PROCEEDINGS OF

THE GEOLOGICAL SOCIETY

OF GLASGOW

Session 141 **1998/99**

CONTENTS

Front cover photograph : "Scotland , the loch" - Loch Garry

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MEMBERSHIP

	Session 141	Session 140
Honorary Members	**2**	2
Life Members	**1**	1
Ordinary Members	**346**	348
Associate Members	**59**	64
Junior Members	**3**	9
Total	**411**	424
New Members	**28**	38
Deletions	**(19)**	(24)

Note that the discrepancy between year-on-year total differences and net new additions is due to the date of recording the deletion of lapsed members. Members are now deemed to have lapsed if no payment has been received by the end of the session, and deleted from the active list of members at 30th September, when at least three reminders will have been sent to the Member's last known address.

Charles Leslie

LIBRARY

This session has seen another stage in the seemingly endless sorting out the Society's book and journal holdings, resulting in a final move to what are likely to be their permanent homes. The long trek towards a rationalised and concentrated library is nearly over, only a final reshuffle and a new labelling system remain to be completed. The catalogues for the library will be updated during Session 142 (2000 - 01). A number of committee members, including the Secretary, have laboured long and hard to bring the reorganisation to fruition, and the Librarian, as well as the Society, owes them a heartfelt vote of thanks.

Along the way, surplus material has been sold or donated, with a notable donation being to the McKechnie Institute in Girvan, where a new South Ayrshire geological group will benefit from a complete run of the Scottish Journal of Geology, as well as a number of geological textbooks.

The Society's library can now be found in two locations in the Gregory Building – Room 320A/Floor 4 (the Conference Room), where all the books and some of

the journals are housed, and in the Don Bowes Room/Floor 5, where some of the mainstream journals are integrated with the Division of Earth Sciences' periodical library.

A leaflet on the Society's Library is being produced and will be circulated to members shortly and, starting from January 2000, the full consultation and loan service will restart.

C. J. Burton

THE SCOTTISH JOURNAL OF GEOLOGY

The year has passed without major event. We have seen a further increase of 5.8% in costs and these will rise by a further 5% in 2000. Although slightly above the cost of living increase this is in line with other increases in recent years and compares favourably with those of our competitors. We have again seen a decline in Trade subscriptions. These account for libraries and similar public bodies and represent a worrying trend. They are, however, a reflection of the general lack of financial support for such institutions, and we can only note that the Scottish Journal offers good value for money and in recent years has seen less of a decline in this area than some others.

Volume 35 is now complete and we retain our excellent record of recent years of delivering issues on time. We have cleared a backlog of manuscripts that showed no sign of ever being revised and can now offer authors a rapid appraisal of their manuscripts, followed by (almost) equally rapid publication. Our standard of presentation remains high and we continue to receive compliments to that effect. There will be a change in the cover in the New Year to a more robust laminated design. A new departure will be the inclusion of a number of Millennium Essays, more personal views of Scottish Geology and its influence, to celebrate the Millennium. We hope that all members will find these of interest and that many will stimulate further discussion.

The Geological Society Publishing House has continued in its excellent support of the Journal. We are consistently included in widely circulated lists of publications; the Journal was displayed at the European Union of Geological Sciences meeting in Strasbourg in March 1999, and the contents
can now be accessed on the web at :-

<http://www.geolsoc.org.uk/pubs/journals/sjg.htm>

Colin Braithwaite

PUBLICATION SALES

As in previous years, our range of titles has been made available to the various extra-mural classes held by the Department of Adult and Continuing Education, University of Glasgow. This has helped to increase our sales and, we hope, encourage new members to the Society. These sales, along with those to our members at meetings, account for some 37% of our total sales. The Arran and Skye Guides have sold well to retail outlets on both islands - we were able to persuade the Tourist office in Portree to stock our Skye Guide. Maps have been popular with members. The net surplus this session of around £2000 seems very satisfactory. However, this figure is misleading since the discovery of several boxes of "Building Stones of Glasgow", hitherto unknown to me, meant an increase in stock value of about £800 making the surplus closer to £1200.

Roy Smart

PUBLICITY

Posters for Lectures, Membership Cards and Newsletters have all been produced. Publicity for Geology Week was carried out by Council Member Alan Docherty with my help. A significant achievement was the placing of four colourful publicity boards in the Geological Section of the Kelvingrove Art Gallery and Museum. Following this, we have been told that we can place a permanent board there. The long-awaited publicity brochure is now at the printers and should be ready by the AGM.

David Wilkinson

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MEETINGS

The 141st Session of the Society included lectures by six invited speakers between October 1998 and April 1999. The session opened with a lecture by Peter Kokelaar presenting us with a stimulating new look at Glencoe based on remapping by a heroic PhD student who at one stage dragged himself off the hill with a broken leg!. Mike Searle came from Oxford to regale us with an inspiring lecture - illustrated by stunning slides - on the geological evolution of the Himalaya, Karakoram and Tibetan Plateau. This was very timely as it coincided with the showing of "Earth Story" on TV, which featured Mike speaking in the Himalayas. The 1999 lectures began in January with the visit of an old friend, Euan Clarkson who was awarded the TNG Medal and responded with an exposition on the Cambrian Alum Shales of Scandinavia and their extraordinary faunas. In continuation of our recent policy of inviting local speakers, February saw a lecture from Professor Paul Bishop of GU's Department of Geography on

the evolution of passive continental margins with reference to SE Australia. In March, we were entertained by another local speaker, this time from the commercial side of Geology, when Alan Gibbs illustrated the merits of 3D Structural Modelling. The Session's Lecture program was rounded off in April by the Joint Celebrity Lecturer, Dr Martin Rudwick, who considered "How the Geosciences First Became Geohistorical". Members' Night on 13th May followed the pattern of recent years in providing us with an interesting account of members' activities.

Jim Morrison

Thursday 15 October 1998
Dr Peter Kokelaar of the Earth Sciences Department, University of Liverpool

CALDERA MODEL IN BITS: GLENCOE REVISITED

Since the work of Clough, Maufe and Bailey (1909), the Glencoe volcano has been taken to exemplify caldera collapse in which coherent-block subsidence occurs piston-like along a ring-fault during a major eruption. However, recent detailed mapping of the Glencoe caldera floor and fill , and reconstruction of five intracaldera ignimbrites, show that collapse was incremental and that it involved complex movements of numerous fault blocks. Caldera depocentres shifted throughout the early volcanic history, before formation of the ring-fault. This "piecemeal" caldera collapse was profoundly influenced by tectonism along pre-existing major faults trending NW and NE. A dominant NW-trending graben controlled the major depocentres and persistently channelled a major river through Glencoe, probably flowing towards the active Great Glen Fault. Glencoe shows that the "piecemeal" nature of calderas may only be plainly evident in deeply dissected systems and suggests that piston-like subsidence is less common than hitherto recognised. Major aspects of the new interpretation of Glencoe were presented and the implications for old caldera models explained simply.

Thursday 12 November 1998
Dr Mike Searle of Oxford University

GEOLOGICAL EVOLUTION OF THE HIMALAYA, KARAKORAM AND TIBETAN PLATEAU

Since the collision of the Indian plate with Central Asia approximately 50 million years ago, crustal thickening and shortening has propagated southward across the leading edge of India resulting in the rise of the Himalaya, and also

northward across Asia resulting in the highest uplifted landmass on Earth, the Tibetan plateau and its extension west into Karakoram. Present research is concentrating on the timing of deformation, metamorphism and granite emplacement and its relationship to major tectonic and climatic changes, notably the initiation of the monsoon.

