new submissions this is an excellent position for us to be in and we are able to offer prospective authors a very rapid service.

There has been one change in the composition of the Board with the resignation of Dr Gordon Curry. Palaeontological interests will now be dealt with by Dr Sue Rigby of the University of Edinburgh.

The number of Trade subscriptions has unfortunately continued to decline. At the end of June 1997 the number was 225, compared with 236 for the same period in 1996. This represents a fall of 4.6%. The causes are thought to be a general decline in library subscriptions forced by the lack of money in many academic institutions. However, the National Average for Journal cancellations is currently running at 5%, so we have cause to be relatively satisfied.

The Publishing House continues to promote the Journal at every opportunity. Our name appears in the Cooperative Subscription catalogue, with a circulation of 10,000 and we had a full page in the Geological Society Publications catalogue for 1997 circulated to more than 60,000 earth scientists worldwide. The contents lists of issues from volume 33 onwards are available on the Internet via the sci.geol usenet newsgroup and on the Geological Society Homepage at http;//www.geolsoc.org.uk/pubs/sjg.htm

Colin Braithwaite

PUBLICATION SALES OFFICER'S REPORT

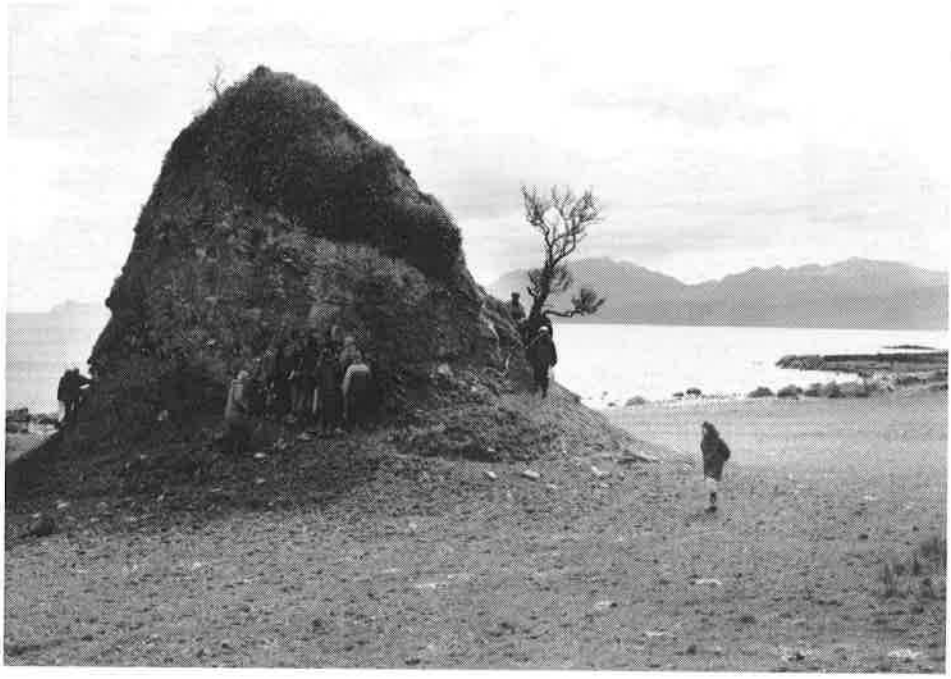
Session 138

50 titles were stocked during the year. The Skye Guide sold well in Skye and with various Universities. Present stocks of the Arran Guide should cover next year's sales. South West Scotland and Fife & Angus were popular with members. Sales to members and extra mural classes amounted to 42% of total sales. We are always pleased to have suggestions from members for new titles, preferably those of reasonable price and general appeal.

Session 139

Gross sales this year were up a little on last year though the surplus was down to £768. Sales to members were £1050, representing almost one third of total sales. The Department of Geology & Applied Geology, University of Glasgow, has been a building site for much of the year and we are indebted to Dr. Chris Burton for ensuring that our stocks of books were carefully moved around and re-stored. The BGS regional booklets were popular, as were dictionaries and two of the Palaeontological Association Field Guides. Members on the Guernsey excursion were well supplied with guide books and maps. The stock of the Arran Guide is now exhausted. This volume has stood the test of time from its inception by Murray MacGregor in 1965 through reprint in 1968, second edition in 1972 and third edition 1983, updated progressively by A.Herriott, B.C. King and J.G. MacDonald. As already reported, Council intend to replace this popular book as soon as practicable.

Roy Smart



Bute - The "Haystack", an odd formation on the raised beach at Scalpsie Bay.

LECTURES 1995 - 1996 (Session 138)

Session 138 started on Thursday 12th October with **"Constraints on Rapid Rates of Metamorphism in the North-West Himalaya"** by **Dr Peter Treloar,** (Department of Earth Sciences, Oxford). Dr Treloar looked at the relationship between deformation and metamorphism in the North-West Himalaya. He gave us a detailed explanation of how the dissipative heating associated with friction permitted the attainment of high temperature and rapid metamorphism in the Indian Plate within 10my of collision.

On November 9th the lecture was entitled **"Round the Bend - Aspects of Deep Water Sand Deposition"** by **Dr Peter Haughton** (Badley Ashton Associates). The study of deep water sand deposition has been dominated by a number of elegant models. There are however more complex deposits in small basins where containment causes flow to behave unusually. Well exposed outcrops in small Tertiary strike-slip basins off SE Spain form the starting point for a re-look at some key aspects of deep-water sand deposition in both "open" and oversupplied settings. The understanding of some of the concepts developed can lead to knowledge of where pockets of hydrocarbons in the North Sea can be located.

The **AGM** was held on Thursday 14th December. After the business was conducted, the **Social Evening** started off with a geological quiz based on musical themes. Two teams competed to identify the geological connection in a number of musical items. Jim MacDonald was not able to be present in person so he had recorded the musical themes - all played by himself on his clarinet.

Thursday 11th January was the first meeting of 1996 and this was given by **Professor Colin Ballantyne** (School of Geography & Geology, St Andrews University), entitled **"Reconstructing the Ice Age: Ancient Glaciers and their Implications."** Glaciers are one of nature' s great thermometers. He described how climate changes can be identified, how summer temperatures, wind direction and precipitation can all be determined by studying the periglacial trim lines of frost shattered rock of ancient glaciers.

On February 8th the Society was addressed by **Dr Robert Hutchison** (Department of Mineralogy, British Museum) on the subject of : **"Birth of the Sun and Planets: the Evidence from Meteorites."** Most meteorites are pieces of rock from asteroids. Friction with the earth's atmosphere melts the surface, but the inside stays cold. Meteorites preserve evidence of events in the emerging Solar System from about 4700 million years ago. Then, stars were forming in a gas and dust cloud which was seeded with newly formed elements, including plutonium, from a supernova. Other stars produced diamond and silicon carbide. A second supernova made yet more new elements and 1-2

million years later the sun and planets had begun to form. The planets originated close to 4560 million years ago.

Dr Adrian Lister (University College, London) gave us a very interesting and entertaining talk on 14th March entitled **"The Natural History of the Mammoth"** This is one of the best known extinct species of mammal. A lot of detail has been preserved in the frozen mammoths found in Siberia. The woolly mammoth evolved from an African ancestor and appeared in Siberia at the start of the Ice Age. Their food was mainly grasses, mosses, ferns and small shrubs; they only had four teeth, but there were six sets of them - replaced from the back of the jaw, and each set bigger than the previous one. Their extinction came 10,000 -12,000 years ago, possibly by a combination of climate change leading to a change in vegetation, and overhunting by the growing human population. Mammoth bone huts have been discovered in Siberia - one with the remains of 96 mammoths in the one hut - were they collected or killed?

The meeting on 18th April was entitled **"Geology of the Shiant Isles"** by **Dr Fergus Gibb** (Department of Earth Science, University of Sheffield.) The Shiant Isles are formed of four alkaline basic sills of Palaeocene age intruded into the Lower Jurassic sediments of the Little Minch Basin. The largest of these, the Shiant Isles Main Sill, has long been regarded as a classic example of a differential sill. With the aid of slides of these rather desolate islands, Dr Gibb described how his investigations have completely revised the internal structure of the sill. Although it is indeed a classic differential sill, the differentiation is due to multiple intrusions, the accompanying processes and strong *in-situ* magmatic fractionation.

The final meeting of session 138 was **Members Night** on 25th April.

The topics covered by members were:-

Mr Julian Jocelyn - " Billion year old agate from Lake Superior - an isotopic study."

