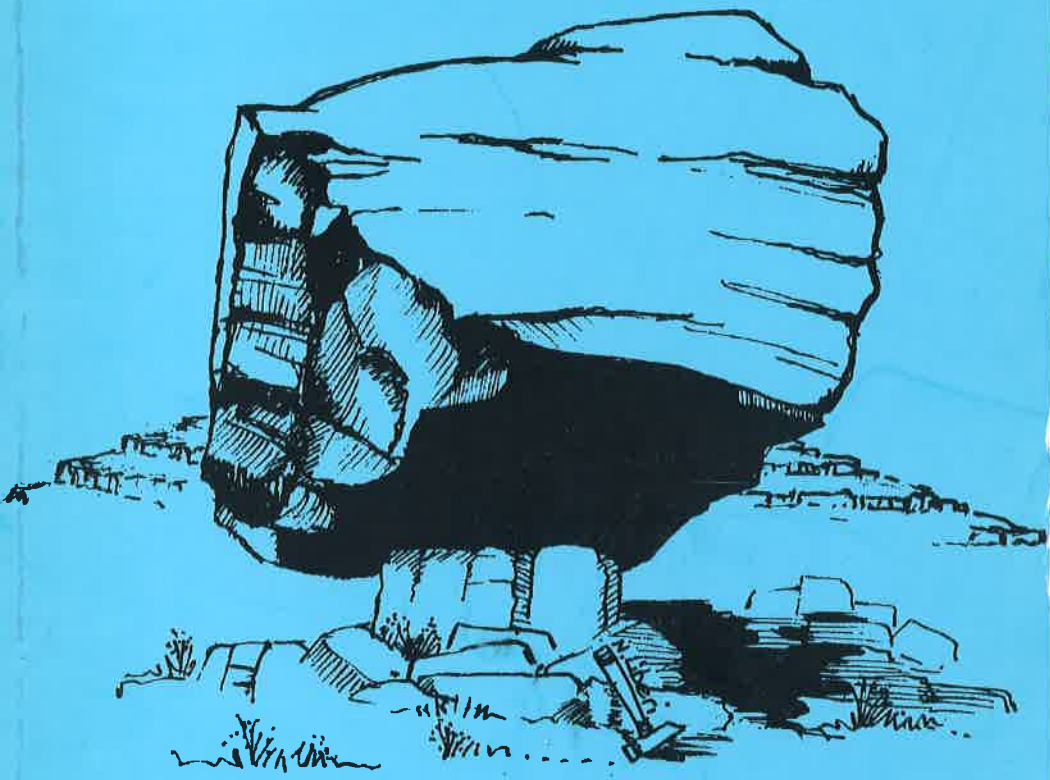
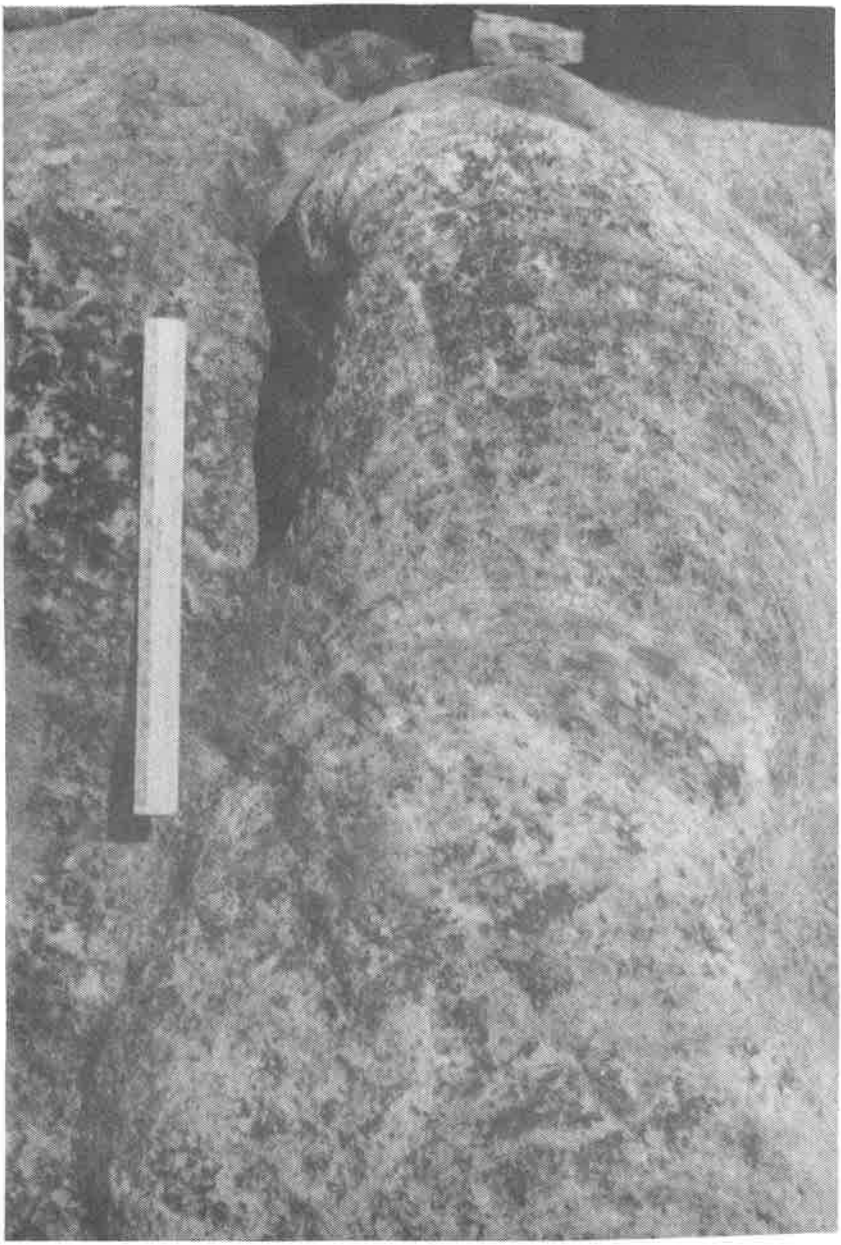
PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF GLASGOW



Sessions 129, 130, 131 and 132

1986/1990



The trace fossil *Beaconites*, from Kings Barns, Fife. See Page 50
Photograph by Dr. Alex. Hall

PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF GLASGOW

SESSIONS 129, 130, 131 and 132
1986-87, 1987-88, 1988-89 and 1989-90

Contents

LECTURES 1986-87 (Session 129)

The session opened on 9 October 1986 when **Dr. Euan Clarkson** (University of Edinburgh) spoke on "Life in Carboniferous Lakes and Lagoons of the Eastern Midland Valley".

Some unusual sedimentary sequences in the Carboniferous of the Edinburgh district have remarkably preserved faunas of crustaceans and fishes and are notable for the absence of 'standard' coral-brachiopod sequences. These laminated 'shrimp-beds' have usually been considered as deposited in marginal marine and brackish lagoonal facies and recent sedimentary work on the fresh to brackish 'Lake Cadell' complex bears out and extends this interpretation. The first adaptive radiation of shrimp-like crustaceans took place in these environments. Although the animals must have had a high physiological tolerance to cope with the rigours of these 'difficult' habitats, there are many instances of mass mortality evident in these beds, the result perhaps of algal blooms, of fluctuating salinity, or lowered oxygen tension. There are similarities between these shrimp-beds at Granton and Gullane, but significant differences too, which were compared with other occurrences at Foulden, Berwickshire, and in North America. From these restricted environments of the Carboniferous, the higher crustaceans evolved in a series of major radiations in the Mesozoic and Tertiary to be amongst the most important life forms in the sea today.

The second meeting of the year was held on 30 October, and was addressed by **Dr. David Smythe** (British Geological Survey) on "Nevada and the North Sea".

The off-shore area around the British Isles suffered a considerable amount of crustal stretching in the Late Palaeozoic and Mesozoic. New and radical interpretations of the stretching of the Viking Graben and of the Old Red Sandstone basin of the Orkney-Shetland region, for example, draw upon an analogy with the kind of extension on low angle normal faults observed in the Basin and Range Province of the western United States of America. A review of some of the arguments in the current debate on the nature of the extensional faults was presented. The talk was illustrated with slides of the spectacular geology of southern Nevada and Death Valley, California, as well as by deep crustal seismic sections.

On 13 November **Professor Raymond Skelhorn** spoke to the Society

on "The Tertiary Lavas of Mull: Environment of Eruption"

One of the great Scottish geological controversies has been the mode of eruption of the Hebridean lavas. Judd believed that they had been erupted from central type volcanoes, the central intrusive complexes being the basal wrecks of these volcanoes. Geikie, as a result of his travels across the Snake River Plain, proposed that the lava pile had been built up by fissure eruptions, the dykes representing consolidated feeders. The lecture emphasised criteria which can be used to reconstruct the volcanic environment. A systematic analysis was made of the structural features (pipe amygdales, flow folds, flow foot breccias, inclined columns etc.) of lavas which can be used to determine the direction of flow, allowing the position of the erruptive centre(s) to be located. Pyroclastic deposits are rare, usually resulting where magma has interacted with groundwater to produce, in places, base surge deposits. The sediments associated with the lavas are predominantly clastic and non volcanic in composition and represent alluvial facies at the foot of fault scarps. The tectonic significance of the Mull lava pile and the associated dyke swarm were discussed.

The one hundred and twenty ninth **Annual General Meeting** was held on 11 December. The formalities were followed by a short illustrated talk by **Dr. Peter Thomas** (Paisley College of Technology) on "The Syntectonic Landscape of Nepal". Dr. Thomas touched upon continental collision and the evolution of the Hymalayan landscape, as well as showing some spectacular scenery. As usual, the evening was rounded off with the annual social.

The first meeting of 1987 was addressed by **Mr. John Bell**, a quarry manager from the Durham area, who battled through snow to speak on "The Permian Boundaries of North-East England".

Mr. Bell provided a new explanation of the Upper Permian marine incursion onto the Lower Permian desert environment in the Durham Province, in the light of new fossil evidence brought to light by quarrying operations in the Durham area. As well as illustrating the geology of this classic area, Mr. Bell showed slides of numerous exquisitely preserved fossil fishes.

What for many is the highlight of the annual programme, **Members' Night** was held on 12 February. Once again it did not disappoint. Short

illustrated talks were presented as follows:-
Dr. I. Allison - Algalmatolite;
Mr. A. Herriot - "S.A.P.S.";
Mr. J. Little - James Croll;
Dr. M. C. Keen - Dinosaur footprints in Texas; and
Dr. J. G. MacDonald - Milos—Volcanic activity in the Aegean.

Both before and after the talks, members were able to enjoy the following exhibits:-
C. J. Burton - Carboniferous fossils form Trearne Quarry, Beith;
N. Clarke - *Cyclus*? - a Carboniferous Copepod from Bearsden?;
M. Dentith & J. Doody - MAVIS - Midland Valley Investigation by Seismology;
R. Jones - Fracturing of Old Red Sandstone conglomerate clasts near the Highland Boundary Fault;
M. Keen - Freshwater limestones from the Eocene of the Isle of Wight;
A. Park - Finish Soapstone;
P. Tanner - Octahedral pyrite from the Rowenzori Mountains, western Uganda; and
G. Whelan - Organic microfossils from deformed rocks in Scotland.

On 26 February, **Dr. Peter Kokelaar** lectured the Society on "Ups and Downs of New Zealand's Volcanoes".

Active andesite-dacite volcanoes, from White Island in the north to Ruapehu in the south, define a fairly typical continental arc, with which is associated an actively widening marginal basin characterised by basaltic (e.g. Tarawera) and rhyolitic (e.g. Taupo) volcanism. The contrasting styles of the arc and basin volcanism and tectonism were described, with uplift and construction versus collapse and erosion as persistent themes. Aspects of volcanic hazards and the well known geothermal systems were also described.

Two weeks later, on 12 March, **Dr.. C. Whatley** (University of Wales) spoke on "Some aspects of the Palaeobiology of Cainozoic Deep-sea Ostracods".