T. NEVILLE GEORGE MEDAL

At the meeting on Thursday 14 January 1999, the award of the T.Neville George Medal was made to **Professor E.N.K.Clarkson**, University of Edinburgh by our Society's President, Mrs. Jane E. MacDougall after the following citation was delivered by Dr. C.J.Burton, Head of the Division of Earth Sciences, University of Glasgow

This Session's medal winner - Professor Euan Clarkson - gained his first degree and his PhD from the University of Cambridge, after which, in 1963, he travelled north to take up a post at the Grant Institute of Geology of the University of Edinburgh, where he has remained throughout a long and distinguished career as a Palaeontologist and Stratigrapher. His recent elevation to a personal Chair in Palaeontology at Edinburgh is testimony to the excellence of his scientific work over many years.

Professor Clarkson has produced a huge volume of contributions, notable for their innovation, and for their exploration of a wide range of palaeontological and stratigraphical themes. However, the central core of his work has involved a long interaction with trilobites - their morphology, ontogeny, evolution, and taxonomy. In his earliest works he studied the structure and vision of the schizochroal eyes of acastid and phacopid trilobites, a theme continued by studies, one published in French, on the eyes of dalmanitids. A further study, with Levi-Setti explored the optics of such eyes as aplanatic surfaces. These highly innovative and seminal works led to works on other aspects of trilobite function, and to taxonomic work on trilobites from the Cambrian to the Carboniferous - although the trilobites of the Permian would appear to have temporarily escaped his attentions.

Work on non-trilobite Arthropods, part of a study of Scottish Lower Carboniferous Lagerstätten, yielded not only exquisitely preserved shrimps, but also what must be one of the key palaeontological discoveries of the century - a conodont animal. A discovery which came as a great relief to the rest of us, since it solved a long standing mystery. More importantly it opened up an entirely new field of work on early vertebrates and their origin.

Professor Clarkson's interests have expanded out from the purely palaeontological to include a series of combined stratigraphical and palaeontological studies of the inliers of Lower Palaeozoic rocks along the southern margins of the Midland Valley, notably the North Esk Inlier, and fossiliferous units within the Southern Uplands. This work led to a series of crucial palaeoecological publications on faunas hitherto neglected. Latterly his work, with Dr. Alan Owen of this University, in the area south of Biggar has led to further rich discoveries and to further publications

Taxonomic work has always been a major theme of Professor Clarkson's research, and he appears to have published on seemingly everything that swam or crawled in the Palaeozoic oceans. His latest theme draws on this wide range of experience, bringing together ontogeny evolution, taxonomy and palaeoecology in a series of remarkable studies of the Alum Shales of Scandinavia and their marvellously preserved trilobite faunas.

All of Professor Clarkson's work has been marked by the highest quality of illustration including photographs and, especially, drawings - a startling head-on view of *Leonaspis* at speed being typical of the latter mode.

Professor Clarkson has not only communicated his knowledge as a writer of the highest quality of scientific publications, but also as an inspiring and enthusiastic teacher in the lecture room, the laboratory and the field - as many of us here can testify. He is also the author of one of the most widely known and used palaeontology texts in the World, now in its 4th edition. Its original publication in 1979 marked a quantum leap in the texts available to undergraduates, and his painstaking updating for every new edition has ensured its enduring freshness and relevance.

Professor Clarkson has always been an enthusiastic and dedicated supporter of palaeontology and palaeontologists in Britain, and has consistently provided scientific leadership, having been a Trustee of the Natural History Museum in London, an editor for the Royal Society of Edinburgh and a leading member, currently the President, of the Palaeontological Association.

Professor Clarkson's outstanding contribution to all aspects of palaeontology makes him a truly worthy recipient of the T. N. George Medal.

After being presented with the medal, **Professor Clarkson** then gave the T.Nevill George Lecture, summarised below :-

THE CAMBRIAN ALUM SHALES OF SCANDINAVIA AND THEIR EXTRAORDINARY FAUNAS

In Scandinavia the Middle and Upper Cambrian is represented by the Alum Shales, dark shales with limestone bands and nodules remarkably rich in fossils, chiefly trilobites. Studies of palaeontology, stratigraphy, sedimentology and geochemistry have enabled a picture to be constructed of a long-extinct environment. The rich and diverse fauna of the Middle Cambrian vanished and was replaced by a restricted fauna of olenid and agnostid trilobites, adapted for life in low-oxygen conditions. An understanding of their evolution, ontogeny, functional morphology, and population dynamics sheds much light on the conditions under which they lived. Tiny phosphatised crustaceans and other fossils formed part of the complex ecosystem, in a vanished environment for which there are no direct modern analogues.

Thursday 11 February 1999
Professor Paul Bishop, University of Glasgow

THE EVOLUTION OF PASSIVE CONTINENTAL MARGINS ; lessons from the long-term geomorphological history of SE Australia

One of the ways in which plate tectonics has revolutionised our thinking about Earth history is by linking deep Earth processes, Earth surface morphology and evolution. The development of passive continental margins is understood to occur via lithospheric extension, rifting, continental break-up and sea-floor spreading. Each of these stages has expressions in the topography of the evolving margin but this topographic development has often been ignored in margin research which is generally based in geophysics and numerical modelling. The Tasman continental margin of SE Australia has an enormous wealth of geophysical, geological and geomorphological data relevant to its evolution throughout the Tertiary and so provides an opportunity to explore the topographic changes associated with, particularly, the post-break-up development of a passive continental margin. This talk presented a range of these geomorphological data, and argued that there are some significant mismatches between theory and field evidence on this margin. The geomorphological evolution of the Tasman margin provides the opportunity, therefore, to test competing models of passive margin development, thereby reinforcing geomorphology's important place in the Earth sciences.

Thursday 11 March 1999
Dr. Alan Gibbs, Midland Valley Exploration, Glasgow

VIRTUAL GEOLOGY - TIME TRAVEL AND FIELD WORK WITHOUT THE RAIN ?

Geology involves us in the process of making observations and then trying to place these in the context of a model which allows us to understand the geological processes in space and time, which gave rise to present day geology. The development of geological tools to take advantage of recent advances in computer graphics gives rise to new capabilities in our science. In particular, we can now work in full three dimensions rather than on flat paper and then use the power of the computer to travel through geological time.

Joint Celebrity Lecture
Thursday 22 April 1999
Martin Rudwick, University of Cambridge

HOW THE GEOSCIENCES FIRST BECAME GEOHISTORICAL

This talk suggested a new interpretation of a "classic" period in the geosciences, in the light of recent historical research. Modern geoscientists take for granted that they can locate terrestrial events and processes of all kinds within a contingent *history* of the Earth. But there was nothing inevitable about the development of this geohistorical perspective. In the decades around 1800 - the period of Hutton and Lyell, among other eminent figures - two well established ways of studying the Earth began to be transformed into geohistorical interpretation, as a result of the deliberate transfer of methods from *human* history into the natural world.