Dr Gordon Todd - " New facets of Scottish gem stones"

Dr Neil Clarke - "A Break for Scottish dinosaurs" - Dr Clarke described the dinosaur footprint found on Skye and how he broke his leg collecting the slab of rock containing the footprint.

Iceland Expedition 1995 - Glasgow University Expedition to Iceland

Edward Ewing & Ian McInnes - "Bolivia 1995" Glasgow University Expedition to the Andes

Exhibits on display included:-

Dr Ian Lawson - Aerial photos of Gulf of Aden, Yemen Republic.

Dr Mike Keen & Amur Gammudi - Palaeocene fossils from Libya

Mr David Hollis - Images of Millport

Dr Gordon Todd - Scottish Gems

Mr Julian Jocelyn - Lake Superior Agates

LECTURES 1996-1997 (Session 139)

The first meeting of Session 139 was on Thursday 10th October 1996 and was the occasion of the presentation of the **T. Neville George Medal** to **Professor Bill Chaloner** (Royal Holloway University of London). His subject was **"Fossil Plants and Climatic Change."** The sedentary character of terrestrial plants gives them a direct and total dependence on the climate of their habitat. As a result, fossil plants offer a unique record of climate change through time. For as far back as plants can reliably be assigned to extant species, this "climatic signal" can be read with some precision. Fossil plants can also offer a basis for assessing changes in atmospheric composition, most notably carbon dioxide, which is linked through the "greenhouse effect" to global climate. Professor Chaloner reviewed some of the recent results in this field.

The November meeting on Thursday 14th was the Joint Celebrity Lecture in association with the Geological Society of Edinburgh. The speaker was **Professor Ian Dalziel** (University of Texas). He spoke on **"Scotland before Pangea: Pisco Galore?"** The assembly and disintegration of supercontinents has brought about fundamental changes to the earth's surface, oceans and atmosphere. Professor Dalziel spoke of the fact that it is now more possible to understand and reconstruct the pre-Pangea continental assemblies. A clue lies in the fact that it appears that Laurentia, the Precambrian core of present-day North America, was not always a "northern craton". The rocks of the Scottish Highlands were part of Laurentia until the time of the opening of the North Atlantic ocean basin approximately 55my ago. They may therefore provide critical clues to understanding the geography and global environment throughout the interval that multi-cellular life evolved on the planet.

The final meeting of 1996 was the **A.G.M.** After the business we enjoyed the **Christmas Social;** this year taking the form of a quiz for all present designed by Drs Hall and Allison, followed by the usual relaxed and friendly wine and cheese .

1997 started with a lecture on the 16th January by **Mr Norman Butcher** of Edinburgh. His topic was **"1797-1997: The Legacy of James Hutton and Charles Lyell".** 1997 marked the anniversary of the death of James Hutton and the birth of Charles Lyell. These two major figures in Scottish Geology are recognised world-wide for their contribution to our understanding of the Earth The lives and works of the two great geologists were compared and contrasted, their contributions to geology assessed as was the development of the Geological Sciences since their time. On February 13th **Dr Allan Roberts** (Badley Earth Science) took as his subject **"Mesozoic extension in the Scottish Highlands?"** - reappraising the links between the onshore and offshore Highland geology. Dr Roberts took us through a detailed discussion leading to the suggestion that many of the late faults cutting the Scottish

Highlands are possibly Mesozoic structures and that their Caledonian heritage can be called into question. Using models he explained the mechanics of hurst grabens and drew our attention to the fact that the footwalls go up as the fault continues. In the north-east lies the Moray Firth Basin; strain compatibility requires that extension in this basin should probably be transferred onshore into the Moine of the basin's footwall. West of the Northern Highlands lies the Minch basin. In this area the distribution of Precambrian basement at the present surface results from footwall uplift adjacent to large Mesozoic faults. Some of these faults are known to extend onshore.

The Strathconnan fault is suggested to be the missing Mesozoic link between the east and west coasts of the northern Highlands It is responsible for elevating Lewisian basement to the surface in its western footwall (Glenelg) and also for exposing deeper levels of the Moine (Morar Group) to the west. Extrapolating the Strathconnan fault offshore takes it through the Sound of Sleat and directly across the eastern margins of Coll and Tiree. This hypothesis suggests that a reappraisal of the link between onshore and offshore Highland geology may be appropriate.

On Thursday 13th March the Society was addressed by **Dr David Stevenson** (British Geological Survey, Edinburgh) on **"The Dalradian of the NE Grampian Highlands; New Order from the Chaos."** Over the past 15 years BGS and university co-workers have completed most of the mapping of the east Grampians, and the Dalradian stratigraphy has been traced from Perthshire to the Banffshire coast. Igneous rocks, both within the succession and as later intrusions, are many and varied, with some unusual compositions that may have tectonic implications. Their distribution assists in defining tectonic boundaries, such as the Portsoy-Duchray Hill Lineament, one of several major ductile shear-zones. The shear-zones in turn are also the locus of intrusions, as shown by the hitherto unknown Keith Shear-zone, with its granitic sheets and strong linear fabrics. The lecturer on 24th April was **Dr Godfrey Fitton** (Department of Geology and Geophysics, University of Edinburgh). His talk was entitled **"Ocean Drilling and the Iceland Plume"**. The North Atlantic margins provide a unique natural laboratory in which to investigate the role of mantle plumes in the break-up of continents and the formation of large igneous provinces. The opening of the ocean 60 million years ago was accompanied by the eruption of vast amounts of magma, most of which lie beneath the sea. The international Ocean Drilling Program has recently devoted two two-month legs of drilling to study volcanic rocks off the southeast Greenland coast. The results provide a detailed record of the initiation of the Iceland plume and the birth of the Atlantic Ocean.

The final meeting of session 139 was **Members Night** held on 18th May. The following gave talks and mounted exhibitions.

Mr Wim Van der Bruggen - from Birk Knowes SSSI, Lanarkshire
- Thelodonts - 430 million year old jawlwss fish from the Silurian era.

Dr Jim Buckman - Carboniferous orthocones from N.W. Ireland

Dr Neil Clark - Making tracks in Scotland - fossil tracks from Elgin

Rachel Hosein - Glasgow University Exploration Society Spitzbergen expedition.

Emily Campbell - Glasgow University Exploration Society expedition to Kimberley, North West Australia.

Mr Julian Jocelyn - spherulite from Jersey

Exhibitions from Hunterian including stilbite crystal from Minginish, Isle of Skye and samples of tracks from Elgin

A Geological Society microscope from 1915

T NEVILLE GEORGE MEDAL

At the meeting on 10th October 1996 of the 139th session the award of the T Neville George Medal was made to Professor William Gilbert Chaloner, FRS. This citation was delivered by Dr Colin D. Gribble, Head of Geology and Applied Geology, University of Glasgow.

"Professor Chaloner, during a long and distinguished career you have demonstrated the importance in science of occupying the ground linking two major branches of study, namely botany and geology. During a period of time when there has been an increasing tendency for individuals to confine themselves to narrow specialisation you have used your breadth of scientific knowledge, powers of observation and insight to illuminate the past history of our planet by interpreting evidence provided by fossil plants.

Since your days as a postgraduate student at the University of Reading where you obtained your doctorate for a study of the spores of Carboniferous lycopods you have led the way in many important fields within the broad scope of palaeobotany. During a career which has taken you to appointments in the USA and Africa, as well as several colleges of the University of London, your interests have varied from the study of growth rings in fossil trees to biomolecular palaeontology and the reconstruction of Palaeozoic climates.

It is hardly surprising that your achievements and contributions to scientific understanding have been acknowledged on numerous occasions. You were made a Fellow of the Royal Society in 1976, while Professor of Botany at Birkbeck College. In more recent years you have been awarded the Linnean

Medal for botany, by the Linnean Society, and the Lyell Medal of the Geological Society of London.
You do us great honour by being present with us tonight to allow us to add our own tribute while at the same time commemorating the memory of the late Professor George. We look forward to experiencing the eloquence of delivery with which you have captivated generations of students and scholars in the fields of botany and geology. But before we share that pleasure I call upon the President of the Society to present you with the Professor George Memorial Medal on behalf of the Geological Society of Glasgow and the Department of Geology and Applied Geology of the University of Glasgow."