This lecture demonstrated the different types of ostracods which inhabit the deep sea and sought to isolate early and latecomers to this environment.

The mechanisms by which Ostracoda have invaded the abyss was discussed and it was shown that from certain major loci of induction, how various taxa have, via abyssal pathways, migrated out to colonise all of the world's oceans. Other aspects which were covered included their evolution, particularly in bathymetric isolation on sea mounts, and guyots, their response to palaeoceanographic changes and the development of bizarre morphologies.

After Easter, on 23 April, **Dr. J. Nicholson** (Midland Valley Exploration) addressed the Society on "Structure and Sedimentation of the east Greenland Old Red Sandstone".

John Nicolson was a member of Peter Friend's 1968-70 Scott Polar Institute expeditions to Central East Greenland, working on the sedimentology of the Old Red Sandstone sequences of gauss Halvo and Ymers O, on Kaiser Franz Joseph Fjord. This lecture summarised the results of that work, reviewing the structural style and sedimentation of the Middle and Upper Devonian Old Red basin. This is a strike-slip fault controlled deposystem which shows a very interesting and well exposed association of shortening and extensional major structures. Sedimentation patterns and some dramatic local unconformities are clearly associated with, and dependent upon, the structural development of the basin by movement on major wrench faults.

The final lecture of the session took the form of the joint celebrity lecture with the Edinburgh Geological Society. It was delivered by **Professor P. Molnar** (Massachusetts Institute of Technology), who spoke on "The Deep structure and Tectonic Evolution of the Himalaya and the Tibetan Plateau".

The Himalaya and the Tibetan Plateau appear to be direct consequences of the collision of India with the rest of Asia beginning in the eocene period. Fault plane solutions of earthquakes in the Himalaya suggest that the Indian shield continues to plunge beneath the Himalaya along a gently northward dipping thrust fault. Within the high plateau however, crustal shortening has ceased, and the active tectonics is characterised by extensive normal faulting on northerly trending planes and strike-slip faulting that allows Tibet to be extruded eastward with respect to impinging Indian and Eurasian plates. Thus, although the convergence between India and Siberia

continues, the Tibetan Plateau appears to be in an incipient state of collapse.

LECTURES 1987-88 (Session130)

The session was kicked off by the presentation of the T. N. George medal to Dr. W. Mykura. The presentation was followed by a lecture from **Dr. Brian Bluck** (University of Glasgow) on "The Growth of Scotland during the Caledonian Cycle".

There is now substantial evidence that Scotland south of the Highland Boundary Fault grew by the addition of crustal blocks which formed elsewhere. Growth of continental crust by the addition of exotic terrains is well documented around the Pacific Ocean today, and such a pattern of growth seems to have characterised large sectors of the southern margin of Laurentia. Peak periods of terrain accretion appear to be pre-Llandovery, and most terrains grew outboard of Laurentia, then possibly migrated north east along its margin. By late Silurian—early Devonian times a major continental mass (Laurussia) became established when Greenland collided with Scandinavia-Russia. Sediment from this collision may well have dispersed into the Scottish sector during Devonian times.

On 29 October **Dr. K. W. Glennie** (Shell U. K.) spoke to the Society on "Deserts".

Tropical deserts typically occur in trade wind belts where the potential rate of evaporation greatly exceeds that of precipitation, whereas the deserts of polar and high altitude areas result from ground temperatures that are too low to permit much growth of vegetation. About half the area of modern tropical deserts consists of outcrop subject to erosion; the rest comprises sediments of fluvial, lacustrine, paralic and aeolian origin, and of evaporites. Most of the sedimentary features of modern deserts can be recognised in their ancient counterparts. Deserts are probably not permanent features of the world. Systems of sand dunes, for instance, seem to have been most active when polar ice caps were at their peak (Pleistocene, Permo-Carboniferous, Ordovician, Cambro-Precambrian); the inference is that high latitude glaciations cause an increase in the sand transporting power of winds in desert areas — dryer and stronger winds. Linear dunes seem to have formed only in glacially activated deserts. Nevertheless, deserts did exist at times when there was no known glaciation (e.g. Triassic, Jurassic). These, however, may be better characterised by a relatively high

proportion of fluvial sediment transported by water precipitated during relatively frequent convection type thunder storms.

The third meeting of the session, on 12 November, was addressed by **Professor W. S. Pitcher** (formerly of Liverpool University), who spoke on "Andean Batholiths: Geology on Horseback".

The Andes provide a prime example of magmetism at a plate edge with a subduction history complicated by extensional tectonics and the lateral displacement of terrains. During the Mesozoic the formation of volcanogenic marginal basins was accompanied by the generation of new crust which became the source of vast volumes of granitoid magmas welling up to high levels in that crust to form huge multiple batholiths. In Peru the western Cordilleras provide exceptional three dimensional exposure of one of these batholiths and a rare insight into the arrival shape and general nature of granitic plutons. In so far as illustrated commentary could permit, those of us who were present were able to view a major global geological process at work.

On 10 December the Society had it **Annual General Meeting** and Annual Social. Sandwiched between these was an amusing geological quiz, organised by the President, Dr. Judith Lawson.

The first meeting of 1988 was held on 14 January, when **Dr. A. Robertson** (University of Edinburgh) spoke on "Geological Evolution of the Alpine—Mediterranean Tethys".

The lecture outlined the development of the ancient Tethys Ocean beginning with a giant ocean sited between Africa and Eurasia in the Palaeozoic, and then traced its development through to the present time, when it is almost entirely closed up to form mountain belts. Topics covered included the rifting of continents, the development of Mesozoic small ocean basins (and ophiolites) and the record of ocean basin closure involving subduction and arc magmatism. The talk was illustrated with slides taken in Greece, Turkey, Cyprus and Oman.

At **Members' Night**, on 11 February, the following illustrated talks were given:-

Neil Clarke - Conan the conodant animal; a palaeontological discovery;
Graham Durant - Crystal worlds: from inner space to outer space;

Stan Wood - the Fossil & Mineral Fair, Munich 1987; and
Jim MacDonald - Geology and Scenery in Southern Greece.

Before and after the talks, members were able to view the following exhibits:-

Chris Burton - a molluscan assemblage from Trearne Quarry;
Julian Jocelyn - Silicified wood, with microscopic slides;
Mike Keen - Miocene evaporites from Cyprus;
Judith Lawson - Svalbardia, a Middle Devonian plant from Fair Isle;
Jim Morrison - The Highland Boundary Fault, Loch Fad to Clattering Brig;
Jim MacDonald - Glacial fossils from Bute;
Stan Wood - The Fossil & Mineral Fair, Munich 1987; and
Hunterian Museum - recent acquisitions, including the skeleton of an early amphibian from east Kirkton Quarry, Bathgate, and a display on Fossil Grove.

Normal lectures resumed on 25 February with a talk from **Dr. N. H. Trewin** entitled "Palaeoecology of the Orcadian Lake and its Fossil Fish".

The Orcadian lake of the Middle Old red Sandstone of the north of Scotland varied greatly in extent, controlled by climatic fluctuations. During periods of high lake level, fish entered the lake from marine areas to the south east, and occupied a variety of habitats in lake margins and rivers. Periodic fish kills in the lake were caused by changing salinity and deoxygenation events, and the rotting carcasses drifted and sank to be preserved in finely laminated sediments of the deeper parts of the lake.

The fish had varied lifestyles and habitats, including small shoaling acanthodians (*Mesacanthus*), and the bottom dwelling mud grubber *Pterichtyodes*. Omniverous forms are represented by *Dipterus* and *Osteolepis* and carnivores by *Coccosteus* and *Glyptolepis*. The basis of all food chains was dominantly algal phytoplankton, but arthropods, represented by trace fossils, may have made significant local contributions.

On 10 March, **Professor B. W. Windley** addressed the Society on "The Geology of the Himalayas".

The evolution of the compressional stage of this orogenic belt began in the early Cretaceous with the formation of an island arc, that was accreted

onto the Asian plate in the late Cretaceous. India collided into this Asian continental margin in the Palaeocene to early Eocene, and has continued to push northwards into Asia at a rate of 5 cm/year for the last 40 Ma. It is this post-collisional indentation of India that delaminated by thrusting the northern margin of India, and this thickened and uplifted the crust and so gave rise to the present mountain range. Further expressions of this late indentation are the formation of Quaternary rifts in Tibet, and the upthrust of the Karakoram mountain range, which is the western uplifted extension of the southern Tibetan plateau.

The final indoor meeting of the session was held on 28 April. At it, **Professor P. E. Baker** (University of Nottingham) spoke on "The Enigma of Oceanic Islands".

Oceanic islands have played a chequered role in the history of the geological sciences; sometimes regarded as little more than curiosities, they have been considered representative of the ocean basins or as unrepresentative anomalies. Their status has been enhanced in recent years since it seems likely that they hold the clue to some of the fundamental dynamic processes operating within the Earth. Darwin made the first important geological observations on oceanic islands with his hypothesis for the evolution of atolls. Both Darwin and Daly highlighted relationships between different types of volcanic rocks and eruptive mechanisms. The isolation of oceanic islands was important to petrologists seeking the connection between different volcanic suites. Petrogenic variables could be confined to the mantle and oceanic crust; any contamination by continental crust could be ruled out. With the advent of plate tectonics, age relations within island chains and groups provided evidence of migrating lithospheres, and the hot spot hypothesis emerged. As more geochemical data became available, particularly isotopic ratios, it became apparent that the source of oceanic island magmas differed significantly from that of ocean floor basalts. The islands are clearly tapping a different source and sometimes mixing with MORB magmas. Is the island (or Ocean Island Basalt) source in a deeper part of the mantle that has remained untouched by shallower events for much of geological time? Or could there be another reason? Recent ideas suggest that either subcontinental lithosphere or oceanic lithosphere carried to the base of the upper mantle may form a

component of Ocean Island Basalt source.

LECTURES 1988-89 (Session 131)

The session started on 13 October 1988 with a lecture from **Dr. K. G. Cox** (University of Oxford) entitled "Rocks from the Upper Mantle".

While rocks from the Upper Mantle recovered from Kimberlite pipes are mainly peridotites, there is also a great variety of minor rock types such as eclogites. Studies of geochemistry, mineralogy, and texture reveal much about the geological history of the mantle, and enable us to speculate about the origins of basaltic magmas, the peculiar nature of mantle metamorphism, and the early differentiation of the Earth.

On 27 October, **Dr. D. G. Jenkins** (Open University) spoke on "Planktonic Foraminifera and the Deep Sea Drilling Project".

Our knowledge of the world wide distribution of Cenozoic planktonic foraminifera has been enhanced by the data from the Deep Sea Drilling Project. The lecturer drew on his experience of participating in Legs 9 (1969-70), 29 (1973) and 90 (1982-83) in the Pacific. Topics discussed included Archibald Geikie, David Samwell, extinctions, evolution and initiation of the Circum Antarctic Current.

On 10 November **Dr. R. E. Holdsworth** (Reading University) lectured the Society on "Basements, Thrusts and Basins in the Caledonian Orogen of North Scotland (or why the Highlands didn't sink!)".

The Upper Proterozoic metasediments of the North Highland Moine in Sutherland are disposed in a series of major Caledonian (c.470-430 ma) metamorphic thrust nappes, produced by north west directed foreshortening and reworking of parts of a pre-existing Precambrian (c.1,000 ma) orogen. Lewisian inliers occur throughout Sutherland and represent tectonically interleaved units of original basement gneisses upon which the Moine cover sequence was deposited.