MEMBERS' NIGHT

This, the final evening meeting of the Session 141 was held on Thursday 13 May, 1999, with the following short **talks** being given by members:-

Stephen Thomson spoke on the 1998 **Expedition to the Breidamerkurjokel glacier in the SE of Iceland.** This was a joint expedition (for which the Society provided financial assistance) of geographers and one geologist from Glasgow

University studying the sedimentation in and around a glacial lake and 7 civil engineers from Loughborough University updating maps of the area.
The glacier no longer reaches the sea but calves icebergs from its toe into a lake which in turn discharges to the sea through many more meltwater channels than were mapped on the last survey. Traversing the area is difficult with a "new" road bridge now threatened by icebergs in a meltwater channel.

Julian Jocelyn - Gem Stones of Scotland
The Popular Science Review of 1868 shows a picture of a box given by the Duke of Atholl to Dr.John McCulloch (1773 - 1835), who produced a geological map of Scotland and was an early president of the Royal Society of London, containing what was called "The Gem Stones of Scotland". A central Cairngorm gem stone is surrounded by gems including garnet, beryl, agate, pearls, and the green feldspar, Amazonstone. Are they true "Gems of Scotland" ?. Although now, only crystals found on Cairngorm can be described as Cairngorms, this was not always the case.
The stones on the box may only indicate the types found in Scotland and may not actually come from there. In particular, the garnet is of a much higher quality that that normally found in Scotland.

Dr. Neil Clark - A Stegosaur from Scotland - All the earlier finds described on Skye have been on the Trotternish Peninsula in the north of the island. In Berreraig Bay two pieces of ulna and radial elbow bones of the fore limbs of a dinosaur were found. From their size and shape the animal walked on all fours. These were compared with the appropriate bones of a Stegosaurus with which there were many similarities. In fact no other animal remains, especially from the Jurassic exhibit the same characteristics although there were some from the Cretaceous.
From the fossil assemblage, these Skye bones were dated in the Middle Jurassic, Bajocian stage. Prior to this, the earliest Stegosaurus discovery came from the Lower Bathonian Stage, the one above the Bajocian, of the Jurassic. So these Skye bones came from the **oldest** Stegosaurus in the world.!
Although only five dinosaur bones have been found in Scotland they represent a range of animals - Femur of a plant eating Sauropod, a rib bone, possibly of a Sauropod, a vertebrae of a Sauropod, one vertebrae of a Coelophysis and the Stegosaurus.

Roy Smart - "In the beginning" - An entertaining selection of excerpts from the History of the Geological Society of Glasgow 1858 - 1908 concerning some of the very early (1859) excursions of the Society many of which started on Saturdays after 1 p.m. because most people had to work on Saturday mornings. Although there were some railways, transport was mainly by horse drawn omnibus followed by a lot of walking, with reports of the strange sight of a

group of people walking through the villages of Bearsden and Milngavie. Only if public transport was unavailable and the walking distances were too great did the Society hire an omnibus and charge an appropriate amount for its use.
Excursion reports - all non-geological - were a collection of personal recollections and comments including a rebuke in one about the excessive taking of refreshments. This was tempered in another report when members had to repair to the local inn in Strathblane while the horses were rested for the return journey to Glasgow

Allan Hall - Island of Melos (100 miles S of Athens)
This island, where the Venus de Milo statue was found, has no airport and therefore has few international tourists. It contains several connected volcanic centres , all now extinct, which caused high grade metamorphism. The resultant hot springs created deposits of sulphur, gypsum, alum, and china clay all of which have been extensively worked leaving only the coastal fringe untouched. Because of the economic importance of these deposits, the island has a long human history with a map from 200 BC. The many archaeological sites are now protected by guards.

Michael Pell /Bill Lamb - Personal experiences on a DACE excursion to **Madeira** in **December 1998** were illustrated by slides, local wines. and a funny hat .

The following **displays** were mounted:-

Neil Clark	: Stegosaur (?) leg bones from Skye
Alan Docherty	: Photographs and specimens from Isle of Wight excursion, September 1998.
John Faithfull	: Thin sections from the Alex Herriot collection
Brendan Hamill	: Specimens from the area of Loch Glow, Kinross-shire.
Julian Jocelyn	: John McCulloch and the Gems and Precious Stones of Scotland
Charles Leslie	: Photographs of 1998 excursions by the Society.
Janey MacDougall	: OU's Multi-media CD Rom material: Skiddaw Excursion: Virtual microscope: Structural Geology
Jim MacDonald	: Mauna Loa, the Earth's largest volcano
Lisa Wylie	: Undergraduate mapping dissertation
Division of Earth Sciences	: Rock slabs

Obituary

Alexander Herriot, M.I.C.E., M.C.I.W.E.M. 1913-1999

From time to time there emerges someone who while pursuing a successful career in one profession is remembered by many of those who knew him for the contributions he made in another field of activity; Alex was one of these. From boyhood he spent many holidays on the island of Arran. Later in the 1930s, while studying civil engineering, it is perhaps unsurprising that he took up an interest in geology as a hobby. What is more remarkable is that having equipped himself with a petrological microscope, and having mastered the use of this instrument in the study of thin sections of rocks, he acquired a mastery of igneous petrography of truly professional standard.

Alex joined the Society in 1937 and devoted a lifetime of support to it thereafter. He was a member of Council for 35 years, held the office of Treasurer and was elected President from 1976 to 1979. His interest in Arran and its igneous rocks in particular never abated. It is no exaggeration to maintain that his knowledge of the island was unsurpassed and when the professionals needed help they could rely on Alex to keep them right on the intimate details of the outcrops there. He published a number of papers in The Scottish Journal of Geology and the Society's Proceedings and was co-author in 1983 of the 3rd edition of the Geological Guide to Arran. The value of his work was acknowledged by the British Geological Survey when it incorporated many of Alex's observations in the 1987 edition of the geological map of the island.

His interests in geology were not confined to Arran. He collected material from many parts of the British Isles and from farther afield. One certain way to please was to present him with a piece of some exotic rock from a far country. His only stipulation was that it had to be big enough to make a thin section of it. Latterly his collection of thin sections exceeded 5000 and it is now housed in the Hunterian Museum where it constitutes a remarkable memorial to his skill and passion for igneous petrography. This enthusiasm was infectious. With Alex's encouragement many of the Society's members were persuaded to take up the making of thin sections as a hobby and there was a surge in the sales of Canada balsam.

Alex's service to the Society was recognised in 1983 when he was made an Honorary Life Member. In 1990 he was presented with the Worth Medal of the Geological Society of London in recognition of his 'scholarship and devotion to the advancement of geology '. But above all he is remembered with affection by all who knew him for his passion for geology, his patience and good humour

when he taught others the skills that he had acquired, and the meticulous attention to detail that accompanied his investigations in the field or under the microscope.

J.G.MacDonald

EXCURSIONS

During 1999 one six-day, one weekend and 6 day excursions were arranged as reported below. A tremendous vote of thanks is due to all the leaders who so generously gave their time to lead us on such a wonderful feast of geology. The numbers attending are still on the increase and all of the day trips had a waiting list for places on the bus. It would not be feasible to hire a bigger bus as we would run into parking problems. Numbers were restricted on the Dumgoyne trip due to the difficult terrain. The Fife trip was the annual joint excursion with the Edinburgh Society and about 30 of their members also attended. I would like to thank them for arranging the trip this year.
We are being more safety conscious on the field trips now and all members were issued with a safety code of conduct and were asked to sign the booking form to state that they had read it. The weather this year was not so kind to us as usual - my apologies for this and I will try to do better next year!!