OBITUARIES

Alison Lawson

Members of the Society were greatly saddened by the untimely death of Alison Lawson. Her consuming interest in geology was reflected in active participation in the Society's events and enthusiastic studies of the subject in extra-mural classes. She enrolled as one of the first intake of students in the University of Glasgow's Continuing Education Certificate in Geology and the Environment when it was originally set up in 1977. She successfully completed the course and was awarded the certificate in 1980. As a member of Council, Alison took on the demanding role of Membership Secretary for two successive terms of office from 1983-1989. She became unwell in 1993 but appeared to have made a good recovery and was beginning to resume her active interests in the Society when she passed away suddenly on the 3rd of August 1996.

Douglas Stuart Weedon, MA, D.Phil, FGS.

Douglas Weedon belonged to the distinguished generation of igneous petrologists who were associated with the late Lawrence Wager. After service as a pilot in the Royal Air Force in the latter part of the Second World War he studied geology at Oxford and took part in Wager's celebrated East Greenland Expedition of 1953 when, along with Malcolm Brown, Alex Deer and others, he was involved in pioneering investigations of the Skaergaard Intrusion. He will best be remembered, however, for his studies of the basic and ultrabasic rocks of the Cuillins in the Isle of Skye. He published papers on the Sgurr Dubh ultrabasic rocks and the Garsbheinn sill, and also on the ultrabasic/basic igneous rocks of the Huntly region. As Secretary of the Society in the 1960s he presided over a series of splendid annual dinners which were held at that

time and later held office as President. Doug and his wife Sue developed a great love for the Isle of Skye and the Cuillins and they planned to settle there after he retired. Tragically this ambition was frustrated by the untimely death of Sue. He never fully recovered from the effects of this event and later family bereavement, and died after a long illness on 28th February 1997 at the age of 73. Doug's quiet good humour and generous nature combined with enthusiasm and the ability to communicate his wide and deep knowledge of geology endeared him to successive generations of students.

Edward Mervyn Patterson, BSc, MSc, DSc, FRSE, FGS.

Dr Patterson, an Ulsterman and former President of the Society, died on 11th April 1997 at the age of 77. After embarking on a career with ICI, Ted left industry in 1947 to take up a lectureship in the Department of Geology at the University of St Andrews. However in the mid 1950s he returned to an industrial career with ICI in the Nobel Division at Ardeer. He remained there until he retired, having risen to the position of Manager of the Detonator Section. Although he had left an academic career he never lost his enthusiasm for his great love, the study of geology, and this interest was expressed in a number of his papers which were published in the Society's Transactions on the tectonics, igneous rocks and Old Red Sandstone deposits of parts of Ayrshire close to his home in West Kilbride. However his most significant contribution to geological research was through the series of papers which he produced in the 1950s on the basalts and associated rocks of the Antrim Plateau. He communicated his enthusiasm to others as a part time lecturer for the University of Glasgow's Department of Adult and Continuing Education from 1963 to 1977. In 1995, in recognition of his services to geology and long association with the Geological Society of Glasgow, he was created a life member. He is remembered with affection for his forthright manner and wry humour.

J.G.MacDonald

EXCURSIONS 1996 (Session 138)

ISLE OF BUTE: 4th May 1996
Leaders - Dr J MacDonald and Dr C Burton, University of Glasgow.
by M Greene

We gathered first in the Boyd Orr car park where we were distributed into four cars in order to cut down the cost of crossing to Bute.
Jim MacDonald met us from the ferry in Rothesay as he was there for the weekend's Jazz Festival, a definite factor in choosing this day for studying the geology of Bute.
Our first stop was in the north of the island at Balnakaily Bay to look at the youngest rocks on Bute - fossiliferous clays from the last Ice Age. We parked at the ferry slip and followed a track round the bay to Balnakaily Burn, which cuts through the glacial clay and sand on the raised beach. Many fine fossil specimens were found on the shore line where they had been washed out of the clay. Chris Burton was kept busy identifying Chlamys, Pecten, Mya truncator, Cyprina islandica amongst others. The shells we found were not actually fossilised and some were so fresh looking that it was hard for the lay person to identify them as being 12,000 years old (when asked what constitutes a 'fossil', we were told "anything which was around before books were written"!).
The second location was at Clate Point to look at Dalradian rocks, here we were set the task of determining the 'way up' by means of graded bedding in metamorphosed greywackes. This section is in the area of the 'nose' of the Tay Nappe, so determining which way up the sediments are can indicate which part of the Tay Nappe we are in.
Once we had all agreed the sediments were lying upside down we moved on to Ettrick Bay where we had our lunch at the beach and enjoyed the sun - despite the low temperature.
The third location was at Scalpsie Bay where we were to study the relationship between the Upper ORS and the Dalradian, and attempt to determine the line of the Highland Boundary Fault. Closely watched by a colony of seals we first studied the 'Haystack', a large solitary outcrop of agglomerate - this is thought to be the result of an infilling of a feature during Permo-Triassic times. We carried on further round the bay noting the intrusions and layout of the ORS and the Dalradian rocks: after observation and discussion it was decided that the map on our handout was misleading in the direction it gave for the HBF. Returning along the beach we examined more Dalradian sediments to determine their 'way up', and finally our attention was drawn to a serpentine suite - a sure indication of the presence of the HBF.

The final location was at Dunagoil Bay, where, from the vantage point of the vitrified fort on top of the Dunagoil Sill, we could observe the wave-cut platform of ORS and, in the opposite direction, the Tertiary lava flows.
Thanks to Jim MacDonald and Chris Burton we had a very instructive 'taster' of the geology of Bute - and the sun shone all day!
Reference: Julian Hill. Reading the Landscape of Bute through its Geology

A STROLL IN THE KINGDOM - THE FIFE COASTAL PATH FROM KINGHORN TO KIRCALDY: 11th May 1996
Leader - Mr Mike Browne, British Geological Survey
by John J Convery

On Saturday 11th May the Glasgow Geological Society undertook an excursion to the Kingdom of Fife. The weather could have been kinder, a grey day with a strong cold wind blowing in from the Forth. However, the greyness of the day was soon dispelled by the interesting and unusual geology that is intrinsic to this part of the Fife coast.
The sedimentary and mainly volcanic igneous geology of the area is interesting enough on its own, but is further enhanced by a Site of Special Scientific Interest.

The Lower Carboniferous basaltic lava flows (Bathgate Group) could be seen, along with subaerial autobreccias, waterlain tuffs and hyaloclastites (subaqueously brecciated volcanic rocks) and pillow lavas.

> "When is a pillow lava, not a pillow lava?" ...
> "Why, when it's columnar jointing whose polygonal cross-sections didn't just quite make it all the way!"
> "Didn't everyone know that? ah well another myth dispelled. Remember you read it first here!"

Although true pillow lavas were observed, these were not as well formed as those to be found in the west coast near Girvan.
Other unusual occurrences to be observed were, **WAIT FOR IT, YES!** - sand boils, or sand volcanoes, with crater-like depressions in the middle, and radially arranged sand lobes on the flanks. They are apparently the result of localised upward escape of water from a liquified bed. A further feature of the sediments included stigmarian roots, and the question was asked,

> "How did those trees get in there?" ...
> "Carboniferous sawmills!",

was put forward as a possible explanation. Although, whether or not Fred Flintstone's ancestors were environmentally

friendly remains to be seen, for there was no evidence of fossilised sawdust heaps in the immediate vicinity!
Lower Carboniferous (Clackmannan Group) marine and deltaic cyclic sedimentary rocks (Lower Limestone Formation) were observed. The highlights included the second and third (Seafield Tower) Abden limestones. The Second Abden Limestone is underlain by mudstones including a *Naiadites crassus* shellbed. A further feature of this limestone is Spaghetti Junction, oops sorry!. Wrong period, wrong location and it is a well documented fact that the Baillieston Interchange is the work of *Homo modernus*! But what was in view was a splendid example of Lithostration Coral colonies (spaghetti rock) which brought exclamations of surprise and delight from members of our party. Other features observed were the 'Thrust' Limestone (Mid Kinniny) with burrowed beds which are a feature of this part of the succession; early Permian Midland Valley Quartz-dolerite Sill intrusion and Carboniferous olivine dolerite sill which is seen to split into two leaves; coastal erosion including caves and landslips. One day could not do justice to this excursion but none the less it was immensely enjoyed by the nineteen members of our party.
A feature not seen by our party was the Tyrie Coal which has eroded away but our leader Mike Browne remembers seeing it in the days of his youth. To Mike we extend our sincere thanks and well deserved laudation both for his patience and knowledge of the geology of this part of the Fife coast which made for a successful and informative trip.