In the westernmost Moine Nappe of the Kyle of Tongue region little deformation and basement cover interleaving occurred during the Precambrian event, but the associated metamorphism (to at least garnet grade) produced peak metamorphic mineral assemblages. Subsequent Caledonian reworking produced a foreland propagating system of north west directed ductile thrust and related major sheath folds, both of which

resulted in much of the observed Moine—Lewisian interleaving. Caledonian metamorphism decreases in grade progressively westward occurring at similar, or slightly lower, grades than the Precambrian event. The Caledonian folds and ductile thrusts are geometrically and kinematically similar to the structures recognised within the Moine Thrust zone to the west; the shallow ramp angles suggest that the thrusts must have very shallow dipping trajectories through the crust. A study of Caledonian fabrics demonstrates that the orogenic wedge was undergoing internal extension contemporaneously with shortening along the bounding ductile thrusts; this may indicate supercritical wedge motion.

In the final part of this presentation, the influence of the established early Caledonian structural framework upon phases of late Caledonian extension was examined. Onshore these include 'shallow' extensional collapse of the Moine Thrust wedge. Offshore still later extension, probably affecting the whole crust, led to the development of the Devonian West Orkney Basin. A possible explanation for the absence of this basin forming extension on land was given.

The one hundred and thirty first **Annual General Meeting** of the Society was held on 8 December. It was followed by the Presidential Address from Dr. Judith Lawson, on "Some Building Stones of the World". Her talk was illustrated with slides of examples from Egypt, India and Mexico. Her talk in turn was followed by the Annual Social.

On 12 January 1989, **Dr. Roger Anderton** (University of Strathclyde) addressed the Society on:

"Pans, faults and mineralization in the Canadian Rocky Mountains"

The Rocky Mountains of British Columbia are composed of late Precambrian to Carboniferous sediments deposited on the Canadian passive continental margin and caught up in the Columbian-Laramide orogeny of Jurassic to Cretaceous age. If the Gataga area, a remote region in the north of the state about 2,400 km from the nearest permanent habitation, 3000 km^2 of ground has been mapped in detail by a team which included the author and was led by Dr. Ken McClay of RHMBC, London. This mapping was part of a regional study of the sedimentary and tectonic evolution of the Rockies focused on the origin of stratiform mineralization which is found at localities in Devonian black shales.

The talk described the Precambrian to Devonian Sedimentary evolution of the Gataga area and its Subsequent orogenic history. During the Middle Devonian the area was dominated by a complex half-graben, the Kechika Trough, with the western margin marked by a normally-faulted terrace. Coarse sediments poured into this Trough from the uplifted continental margin to the west. These were deposited as a sheet of cobble gravel on the faulted terrace which passed eastwards into a series of lens-shaped, coarsening- and thickening upwards submarine fan bodies at the edge of the trough proper. Further east still, within the fine clastics along the trough axis a series of syngenetic Ba-Zn-Pb deposits, that were probably exhaled along the trough margin faults, were deposited. During the Columbian-Laramide orogeny, some of the syndepositonal faults were rotated and reactivated as thrusts. Adjacent thrust packets show very different stratigraphic sequences because they originated in different parts of the trough or on its margins.

The talk also described the techniques of mapping used in such terrains, which rely heavily on helicopter supported ridge traversing. The scenery, flora and fauna was also illustrated.

On 9th February 1989 **Dr. R. A. Spicer** (University of Oxford) spoke on "ARCTIC CLIMATE, VEGETATION & DINOSAURS OF THE LATE CRETACEOUS"

Late Cretaceous non-marine sediments of the Nanushuk and Colville Groups, northern Alaska, were laid down at paleolatitudes of between 75° and 85°N and contain abundant plant and animal remains. Detailed sampling along approximately 4OOkm of the Colville River has yielded large collection of well preserved leaves, wood, and pollen from swamp, lacustrine, overbank, fluvial, and marine facies. By taking sedimentological and taphonomic biases into account deltaic floodpan plant communities have been reconstructed for latest Albian to Maastrichtian times. Using leaf and vegetational data Cenomanian mean annual temperatures are interpreted to have been 10°C ±3°C. Mean annual temperatures were perhaps slightly higher in Coniacian times before falling to below 5°C by the end of the Cretaceous. The absence of broadleaved evergreens and minimal latewood suggest dark, probably cold, winters, although cell dimensions

and sedimentary data suggest deep freezing of the soil did not occur. These climatic data can be used to define the "snow line" at high latitudes and constrain models of global "greenhouse" climates.

Skin impressions and skeletal remains of both juvenile and adult hadrosaurs (>18m in length), together with tyranosaur and troodont teeth, occur in North Slope Maastrichtian sediments and the discovery of ceratopsian skeletal remains lower in the same unit are evidence of a diverse persistent dinosaurian fauna in polar environments. These finds, together with those of large-eyed chicken-sized dinosaurs from very high southern palaeolatitudes raise important questions of dinosaur physiology and ecology.

On 23 February 1989 there was another successful **Member's Night.**

Short, illustrated talks were presented under the following titles:-

Dr. Simon Cuthbert "Eclogites from Norway and the Alps: samples of subducted oceanic and continental crust".

Mr. K. Oakley "Krafla: a troll with fire in her belly"

Mr. N. Butcher "The Channel Tunnel"

Dr. J. Gordon Todd "The Cinderellas of Trearne"

Dr. Gordon Curry "Molecular Fossils"

Mr. Neil Clark "Bearsden: the End of the Story"

Dr. G. Durant "Diamonds"

Mrs. A. Roberts "Dunite Serpentinites from the Lizard Complex"

Neil Clark "Shrimps from the Namurian of Central Scotland"

Dr. J. Gordon Todd "Minerals from Trearne"

Dr. J. K. Ingham "Trilobite *Hemiarges* from Girvan"

Mrs. S. Pearce "Society Excursion Photographs"

We were also delighted that **Mr. Stan Wood**, on his way home from an exhibition at the SECC, called in to share the evening with us. He brought information which related to "Lizzie" and this was also displayed.

On 9th March 1989 **Professor Cordon Craig**, International Commission on the History of Geological Sciences, spoke on SCOTS ON THE ROCKS.

Scottish geologists seem to figure prominently in the development of the science of geology. The lecture sought to answer whether this apparent

pre-eminence is a consequence of the Scottish character, education, climate, a "here's tae us who's like us" syndrome or merely the rocks of the country.

On 20 April 1989 our guest speaker for the joint celebrity lecture was Professor Peter J. Wyllie (California Institute of Technology) will spoke on "The Origin of Kimberlites and Carbonatites"

Kimberlites and carbonatites are rare rocks providing insights to material and processes beneath continental cratons, and to processes of extreme chemical differentiation. Kimberlites bring mantle samples including diamonds to the surface. Carbonatites, igneous "limestones", may yield ore deposits for phosphates, niobium and rare earth elements. There has been debate about the genetic links between kimberlites and carbonatites. Selected field occurrences were illustrated. Selected results of experimental petrology relevant to the origin and nature of kimberlite and carbonatite magmas were outlined. A comprehensive model relating mantle metasomatism, kimberlite formation, rifting, formation of nephelinite magmas and carbonatites, suggests that there are genetic links between kimberlites and carbonatites, forged in the depth interval 200-75 km, but the divergency of the near-surface products is clear.

On 11 May 1989 **Professor Steven J. Gould** (Museum of Comparative Zoology, Harvard University) received the T. Neville George Medal, and addressed the society on: "Pathways and Predictability in the History of Life; the Burgess Shale and the Nature of History"

Professor Gould, a popular and controversial speaker, gave a characteristically thought provoking talk, in which he ranged from the relationship between Charles Darwin and Captain Fitzroy to the exquisite fossils from the Burgess Shales of British Columbia.

LECTURES 1989-90 (Session132)

The session kicked off, on 12 October 1989, with a reception in the Hunterian Museum to mark the inauguration of the new Department of Geology and Applied Geology at Glasgow University. The evening was very well attended, and a great success.

On 26 October, the first lecture of the session was given by **Dr. R. Gayer** on "The Variscan Foreland in South Wales". This was folowed on 9

November, when **Dr. C. Rice** (Aberdeen University) lectured on "Gold bearing Hot Springs in the Western Central United States of America and Scotland".

Hydrothermal systems associated with high level igneous activity have provided large quantities of gold (and silver) since the Gold Rush days. More recently it has been discovered that the surface manifestation of these systems, i.e. hot springs, may also contain considerable amounts of gold. Exploration targeted at fossil hot springs has identified some major deposits, especially in the western United States of America, whilst research on modern gold bearing hot springs, e. g. Yellowstone Park, U.S.A. and Rotowana, New Zealand, has been extremely valuable in identifying the key factors responsible for gold deposition. In this talk the essential features of gold bearing hot springs was outlined with reference to ancient and modern hot springs at Rhynie in Aberdeenshire, which remains the oldest yet discovered.

On 23 November, **Dr. H. E. Huppert** (University of Cambridge) spoke on "The Intrusion of Fluid Mechanics into Geology".

Fluid mechanics plays a large role in many geological problems. However, only recently have the fundamental concepts of fluid mechanics been introduced into geological models in a quantitative manner. The talk reviewed some of the recent attempts to understand several of the fluid aspects of vulcanology. A physical description of how a volcano works was followed by an evaluation of various fluid models, including ones for the solidification magma in magma chambers beneath volcanoes; the possible melting of the surrounding country rock as the magma passes through the crust during an eruption; and the different forms of flow of lava which occurred recently and in the distant past. The talk was illustrated by colour slides and some 16mm colour movie sequencies of both natural phenomena and laboratory experiments. There was an opportunity to see, and to try, two experiments, simulating the flow of lava down a slope and the consequence of the solidification of magma in a magma chamber.

December 14 saw the **Annual General Meeting** and Annual Social. This was followed on 25 January by the first meeting of the 1990's. It was addressed by **Dr. S. Brown**, on "Jurassic Stratigraphy, Facies Patterns and

Oil in the North Sea Basins".

The North Sea sedimentary basins are not only remarkable for their richness in oil and gas, but also for the diversity of their hydrocarbon traps and reservoirs. The Jurassic is the single most important stratigraphic interval in the central and northern North Sea from an economic viewpoint, providing many of the major reservoirs and the principal oil source rock. Furthermore, the tectonic movements during the Jurassic were crucial to the construction of many of the most important traps.

This presentation placed the Jurassic strata in their regional context and then concentrated on the nature of the reservoir rocks which range in origin from fluvial to submarine fan. Particular emphasis was placed on the mid Jurassic Brent Delta in the area to the east of Shetland, its nature and development, its palaeogeography, and its significance as a hydrocarbon reservoir.

A typically varied **Members' Night** was held on 8 February, during which the following talks were given:-

Morgan Sullivan - San Fransisco earthquake 1989;
Graham Durant - Giants, Gems and Jewels;
Stan Wood - 1990 Winter Collection;
Gordon Todd - Muirshiels—Moors, Mines and Minerals;
Norman Butcher - Moscow and Washington 1989; and
Peter Macdonald - Who Owns the Fossils?

Before and after the talks, the following exhibits could be viewed:-

Stan Wood - 1990 Winter Collection;
Allan Hall - Computers in Mineralogy;
Gordon Todd - Specimens from the Muirshiels Mines;
Craig Mains - Fossil Orientations in Trearne;
Tim Morrison - Odscotrox
Nancy McGregor - Minerals in Watercolour;
Julian Jocelyn - Agates and recent books on Agates;
Calum Macaulay - Powerwaters remain static during 35 Ma subsidence, Magnus Oilfield, North sea;
Rona McGill -East Kirkton - a hot spring environment?
John Cameron - Rock Art;
Neil D. L. Clarke - Recent acquisitions to the Hunterian Museum

collections — Minerals from Spain and Morocco;
Peter Chung - Hey-Ho Silver;
Joe Crummy - Scotland's potential for new Gold Deposits;
Mark Kennedy - Minerals from Aberdeenshire;
Clark Fenton - Neotectonics and palaeoseismicity in North west Scotland; and
Roz Quinn & Maggie Cussack - Molecular palaeontology.

On 22 February **Dr. C. Gillen** (University of Aberdeen) lectured on "Geological Evolution of the Precambrian Rhodope Massif, Greece and Bulgaria".