Rosemary C McCusker

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FORELAND and THRUSTS in the KISHORN area : 21 - 24 May 1999
Leader : Dr. S.J.Cribb
Participants: 23
Report by : *Ken Smith*

The aim of the group, based in Strathcarron, was to examine, firstly, typical North West Highland Precambrian foreshore exposures and, subsequently, early Cambrian deposits, which together would form part of the Kishorn Thrust Zone, a feature which underlies the major Moine Thrust plane.

A short excursion on the first afternoon took us to Upper Loch Torridon and specifically to the Bridge of Balgy/ Shieldaig area. Here a striking unconformity of unfolded coarse Torridonian sandstone overlay tilted and eroded Lewisian Gneiss and was described as being representative of the extensive Caledonian Foreland. Within the basal Torridonian could be seen unsorted angular Lewisian

fragments including granite clasts and mica quartz which was said to have originated in the area to the north west of the Hebrides. Although eager to see more, it quickly became apparent that our Excursion Secretary had failed to appease the weather gods, on this occasion, and the ensuing deafening wind, hail and rain brought further proceedings to a sudden halt. These sudden, severe, squalls with the high winds blowing any rain showers through quickly, were to become a feature of most of the weekend, although their frequency decreased.

Inclement conditions notwithstanding, day 2 did not permit any escape back to the refuge of our transport. Approximately 1 km north of the head of Loch Kishorn we commenced the easy scramble up the lower south west facing slopes of Sgurr a' Gharaidh to examine in detail east/ south east dipping marine derived Cambrian material of the Lower Durness Group. Two phases of haematite stained quartzite(Pipe Rock), showing vertical worm cast traces, were succeeded by the Fucoid Beds consisting of dolomitic shales and muds including Annelid burrows. The Salterella (formerly called Serpulite) Grit followed and was described as a coarse grained orthoquartzite with an arkosic and dolomitic sandstone. The last in the series was a more steeply dipping dolomitised limestone (Durness) within which a faulted crush zone revealed traces of copper ores, including Malachite. As we moved into the shelter of the North/ South trending valley of the Allt Mor for lunch there was little realisation the afternoon session would prove rather more mind challenging.
Exposures in the Allt Mor valley revealed light grey coloured sandstones but their stratigraphic position was unclear. A haematite lens, scree and other disturbed rock led to some evidence of fold "closures" indicating the possibility of a tectonic boundary through the valley. Viewing the higher ground we were asked to consider the probability that this was made of rocks which were older than Cambrian, with the highest looking like Lewisian. Discussion of these factors pointed to the presence of a thrust, producing and overturning a fold, the Kishorn Nappe the lower limb of which we were studying because the upper limb had been carried away on a thrust.
The final sortie of the day was to inspect an iron mine abandoned since 1918 near the head of Loch Kishorn. Brave were those who entered the rough and overgrown area but, alas, quick was their return as the guardian midge minders won the day.

Few realised that day 3 would be quite so arduous but very worthwhile.
We left the comfort and warmth of our transport at Loch Coultrie and, in the rain and gale (on our backs, fortunately) began what was to be our ascent over the Bealach a' Ghlas-chnoic situated to the north and east of both Sgurr a' Gharaidh and the ground covered the previous day. Yesterday, we were assured, was essential preparation but even to the relatively untutored eye, the distant view of the higher ground to the south west appeared to confirm the Precambrian

Quartzite/ Torridonian thrusted sequence looking North from NG 9050 4596

overlay on the younger rocks. In what seemed like an unrelenting ascent, geology was taken "on the hoof" at the increasingly frequent stops in the high winds which had blown the rain away. We initially encountered a feldspar rich quartzite showing worm casts overlain by Lewisian and possibly overturned Fucoid Beds. The accumulation of evidence for the presence of the nappe was strong.
The summit of the pass was floored by an arkose grit while on descending into a stream section for lunch we again encountered Fucoid Beds.
After a sunny but wind chilled lunch stop, the group climbed over a bleached quartzite watershed to an escarpment providing an ideal panoramic view to the North of bare and planed massive tectonic slices or wedges of alternating Torridonian and Quartzitic rock, the origin of which was the possible consequence of repeated overthrusting of the same rock suite, subsequently glacially modified. With spirits revitalised by this unique spectacle, we commenced the long return to our transport over Torridonian slabs, bogs and overfilled streams, returning very much bedraggled and exhausted.

The last morning took us some 2 km west of Loch Carron village to a quarry cutting on the roadside. While we needed no convincing about the Torridonian surface, new evidence of mylonisation, which we had not seen previously provoked the possibility that the Loch Kishorn Thrust may have had a more eastwards existence, or that the main Moine Thrust several kilometres to the East had bent westwards here. An alternative explanation for the shearing and dislocation could be the presence of a further East/ West trending fault.

As we prepared to make our way home, the wind finally died away and the rain clouds disappeared. Such was perversity.

Our appreciation for the challenging and stimulating weekend was given to Dr. Cribb and extended to his able assistant, Jane Hickman, a Society member who lives locally, for pre-locating the best exposures for us and their participation in our discussions.

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FUNNELS and FOSSIL FORESTS of FIFE : 5th June 1999
Leaders: Rosalind Garton and Mike Brown
Participants: 64 (30 from Glasgow : 34 from Edinburgh)
Report by : *Charles Leslie*

This, the annual joint excursion with the Edinburgh Geological Society, started with the leaders outlining their plans for the day and summarising what might be seen while all were assembled in the car park at Anstruther Harbour.

Most of the sediments are fluvial or lacustrine with some marine beds in the Anstruther and higher Pittenween Formations laid down in the Lower Carboniferous (Dinantian) Period some 340 Million years ago.
At Cellardyke, just down from the old Town Hall, one of Fife's best kept geological secrets, spectacular distortion in the sedimentary rocks was viewed and examined. Various theories on how these funnel shaped collapse structures formed were discussed.
From the coastal path north from Cellardyke, the teschenite sill forming the Isle of May was clearly seen, while on the near shore the gently Northwards dipping beds were exposed in section while we gradually moved up the succession.
After lunch, taken on the rocks to the north of red roofed cottages beyond the pig farm, we went tree fossil hunting. At about NO 596 065, some 50m out from the High Water Line, 1m high tree sections were found protruding out of sandstone along with several fallen slices of tree trunk some 500 mm in diameter. Annular depressions in the sandstone surrounding the protruding tree stumps may be caused by "recent" erosion or could indicate dewatering of the sandstone by a tree causing a local depression around the tree and in the extreme, a Cellardyke collapse structure. This tree horizon was separated from another, by a mussel band ironstone marker bed with non-marine *Paracarboniola,* indicative of lacustrine deposition while the fluvial sandstones indicate a lake delta environment.
We reached the Cailpie Caves just in time to shelter from a rainstorm, along with local cattle that had taken up residence there. Although these caves are some 6 - 8 metres above present high water the base of the 10 metre high outcrop was undercut by ancient (6000 years ago) wave action. The outcrop itself was made of fine grained semi-angular fluvial sandstone from a NE source. North of the Caves a W - E fault marks the passage from the SE running reefs of Anstruther to the N - S reefs of the Pittenweam Formations. Three horizons of bryanzoans indicated the change to marine conditions.
The two leaders were thanked for their informative excursion as members of the two societies repaired to a local hostelry at the end of the day.

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DUNKELD AREA - THE TAY NAPPE : 19 June 1999
Leader :- Dr. J.Mendum
Participants :- 32
Report by :- *Alan Docherty*

A typical summer's day, as we had come to know it over the last few weeks, a sky full of leaden grey clouds and the ever present flecks of drizzle always threatening to merge into something more substantial.