CAMPSIE GLEN AND LOCH ARDINNING: 1st June 1996
(Joint with the Edinburgh Geological Society)
Leader - Dr J.G. MacDonald, University of Glasgow.
by David McCulloch

The title intended for this excursion was "Strathblane Hills and Dumgoyne" but unfortunately the 1st day of June produced the same wet weather as had characterised April and May so that Plan B had to be brought into operation. Nevertheless 18 members of the Glasgow Society were joined by 17 members of the Edinburgh Society to brave the heavy showers and hailstones.
The excursion's aim was to explore the Lower Carboniferous succession exposed in the vicinity of the Campsie Fault with particular reference to the Clyde Plateau Lavas and the sediments which lie immediately above and below them. Dr MacDonald explained that there may have been up to 1000 metres of movement across the fault and that as a result a large part of the Carboniferous succession could be examined within a relatively small area on either side of the fault.

In Campsie Glen (north of the fault) the lower part of the sequence was examined. The cementstones and shales of the Ballagan Formation were interpreted as probable "Sabkha" deposits formed in high temperature, sub-tropical, shallow lagoons. The group appeared to have some difficulty comprehending such conditions today! There was some discussion of the possible origin of the carbonated dykes found intruding these sediments. The party then proceeded up the glen to the base of the lowest basalt lava flow which was seen to rest on a red, weathered, volcanic detritus (a laterite) indicating that the land surface must have emerged from the Sabkha lagoons into sub-aerial conditions. Dr MacDonald explained that between 20 and 30 lava flows were found in the Campsie succession. Further up the glen the relationship between a landslide and some small faults running behind it was examined.

The party then proceeded south of the fault to Loch Ardinning to study the succession above the lavas. Starting at the north end of the Loch with its exposures of Craigmaddie Quartz Conglomerate (which was seen to contain no volcanic detritus) the group proceeded past a huge disused quarry to the south end of the loch to view cross-bedded sandstones containing lenses of conglomerate. Moving west, the group "descended" to an outcrop of the uppermost lava flow of the Campsie succession. Finally, to the south a Quartz Dolerite dyke of late Carboniferous age was visited before the group adjourned to a nearby tea-room for shelter.

DUNBARTON ROCK: 19th June 1996 (Evening)
Leader - Dr Judith Lawson, University of Paisley
by Sally Rowan

The excursion began from the car park, studying angled cooling columns of very black, fine grained basalt/dolerite. Further round, it was apparent from the raised beach that the Rock had once been an island.

Above the raised beach, the huge overhang - from which gigantic, tenement-sized boulders had fallen - was probably a fault plane. Since these boulders are on the upper beach, they must have come away <6000 years ago. Several climbers were ascending the rock faces: it was a pleasant, still summer evening. Dogs were chasing waterfowl across shallow water on the mudflats - disconcerting to see the dogs apparently "walking on water" several hundred yards from the shore!

The Carboniferous sandstone was now vertical (possibly faulted?). Tuff strata included unsorted, angular limestone fragments. This alternating cementstone/siltstone sequence showed similarities to the Balaggan Beds.

Striations indicated small vertical faults between shales and sandstones. Imprints of salt crystals and a few fossils (both found during research work, not on the excursion) suggested a lagoon environment with rhythmic patterns of flooding, evaporation, flooding ....
There is an ash cliff round the shore, but large amounts of scree hide exposures. At the igneous/sedimentary contact, the rock is lighter and greener where it has been altered by contact metamorphism.
Volcanic activity in O.R.S. seems to have been similar to the Icelandic fissures, with no large central volcanoes. However, there may have been a small volcano at Dunbarton Rock. As a typical volcanic pipe is only 100m or so across, and the Rock is rather larger, other processes must have been involved. Probably the cone collapsed, forming a caldera, which was subsequently intruded. The resultant mass was later eroded by rivers and glaciers. This theory is borne out by the angles of the cooling joints.
The last locality visited was near the top of the O.R.S. Prior to the formation of the raised beach, there may have been a crag and tail formed by glacial erosion: the tail seems still to exist beneath the raised beach. One side of the Rock is smoother, the other rougher - both ascribable to ice action. Striations on the walls further up support the idea of a huge roche moutonee.
Dr Lawson was thanked for her clear, accessible exposition and for a most interesting and enjoyable evening.

GIRVAN: 27th July 1996
Leader - Dr J.K.Ingham, Hunterian Museum.
by Mary C Lawrie

As a new member to the Society I was honoured to be asked to write up the proceedings for the Girvan outing. No problem I thought - pillow lavas and ophiolite sequences. A delusion to be shattered as soon as the coach approached Girvan when Dr Ingham distributed what seemed like reams of hand-outs with lots of complicated diagrams splattered with strange words. Panic set in.
Following a steepish climb up from the scenic village of Barr with a stop en route to catch breath and view the overall geology of the Upper Stincher Valley we reached our first site at the Plantation Burn where, as not an SSI site, members with magpie instincts enjoyed the unusual pleasure of hammering for specimens for their collections. Meanwhile Dr Ingham explained the significance of deep and shallow water trilobites and related the history of his naming of the Gorse, Fence and Jubilee Members: the Gorse and Fence fairly obvious, whilst the Jubilee Member christened after the jubilation of finding a perfect specimen almost accidentally. Whilst no cries of jubilation emanated from the exposure during our hammering, a few squeaks of pleasure were heard

as a Numastoides eye, part of a Nileus Teres and an unusual Nautilus were extricated and identified by our Leader. These were enough to satisfy avid collectors that a return journey would be well worthwhile.
After a return to the village of Barr for a picnic lunch by the scenic burn we set off to explore sites along the Girvan foreshore:- Kennedy's Pass where, after examining the Kilranny Conglomerate with its distinctive pink granitic clasts, our Leader patiently ensured that everyone could note the faulting and follow the erosive contact to the channel fill: Ardwell shore with its spectacular folds where, after checking for 'way-up' structures to prove younging seawards and mentally rotating the stratigraphy to original position, we accepted explanation of slumping from NW of partly lithified sediments down an unstable slope: and finally exploration of the Whitehouse Shore with its turbidity sequences; the jaggy 'ribbon' sequences of alternating sandstone and shale beds; grey/green shales; red and green mudstone sequences; unusual Neptunian dyke; and the Gray beds, with the excavation where Mrs Gray gathered her famous fossil collection still exposed. Dr Ingham's anecdotes of the elderly Mrs Gray's outings and her contacts with the geology students of her day were, for me, the highlight of the afternoon. Having learned there is much more to Girvan than pillow lavas and ophiolites we returned home fired with enthusiasm for return visits.
Our thanks are due to Dr Ingham for a very full day of complicated geology interspersed with interesting historical anecdotes ensuring the interest of beginners and experts alike.

SICCAR POINT (NT 813710) and CATCRAIG (NT 712772):

17th August 1996

Leader - Mr A. David McAdam, British Geological Survey
by Roy Smart

Whether you make your way to Siccar Point by sea, as James Hutton did in 1788, or by land as we did, the scene is spectacular. Sea caves, towering cliffs, huge blocks broken from the land by the power of the sea surround near vertical Silurian greywackes and shales underlying, and in places piercing, the gently dipping sandstones and breccias of the Upper Devonian. The unconformity is quite evident even from the top of the grassy cliff. At close quarters it is yet more arresting. Hutton had earlier observed such unconformaties in Arran and Jedburgh, but Siccar, in Playfair's words, "On us who saw these phenomena for the first time, the impression made will not easily be forgotten".
The afternoon at Catcraig provided a complete contrast in topography. From the fine beach at Whitesands to the lighthouse at Barns Ness stretched well

exposed almost horizontal strata of the Lower Limestone Formation. The Middle Longcraig Limestone is the most evident and contains crinoids, corals and brachiopods. A most interesting feature is an area of regular, closely spaced indentations in the limestone about 1 metre across. A filling of fireclay indicates Carboniferous age, supporting the belief that these potholes are the sites of Carboniferous forest trees. This whole shore area has been extensively quarried for limestone which was processed in the Catcraig limekiln, a well preserved industrial monument. Notable too are four illustrative boards, provided by East Lothian Council, describing the geology of the area. These limestone formations are still quarries on a much larger scale to provide the raw material for the adjacent Dunbar Cement Works. It is estimated that there is enough limestone to last the works into the middle of the 21st Century.