The Rhodope Massif is an ancient block of continental crust located in the centre of the Balkan peninsula and is one of a number of massifs within the southern chain of the Alpine fold belt. Its true age is not known for certain, but much evidence points to its being Precambrian, possibly Archaean. Successive orogenic events, including Caledonian, Hercynian and Alpine, each with considerable igneous activity, have combined to create a picture of great complexity.

The Rhodope massif lies between the younger Balkanide and Hellenide orogenic belts. It is bounded to the west by a fault which separates it from the Serbo-Macedonian massif. These older metamorphic massifs are grouped together with the younger Vardar, Pelagonian and sub-Pelagonian zones and are collectively termed the 'internal' tectonic zones of Greece and Yugoslavia. This distinguishes them from the 'external' zones that occupy Greece and Albania west of the sub-Pelagonian zone. The external zones consist of younger structural units, separated by major thrusts, which have been welded on to the ancient crystalline massifs during the Alpine orogeny. The internal zones contain fragments of the so called Tethyan ophiolites, some of which have considerable exploration potential for copper, lead, zinc, etc.

Lithologically, the Rhodope massif consists of a basement gneiss and migmatite complex (Archaean?) which is unconformably overlain by metasediments with amphibolites and serpentinites of Proterozoic age. Above is a group of very low grade metamorphic rocks belonging to the lowermost Cambrian. The Rhodope massif is surrounded to the south by

the Circum-Rhodope belt of Permian to Cretaceous greenshists. Finally, the metamorphic basement is unconformably overlain by a thick sequence of Tertiary sediments and basalts situated in fault bounded basins.

8 March saw a talk by **Dr. P. Selden** (Manchester University) entitled "Chelicerates: Butchers and weavers in the Fossil Record".

After the insects, Chelicerates are the most numerous and diverse animals on land today. They include the scorpions, mites, harvestmen and spiders. In the middle Palaeozoic, they ruled the seas, in the form of the extinct Eurypterids: up to two metres in length, remains of these ferocious predators can be found in rocks of Lesmahagow and the Hagshaw Hills. Exquisitely preserved scorpions, too, occur in the Carboniferous strata near Edinburgh. The more familiar spiders are exceptionally rare as fossils, but the earliest weavers of orb webs have been discovered in Cretaceous rocks of Spain, and even the minute silk spinning spigots of one species from the Devonian of New York are now knows. This is the oldest known spider and the earliest evidence of the use of silk.

On 15 March **Professor J. Horner** (University of Montana) spoke to the Edinburgh and Glasgow Societies in Edinburgh on "Social Behaviour in Dinosaurs", when he gave a fascinating account of the recent discoveries of herding and parental care in the Dinosaurs.

SECRETARIES' REPORT (Session 131)

Session 131 was another exciting and successful year. Membership numbers rose steadily, and the average attendance at the lectures was just over 100, with a marvellous total of 300 attending the T.N. George Medal lecture given by Prof. S.J. Gould in May.

Council met on 9 occasions, and, as well as dealing with the ordinary business of the Society, made plans for the Reception held at the start of Session 132 to commemorate the inauguration of the new Department of Geology and Applied Geology. Council also considered ideas for involvement in the 1990 City of Culture Year.

Jane MacDougall & Nora Liberi.

SECRETARY'S REPORT (Session 132)

Session 132 was a busy one as can be seen from the report of the Meeting's Secretary. Council met on six occasions. During the year a

computer was purchased by the Society for use in production of the new edition of the Glasgow Guide, and for the publication of future editions of the Society's Proceedings, etc. The plans and editing work for the Glasgow Guide are well underway, but rather thwarted by he slow submission of excursion details by some of the contributors.

During session 132 the Constitution of the Society was updated and approved by the members. Our grateful thanks go to Peter Macdonald for his work on this.

It was decided to award a £20 Book Token Prize to the pupil (under 21) with the highest marks in the 'H' Grade Geology paper. Details for this are under discussion with the Scottish Examination department at the moment. The Society also contributed to the purchase, by the National Museum of Scotland, of Lizzie—the earliest reptile known, found by Stan Wood at East Kirkton Quarry. Lastly, we were delighted to make Miss Fotheringham an honorary life member of the Society this session.

Jane MacDougall

EXCURSION SECRETARY'S REPORT (Session 130)

During the 1988 session 2 weekend, 1 morning and 6 day excursions were arranged as listed:-

9 April The Glasgow Garden Festival 43 attended

23 April Mapping at Limecraigs 14 attended Drs. Peter Thomas and Judith Lawson

7 May Oil Shales of the Lothians 14 attended Mr. J. Kenneth Oakley

21-23 May Isle of Eigg 21 attended Dr. Judith Lawson

4 June Balmaha and the Highland Boundary Fault 18 attended Dr. Brian Bluck

18 June Tyndrum Vein Mineralisation 24 attended Dr. A. Hall

27 August The Western Ochils 21 attended Dr. Jim MacDonald

3 September The Stirling Area 16 attended Mr. J. Laxton and Mr. J. Merritt

9-12 September Aberdeen and Stonehaven 17 attended Dr. Con Gillen

I think all who attended field trips this summer would agree that the programme was interesting, instructive and very enjoyable. We visited many fascinating sites and managed to have good weather most of the time.

The Stirling excursion was the joint excursion with the Edinburgh

Society, and I would like to thank them for making all the arrangements for a most interesting day. The joint excursion is now one of the highlights of the summer season, and provides a good opportunity to meet members of the Edinburgh Society.

EXCURSION SECRETARY'S REPORT (Session131)

During the 1989 session, 2 weekend, 2 evening and 5 day excursions were arranged as listed below.

6th May Volcanic Rocks of GIencoe 60 attended Dr. G. Durant and Dr. D. McGarvie
2Oth-22nd May Yorkshire Dales 15 attended Dr. P. Thomas
25th May Milngavie and Mugdock 19 attended Dr. J. A. Lawson
l0th June Tourist Geology around the Forth 14 attended Mr. M. Browne
20th June Trearne Quarry 30 attended Dr. C. Burton
5th August Valley of the Teith 19 attended Dr. C. Gribble
26th August Yellowcraig and Cheese Bay 24 attended Dr. E. Clarkson
9th Sept The Oil Shales of the Lothians 8 attended Mr. K. Oakley
15th-18th Sept Assynt 20 attended Dr. I. Allison

This year we had once again a very interesting and instructive set of field trips. We owe a tremendous debt of gratitude to all the leaders who made this possible by giving up their free time to take us to such a wide range of interesting localities.

We are still running our bus trips at a considerable loss due to members cancelling at the last minute or not turning up on the day. For the Yellowcraigs excursion 39 people booked and later a billet was sent out asking for prompt cancellations. As none were forthcoming a larger than usual bus was booked at an additional cost of £25. A few days before the outing 12 cancelled and on the actual day a further 3 did not turn up, so we were left with 24 people on a 39 seater bus. There were 10 last minute cancellations for the Teith Valley. We do not have this problem with the weekend excursions where a deposit is charged.

The change of meeting place to the Boyd Orr Car Park seemed like a good idea until the Excursion Secretary's car was stolen from there on the very first excursion! Suggestions for a suitable meeting place for 1990 will be gratefully received.

Rosemary McCusker

PUBLICATIONS SALES REPORT (Session129)

I took over publications and sales from Chris Burton on 30 January this year and I wish to thank him for his help and continued support while I tried to master my new duties. Thanks are also due to Dorothea Blake and Nora Liberi for risking life and limb in the basement cupboard to count the stock and to all those people who have helped me during the past months.

Since I took over 312 copies of the Skye Guide have been sold leaving a stock of 2529. 230 Arran Guides were sold leaving 1815 and 73 Glasgow Guides were sold leaving 240.

The popularity of Dr. Gribble's excursion to Ardnamurchan in August led to the sale of 21 of his guides.

We now have a stock of 'The Story of Fossil Grove' and they sold well along with 'Building Stones' at the joint meeting with the Edinburgh Geological Society in September.

This year has seen the publication by Scottish Academic Press of the Lothian and Aberdeen Guides and a Guide to the Moine is expected early in 1988.

We also have 'Gemstones' in the British Museum series, beautifully illustrated at £4.95 and a special offer pack of some of the old favourites at £4.99.

The publications sales account appears within the main accounts and members will be pleased to note that publications and sales generated a useful profit of £1,473.68 for the Society.

Alison Roberts

PUBLICATIONS SALES REPORT (Session130)

Publications and sales have made a surplus this year of £1,588.03, a useful addition to the income of the Society.

Sales this year follow the usual pattern. British Museum publications, local and Glasgow guides were sold to undergraduate and adult students at the beginning of the academic year.

In spring and summer excursion guides were in demand, not only by members of the Society, but by many other individuals both amateur and professional from home and abroad. Retailers include the British Museum of Natural History, the British Geological Survey, and booksellers

countrywide. Skye guides are sold in Skye and Arran guides in Arran.

In August John Smith and Son and the Hunterian Museum were suddenly sold out of Glasgow Guides, perhaps as a result of interest in the area brought about by the Glasgow Garden Festival.

The Moine guide arrived in September and is proving popular, 80 having been sold to date.

I am pleased to be able to report another successful year.

Alison Roberts

PUBLICATIONS SALES REPORT (Session131)

Publications and Sales have once again made a useful contribution to the income of the Society. 500 copies of the Moine Guide were purchased in September 1988 and 218 were sold during the year leaving a stock of 282. 290 Skye Guides were sold and the stock is now 1931. 380 Arran Guides were sold, which is more than 100 up on the previous year, and the stock of these stands at 1260.

Sales of other excursion guides and British Museum publications followed the usual pattern.

I am pleased to be able to report another successful year.

Alison Roberts

PUBLICATIONS SALES REPORT (Session132)

The number of books sold during the year, with residual stock figures in brackets, are as follows:-

Geology of the Isle of Skye	196	(1735)
Geology of Arran	154	(1106)
Building Stones	14	(566)
History of GGS	6	(55)
Guide to the Moine	55	(227)

There have been a number of orders for the Glasgow Guide which is still out of print. I look forward to the launch of the new enlarged edition in the not too distant future.

The inexpensive British Museum books, so beloved of students and Society members, are being phased out. They will probably be replaced by more specialised and considerably more expensive volumes.

My thanks to all those who helped to sell books at the Reception last October and at meetings throughout the year.

Alison Roberts

MEMBERSHP REPORT

Session	**129**	**130**	**131**	**132**
Honorary Life Members	5	4	5	4
Life Members	1	1	1	1
Ordinary Members	425	456	431	474
Associate Members	43	43	48	53
Junior Members	15	11	18	31
Total Members	**489**	**521**	**503**	**563**
New Members	43	49		62
Deletions	32	3		20

LIBRARY REPORT (Session 129)

The library continues to grow, this session's additions being numerically the largest in recent years, with 16 books entering the stock. As always field guides form a dominant part of the incomers and this year include an illustrated and extensive geology of the wine-producing areas of France (with much attention paid to the wine side), the new guide to Aberdeenshire, guides to the Glamorgan and Sussex coasts and to the volcanoes of the Auvergne. A notable addition is a beautifully illustrated series on gemstones, including Amber, Garnet, Quartz and Jet. Volumes on the evolution of mammals, plate tectonics and a general geological history of the earth complete the acquisitions.

Library services have continued to include both general and specific reading on all aspects of geology, including the provision of information packs of field guides, maps, etc. for specific localities required by individual members. Members planning holidays in Britain or elsewhere

should note that the librarian is able to draw on considerable resources, both from our own library and departmental stocks and knowledge, to provide itineraries, points of interest or maps for the geological traveller. Members are further encouraged to consult the librarian for suggestions on reading in any field of geological interest.

Projects undertaken this session include the production of a detailed catalogue of all the field guides, Geological Survey Memoirs, sheet explanations and other detailed sources on fieldwork. The catalogue will be completed shortly.

This session 33 borrowers (24 last session) took out 222 items (177 last session), including a number of geological maps. The latter are available, for loan to members, from the department's considerable collection - ask the librarian for details.