Spirits were none the less high and when during the course of conversation Carole produced a clipping indicating that today at the Hermitage (close to Dunkeld) they were climbing the tallest tree in Britain, a Douglas Fir, to celebrate Douglas's centenary, we did not realise there would be more of this later.

After a 40 minute journey we turned off the A9 onto a side road to head towards our first location at Little Glenshee. Our leader John explained our itinerary for the day and handed out excursion notes. John took a few minutes to provide an overview of the Tay Nappe and how at this point we were on a vertically plunging limb of a huge fold structure running approximately 50 km to the north and west.

A short scramble through knee high heather and loose rock up the steep 30^{o}- 40^{o} slope of the Glen took us towards a small somewhat un-imposing outcrop of silvery grey rock. On closer inspection the rock face was a spectacular array of folded turbidite beds, at this point running at about 60^{o} to the vertical, and within each there appeared to run smaller more closely packed curving folds but at hugely differing angles which was explained as spaced cleavage.

Our second stop at Craigiebarns took us all on a single file half hour hike up the hillside through open clearings and dense forest interspersed with spectacular views of the Perthshire countryside.

Efforts were rewarded with a massive 20 m high crag. We discovered we were not alone as there were various figures with ropes clambering up and down the rock face: no it wasn't the Edinburgh Society but a group of local climbers.

At this point we were in a higher grade of metamorphism and a much less steep part of the fold structure. On close examination there were intricate folds and crenulations which this time could be interpreted as second and third stages of deformation.

After half an hour or so of we were off again this time up a narrow tree lined defile populated with glacial debris and interpreted as a glacial melt water channel. It was a steady climb for 20 minutes or so until the landscape flattened and opened up to reveal a huge cliff face running horizontally across our field of view; this was the flat part of the major fold structure.

The major feature of the cliff face was a 4-5 metre thick bed of Arenite which due to its rigid incompetent properties "controlled " the overall nature and orientation of the fold.

Then we started the descent which was now in the dry and much warmer, a short bus ride passed Dunkeld and we rolled into the car park of the National Trust's Hermitage. The main feature is a folly which overlooks a spectacular waterfall. As we looked further up stream we could see our leader confidently hopping and skipping over the various rock formations at the water's edge. When the rest of us got there our leader's agility seemed miraculous as we

lesser mortals slithered, slipped and performed various involuntary acrobatic feats trying to stay upright on the wet rocks. Eventually we had to coalesce into little groups for mutual support and gingerly make our way back to the safety of the bank.

Finally on the way back to the bus we passed a spokesman for the Trust sheepishly explaining to a local newspaper reporter that the measuring of "the tallest tree" in Britain had resulted in the latest measurement being several feet shorter than the previous measurement and perhaps it wasn't the tallest tree after all, Oh dear !

Never mind everyone agreed we had had a most enjoyable and enlightening day out.

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MUIRKIRK: 3rd July 1999
Leader : Dr. J.G.Floyd, British Geological Survey
Participants: 33
Report by : *Jean Willing*

The good weather usually enjoyed by the Society on their excursions deserted us on this occasion. Apparently Nostradamus had made dire predictions for July 1999 which had been interpreted as meaning the end of the World. Not so; it should have been interpreted as a deluge. Had we understood the prediction we could have arrange a different day for the long walk to the disused Auchinlongford / Nether Whitehaugh haematite mine workings (at about NS 606 295)

However, the rain started immediately the party stepped off the coach and continued solidly for the hour-long trudge to the mine workings up the old tramway route which in places resembled a river, running red with haematite staining. Jim Floyd encouraged us to look for specimens from the beginning of the walk and our red hands soon showed evidence that we were doing as we were told. A short length of trackway was pointed out to us. The trackway had been laid directly on stone blocks without sleepers. The wheels on the trams did not have flanges but the rail was shaped to guide the wheels and keep them in place. From the end of the tramway the ore was taken by pony to the coast and shipped to Bowawe where it was smelted into pig-iron. For a time, the pig-iron was then returned to Ayrshire to be manufactured into malleable iron.

Jim explained that the haematite vein mineralisation, trending W - E and NW - SE cut the rocks of Plewland sandstone, Dungarval Group of late Silurian, at the South-West end of the Lesmahagow inlier. And that the veins were worked by two different companies owing to the fact they occurred on the boundary of two parishes and two properties. The tramway on the Auchenlongford side went to

the public road there, while the tramway on the other side of the Pennel Burn went to the road to Nether Whitehaugh farm.
The shafts were sunk about 280 ft. at Auchenlongford and extensive galleries were driven along the vein workings, with the most productive period of mining being in the decade from 1872 to 1882. The working conditions in these long galleries down that deep shaft in late Victorian times do not bear thinking about.
We searched for specimens in the spoil heaps. Not an easy task as the heaps had become overgrown with grass in the 80 years or so since the mines had finally ceased working. Many good specimens of haematite ore were found by the more successful and diligent who generously shared them with the less successful. We even managed to eat lunch in the (nearly) dry.
After lunch Jim took us on an extensive tour of the area to explain the underlying rock structure. Various rocks were examined before we returned to the coach, again in torrential rain, and headed for home. *A visit to a final site had to be abandoned because the burn which had to be crossed to reach it had become a raging torrent although by then a weak sun had appeared.*
Many thanks to Jim Floyd for his valiant effort to make his voice heard above the deluge and for making the day so interesting.

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BATHGATE HILLS: 31st July 1999
Leader: Dr. Colin MacFadyen, Scottish Natural Heritage
Participants: 29
Report by: *Chris Henderson*

The bus left Glasgow on a fine sunny day with 27 members aboard. Dr. MacFadyen met us, in the mist, at East Kirkton Quarry, Bathgate and outlined his planned itinerary, essentially a South to North traverse of the Bathgate Hills. Hard hats were issued and we entered the disused quarry having been warned that since this and most of the other sites we were to visit were of Special Scientific Interest, hammering of debris was discouraged and of fresh faces, forbidden.
The East Kirkton Limestone is of freshwater origin and the succession consists of limestones overlain by mudstones with tuff horizons containing spherulitic structures. The quarry has been extensively investigated and has yielded an unusual array of fossils, including amphibians, millipedes and water scorpions as well as plant material.
The next location was the Petershill Reservoir (disused) where the limestones were of high carbonate content. Excellent fossils were found here including lithostrotian, spinose productids, brachiopods and some very large solitary corals. The fossils were well preserved and showed little disturbance, suggesting quiet sedimentation.

Lunch was next on the agenda and we had an excellent picnic in the sun, followed by a short walk to the next site. This location was an extension of the Petershill Limestone but here fossils were overturned and broken up which suggested a more turbulent nearshore environment.

Petershill Limestone at base of cliff near NS 988 708

A short bus ride took us to The Knock, a local viewpoint. From the top a good view of the surrounding landforms can be seen. The sky was hazy and we could only see the more local features including the red oil shale bings which are the remains of the West Lothian oil shale industry.

Nearby the Hilderston Mine was originally worked from 1606 to 1614 for silver. An extensive range of minerals has been found here including baryte, niccolite, sphalerite, galena and annabergite. The mineralisation is associated with Carboniferous volcanic activity. Close to the mine workings an upward coarsening sequence of sediments was seen and trace fossils were found in fallen sandstone blocks. Evidence of root material and animal burrows suggest deltaic sedimentation.