An excellent excursion, enjoyed by 27 members, proving yet again that Scotland encompasses some of the most diverse geology to be found anywhere.

Catcraigs - These regular depressions in the Lower Limestone Formation may have their origins in a Carboniferous forest.

JERSEY: 7-11th September 1996
Leaders - Dr C.J. Burton & Dr J.J. Doody, University of Glasgow
by Judith Lawson

On 7th September 1996 24 members and friends of the Society left Glasgow by air for a field excursion to Jersey, led by Chris Burton and Ben Doody.
The geology of the Channel Islands is very different from that of Scotland and was therefore a new experience for most of the party. The rocks are rarely visible under the blanket of soil in the centre of the island but are well exposed on the cliffs in the north and on coastal platforms in the south. There is an extensive network of lanes and well made paths along the coasts which allow easy access to the coastal areas and from which descents can be made to vital exposures at sea level. These descents (and ascents!) will remain long in the memory! Another feature was the easy availability of ice-cream!
The Channel Islands, although so close to each other, show quite varied geology and are considered, by British geologists, to be slices of terranes which have been slid into their present positions along lateral faults. They are part of the North Amorican Massif which includes Brittany. The oldest (2018-1790 Ma), basement, rock of the Channel Islands - the Icartian Gneiss - belongs to the Gondwana basement complex and is well seen on Guernsey. Jersey is formed of younger rocks. These include a succession of sediments and calc-alkaline extrusive rocks of Brioverian age (Vendian - early Palaeozoic) which formed at an Andean type continental margin with a major subduction zone dipping to the south. This Cadomian Orogeny started around 700Ma, reached its peak at 540Ma and ended at ca. 485Ma. There were also plutonic complexes and dyke swarms associated with later stages of the orogeny and post orogenic sediments of Cambro-Ordovician age. There is then a major gap until very recent times, either because nothing was formed or because erosion has removed any trace of later events. Later, erosion has formed the islands as they are today. Marine erosion has led to the development of platforms. The airport is built on one such Neogene platform and there are numerous more recent caves and raised beaches. Four days were spent looking at the geology on the coasts with the southwest corner the only major area not visited.
On the first day some of the oldest sediments were seen in Giffard Bay, on the north coast, where a small outcrop of the Jersey Shale Formation was exposed along the Fremont Fault at the eastern end of the bay. This was a hard black shale with some evidence of slumping. The main area of the bay is formed of a succession of pyroclastics and lavas, typical of a continental plate margin environment. There were good exposures of ignimbrites, often showing a streaky (eutaxitic) flow texture, of agglomerates with large bombs and of andesite and rhyolite lavas. In general the andesites were extruded first and

then rhyolites later in a cycle. There are frequent erosion surfaces showing that these were produced sub-aerially.

Later Bouley Bay was visited where younger outcrops of the Bouley Rhyolite Formation occur in the bay north of the harbour. Numerous pebbles with spherulitic textures were seen on the beach. The spherulites form as viscous rhyolitic lavas become devitrified.

The day ended with a walk to Belle Hougue Point where the post orogenic sediments, coarse conglomerates, of the Rozel Conglomerate Formation outcrop.

The second day, on the east side of the island, started at Anne Port. Good exposures on the north side of the beach allowed a detailed study of rhyolite flows. Lying on the eroded top of the previous flow occurred agglomerates, indicating explosive activity, followed by unjointed units, columnar jointed units and an autobrecciated unit at the top, formed when the top of the lava flow cooled and broke up while the lava was still moving. Not all the sequences were complete as erosion has often removed part of them.

In the afternoon the Rozel Conglomerate was examined at St Catherines. The party was split up into groups to identify as many clasts in the conglomerate as possible and to try to get a rough, quantitative idea of the proportion of each in a metre square. The clasts varied from sub angular to very well rounded, indicating several cycles of reworking. There were andesites, rhyolites, ignimbrites and granites and also conglomerate clasts similar to the conglomerate itself, again suggesting erosion and reworking of the main conglomerate. The final stop of the day was for some (a few!) of the party to descend from the cliff path at L'Etacquerel to view the contact between the Rozel Conglomerate and the volcanic rocks. It was reported that the conglomerate was indeed spectacular. (S.A.S. training might have come in handy here!).

The third day was taken up by a visit to the west coast starting at L'Etacq. The wide bay here has been eroded in the softer sediments of the Jersey Shale Formation. Near the slipway was a good sequence of turbidites formed by the slumping of wet sediments, at intervals, from a shelf area into deeper water. Many showed typical Bouma sequences with a scoured base with coarse sediment, fining upwards to mudstone, possibly with slumping. There were flame structures where wet sand had been forced up into the overlying unit. A little further to the north, at Le Pulec the contact between the Jersey Shale Formation and the North-western Granite was exposed. The granite, of approximately the same age as the Rozel Conglomerate i.e. Ordovician-Silurian, has invaded and metamorphosed the sediments producing a hornfels with cordierite. Xenoliths can be seen near the margin showing where the granite moved round and incorporated the country rock. Locally, mineral enrichment has occurred and veins have been mined for antimony by

the Romans and for silver in the 18th century. The veins are now thin slots in the cliff.

This part of the coast still has massive concrete bunkers and gun emplacements built by the German Army during the Second World War. At Le Pinacle, about a mile to the north, there has been much longer habitation as Neolithic remains have been found on the saddle between the pinnacle and the cliff. The granite pinnacle was once a sea stack and the saddle between it and the main cliff is a raised beach remnant when sea level was about 18m higher than today, around 180,000 years ago. A cave was eroded below the pinnacle with dating of sediments to approximately 200,000 years. The granite in this area is cut by dolerite dykes easily visible against the light coloured granites.

Later, Sorel Point on the north coast, was visited. A large quarry in diorite could be seen at Ronez Point immediately to the east. The diorite was formed by the intrusion of granite into and mixing with, a gabbro. The diorite often contains xenoliths of gabbro. After a steep scramble down the Fishermens' Path at Sorel Point both the gabbro and the red granite could be seen with pegmatitic veins cutting through the granite. A later intrusion of granite mixing with the diorite produced adamellite. A feature here is the presence of adamellite pipes up to about 20cm diameter which have intruded vertically into the diorite and represent points where mixing of the magma took place.

The final stop of the day was at the Wolf's Caves where the steep descent from the cliff path, (here with 307 steps!), was to a deep cleft in the cliff. This was formed in the deeply weathered, 12m wide, olivine gabbro dyke.

The final day was spent along the south coast. At Green Island the exposures on the beach show the dykes of the late Jersey Dyke Swarm, one of the last (Ordovician-Silurian) events in the Cadomian Orogeny and the solid geology of the island. In this very complex area granite appears to have intruded gabbro to give diorite. Later renewed granite emplacement gave adamellite. Working out the relationship of these dykes proved very difficult to the party!

After lunch stop at La Hougue Bie - where there is a magnificent neolithic tomb - the outcrops on the beach near Le Nez Point were visited. Here granite and gabbro mixing and differentiation, in pulses, gave diorite units with a darker, more basic base becoming lighter, more siliceous towards the top. At times very large hornblende crystals grew out from the margin to give the spectacular spinifex texture.

The final stop of the day was near Gorey Castle where dykes intruded into the granite were observed. These included a minette dyke intruded into the , by then, cold granite and representing the last phase of the Cadomian Orogeny.

A vote of thanks to the leaders for a most interesting and entertaining field trip was proposed by Jim Lawson. A request was made to and accepted by Chris to lead a field trip to continue the Channel Island story on Guernsey in 1997.

EXCURSIONS 1997 (Session 139)

ISLE OF MULL: 9th - 12th May 1997
Leader - Dr. Colin MacFadyen, Scottish Natural Heritage.
by Charles Leslie

Although the Mull scenery is dominated by the remains of Tertiary volcanoes and lava flows, this excursion concentrated on the earlier history including Precambrian Moine metasediments intruded in the South-West by the Devonian Ross of Mull Granite at the end of the Caledonian Orogeny and unconformably overlain by Mesozoic sediments in the Gribun area and Carsaig. The excursion ended with an examination of glaciation formations from the last Ice Age so that some 1000 Million years of geological history was revealed - in three days by an excellent leader who also provided a detailed handout for those of us who need more time to assimilate what we have been shown.
Our excursion secretary managed the difficult task of finding accommodation in SW Mull for the party of 21 in a number of Bed and Breakfast establishments and a Hotel. The Red Bay Cottage **NM 308 252** near Fionnphort had a dining room large enough for the whole party so that we could all meet together for dinner and the owner was persuaded to delay his holiday to accommodate us. The menus were varied and imaginative and the food was served by efficient and cheerful staff adding enormously to the social success of the excursion.
The excursion minibus was skilfully driven by Caroline Miller who stepped in at the last minute when the original driver hurt his back - before he joined the group in Glasgow.