C.J. Burton

LIBRARY REPORT (Session 130)

The library continues to grow, this session's additions being numerically the largest in recent years, with 17 books entering the stock. As always, field guides form a dominant part of the incomers, and this year includes such exotic destinations as the West Indies and the Champagne region of France.

Library services have continued to include both general and specific reading on all aspects of geology, including the provision of information packs of field guides, maps, etc. for specific locations required by individual members. Our capacity to provide a guide for any particular holiday destination rises yearly.

This session 42 borrowers (33 last session) took out 193 items (222 last session), including a number of geological maps.

C.J. Burton

LIBRARY REPORT (Session 131)

My normal introduction is that our library continues to grow, as indeed it does, but this last session has been complicated by the fact that the amalgamation of departments has had a decided impact on library stocks. So much material has arrived, in addition to new works on Applied Geology, that the stock that members are accustomed to using has had to

be radically reorganized. Older books are being removed from the shelves and newer books, additional journal runs, reprints, etc. are being put in their places. In the meantime the end of the session has seen mounds of book boxes in the library annexe which have yet to be cleared. The task in the present session will be to tackle this ongoing job and fully reorganize the library.

Over the session regular purchases have continued with books on offshore oil and gas (from the Natural History Museum series), volcanoes, ecology, geological maps, meteorites and ore microscopy as well as the more usual geological guides.

This session we were able to provide members with geological guides to a variety of destinations both within Britain and abroad, and stand ready to do so again. Regular borrowers this session numbered 37 (42 last session), who took out 193 items (222 last session).

C.J. Burton

SCOTTISH JOURNAL OF GEOLOGY EDITORS' REPORT (Session 129)

Volume 22 (1986) was published in three parts totalling 432 pages. The volume included 28 papers, 5 short communications, one letter and a conference report. The lead time from acceptance date to the publication of a paper varied from 7 to 16 months with an average of 10 months. This was partly caused by delays in publication of the Special Issue which constituted part 4 of volume 21. There has been a considerable improvement, however, in lead times for papers in the two parts of volume 23 published to date.

From January this year, the Society has had two new editors, Drs. Ashcroft (Aberdeen) and Thomas (Paisley), following the retiral from the editorial board of Drs. Hall and Allison after several years of dedicated service.

A. W. OWEN

SCOTTISH JOURNAL OF GEOLOGY EDITORS' REPORT (Session 130)

Volume 23 (1987) was published in three parts, totalling 329 pages. The volume comprised 20 papers, 4 short communications and 2 letters.

SCOTTISH JOURNAL OF GEOLOGY EDITORS' REPORT (Session 131)

Volume 24 (1989) was published in 3 parts, totalling 312 pages, the volume including 21 papers, 8 short communications and 3 letters. The time from the acceptance of a paper to its publication varied from 5 to 12 months with an average of 7-8 months - an improvement of a month on volume 23.

Volume 25 is the Silver Jubilee Volume and to mark the anniversary each part has a coloured cover, the various colour pictures, of commercial geological activities, each being sponsored by a particular industrial concern. Volume 25 part 3 will incorporate a cumulative index to volumes 1-25.

With volume 26 will come a change in format to A4 double column layout, with 2 parts per year, which will contain at least the same number of papers (if not more) as at present.

The institutional subscription to the journal which has been held at £50 for the last 5 years will rise to £60 for 1990 and beyond.

Dr. Alan Owen's term on the board finished at the end of last session and we would like to thank him for all the excellent work he has done on behalf of the Society.

P.R. Thomas, C.R. Braithwaite, C.J. Burton

SCOTTISH JOURNAL OF GEOLOGY EDITORS' REPORT (Session 132)

During the year (1990) the publication of the Jubilee Volume of the Journal was completed, the last issue in the old format. The covers on volume 25 made a good impression and enhanced the presentation of the journal but unfortunately would have cost far too much to maintain independently, and it was clear that the generous sponsorship which had made them possible was difficult to sustain.

The first issue in the new format, 26/1 has appeared and 26/2 is nearing completion and should be ready for publication shortly. In general the new format has been well received, diagrams and figures are much improved and the added space gives authors greater flexibility. The text is easier to read and the layout is generally liked. On the other hand, 26/1 contained

6 papers, 2 short communications and an editorial and still looked a little thin because of the increased page size. This, and what seems to be a comparatively poor performance in the postal system, has provoked adverse comments.

Having gone through a leaner period we now have a number of interesting papers in hand for 27/1 but there is still a need to encourage more people to submit their work to the Scottish Journal and to attract more prestigious reviews on matters of Scottish interest.

THOMAS NEVILLE GEORGE MEDAL

During the period covered by this volume, the following citations were delivered at the presentation of awards:-

WALTER MYKURA

Madame President, Dr. Mykura, Ladies and Gentlemen:

It is a great pleasure to present the citation to accompany the sixth award of the Thomas Neville George Medal to Dr. Walter Mykura for his distinguished contribution to the Devonian and Carboniferous evolution of Scotland.

Dr. Mykura, you were born in Czechoslovakia and your early schooling was there until, at the age of 13 years, you came to Britain to escape oppression. Your interest in geology was aroused while you were still at school in Birmingham where an enthusiastic geography teacher (who had himself been fired by Professor Wills) took you on field excursions to Llangollen and Derbyshire in both of which places, Carboniferous limestone, Carboniferous fossils and limestone-dominated landscape panoramas attracted you to geological mapping and investigation. The second World War interrupted your study of the ground by catapulting you into the Royal Air Force and it was not until the end of the war that you could resume terra firma studies at Birmingham University. Here you read Geology under first Professor Wills and then his successor, Professor Shotton; both stratigraphical men to their inmost layers. Harry Whittington also greatly influenced you during your studies in Birmingham. Your B.Sc. work included a perceptive and meticulous study of the faunal divisions of the Ludlow rocks of the Abberley Hills, north of the Malverns, displaying an early flair that was subsequently to be so characteristic of your work.

In 1950 you joined the Geological Survey in Scotland where you were to spend the whole of your professional life. Your first major work was mapping the Silurian and Old Red Sandstone lavas in the Pentland Hills, as well as the Carboniferous of the Midlothian coalfield.

From 1953 to 1960 you worked on "this side" in West Ayrshire in the active coalfield, in close association with the National Coal Board. You established yourself as an outstanding mapper, stratigrapher and keen observer with a series of papers including an important description in 1960 of the replacement of coal by "limestone" in areas of reddened Coal Measures and also by a recording of plants in the Mauchline lavas. A comprehensive account of the west Ayrshire coalfield followed. During this time the legendary G.H. Mitchell, District Geologist, was a significant influence on your Carboniferous work. You acquired a reputation for enthusiastic field work and high productivity

Your subsequent scene of operations moved northeastwards to Shetland; an area the Survey had tackled in the late 20's and 30's but never completed. You remapped West Shetland with its Old Red Sandstone sediments and lavas, several granite-diorite complexes and various metamorphic rocks and produced the West Shetland Sheet Memoir which was published in 1976. After this you moved on to tackle Central Shetland and Fair Island and then you became familiar with the remaining parts of the Shetland and the whole of the Orkney Old Red Sandstone together with its igneous intrusions. All this culminated in the magnificent Regional Geology Handbook of Orkney and Shetland, a task in which Frank May and Derek Flinn were of great assistance but it was you who recognised that three different Old Red Sandstone successions had been brought together by two major faults in Shetland.

By now you were recognised as a leading authority on the geology of the Old Red Sandstone of the Orcadian basin with election to the Royal Society of Edinburgh in 1970 as an accolade for your contributions. You became involved in the Caithness ORS and then in the ORS of the whole of the Northern Highlands which culminated in your contribution to the Regional Guide to the Northern Highlands. You also worked on the Loch Ness ORS, which is highly deformed, and unravelled the details of two

different successions, Lower and Middle ORS,

In 1976-78 you were honoured by being President of the Edinburgh Geological Society. In 1979 you received a Special Merit promotion to the Senior Principal Scientific Officer. Your scholarly writings have earned you a D.Sc degree from your mater alma, Birmingham University.

Dr. Mykura, your infectious love of field geology, your enthusiasm, your careful observation and documentation of the Carboniferous and Devonian rocks of Scotland; your persistence and industry in writing up the results for publication have justly earned you a reputation as an outstanding Upper Palaeozoic stratigrapher and geologist a field very close to that of Professor George himself. The Glasgow Geological Society and the Department of Geology are therefore pleased to award you the Thomas Neville George Medal for 1987.

PETER ZIEGLER

Mr. President, Dr. Ziegler, Ladies and Gentlemen:-

It gives me great pleasure to present the citation to accompany the award of the eighth Thomas Neville George Medal to Dr. Peter Ziegler for his distinguished contributions to regional syntheses of structural and stratigraphical geology.

Dr. Ziegler: you are the second of three geological brothers in a Swiss family which had a long scientific tradition. You became interested in geology during holidays in the Jura Mountains with a neighbour's son, John Haller, who subsequently went on to unravel the geology of a great tract of East Greenland. You studied geology at the University of Zurich under the distinguished trio of Professors Niggli, Staub and Trumpy with a Ph.D. thesis on the comparative stratigraphy of the Upper Jurassic carbonates in the Central Swiss Jura Mountains.

Your first post with Isramco in 1955 involved fieldwork in the Dead Sea area of Israel, was followed by work for the Petroleum Company of Madagascar in the Morondava basin and then fieldwork in Algeria for the Petroleum Exploration Co. after which in 1958, you joined Shell Canada Ltd. For twelve years you worked in the Canadian Cordillera, the Mackenzie Mountains, the Alberta Plains and the Pacific offshore in a wide variety of environments involving some of the most exciting geology in North

America. During this phase major oil and gas discoveries were made. You came to the forefront of international recognition with the publication in 1969 of the atlas and text of "The development of Sedimentary Basins in western and Arctic Canada" published by the Alberta Society for Petroleum Geology. In this skillful and perceptive blend of seismic, drill-hole and surface geology you established yourself as a synthesiser of great merit who could see the wood for the voluminous data-base.

This was recognised by Shell in 1970 when they transferred you to the Hague where you remained until your recent formal retirement which has enabled you to concentrate on work closest to your heart. Your responsibilities within Shell progressively enlarged from Regional Geologist for Northern Europe and Acting Exploration Manager for Norske Shell (1970 -77), Exploration consultant with special responsibility for Europe, South America, and seismic stratigraphy and exploration in folded belts (1978-82) to senior exploration consultant and team leader in global geology. A whole series of papers, drawing on and synthesising the vast Shell database, has emerged since 1975, the best known being the prestigious "Geological Atlas of Western Central Europe" with its 40 plates depicting the geological development of this region since Palaeozoic times. Here is a masterpiece of perspicacious synthesis blended together by a master-craftsman of imaginative genius but constrained by an enormous compendium of published and unpublished factual information The individual nature of your contributions - albeit, as we know, drawing on information largely obtained by your colleagues - is emphasized by the fact that of over 30 publications since 1975, largely dealing with European geology, nearly all of them have been single-authored and written in your own time albeit with the generous support of the Shell International Petroleum Company. More lately you have drawn on your encyclopedic knowledge of Canadian geology to complete the Evolution of the Arctic - North Atlantic and the Western Tethys in American Association of Petroleum Geologists Memoir 43 (1987). Currently you are revising and extending your geological atlas of western and central Europe with a view to publication by Shell.

In addition to your published works, your professional evaluations for Shell and your successful hydrocarbon discoveries which have benefited

mankind you have also distinguished yourself as a public lecturer of great merit on the international lecture circuit - for instance in 1986 alone you spoke at nearly 30 Universities and Societies.

These contributions have been recognised not only by your high office in Shell but by the Geological Societies of Belgium and the Netherlands, each of which has awarded you their principal medal, and by the Geological Society of London when, in 1988, I was privileged to present you with the William Smith Medal for your distinguished contributions to applied geology.

The present medal was jointly subscribed to by members of the Department and the Glasgow Geological Society in order to commemorate Professor Neville George. His interests in stratigraphy, and in regional syntheses of palaeogeography are well represented among your distinguished studies. I now have great pleasure in asking the President of the Glasgow Geological Society, Dr. Keen, to present the 1989 Thomas Neville George Medal to you.