We had moved up succession from the carbonate deposits of the Petershill Reservoir Limestone, through the turbulent nearshore zone to the deltaic clastic deposits at Hilderston.

All this was thirsty work and we retired to the nearby Beecraigs Country Park for refreshments. Across the road from the Country Park we were able to see an example of stoop and room workings where the Hillhouse Limestone was mined.
A vote of thanks was given to our leader, Colin MacFadyen for his well prepared and very informative excursion.

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DUMGOYNE : 7th August 1999
Leader : Dr. Jim MacDonald
Participants : Restricted because of terrain to 11
Report by: *Stephanie Kape*

The participants gathered on a slightly damp day in the carpark near the Glengoyne distillery, to walk up to the summit of Dumgoyne, cutting through the stratigraphy as we ascended.
The first outcrop was in the woods behind the distillery, and comprised the uppermost units of the Stockiemuir Formation. This is the lowermost unit in the succession and is comprised of Old Red Sandstone facies. It's age is uncertain, and is likely to be Lower Carboniferous rather than Devonian, as the upper ORS is of Lower Carboniferous age in the Dunbar area, as determined by fossil fish.
As we ascended the hill, we walked over the vegetation covered Kinnesswood Sandstone formation. Its presence was indicated by a small outcrop showing a fine grained sandstone, with a discolouration that might indicate carbonate. Unfortunately, no one had the forethought to bring acid to test it ! The Kinnesswood Sandstone Formation has been described as a transitional facies comprising fluvial sandstones, resulting from the climate gradually becoming wetter between the Devonian and the Carboniferous. A spring line above the outcrop indicated a transition to an impermeable rock, possibly showing the location of the overlying Ballagan Formation. This Formation was entirely vegetation covered on Dumgoyne (although was seen later on), and comprises interbedded black shales and impure sandy limestone units. It has been interpreted as being formed in a high salinity coastal sabkha (saline mudflat), containing distinctive 'cornstone' (calcrete) horizons which contain nodules of calcium carbonate formed in an arid environment just below the soil surface. They indicate a prolonged period of exposure - as would be found on a saline coastal mudflat. The uppermost unit in the succession is the Clyde Sandstone Formation, comprising fluviatile sediments thought to result from the uplift of the land due to the extrusion of the Clyde Plateau lavas and the intrusion of the vents, of which Dumgoyne is the most recognisable.
The rocks exposed towards the summit of Dumgoyne comprise vent agglomerates cut by some very visible dykes and sheet basalts that show strong

columnar jointing. The summit of Dumgoyne (427m) afforded a view (before it became completely clouded over) of the line of vents which run along the north face of the Campsie Fells towards the Meikle Bin, (thought to be the location of a main central vent). This line of vents probably represented a fissure zone from which the plateau lavas of the Campsies extruded. The vent agglomerates on the summit suggest that the magma passed through "wet" sediments, leading to fairly explosive behaviour, analogous to the present day Stromboli volcano in Italy. Looking from the summit the succession of plateau lavas on the Campsie Escarpment to the SE was clearly visible. Apparently, a large number have been identified (18?) - we didn't count them - mostly basalts, although one flow shows a composition of Hawaiite. This unusual basalt is found elsewhere only on Hawaii and has a higher alkali content than most other basalts. It is thought to have been produced at high pressures 20 - 30 km deep in the mantle.

Descending from the summit towards the NW and continuing round to the North to pass between Dumgoyne and Dumfoyne, a sheltered spot was found for a welcome rest and lunch.

During this traverse, it was noticed that the actual surface geology differed to that represented on the Geological Survey map ! The line of the Campsie Fault which runs along the Blane Valley, separating the Campsie Fells from the Kilpatrick Hills is clearly seen. This fault is thought to have been active during the deposition of the Clyde Plateau lavas, as the succession on the Kilpatrick side is likely to be 1000 m thick (based on gravity and magnetic anomaly data), while the Campsie succession is currently 300 m thick, with evidence to suggest the erosion of a further 500 m. Isolated vents are seen on the Kilpatrick Hills, but there is no evidence for a line of them as in the Campsies.

Further outcrops traversing across the hillside shed more light onto the stratigraphy. In particular, a few good exposures of the Ballagan Formation were seen in a stream section, and our first glimpse of the Clyde Sandstone Formation immediately below the plateau lavas.

The day ended with a thanks to our Leader for a thoroughly enjoyable field trip. He even managed to make igneous petrology exciting for the "soft rock" brigade.

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ROSENEATH PENINSULA : 21st August 1999

Leader Dr. Iain Allison, University of Glasgow
Participants: 31
Report by: *Evelyn Lennie*

For a moment, I thought I'd mistaken the date, because of the number of caravans and trailers in the Boyd Orr car park. However they were there for a film shoot in the University. The sun shone brightly on the river as we were

driven from Glasgow to Helensburgh and it continued to do so nearly all day. After a brief stop at Helensburgh to collect a few people, we continued on to Roseneath to begin the excursion proper along the shoreline of the Gare Loch and Loch Long.
Our leader, Dr. Iain Allison issued hand outs which he explained were mainly derived from guide notes produced by Dr. P.W.G.Tanner, some of which appear in the Society's "Glasgow Guide", excursion 13.

Although the tide was not as low as our leader would have liked, we were able to scramble across rocks, without any mishaps, to the first location to study the Dunoon Phyllites, the youngest rocks of the Upper Dalradian, at the top of the Southern Highland Group, deposited in small basins as turbidites to form marine mudstones. The coarser material between the finer muds at the top and bottom of the units showed less well developed cleavage on metamorphism.
From admiring the views in the sun we were brought back to reality by our leader's valiant attempt to get us to understand the concept of "fold-facing". At this locality, about 200 m from the Highland Boundary Fault we noted that the rocks , the Bullrock Greywacke, were downward facing.

On the rocks by Loch Long

At the next stop, because the grain size was finer, it was easier to spot the effects of later deformation. In the limb of the folds it was noted that the bedding plane and the cleavage were almost parallel. We also noticed many veins of quartz, some being very thick indeed.

At the third stop, now in Loch Long, we gathered at the Northern end of an exposure to describe what we had crossed over. Our leader then made us turn round to show that our perception of structure depends entirely on the direction in which it is viewed. A very useful lesson !. We were advised to always walk down plunge to see the structures best.
While laboratory testing of specimens yields valuable information, in-situ field study is critical. The minerals identified had a muscovite sheen indicating their formation at about 300^0C which with a geothermal gradient of 30^0C per km depth suggests that the deposits were buried to a depth of some 10 km at which the pressure would have been about 10^7 Pascal. (Conversion factors to arrive at this conclusion were dragged from us by a determined leader as we sat in the sun by a quiet loch). The unanswered question was where had all this overburden (as high as the jet trails 35000ft.above us) gone. There is little evidence of Dalradian erosion products in the nearby Midland Valley but slide/ slip movement along the Highland Boundary Fault could have left the deposits hundreds or even thousands of kilometres away from our present position. There is evidence that deformation of the sediments took place over a long time at a low strain rate during the closing of Iapetus. As folding took place, dark mica-rich material migrated from the hinge to the fold limbs while light, quartz-rich material moved in the opposite direction producing a layering effect.
As the rocks cooled and became less plastic, very angular folds or "kink bands" formed.