9 May - afternoon (on way to accommodation)
Centres of Tertiary Volcanic activity in Western Scotland included Arran, Skye, Ardnamurchan and Mull with up to 6 km of flood basalts and mantle derived Gabbros being emplaced. Cone sheets, produced by the upwelling of magma chambers and ring dykes produced by cauldron collapse form the ridge features on the hillside above **Allt Molach NM 629 312** about 11 km from Craignure on West side of the A 849 road to Bunessan.
Some 14 to 15 ring dykes and cone sheets are exposed in the stream section and several of these were examined by the party. They represent multiphase activity with dyke composition depending upon the amount of differentiation that had taken place in the magma chamber before intrusion.

10 May - morning
Moine History - The Moine rocks exposed in SW Mull were laid down some 1100 million years ago as piles of sandstones, shales, silts and some calcareous

bands in large basins off the coast of Laurentia of which the Lewisian Gneiss of Iona and the Outer Hebrides represent the continental margin. The Torridonian could have formed on the coastal plain with the Moine as their distal equivalents - but this association is highly speculative. The Moine then suffered some 600 million years of deformation, during which time they were taken down to a depth of some 20 km (6k bar pressure and 500^{0}C) in the Precambrian. Finally during the Caledonian Orogeny (about 450 - 500 MYa.) the Moine rocks were thrust on to the Torridonian and Lewisian foreland along the Moine Thrust line which passes just to the West of Mull and may lie between Mull and Iona.

The Ross of Mull Granite then intruded the assemblage about 410 MYa

The evidence of some of this history was examined at **Ardalanish Bay NM 375 187** , a Site of Special Scientific Interest (SSSI). The Ardalanish Striped and Banded Formation made up of mainly sandstones and mudstones (pinkish and greyish bands) showed signs of multiphase folding corresponding to peak metamorphism when kyanite would have formed before becoming part of a large late Precambrian synformal structure (Assapol Synform). A garnetiferous Moine dyke was examined that contained large impressive garnets formed during regional metamorphism that destroyed any evidence of the earlier contact hardening of the intruded Moine sediments.

After walking along the shore to the South-West and a scramble up a steep ravine, the contact between the Moine and the Ross of Mull Granite was reached at about **NM 365 180**. The contact occurred "at depth" with the granite easing apart bands of schists in the Moine rocks creating dark xenoliths of Moine rocks within the pink granitic mass.

10 May - afternoon

Behind Bendoran Cottage **NM 363 218** kyanite produced by the regional metamorphism of the Moine sediments was seen to have been converted to brown lozenges of sillimanite by the intrusion of the hot Ross of Mull Granite.

The **Ardtun leaf beds** are exposed in a ravine at **NM 377 248** between layers of vesicular, jointed basaltic lavas. The composition of the sedimentary sequence and the fossil flora and fauna suggest they were formed during a long inter-basaltic period when clastic sediments accumulated in a lacustrine environment developed within the lava landscape under tropical climatic conditions during the early Tertiary period.

The area is a Site of Special Scientific Interest of international significance and therefore hammering for specimens was inappropriate, with collection opportunities restricted to sifting of the debris on the floor of the ravine.

Spectacular columnar jointing was evident at the seaward end of the ravine in the lavas below the beds while the 1000 feet of successive lava flows were clearly seen across Loch Scridain on the Ardmeanach peninsula.

11 May - morning

A 1 km shore section North from Port Uamh Beathaig **NM 442 326** was examined to find Mesozoic sediments lying unconformably on a Moine basement (a gap of at least 600 Million years.). The Moine here equates to the Morar Division on the mainland consisting of fine quartzite formed from sands deposited on a tidal shelf. At Port Uamh Beathaig, gullies in the Moine have been filled with mainly Moine breccia.

Just North of there, the essentially horizontal basal beds of Triassic conglomerate overly the tilted Moine, which at this point dips some 20^0 to the South - East with a pronounced unconformity. The pebbles in the conglomerate include Cambrian limestones, Torridonian sandstones and Moine schists and their angularity suggests their deposition by flash floods in desert basins and gullies from a nearby Western landmass in the early Triassic. On the sea shore beyond the North bank of Allt na Teangaidh, **NM 444 335,** fine sedimentary structures including cross bedding were seen in the generally fine Moine sediments with occasional pebble layers.

11 May - afternoon

After lunch on the old pier at Carsaig **NM 545 214,** the party moved around Carsaig Bay to examine the Jurassic rocks on the shore which had fallen from the cliffs topped with a lava capping. The fine white sandstone in the cliffs contained "doggers" or large round calcareous concretionary balls some of which had weathered out to leave distinctive indentations. Caries weathering of the Calcium Carbonate matrix of some of the rocks has left galleries exposed high up under the lava.

12 May - morning - (on way to ferry)

As conditions became more arid in the Cretaceous and clastic sedimentation ceased, chalk deposits were laid down in the Outer Hebrides as well as in Southern England. Remains of these chalk deposits silicified by circulating ground water were examined on the slope under the lava by the roadside at **NM 507 367.**

Up until then the weather had been kind to us with a range of "shirt-sleeve", sweater and brief "rain-jacket" conditions but now for the last exposure full weather protection was needed as the party went seaward of the road at Scarisdale Point **NM 518 378** to look at "p" forms. These grooves and troughs (some 1m wide) were formed by the action of a meltwater/ rock powder slurry under pressure at the base of a glacier.

HAGSHAW HILL INLIER: 31st May 1997
Leader - Dr W.D. Rolfe, formerly of Royal Museum of Scotland
By Roy Smart

This was a joint excursion with the Edinburgh Society bringing the complement to around 50. The two parties met at Parish Holm on the A70, west of Douglas. We enjoyed continuous sunshine under a cloudless sky for the whole day.
The morning location was at the lower part of the Ree Burn (NS 761278). Here, greywackes and siltstone alternate with medium grey shales and mudstones. Several features were noted; graded bedding, sole markings, flute casts, groove casts, prod and skipcasts. One of the Caledonian sills of amygdaloidal plagiophyre was examined. One member found a good example of part of a pod shrimp, *ceratiocaris papilio*. Hatchettite, a soft vaseline like wax was found in a septarian concretion, split by our leader. Returning to the main road, alluvial fan conglomerates were noted.
The afternoon visit was to the fish bed formation in the Monks Water valley (NS 777291). This area is noteworthy for containing some of the oldest complete fossil fish in the world. Characteristically these fish are jawless. An armoured anaspid, *Birkenia elegans*, was found. Ian Rolfe spoke of the value of items found being placed in museums for the benefit of everyone and the dangers of illegal collecting and whole-sale removal outwith the country.
Next and final location was the Douglas Arms Hotel for high tea. Good weather, good company, good meal and an excellent leader made this a memorable day.

RIVER AYR AND HEADS OF AYR: 14th June 1997
Leader - Dr G.E. Bowes, formerly University of Glasgow.
by Monica Thorp

On 14th June 1997, Dr George Bowes led a large party to the Ballochmyle Gorge near Howford Bridge, and then to the Heads of Ayr.
The River Ayr cuts a very attractive gorge through Permian (New Red) sandstone near Ballochmyle, which is now bridged by what is possibly the largest single-span masonry arch in the world, the Ballochmyle Viaduct, that carries the railway line from Glasgow to Dumfries. This remarkable example of early Victorian engineering was built in 1846-7 from quarries opened for the purpose in the gorge itself, so given both natural and artificial exposures we had excellent opportunities to work our way down the succession.
In the highest quarry we saw good examples of dune bedding orientated East to West, suggesting Saharan latitudes and the influence of the northeast Trade

Winds. At river level we were shown a different fabric: a laminated sequence with occasional small lenses of cross-bedding (sections of ripple-marks), indicating that this was water-laid sand, probably in a transient lake in the desert. Coarser bands consist of secondary depositions of typically wind-rounded 'millet-seed' sand grains. The sandstone was deposited on top of late Carboniferous-early Permian lavas, and working up the gorge and yet further down the succession we could see dark fragments of volcanic debris within the sandstone. Finally we reached the lowest level, at which perhaps 70% of the sediments consist of water-laid igneous debris.