OBITUARIES

ARCHIBALD GORDON MACGREGOR

Archibald Gordon MacGregor was born in Halifax, Nova Scotia in 1894. While he was quite young his father took up a post in Edinburgh University. Our capital city was his home for the rest of his long life. In it he got his schooling, college education (B.Sc.) and his appointment to the Geological Survey. His army service during the 1914-18 war, which interrupted his degree studies, earned him the Military Cross and Croix de Guerre (Belge). He joined the Survey in 1921 and progressed steadily to reach the rank of Assistant Director in 1952, a post he held until he retired in 1959. His alma mater conferred the degree of D.Sc. on him in 1938. He was a Life Member of our Society from 1927.

His main geological interests were volcanological and petrological. His contributions to our knowledge of the types of igneous rock which occur in the Ayr and Renfrew Districts of Strathclyde Region are of great interest and importance. The North Ayrshire memoir, published in 1939, especially, contains a wealth of petrographic detail relating to lavas and

intrusions ranging in age from Devonian to Tertiary. When in 1949 the Central Ayrshire Memoir (Sheet 14) appeared, the Director's Preface stated that "petrographic detail has been deliberately eliminated," no reason being given. It seems more than likely that Dr. MacGregor would willingly have finished the task started in the North Ayrshire Memoir.

When in 1936 the first edition of British Regional Geology; "The Midland Valley of Scotland" appeared, written by Murray Macgregor and A.G.M. the latter inserted a surpassing amount of petrographic information, some of this relating to areas in which no more detailed work has been done. His authoritative paper on "The Classification of Scottish Carboniferous Olivine-basalts and Mugearite" was published in the Transactions of the Society (vol.18, pp 324-360, in 1928.)

Further information regarding Dr. MacGregor's professional life and scientific achievements can be got from obituaries already published, such as those of the Royal Society of Edinburgh (Year Book 1987, pp59-60) and the Geological Society (Annual Report 1986, pp29-30).

He died at home in Edinburgh on 19 December 1986. He is survived by Mrs. MacGregor and one of two daughters.

JAMES PHEMISTER

James was born in Glasgow on April 3,1893 and educated there. He graduated at Glasgow University with the degrees of M.A. and B.Sc., both with distinction. He had two brothers, one of them Thomas C. being latterly Professor of Geology and Mineralogy in the University of Aberdeen. Service in the armed forces during the 1914-1918 war ended in 1917 after he was severely wounded.

He joined the Geological Survey in 1921, and was engaged in mapping in the Northern Highlands. He became particularly interested in the Loch Ailsh igneous complex, which he described in great detail in the memoir on "The Geology of Strath Oykell and Lower Loch Shin" (1926). This interest naturally spread to include the adjacent Loch Borrolan complex. For a thesis entitled "A petrological study of the composite alkaline intrusions of north-west Sutherlandshire" he received the degree of D.Sc. from Glasgow University in 1928. He was author of all three editions of the British Regional Geology on the Northern Highlands, the first edition

of which is dated 1936. In the following year he and his great friend Dr. Murray Macgregor were joint authors of the highly successful "Geological Excursion Guide to the Assynt District of Sutherlandshire", published by the Edinburgh Geological Society. His first contribution to the Transactions of our Society was a paper "Note on a fused spent shale from a retort at Pumpherston, Midlothian," (vol.20 (2),1942) . He was one of the six eminent geologists invited to contribute to the Society's Centenary Volume of the Transactions (vol.23) .His choice of topic was "Summary of Recent Research on the Pre-Tertiary Geology of the Northern Highlands".

James moved to London in 1935 having been appointed Petrographer to the Survey. During the next 18 years he was engaged in a wide spectrum of duties, including that of Curator. In 1946 he was promoted to Assistant Director. In 1953 he relinquished this post at his own request and returned to Edinburgh in order to work on the Shetland maps and memoirs. This involved a massive amount of microscope work. The writer well remembers his slight figure occupying a corner of the "Rock Room" in the Grange Terrace office, with his Swift microscope surrounded by boxes of thin sections and sheaves of "Petrographical Notes" forms. A cup of tea, if not something stronger, was always offered. His Shetland work culminated in the production of the quarter inch geological map of the Shetland group, the one-inch map of North Shetland and, with Dr. W. Mykura, the Western Shetland memoir (1976).

Dr. Phemister was president of the Mineralogical Society of Great Britain 1951-54, editor of the Mineralogical Abstracts 1953-60, and president of this society 1961-64. He was an honorary Fellow and an Honorary Life Member of the Edinburgh and Glasgow Societies respectively. From the former he received the Clough Medal for 1971-72. A fellow of the Geological Society, he was awarded their Murchison Medal in 1948. He was a long-standing Fellow of the Royal Society of Edinburgh, elected in 1931. The Mineralogical Society of America elected him to Life Membership in 1959.

For further information regarding Dr. Phemister's professional and Scientific work, the reader is referred to the obituary notice published by the Geological Society (Annual Report 1986, pp.31-32), or to that of the Royal Society of Edinburgh (Year Book 1987, pp63-66).

James is remembered with affection and gratitude by those surviving members who were fortunate enough to attend the long excursions led by him: to Assynt in 1958 (the Society's Centenary Year); to Shetland in 1960 (when the writer was instructed to hand-pick a party of 15 enthusiasts!); to Northern Ireland in 1963 and the return visit by members of the Belfast Geological Society. His leadership was impeccable.

He died in Edinburgh on May 18, 1986, aged 93, survived by a daughter and two sons. Mrs. Phemister died in 1982.

A.H.

NORMAN HOLGATE AND MAMIE HOLGATE

A Lancashire lad born and bred, Norman Holgate naturally received his academic education at Manchester University where he graduated B.Sc (1937), M.Sc. (1938) and Ph.D. (1941). The war years saw him employed by H. M. Government at the radar research establishment at Great Malvern. Later he joined the staff of the Geology Department of Glasgow University under Professor T. Neville George and was to remain there until he retired in 1979. A spin-off was his marriage to the professor's secretary, Mamie Allison. This was a most successful match, the ebullient Mamie being the perfect foil to the very sober Norman. It ended with Mamie's premature death in August 1986.

Norman's academic duties in the lecture theatre and labs related mainly to mineralogy and petrography. He did the select field of amateur petrographic microscopist in the country, a service the value of which he probably never realised by drawing to the writer's attention the practicability of supporting their microscopic observations with refractive index determinations. His publications dealt with diverse topics including the basic Precambrian igneous rocks of Hanter and Stammer near Old Radnor, Powis (with K. A. Knight-Hallowes), the Caledonian granite-diorite complexes of Portencorkie and Glen Banvie, and the evidence for transcurrent movements on the line of the Great Glen Fault; shown by the lack of alignment of dyke swarms of late Carboniferous and Tertiary ages and of topographic features of more recent age. In 1954 he ventured on to geologically dangerous ground with a paper dealing with liquid immiscibility in igneous petrogenesis. This was eventually published in the United

States of America (J. Geol. v. 62). His last publication described the severe pyrometamorphism of the local Dalradian by a tholeite dyke on the west coast of Arran (Miner. Mag. v. 42, 1978).

On more than one occasion Mamie and Norman served on the Council of the Society, mainly in secretarial capacities. For this and service to geology, Norman was elected an Honorary Life Member of the Society. After he retired he pursued his life long interest in plants, indoor and out, in photography and in railway rolling stock, both full sized and model. He died after a period of failing health on 27 August 1990.

A.H.

EXCURSIONS

The following report of excursions have been received by the editor:-

SESSION 129 (1987)

CORRIEBURN:- 12 May 1987 (Leader Dr. G. E. Bowes)

This area is situated on the south side of the Campsie fault which separates the Clyde Plateau Lavas from a mostly sedimentary succession of Carboniferous age. In a west to east section through an easterly dipping succession, one can trace in succession volcanic detritus which rests on top of the Clyde Plateau Lavas followed by representatives of the Upper Sedimentary Group (Calciferous Sandstone Series), the Lower Limestone Group, the Limestone Coal Group and the Upper Limestone Group.

Important fossil bearing horizons occur within and below the Hurlet Limestone and at several other horizons further up the succession.

A wide variety of sedimentary sub-facies associated with deltaic sediments can be studied in the area.

GARABAL HILL - GLEN FYNE:- 16 May 1987 (Leader. Dr. J. G. MacDonald)

This 'Late Caledonian' igneous intrusive complex, the subject of a major piece of work by S. R. Nockolds, published in the Q.J.G.S. in 1941, illustrates particularly well the range of rock types associated with this type of activity. Lithologies varying from peridotits through pyroxene-mica-diorite to granodiorite were examined.

ARRAN:- 29th May - 1st June 1987 (Leader Alec Herriot) *by Mrs. E. Henderson*

Fourteen society members and friends, including an inner circle of committed

slidemakers, spent a relaxed weekend on Arran under the experienced leadership of Alec Herriot. The party, based in Brodick, spent the first morning on the Corrie-Sannox shore, where contrasting sandstones were examined at the Permo-Carboniferous boundary, and a varied Carboniferous sequence was followed to its junction with the Upper Old Red Sandstone. Fossils proved elusive, but igneous enthusiasts were rewarded with samples from lavas and dykes. The group proceeded after lunch to North Glen Sannox, where they located a contact with the Northern granite and observed in the North Sannox Water a sequence ranging from Dalradian grits to Ordovician spilites and black shales. The inarticulate brachiopods of Arenig age remained obstinately "silent"!

Spirits were not dampened by a rainy start to day two, when Alec Herriot really came into his own, and the company revelled in the complexities of South Arran's Tertiary sills and dykes, noting in passing a transition from New Red Sandstones to ripple-marked Triassic marls. Areas covered were Kingscross/Whiting' Bay and Largybeg/Bennan, tides being sadly unsuitable for a study of the dyke-swarms at Kildonan.

Day three was consecrated in part to the Tormore shore North of Blackwaterfoot, where in beautiful sunshine and against a backdrop of dune-bedded sandstones, the party were introduced to Gunn' dykes - a series of minor intrusives of pitchstone/felsite and pitchstone/tholeite. Lunch at Blackwaterfoot gave a chance to study the nearby felsite sill, and the day was rounded off with a visit to the Central Ring Complex, collection of diorite at Glenloig, and a successful climb in search of foundered blocks of Cretaceous chalk and an associated garnet-bearing skarn.

A bonus during evenings at the Glenartney Hotel was the provision of a microscope for the study of typical Arran rocks in thin section. Sinclair Ross' helpful explanations were much appreciated.

BALLAGAN GLEN 10 June 1987 (Leader Dr. Graham Durant) *by Mike Vickers*

The evening did not look promising, with heavy rain most of the afternoon, but by the time we assembled and got to the glen it was dry and the sun had come through.

After a good scramble around 10 of us led by Graham Durant came into the glen; a spectacular ravine where the river had cut down through the Campsie lavas deep into the softer sediments below. These were mainly sandstones containing interesting ripple structures with brilliant orange

gypsum filling tension gashes caused by "contemporaneous" extensional faulting. From the amount of fallen rock in the river bed and the steepness of the ravine to the west it was clear that the river is still cutting.

There was also a dyke which had been cut by the faults and we attempted to age it relative to the faults; interesting!

We climbed further through mud and branches and got right below the spout of the falls and the sandstones became massive beds, some of which had subsequently shifted. The experts held the view that the origin of the sands could be deltaic (crevasse splay) prograding into a lake. We then finished the climb by getting above the falls on to the lavas and had a wonderful view over Strathblane to Glasgow and beyond.

In the fading light as we came down (an easier way) we were able to look across the glen and pick out the principal Campsie fault and a number- of subsidiary ones and could identify bending of the sediments at the fault boundaries.

We thank Graham for spending the time to take yet another party, the third in two weeks, up the glen.