Further up Loch Long, about 300 m from a MOD gatehouse, we noted that although corrugated, the general fabric of the rock was flat and that we were now seeing the upside down limb of the Tay Nappe which Dr. Allison reminded us is of truly Alpine proportions although we cannot see much of it at the surface.
(While we were busy "observing", two policemen leaned over the wall to ask, very politely, what we were doing. A very polite lady's voice piped up "We're geologists" pause, "from Glasgow University". Though this description was a gross exaggeration and could only apply to 2 or 3 members of the group of 30 it was enough to satisfy the policemen who waved and departed having obviously decided that we did not intend to use our hammers and pointed sticks as weapons.)
Quartz veins here were pulled out into pods by later deformation while the metamorphic grade was too severe to determine the "way up" of the rocks.

Then reluctantly, as the sun was still shining, we returned to the bus where David Wilkinson expressed thanks to Dr. Allison on our behalf for a very stimulating day. My own learning curve was as steep as many of the folds and I only hope it will be as permanent.

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SHETLAND:8-13 September 1999
Leader: Dr. Chris Burton, University of Glasgow
Participants: 20
Report By: David McCulloch

For most of us the trip began with a flight from Glasgow to Sumburgh. Dr. Burton had supplied us all with a hard hat to carry as hand luggage which made us look like oil workers but I couldn't help thinking that the North Sea had never before seen such a motley bunch of riggers. On arrival at Sumburgh airport we were met by fierce winds and driving rain which resulted in a very driech drive up to our base at Hillswick in the far Northwest.

After dinner at the St. Magnus Bay Hotel we gathered in the lounge set aside for our use where Chris gave us an introductory lecture on the geology of Shetland. He explained how the structural geology is dominated by two north-south oriented strike-slip faults - the Walls Boundary Fault and the Nesting Fault. There had been a sinistral movement of 170 km on the former in the Devonian and Carboniferous followed by a dextral movement of 65 km in the Jurassic. The Dalradian rocks west of this fault unlike those to the east cannot be correlated with anything found on the Scottish mainland and ocean floor rocks have been thrust westwards over the Dalradian on the islands of Unst and Fetlar. Shetland has been a 'high' between two basins since the Devonian and unlike Orkney it consists of rocks displaying a wide variety of ages and origins.

Thursday 9th September

We woke up to find dry and fairly sunny weather but we still had to contend with the fierce wind as we arrived at Esha Ness lighthouse (OS grid reference HU 206785). The sea looked simply incredible - a seething cauldron of white water with waves crashing over even the highest sea stacks.

South of the lighthouse we examined the ORS volcanic rocks - spectacular andesitic tuffs which contained some massive blocks measuring one metre across as well as porphyritic andesitic lavas with contemporaneous sediments

filling the hollows on top of the flows. We also noticed strips of gravel and pebbles near the cliff edge in addition to boulder fields, these being the storm beaches formed by the winter gales when rock is hurled vertically out of the sea onto the cliff tops.

After about 500m we turned and walked north of the lighthouse looking first at the mugearite lavas (which Jim MacDonald preferred to call dacitic andesites) before veering inland to stare into the Holes of Scraada where the sea has punched its way through the cliffs to emerge in a cauldron about 150 metres back from the cliff face. Returning to the cliffs a few of us spotted on otter clambering over the spray-soaked rocks. About 1.5 km north of the lighthouse we came upon an outcrop of ignimbrite and whilst trying to remain upright in the wind we searched for fiamme - glassy streaks representing glass shards in the hot pyroclastic flow.

In the afternoon we studied the very complex igneous intrusions of the Northmaven peninsula at the huge roadside cutting at Mavis Grind (HU 342681). Chris pointed out that there were probably four phases of intrusive activity although we had great difficulty unravelling the sequence from the multitude of cross-cutting relationships seen in the cliff face. We had to take his word for it that early basic and acidic phases were followed by a dioritic phase rounded off by intrusion of a late granophyre - all just a hypothesis we were told. The pyrite and magnetite mineralisation of the Dalradian graphite schist at Sullom Mine Quarry (HU 342729) seemed easier to comprehend. The schist grades locally into a psammite and the difference in their folding characteristics was clearly visible. A sample of pyrite produced to us by one of the lorry drivers in the quarry contained some rare tetrahedral crystals as well as the usual cubes.

At Ollaberry we walked across the peninsula to see the spectacular fault plane of the Walls Boundary Fault (HU 372810) reckoned to be a northward extension of the Great Glen Fault. The hard igneous material to the east has resisted the crushing normally associated with a fault plane and so forms a high vertical cliff about 100 metres long. Those of us who scrambled down below the giant cliff discovered water smoothed outcrops of schist on the beach containing incredibly beautiful and regular kink bands looking just like herringbone tweed.

After dinner that evening we were treated to some live traditional Shetland music in the bar provided by around a dozen local musicians. Foot tapping aplenty!

Friday 10th September

Using Shetland's very efficient inter island ferry services we headed over to Yell. Situated between and dissected by the major strike slip faults, Yell is made largely of psammitic Moine rocks but some pelites containing purple garnets were found just south of Gutcher pier. Crossing to Unst we returned to the Dalradian, separated from the Moine by a schuppen zone of high angled reverse faults bounded top and bottom by thrusts. In a small quarry at Belmont pier we studied serpentinised harzburgite, part of the Unst-Fetlar nappe pile representing altered ultrabasic ocean floor material thrust over the Dalradian in late Caledonian times as Baltica collided with Laurentia.

The disused Hagdale quarry (HU 638101) was once used as a source of chrome ore, the ore forming the base of a dunite sequence which is almost pure olivine and so weathers readily - the green fresh surfaces were contrasted with the very distinct and regular brown crust on weathered surfaces. Serpentinised harzburgite when sheared and hydrated produces talc and at our third quarry, an active one at Cross Geo (HU 651122), talc is extracted for industrial uses. Some of the quarry 'faces' were formed of fairly coherent rock but others seemed to consist only of damp slimy powder and the quarry floor was covered by a thick glutinous quagmire of wet talc.

The road end at Skaw at the northeast tip of Unst made John O'Groats seem positively equatorial by comparison. At the beach (HU 660164) we immediately noticed the truly massive rectilinear feldspars in the granite, many measuring about 6 cm by 2 cm. The contact with the schist was very clearly displayed near the north end of the beach with granite veins intruding the schist and xenoliths of schist incorporated in the granite.

Returning through Yell we examined a Lewisian inlier in the Moine at Evra Houll (HU 454839) - and the Shetland ponies in the field across the road were very cute!

Saturday 11th September

After the mainly sunny weather of the last two days the low cloud was disappointing. A spot of sightseeing in Lerwick (with the Shetland knitwear shops doing a brisk trade in sales to geologists) was followed by a visit to a roadside exposure of middle ORS conglomerate at Gremista (HU 467443). Often regarded as the product of torrential rivers the cobbles were in places supported only by the matrix leading to the theory that they may instead be debris flows. At Easter Quarff (HU 432353) a Dalradian nappe has been thrust over the main Dalradian succession. Paragneisses, unusual in the Dalradian, were seen to underly a schist which is overlain by the basal breccia of the ORS.

Submarine volcanics (spilites) in a road cutting (HU 427275) were interpreted as a remnant of limited sea floor spreading in a back arc basin. A short climb up the hillside (coinciding with a sudden and atypical cloudburst) led to an ancient steatite (soapstone) quarry at the Burn of Catpund (HU 423271). The tool marks left by the Viking artisans could still be seen all over the rock terraces. The soapstone was used to make food vessels and was an ideal medium for the purpose as the easily carved soft rock actually hardened with use in cooking as the heat drove off the water incorporated in the rock.