Leaving Ballochmyle, we then travelled further through Burns Country to the coast, into sunshine and back into Old Red Sandstone times, at the Heads of Ayr. Here at the southern end of the bay are Devonian lavas and hydrothermal veins. Amygdales of deep blue-green chlorite, and veins of red jasper abound, and one small agate was found. Coming round the bay one moves up the succession into Old Red fluviatile conglomerates. These have been cut by tertiary dykes of the Arran dyke-swarm, which have been excavated by the sea to leave deep slots in the cliffs, and baked margins. In the middle of the bay, steeply dipping cementstones, of Carboniferous age, have been downfaulted and are exposed below the Old Red cliff.

At the northern end of the bay is a large volcanic vent dating, like the lavas at Ballochmyle, from Permo-Carboniferous times. As we worked round the bay we first encountered water-laid tuff, then dykes running perpendicular to the high cliff, below which is an extensive wave-cut platform providing a horizontal section through that part of the vent. Across this, along faults, are intruded *en echelon* lenses of Tertiary (Arran) dykes. Outcrops of agglomerate show good examples of spheroidal weathering. By the time we got there the tide had covered what is thought to be a raft of sediments that fell into the vent and stayed there.

This most enjoyable day ended at a cave in the cliff where a substantial piece of what appears to be wood is incorporated into the rock, suggesting that a tree growing on the edge of the vent had been caught up in the agglomerate during an eruption, and silicified.

Our thanks go to Dr Bowes for an excellent excursion.

NORTH BERWICK: 20th June 1997
Leader - Mr A David McAdam , B. G. S.
by Margaret Greene

The bus left the Boyd Orr car park with 23 people and picked up our leader David McAdam at Sighthill in Edinburgh.
David then proceeded to hand out leaflets he had prepared which not only told us a bit about what we were going to see but also what to look out for on the way there.
We arrived in North Berwick and made use of the award winning toilets - which are worth a visit!
As the tide was right in and the wind was blowing hard our leader suggested we have a brisk walk up Berwick Law before lunch. David had succinctly described the geology of the Lothians as "everything that sticks up is igneous": Berwick Law is no exception being of phonolitic trachyte: this reddish rock was used in a lot of the buildings in North Berwick. The wind at the top was every bit as fierce, so it was a quick look at the whales' jawbone, round the ruins, and a short examination of the direction finder and back down to calmer climes. We had lunch ranged along a small wall near the outdoor pool - this was not lingered over as the rain threatened to join the wind.
The afternoon excursion started at the ruins of St Andrew's Kirk. Here David explained with paper illustrations the series of lavas and ashes we were to examine in the vicinity, how they had been laid down then tilted so that the different beds were exposed. The topmost of these lavas, forming the west wall of the harbour, is an olivine basalt of the Markle type some 17m thick. From this position we could see several small islands with vertical columnar rock due to their igneous origin, one of the larger being Craigleith which is an essexite laccolith.
Below the Markle basalt is a 10m thick flow of pale purple-grey mugearite with sparse feldspar phenocrysts. Underlying this, and forming the east wall of the harbour area is a 7m flow of dark purple to grey Dunsapie basalt, resting on a bed of red tuff. North from the west end of the paddling pool, separated by the tuff, is the lowest lava, a leucite-kulaite - a trachybasalt. This is a purple altered highly vesicular lava, 4m thick, with a reddened autobrecciated top. After crossing the paddling pool we followed the shore round examining the red and green tuffs. We more or less had the beach to ourselves apart from the odd hardy soul walking their dog. Yellow Craig is a prominent rock near the high water mark; it is a small oval plug of olivine-basalt which was intruded into the tuffs. The intrusion continues to the north-east as thin basalt and agglomerate dykes. Towards the low water mark lies an area of fine green bedded tuffs, within this lie outliers of massive pale sandstone. The sandy part of the beach more or less terminates at the cliff face which is the Parten Craig

vent. This is one of the largest agglomerate filled volcanic vents exposed along this coast. Our leader pointed out the bedded reddish agglomerate tuff near the base, containing large blocks of red siltstone and tuffaceous sandstone, representing a thick debris flow. We followed the coast-line round the vent then climbed up to the coastal path and made our way back to the bus.
A sincere thanks was given to our leader David McAdam who not only gave us a very clear description of the volcanic events which can be seen at the foreshore at North Berwick but who also provided a very informative leaflet to accompany our tour and remind us of what we had seen.

BISHOP HILL, FIFE: 19th July 1997
Leader - Mr M.A.E. Browne, B.G.S.
by "Jasper"

It was Glasgow Fair Saturday, 19th July 1997 when 20 keen amateur geologists led by Mike Browne of the BGS set off to examine the limestone formations and Quartz-Dolerite Sill of the Lomond Hills.
The weather was superb with cloudless skies and hot sun. We explored Clatteringwell Quarry worked during the 1700-1800s where we found fossils including corals, crinoid stems and shells amongst the spoil. Examination of the Biothermal Reef, 5m at its thickest, indicated that this had been a Tropical environment 320-330 Ma.
A soporific lunch was enjoyed in the Quarry, basking in the warm sunshine, watching paragliders with their colourful canopies and gliders searching for thermals overhead.
After lunch we climbed Bishop Hill, joined on our way by two very friendly horses. Bishop Hill presented us with magnificent views of the surrounding countryside with Berwick Law (our last excursion on 28th June) clearly visible.
We traversed the West facing slope of the hills to examine Maggie Carlin, a stack exhibiting columnar jointing associated with the Quartz-Dolerite Sill. No, we did not find Maggie's tourie, and there was some discussion as to which stump was her "missing daughter".
The excursion ended at Scotlandwell where we all gratefully drank the cool water which had allegedly cured Robert the Bruce of epilepsy!!
We all thank Mike Browne for giving up his time to lead this excursion.

EXCURSION ON THE MV GARROCH HEAD: 14th August 1997
Leader - Dr J G MacDonald, University of Glasgow

This was a trip 'doon the water' in the Clyde sludge boat. 65 intrepid voyagers set off just after 8.00 am on a rather foggy Thursday morning. Jim MacDonald not only provided the commentary on the scenery but also the musical entertainment on his clarinet. Unfortunately the rather misty conditions in the morning meant that not a lot of the scenery was seen, but on the way back (after the 'cargo' had been dumped) the weather cleared and the surrounding geological features could be admired (and the view!). Altogether an unusual and enjoyable day.

AFTON WATER: 16th August 1997
Leader - Dr J D Floyd B.G.S.
by Evelyn Lennie

A full bus load of members and friends left the Boyd Orr car park promptly at 9am and headed for New Cumnock. We assembled in Glen Afton literally at the feet of Robert Burns. Our leader had wisely selected a little grassed area surrounding a cairn erected as a memorial to Burns as our meeting place.
Dr Floyd than passed out maps and information sheets and outlined the purpose of the excursion and what we should be looking for at the different locations he had selected. He explained that this deeply glaciated valley presented a truly excellent opportunity to study the different materials and the many different mechanisms of deposition on an ocean floor in the Ordovician Period.
At our first stop below the cairn we clambered down to, and in some cases into, the Afton Water which fortunately was flowing fairly gently at the time. There we discovered an unusual red cherty mudstone, the red colour being due to the presence of haematite. This red mudstone we were told can be traced all the way from Galloway to Edinburgh. At this location the beds above and below were siltstones and greywackes. We studied the many structures, such as graded bedding, flumes, flutes etc. within the siltstones and greywackes and were eventually quite convinced that the whole succession was actually completely overturned. Near this locality an interesting sandstone with magnetic properties was pointed out by our leader and tested by a few of us. Further upstream we studied a Tertiary tholeite dyke which was parallel to the line of the Southern Upland Fault.
The bus then carried us up to the end of the road at the filterhouse below the Afton reservoir. We climbed up the pathway which overlooks the spillway from the reservoir. Much of the granite used to build the spillway and the dam

was found locally. In the spillway we noticed a pale coloured dyke in the granite.
The grassy slope of the dam was an ideal location to spread out and enjoy our lunch, the beautiful view down the valley and the very welcome sunshine.
Back down at the foot of the dam we threaded our way downstream past great thick beds of coarse-grained greywacke. Further down these beds alternated with quite spectacular beds of boulder conglomerate. The rocks within the conglomerate were very varied and included in some places angular blocks of dark siltstone and greywacke suggesting that these blocks had been torn out from channels being formed in the partly lithified material. Most of the boulders were very well rounded clasts of granite, gabbro, basalt, vein quartz conglomerate and many other materials which suggested that some of them had come from earlier conglomerates formed in a different location and in a different environment.
At this point, as we stood in the stream bed studying the boulders and trying to work out where they had originated and by what means they had reached that spot one of our party slipped and had to be helped back to the bus. It was later discovered that her leg had broken in two places. This was a most unfortunate end to what had been a very enjoyable and instructive day. Ben Browne spoke for us all in thanking Dr Floyd for his thorough preparation, clear explanations and above all patience with our questions.