PENTLAND HILLS:- 13 June 1987 (Leader Dr. E. N. K. Clarkson)

The Silurian succession in the Pentland Hills exhibits a regressive sequence beginning with turbidites, presumably deposited in deep water passing up through highly fossiliferous beds with trilobites, brachiopods and many other fossils, then passing into a lagoonal sequence dominated by bivalves, ostracods and gastropods, and finally into Red Beds of continental origin. The sequence is over 3,000 meters thick and due to late Silurian folding is now vertical, the succession younging towards the north west. The Silurian Inlier, 7 km long and 2 kn broad, is best approached from Carlops, which is situated on the Pentland Fault. The Lower Old Red Sandstone conglomerates and marls which are intruded by numerous igneous bodies were traversed first and the lowest Silurian blocks were examined in the vicinity of the North Esk reservoir. Passing upwards through the succession, ample opportunity was given for collecting from highly fossiliferous rocks at Wether Law Linn. The highest beds in the sequence were studied in the afternoon, and the lowest part of the Red Bed sequence with its conglomerates was examined in detail.

SWINZIE BURN 23 June 1987 (Leader Mr. Matt Yuill) *by Ben Browne*

Gathering at Neilston railway station 16 members of the Society started by driving over the glaciated lavas of Ayrshire, enjoying a good view of Neilston Pad to gather at the cottage of Law Clunch (NS461473). Just west of the cottage we took a track running north past an old limestone quarry (now filled) to a stream section in the bed of Swinzie Burn where the Hosie C and D limestones are beautifully exposed. These overlie the Dockra and Hosie B limestones which are found elsewhere. In a small cliff on the bank of the burn shale are exposed which yielded a variety of lower Carboniferous fossils, including Productid spines and small corals. Passing beneath the road bridge we reached a section in the left bank exposing a thin band of ironstone, showing small scale faulting structures, then a further 100m downstream shale beds rich in shell fragments and crinoids were displayed.

Throughout the tour we were entertained by a discourse on the interaction of the local geology and the economy of the area; on the use of the limestones in agriculture, dyeworking and building after burning with local peat and coal; on the baking of clay into drainage tiles for agriculture and the small scale burning of limestones for industry. We were given an insight into the interaction of the land and the lives of local people on that land in recent centuries.

MILLPORT AND GREAT CUMBRAE:- 8 August 1987 (Leader Dr. M. C. Keen)

The aim of this excursion was to have a look at the geology of Great Cumbrae, and to visit the University Marine Biological Station. The geology consists of Upper Old Red Sandstone and carboniferous exposed around Millport, where various sedimentary features were examined. Carboniferous and tertiary Dykes form a conspicuous part of the island, and many were seen. Quaternary and Holocene geomorphology were also studied, including raised beach sediments.

ARDNAMURCHAN:- 28th-30th August 1987 (Leader Dr. Colin D. Gribble) *by Judith Lawson*

The excursion to the Ardnamurchan Peninsula was led by Dr. Colin D. Gribble, editor and co-author of the Ardnamurchan Guide (published by the Edinburgh Geological Society). This guide is referred to in the account below. The party was based at the Sonachan Hotel or in Kilchoan itself. The weather

steadily improved from thick fog on arrival to glorious sunshine on departure.

On Saturday the group started the day by studying a stream section on the eastern slope of Ben Hiant (pp106-8). Here the psammitic Moine rocks outcrop in the lower part of the section. Above the Moine are Mesozoic sediments and then one of the earliest agglomerates of the Tertiary volcanic episode was seen. From this point there was an extensive, although rather hazy, view over the Moine rocks to the east, and there was even a herd of deer as described in the guide! In the afternoon Faskadale, on the north coast was visited. To the west of the bay, on a (very) rocky shore, are superb, sea washed, exposures of agglomerate (pp110-114). As the shore became even rockier an outcrop of quartz gabbro was seen. This is intruded into the agglomerate and is a rather fine-grained rock looking rather like a dolerite, typical of the northern margin of the quartz gabbros of this area. The party then returned to base.

Sunday morning started with a steep ascent up Creag an Airigh (p115/2) from where there was a superb view of the later central complex and of much of the Hebrides to the north. The hill itself is part of the "Great Eucrite" ring which can be followed all the way round the centre. It was possible to see the various concentric rings of the eucrites, gabbros, tonalite and quartz-monzonite of Centre 3, the last centre of activity here .

The party then walked across the gabbro (p116/4) to the central outcrop of quartz-monzonite, a most spectacular rock. Later, near Abhainn Chro Bheinn on the slopes of Glebe Hill (p84/4) the highly metamorphosed, probably originally Mesozoic sediments, were searched for sapphires. There was much enthusiastic hammering and after "getting the eye in" many of the party found good examples. This locality is easy to recognise by the hammered debris. Finally the numerous cone sheets on the shores of Kilchoan Bay were visited after which the group dispersed having spent a very enjoyable and educational weekend.

JOINT EXCURSION WITH THE EDINBURGH GEOLOGICAL SOCIETY TO GLASGOW BUILDING STONES, FOSSIL GROVE AND CAMPSIE GLEN 5 September 1987 (Leaders Dr. Judith Lawson, Dr. James Lawson, Dr. Chris Burton and Dr. Jim MacDonald) *by Rosemary McCusker*

This very interesting and enjoyable day began with 32 Glasgow members meeting 43 Edinburgh members in Queen Street Station as they alighted from the 9.00 a.m. train from Edinburgh. The party was divided into four groups, and each of the leaders then took a group each on a

fascinating tour of the building stones of George Square and the surrounding area.

We saw a wide variety of rock types including sandstones of the Carboniferous and Permian, many beautiful granites and granite gneiss, some from as far afield as Brazil and Argentina and a very exotic gabbro from Larvik in Norway.

We then travelled by Underground to Hillhead and made our way to the Department of Geology to partake of an excellent buffet lunch.

After lunch we set off in two coaches to visit the Fossil Grove in Victoria Park. Here, in one of Glasgow's many lovely parks, inside a glass roofed building with two viewing platforms are to be found 11 fossil tree stumps. These trees have not just been cut down by a lumberjack as would seem at first sight but are the remains of the Carboniferous forest which formed the Coal Measures of Central Scotland.

After this exciting trip back in time it was into the coaches and off to Campsie Glen for the final part of our trip.

We divided into two groups led by Dr. Jim MacDonald and Dr. Judith Lawson, and walked along the public footpath. In the nearby stream we were shown outcrops of cementstones intruded by three carbonated dolerite dykes, one showing evidence of fault movement. Further up the stream there is a second set of dykes but these are not so altered and in fact some felspar is still present.

It was pointed out that there are 33 lava flows in the Campsies and we looked at some of the earlier ones noting the layers of red bole indicating a time lapse between flows.

SESSION 130 (1988)

OIL SHALES OF THE LOTHIANS: 7 May 1988 (Leader: Mr. K. Oakley) *by Alison Lawson*

Sixteen members of the Society left Glasgow by bus to met with our leader at South Queensferry. We were supplied with a "handout" to read on our journey, and met Mr. Oakley at the car park near the rail bridge. After a warning about the unfortunate pollution along the shores of the Firth of Forth, we set out to examine the exposed sediments of the Queensferry

syncline, starting at Long Craigs pier, east of the bridge. During an east-west traverse along the shore we saw typical deltaic sediments of the Oil Shale Group, including sandstones, shales, oil shale seams, cementstones, dolostones and the Pumpherston Shell Bed (a marine incursion). The structures seen included cross-bedding, ripple-marks, desiccation cracks and stromatolite domes.

The lunch break was taken in warm sunshine at the car park in the midst of the local day trippers and with the unaccustomed luxuries of bench seats, toilets and an ice-cream van! We then continued westwards along the shore to examine further features and dewatering structures. After returning to the bus, we had hoped to visit the shore near Hopetoun House, but as time was short it was suggested that another excursion could be arranged for the following year to finish the itinerary.

THE ISLE OF EIGG 21-23 May 1988 (Leader Dr. Judith Lawson) *by Iain Fergusson*

19 members of the Society sailed from Arisaig on the M.V. Shearwater at noon on Saturday 21st. Four other members were already on the island, including Dr. Lawson, who had gone ahead to arrange the itinerary. Conditions during the crossing were ideal, with the sun shining on a calm sea, and the ferry displayed an un-Hebridean punctuality in consequence.

On disembarking on Eigg, there was a delay of some 20 minutes before the local taxi / Land Rover arrived to take us to our accommodation in the Kildonan Guest House and nearby cottages and caravans. After depositing our luggage, we spent several hours examining some of the lower parts of the Jurassic succession on the island, including Hugh Miller's Reptile Bed in the Mytilus Shales, on the northeast shore.

The following day, we picked up the story at the "singing sands" on the northwest shore, where the upper part of the Mytilus Shales outcrops. Working south along the coast, we ascended the stratigraphic column to the Oxford Clay, on the south shore of Laig Bay. This contained the first ammonites we had found, showing the rocks to be truly marine, as compared to the lower parts of the succession, which were mainly brackish-water deposits with rare fresh-water beds.

On the way back to Kildonan, we examined Cretaceous Ostrea beds in

Laig Gorge, immediately beneath Tertiary lavas. As we had seen Tertiary lavas resting on the Mytilus Shales the previous day, this demonstrated the large unconformity between Mesozoic and Tertiary rocks.

On the final day, we ascended still higher, both stratigraphically and topographically, climbing the Sgurr of Eigg to examine the evidence that this was a Tertiary pitchstone lava which flowed along a valley in slightly earlier basalt lavas.

The return to Arisaig that evening was rather rougher than the outward leg as the perfect weather we had enjoyed began to break.

TYNDRUM VEIN MINERALISATION 18 June 1988 (Leader Dr. A. J. Hall) *by Mark T. Hutchison*

The word "gold" seemed to have helped to encourage a large party to assemble (and clog) the car park at Tyndrum South station. Any member spurred to attend only by this would however not have been disappointed when he failed to find any gold, such was the enthusiasm engendered by Dr. Hall.

The object of the excursion was to examine the famous Tyndrum vein mineralisation. A number of major faults cut across the landscape near Tyndrum, the best known being the Tyndrum Fault itself, this being the one upon which we spent most time. It cuts through Ben Lui Schist between Ben Lui and Ben Oss and further north separates rocks of the Dalradian Grampian and Argyll groups. It is on this fault that most of the lead mines are situated. By dating feldspars occurring near this area, the age of the mineralisation has been put at about 360 million years ago.

The party found some good examples of various of the more prolific minerals - sphalerite, galena, pyrite, chalcopyrite and some barytes. An interesting variation from these common minerals was a light blue powdery form of galena. This change from the typical steel grey colour is as a result of an unusually high content of silver. However, the concentration is too low to be economically viable. Most of the minerals found were located in spoil heaps and in the dried up bed of a stream which had carried them east from the vein.

Lunch was taken overlooking an ominously abyssal mine shaft under the welcome gaze of an object rarely seen in the sky in the summer of 1988.

Soon we were able to continue the ascent of the spoil heaps. From the col the hearts of the prospectors in our midst leapt as the site of the proposed gold mine was pointed out to us. This is to cut into Carn Mairg Quartzite of the Argyll group west of the Tyndrum fault. This locality was discovered as a result of lead prospecting, and has caused land prices in the area to soar. The thought of gold is not new to the inhabitants of the area, as it is said that husbands to be used to pan the local streams for gold to make rings for their intendeds.

WESTERN OCHILS:- 27th August 1988(Leader Dr. J. G. MacDonald)
by J. Kenneth Oakley

Fortunately, the torrential rain, which greeted the party as it assembled, ceased soon after arrival, and so did not mar this most enjoyable excursion.

The first site - Wolfhole Quarry, behind Bridge of Allan, was where the stone used to build many of the fine houses in the town was taken from. Sandstones may be thought of as uninteresting, but much was learned from the visit. Cross-bedding indicates river flow from the East. Any coarser clasts were quite small, suggesting that there was little coarse material in the source region. A fine grained mudstone layer, exhibiting slumping, may be a result of a flash flood, depositing debris in a lake. The suggested scenario - a braided stream flowing across a lava plain.