At a road cutting further south (HU 402232) we studied the Channerwick granite, a dyke or sill-like body containing albite, muscovite and biotite with an unusually large thermal aureole in which the phyllite was found to be spotted with chloritoid. The final stop of the day was also the furthest from base - the tombolo leading to St. Ninian's Isle. An outcrop of the Dalradian Bigton Grit at the mainland end was examined before we undertook the breezy walk across the tombolo which consists of a hidden gravel base capped with sand making it especially unusual. At the west end, at St. Ninian's Isle itself, we saw folded schists indicating a sequence of deformational events. An odd pale-coloured outcrop on the beach was found to contain a darker interior. A lively discussion ensued about its likely history although no firm conclusions were reached.

Sunday 12th September

A return to sunny weather was accompanied by a pleasant breeze instead of the earlier high winds. We took the long road out to the west by detouring via Tingwall thereby allowing us to enjoy the breathtaking views south over Whiteness Voe to the Burras, notable both for the sun sparkling on the sea and for the very clear impression of the north-south grain of the topography hereabouts formed by the differential erosion of four meta-limestone horizons in the Dalradian. After a brief stop at a road cutting in the Dalradian (HU 398463) we stopped at a smaller road cutting (HU 393467) in strongly folded crystalline meta limestone (i.e. marble). The very lush green scenery around Weisdale Voe was obviously a product of the underlying limestone and we stopped at the roadside high on the west side of the voe (sea loch) to marvel again at the stunning coastal scenery before continuing on to the quarry at Bixter (HU 342522) and a rock type new to many of us - monzonite. Forming part of the plutonic Spiggie complex just east of the omnipresent Walls Boundary Fault, monzonite contains equal quantities of orthoclase and plagioclase along with pyroxenes but little or no quartz. A strong linear fabric is the result of stresses acting at the time of intrusion. The complex as a whole contains a very varied petrography ranging from ultrabasic units to granite.

Travelling across the fault the landscape changed to a lower relief ORS topography and we followed a little switchback road to its end at Huxter. For the first time on this trip the absence of high winds allowed us to enjoy lunch al fresco at a group of small Norse water mills overlooking St. Magnus Bay and the island of Papa Stour. Just east of the mills, on the bouldery foreshore (HU 173573), we began to hunt for fossils in the lower of two fish beds in the ORS Melby Formation where the siltstones represent a lake deposit. The only fishy thing found (by our Excursion Secretary, no less) was a bit of rock with an impression of some fish scales on it although the siltstones did contain abundant plant fragments. A visit to a ruined broch on the moorland gave us excellent views out to the island of Foula with its very dramatic soaring silhouette formed by the escarpments of its sandstone strata.

At Melby pier we conducted an anticlockwise circuit of the Ness of Melby (HU 186580) a promontory which is formed from tough rhyolite lavas interbedded between softer Upper ORS sedimentary strata.

The final locality took us to the road end at Bousta to look at the fringe of Grenvillian rocks (metamorphosed 1000 Ma) which underlies the ORS on the north coast of the Walls peninsula. At the promontory (HU 223579) we studied the calc schists which are metamorphosed limestones with mudstones and we were told that they could not be correlated with anything found elsewhere in Scotland. From the little knoll above this outcrop we enjoyed a breathtaking view across St. Magnus Bay.

Monday 13th September

On the last day we made our way back to the airport and on the journey we managed to see over to the broch on Mousa and south to Fair Isle thus perfectly rounding off a very comprehensive tour around this remote island group with its complex and often enigmatic geological history.

It was Shetland's uniqueness and variety which came across most strongly to me during our stay - from the spectacular and rugged coastal cliffs, stacks, geos and storm beaches around Esha Ness to the soft green limestone landscape of Weisdale with its linear topography; and from the unusual ophiolite lithologies of Unst to the suite of multiphase plutonic complexes with exotic names such as Spiggie, Graven, Sandsting and Northmaven. Even the apparently familiar Dalradian sequence turned out to be anything but familiar. And everywhere the coastline was indented by long voes and protruding promontories affording breathtaking open views across the sea to distant headlands and outlying islands. This richly varied scenery is of course a reflection of the complexity of the

underlying geology and thanks must go to Dr. Burton for providing such a comprehensive and comprehensible explanation of it.

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GEOLOGY WEEK 11 - 18 September 1999

Scottish National Heritage promoted events arranged to take place during the week throughout Scotland and although it co-incided with our major excursion to the Shetlands the Society still managed to mount the contributions noted below. In addition, Society Member, Dr. Neil Clark was heavily involved in organising the Hunterian Museum's programme throughout the week.
Attendences were encouraging, thanks in no small measure, to the excellent posters produced and distributed by Alan Docherty and the Society recruited several new members as a result.

13 September - Avon Gorge at Chatelherault, Hamilton - **David Wilkinson** explained to the 7 members of the public who attended, the Carboniferous climatic conditions under which the surrounding rocks were formed from the vantage point of of the Duke of Hamilton's hunting lodge. Depositional details were illustrated by examination of the dressed stones of the lodge and of samples collected earlier. This made the later examination of rocks in the stream bed and surrounding banks more meaningfull.

15 September - This was intended to be a visit to **Finnich Glen** but, unfortunately, the landowner would not grant access, so **Mike Keen** quickly devised an alternative for the 10 people who attended. From the vantage point of the Queen's View car park, on the Drymen Road, he gave a quick overview of the second Lomond ice advance. He then descibed the Finnich Glen Gorge as seen from the road bridge. The evening finished spectacularly with a visit to an equally interesting gorge cut through the Old Red Sandstone in the Balinkinrain estate on the Fintry road.

17 September - Dr. J.G.MacDonald gave a lecture on **Hawaii's Volcanic Eruptions** in the Gregory Building illustrated by personal slides and video footage of recent eruptions which are still taking place.

A.M. 18 September - The Whangie
The enigmatic Whangie was visited by a party of 43 led by Dr.J.G.MacDonald, assisted by Dr.J.J(Ben) Doody. The views from the approach path from the Queen's View car park on the Drymen road afforded the opportunity for a potted geological history of the area stretching from the Precambrian highlands in the North to the "recent" ice moulded Carboniferous Clyde Plateau Lavas. The

Whangie, itself, about 1.5 km along the path from the car park, is a narrow defile in the lava, with its back face (S) near vertical and its outer, tilted outwards. Matching features on the faces suggest a tearing apart possibly as the outer edge of the lava flow was undermined by ice action. The excursion ended on the hillside above the Whangie where the leaders are currently engaged in research activities.

P.M. 18 September - Building Stones of Glasgow University

40 people gathered at the University Visitor centre at 3 pm, where the excursion leader, **Dr. C.J.Burton** introduced the history of stone use in western Scotland, and in the University in particular, from the late 18th century up to the present day. The group then explored the University's buildings both inside and out, starting with the Gilbert Scott Building and moving on to the later stone-built and stone-clad buildings and then to brick-built buildings where stone was used merely for decoration. The problems of stone decay and stone cleaning on exterior walls were illustrated at various places on the campus. A two-hour excursion finished, appropriately, outside the Gregory Building (Earth Sciences) with its large cut stone ornamental arch.

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