GUERNSEY - ALDERNAY: 6th-11th September 1997
Leader - Dr C Burton, University of Glasgow
By Judith Lawson

The field trip to Guernsey and Alderney, led by Dr Chris Burton, was planned as a continuation of the geology of the Channel Islands started in Jersey in 1996. The Channel Islands, together with the adjacent areas of France, are geologically part of the Precambrian Cadomian Orogenic Belt. The area is divided into a series of terranes, some of which have had amazing journeys to arrive in their present positions. The juxtaposition of these terranes, with their different rock types has resulted in the Channel Islands having very different characteristics from each other. In Jersey, the upper part of an Andean type subduction zone, with extrusive volcanic rocks was seen. In Guernsey intrusive igneous rocks formed at a deeper level in the orogenic belt, and the pre-Cadomian basement can be seen. They are separated from Jersey by a major strike slip fault. The southern part of the island is formed of the older Southern Metamorphic Complex and the northern part by the Northern Igneous Complex.

After an uneventful flight from Glasgow and the collection of the minibuses the first afternoon was spent at Vazon Bay on the north coast of Guernsey. Here the junction between the two complexes can be seen and the relationships worked out. On the foreshore below Fort Hommet the Cobo Granite, dated at 496Ma, of the Northern Igneous Complex outcrops. This is a relatively homogeneous red granite (adamellite) with quartz, approximately equal amounts of alkali and plagioclase feldspars and small amounts of mica. Moving south west along the outcrop the granite, with a finer grained margin, could be seen to intrude into a gneiss. This was the quartz dioritic Perelle Gneiss, dated at 710-695Ma, of the Southern Metamorphic Complex. This gneiss with plagioclase, amphibole, biotite and small amounts of quartz is considered to have been a dioritic intrusion which was subsequently metamorphosed. Across the bay the Icart Gneiss (probably originally a granite intrusion) was exposed. This gneiss with large pink feldspar augen is dated at around 2000Ma and is therefore much older than the Perelle Gneiss. The Icart Gneiss could in turn be seen to intrude into metasediments. These sediments must therefore be the oldest rocks in this area. The metamorphic rocks, but not the granite were intruded by metadolerite dykes of various ages.

The South East

The second day was spent in the south east of the island. In the bay near Fort Grey the l'Eree Granite (?646 ?598Ma) is separated from the Perelle Gneiss by a broad (100m) band of mylonite. This intensely sheared zone is relatively soft and forms the foreshore near Fort Grey and also the deep inlet, dominated by a massive German tower at l'Angle on the south coast. The l'Eree granite is unlike other rocks in Guernsey and may be part of a terrane brought in with a boundary marked by the zone of intense shearing. To the south, near Fort Pezeries (lunch) the granite is in contact with fine grained metasediments of the Plienmont group. Near the western contact the granite is relatively fine grained and it is thought to have intruded the sediments. These sediments are considerably younger (Brioverian - about 600Ma) than those seen earlier and may be the equivalent of the Jersey Shale seen the year before. In the afternoon Lihou Island, connected by a causeway at low tide, was visited. This islet is largely formed of Icart Gneiss separated by a large fault from the l'Eree Granite. Near the faulted boundary another rock type in the Icart Gneiss, a foliated amphibolite, was examined.

Jerbourg Peninsula (notes from Charles Leslie)

On Monday more rocks of the Southern Metamorphic Complex were studied. At Jerbourg Point the Pea Stacks Gneiss is seen. It is fault bounded so that its relationships to other rocks are not certain but it is thought to be of the same age as the Icart Gneiss. However, the presence of grey bands of metasediments

suggest that it was originally of sedimentary composition unlike the originally igneous Icart Gneiss. Moving north along the coastal path the Doyle Gneiss, much younger at 700Ma, was crossed. This gneiss is somewhat similar to the Perelle Gneiss but contains chlorite which has replaced earlier hornblende. Near Petit Port the largest quartz vein in Britain was examined. This is exceptionally pure with no secondary minerals. In places small areas of other rock have weathered out to give a boxwork effect. The vein was emplaced along a fault and at Petit Port(296 steps!) a gully has been eroded in a shear zone to the north west of the quartz vein. The Icart Gneiss which outcrops here contains some of the best developed augen on the island.
After lunch at St Martins Point the outcrops of Perelle Gneiss were examined. Later there was a CJB scramble down to Lazy Hole. In this cave there is a magenta red glow on the rock surface but this is algal in origin not an exciting new mineral. The cave is eroded along a lamprophyre dyke with abundant biotite. This was considered to be a minette although this rock type is not officially recorded on Guernsey.

The Northern Igneous Complex

On Tuesday rocks of the Northern Igneous Complex were examined in the northern part of the island. These were formed in the root zone of the Cadomian Orogenic Belt. Starting near Grandes Roques typical Cobo Granite was recognised, similar to that seen on the first day. Reddened zones about a metre across, full of alkali feldspar, could be seen. These are thought to be due to metasomatism along shear zones after the granite solidified. To the east is a sharp contact of the granite with granite containing enclaves of darker rock. These enclaves become larger and more common to the east. Some have been recrystallised and some have sharp margins while others are more diffuse. This is the Granite-Diorite Marginal Facies with the enclaves thought to be inclusions of diorite within the (later) granite. On the east side of Poit Soif the diorite itself - a quartz monzodiorite with feldspar, hornblende and small amounts of biotite and quartz. It is thought that a diorite was intruded and slightly later a granite was emplaced before the diorite was completely solidified and as the granite was intruded the Marginal Facies was formed. They were intruded in upper Cadomian times at about 540Ma.
Later, at Chouet Bay, more complex relationships in the igneous rocks were studied. Here the Inhomogeneous Suite outcrops. This is a highly variable suite of rocks formed by fractional crystallisation and partial remelting of the diorites. The l'Ancresse Granodiorite was also seen here. This has sharp margins with the diorite and is the youngest major intrusion in the area. Saumarez Park, in the centre of the island was visited at lunch time.
In the afternoon the oldest rocks, the St Peter Port Gabbro, were studied in the bay north of St Peter Port. In this area, although now largely obscured by

building, the base of the sequence is a massive noritic gabbro containing plagioclase, ortho-and clino-pyroxene. Above this are layered sequences of hornblende gabbro, with virtually no pyroxene and the hornblende crystals poikilitically enclosing the feldspar - a texture the quarry men called "birdseye", alternate with thinner layers of a spectacular "long grain" rock, called bojite, with large acicular horneblende crystals set in a matrix of feldspar. These layers were formed by magmatic differentiation in a magma chamber. Cutting the gabbros are a series of microgabbro dykes and agmatites - zones of brecciated basic rocks in a more acidic matrix.

Alderney

On the last day the party took flight for Aldernay. This island was evacuated during the second world war and turned by the occupying army into a fortress. It is dominated by massive concrete emplacements. The first outcrop was south of the airfield. Near the top of the cliff a conglomerate was seen lying on a granodiorite of the Northern Igneous Complex. This small outlier of the Aldernay Sandstone rests with marked uncomformity on the igneous rocks. It is not metamorphosed and is a post orogenic sediment possibly of Cambrian age. The unconformity is spectacularly seen, although it could not be visited owing to the state of the tide, to the east of Cacheliere Quarry (reached after a typical CJB descent!). Above the basal conglomerate, possibly deposited in a shallow sea, is a thick (>500m) sequence of sandstones outcropping in the east of the island. These show various sedimentary structures and are considered to have been deposited on a land surface by braided rivers. On Essex Hill they include cross bedded arkosic sandstones and at Longis Bay a more thinly bedded series of sandstones and siltstones. The river which deposited these sandstones is thought to have been part of a system draining the Cadomian mountains from west to east.

Once again we would like to thank Chris Burton for leading a very successful trip to a beautiful and interesting part of the world.