Although intercalated near the top of the lava succession volcanic activity had not entirely ceased, for at the top of the quarry, there is an ash layer. Another interesting feature - an adit, used during the mining of one of the mineral veins in the area has been exposed at the top of the quarry.

The excursion continued from the Sheriffmuir Road, along the muddy path to the summit of Dumyat. Again, much of interest was seen. The start is across an outcrop of agglomerate, with many rounded clasts, some of them of very large size. No consensus as to the origin exists; the large size of the clasts means that the vents were close by, though none have ever been discovered. The rounding may be due to gas streaming. One possible explanation is that the material slumped down the side of the cone, the rain, which frequently accompanies volcanic eruptions providing the water.

Further along there is an outcrop of hypersthene andesite. This fine looking rock, is in remarkably fresh condition, prompting the suggestion

that it may be a sheet intrusion. It is veined with haematite. This rock type is typical of regions of compression in the Earth's crust.

JOINT EXCURSION WITH THE EDINBURGH GEOLOGICAL SOCIETY TO STIRLING 3 September 1987 (Leaders John Laxton and John Merritt) *by Sally Rowan*

Our bus left Glasgow in pouring rain and strong winds - the drivers amongst us appreciated comfortable chauffeured transport! Fortunately, the weather had improved by the time we arrived at Stirling Castle. Almost a score of us met rather more from the Edinburgh Geological Society. Our leaders, from the British Geological Survey, gave us an overview of the area to be explored for signs of post-glacial topography.

First, we drove by bus past sea-cut cliffs and raised beaches along the southern margin of the Carse of Stirling. The fluctuating sea levels had also created "sunken" beaches, but these could only be detected from boreholes and quarries. We saw the Loch Lomond Advance terminal moraine at Menteith, and the Lake of Menteith, itself an unusually large kettle hole.

At Gart, we walked along the classic crescent shaped terminal moraine of a Loch Lomond Advance glacier. Near Callander we examined the Roman Camp Esker. Here our party stopped for lunch, and a schism developed - the hardy Edinburgh folk settled down with sandwiched and midges beside the river, whilst we from Glasgow hastily headed for civilisation...

After lunch we visited Cambusbeg Quarry to see the "root" of an esker - now partly quarried away - and observed some beautiful cross bedding in the sands. Now the spades brought along by the Quaternary specialists proved useful, and engendered some good natured ribbing!

Cambushinnie was our last stop. We walked across a high "beaded" esker and examined a small quarry cut into it. This displayed some nice faulting in the sand layers, blurring slightly amongst the gravel, caused by slumping. Another feature was shown, possibly caused by an ice wedge, but with its origins still under dispute.

Finally, Dr. Alex Hall thanked our two leaders for an informative and enjoyable excursion, and also Ian Hogarth, the Edinburgh excursion secretary, for allowing us to share in their arrangements.

SESSION 131 (1989)

JOINT EXCURSION TO GLENCOE BY THE GLASGOW AND EDINBURGH GEOLOGICAL SOCIETIES - Saturday, 6th May, 1989 *J.M.Morrison*

The members of the two Societies made their rendezvous at the Ben More Cafe, Crianlarich on a morning whose brilliance lasted the whole day. By the time we assembled in the quarry at the Clachaig turnoff, we numbered 60.

Leaders Graham Durant and Dave McGarvie gave an introductory talk which set the geological context before the party set up An t-Sron to examine the contact between the Leven schists and the surrounding Fault Intrusion granite.

Lunch was enjoyed in brilliant sunshine by the River Coe before the group set off through the lower basalts - with fine examples of epidote and withamite. A stiff pull up the well-made path and the gorge of the Allt Coire nan Gabhail brought us to the rhyolites with their flow-banding and brecciation. A grassy knoll afforded magnificent vistas and lively discourse between members of the two Societies.

Back at the transport, the leaders summarised the day's observations and showed rock samples from other parts of the volcanic succession. Votes of thanks by J.Morrison (Glasgow) and E. Clarkson (Edinburgh) rounded off a superb day.

THE YORKSHIRE DALES: 20-22 May 1989 (Leader: Dr. Peter Thomas) by *Alison Roberts*

Twelve members left the Boyd Orr car park on the Saturday morning to rendezvous with five more for our first excursion of the Yorkshire Dales weekend, a walk in the Ingleton Glens. The walk followed the River Twiss upstream across the Craven faults on to the Askrigg block, the Lower Palaeozoic basement of which comes in at a small quarry by the track, where our leader explained bedding, cleavage and way up relationships. Our main objective was Thornton Force, a spectacular waterfall dropping almost fifty feet from hard resistant limestone into a deep pool in Ordovician slates. Cameras were out as we contemplated what was certainly the most convincing unconformity most of us had ever seen. After

some climbing in blazing sunshine we were surprised to come upon a van selling welcome cool drinks. These vans turned up a few times during the weekend in apparently inaccessible places, and always with a black polythene bin bag attached for the empties. A feature of walking in the Yorkshire Dales is the absence of litter and the high standard of maintenance of the paths and stiles in spite of the large number of walkers who use the area. While discussing the geology, our leader recommended A. Wainwright's "Walks in Limestone Country" to us, a pocket sized guide, delightfully illustrated and full of wisdom and accurate geological information. Descending by the banks of the River Doe, we re-crossed the Craven faults, which bring in a wedge of Carboniferous Limestone. From Ingleton it was a short drive to Horton-in-Ribblesdale, which is an attractive Yorkshire village with pretty cottages, all built and roofed with local stone. It lies on the Pennine Way and nestles beside Pen-y-Ghent which, like its fellow peak Ingleborough, has an impressive profile of Millstone Grit on easily eroded Yoredale rock surrounded by a collar of limestone. The seventeenth century Crown Hotel provided comfort, local colour and ample local fare.

Sunday promised to be another brilliant day and the canny Scots dared to leave their waterproofs behind and set forth in shirt sleeves. We drove to Malham and made for Goredale Scar, stopping at Janet's Foss, a waterfall in limestone where we were able to examine the building up of tufa. We left the Craven basin for the Great Scar Limestone and the enormous collapsed cavern which is Goredale Scar. Here we were faced with what looked to most of us like an impossible rock climb, but the tufa formed natural hand and foot holds, making the climb considerably easier than it looked. It was a long haul up the dry valley of the gorge, but eventually we emerged at the top and were able to look down and marvel at our achievement. On the limestone pavement we learned to walk on the clints (the "pavements") and hop over the grykes (the weathered spaces between in which wild violets hide). The limestone up here forms strange shapes and water percolates through it forming a network of caves, potholes and underground streams. Lunch was beside Malham Tarn, which lies on an inlier of impermeable Silurian slate. We tried to follow the stream

which flows out of the Tarn but it soon went underground so we continued walking towards Malham Cove in a dry valley. Here some of the party made a detour to the old mineshafts of Pikedaw where it was rumoured that fossils as well as minerals were to be found. At the end of the Ice Ages, an enormous waterfall must have rushed over the 250 foot precipice above Malham Cove, but all that remains now is a small stream emerging from the foot of the precipice. It is not the same stream which we had followed from the tarn, apparently the origins of this one are elsewhere. Strange things happen in limestone country! The day ended with a stroll around Malham village to enjoy its coffee shops and craft shops.

First stop on Monday was Horton Quarry to look at bedding and structures in steeply dipping Silurian flags unconformably overlain by limestone. We then took the road to Austwick. A short climb up Nappa Scar, inspecting basal Carboniferous conglomerate on the way, led us to the Norber boulder field. This is an eerie place, where dark Silurian boulders of unknown origin are perched precariously upon pedestals of white limestone. The umbrella effect of the boulders has protected the limestone beneath them, leaving them a fairly uniform fifteen to eighteen inches above the ground, a measure of the erosion of the general surface since glacial times. We interrupted the return journey to Horton to look at some fine examples of flute casts and graded bedding. After lunch it was Alum Pot, a vertical shaft down which water drops almost 300 feet. We watched some enthusiasts descending on ropes, but none of our party was inclined to join them. We did, however, venture into Diccan Cave, where it was only a few feet below ground, just for the experience! The weekend finished at White Scar Show Caves, a tourist attraction with walkways, handrails and electric light. Thanks were said to our leader for the unhurried way in which he laid bare so much of the geology of this delightful and fascinating part of the world.

THE OIL SHALES OF THE LOTHIANS - 9th September, 1989. (Leader Mr. K. Oakley)

It was a sunny but cold morning when members of the Society met at Hopetoun House.

We were all very intrigued as to the nature of the "mystery object"

promised by Ken Oakley. As we made our way along the foreshore it was evident that this had been a delta system with sediment being brought from the north-east, the sandstone dipping westward. In between the lagoons, shales and limestone had formed. There was sane evidence of cross bedding, and at the base of the sandstone brecciated layers showed that the sediment had been disturbed after deposition. The fine-grained deposits suggested the presence of a slow moving river.

At last we came upon the mystery object which appeared for some distance along the foreshore. In general appearance it resembled a dyke, but the composition of the rock did have some grain-like material in it and we therefore decided it was sandstone. When we tested a sample of rock with hydrochloric acid the surface fizzed showing that it was cemented by calcite. We tried to ascertain if the dyke was intruded before or after folding but this was difficult to detect. Seismic activity caused the fracture and the sandstone intruded along the fissure whilst thicksotropic (jelly like). There was also evidence of faulting from the marked curve in the dyke and the slickensides in the rock with calcite veining on the fault plane.

After all this detective work we felt we had earned our lunch break.

After lunch we tried our hand at mapping. The giant tape measure produced for the task was most impressive. I will not try and reproduce my rather shaky efforts - due in part to frozen fingers from a biting wind blowing in from the sea.

As we made our way eastwards towards the Forth Road Bridge there was evidence of volcanic activity all along the foreshore. We found disrupted material from hot air vents and hot gasses.

It was a most interesting excursion and I do hope we will have the opportunity to do some more mapping in the future.

SESSION 132 (1990)

ROSNEATH PENINSULA AND LOCH LONG: 8 June 1990 (Leader Dr. Geoff Tanner) *by Sally Rowan*

Our group of 20 set off in fine weather for Rhu. Dr. Geoff Tanner of Glasgow University was to explain the structures of the Tay Nappe, culminating in the complex situation at Portincaple on the shore of Loch Long.

At Rhu, our first stop, we saw evidence of D1 cleavage and also ice scratches. Locally graded turbidites provided "way up" markers. Dr. Tanner demonstrated an ingenious method of sketching outcrops: use panoramic photographs taken from a boat!

We drove along the Highland Boundary Fault, and stopped to look at interference between D1 and D2 cleavages. This resulted in microlithons. At Kilcreggan we saw more evidence for the same processes.

Dr. Tanner displayed photomicrographs at several locations. These showed the rock structure very clearly (no weathering!), and can resolve questions arising in the field.

We were shown D3 folds, and how to tell from their shape which way the centre was. The structures became more complex as we neared Portincaple, where the D4 folds could also be seen. Without Dr. Tanner's outcrop sketches - and explanations - it would have been almost impossible to interpret the tangled rocks.

Showers threatened here but held off long enough for an enjoyable walk along the rocky foreshore around Portincaple. Several trawlermen entered a pleasant discussion of the rocks caught up in their nets on the floor of the Firth of Clyde.

Finally, Dr. Tanner summed up the evidence we had seen of the development of these structures. He was thanked for his time, patience and hard work which together had resulted in a very successful excursion.

LEADHILLS 30 June 1988 (Leader Mr. Richard Gillanders) *by Colin Edwards*

Richard Gillanders of the geological Survey led a party of 31 Society members to the Leadhills area of the Southern Uplands, on what started as a very wet day, but thankfully improved.

The excursion was in three parts. The first concerned the gold bearing area near Crawfordmoor, where alluvial gold deposits have been worked since the thirteenth century. When activity was at its height in the sixteenth century, 300 men were employed and extracted £100,000 worth of gold at sixteenth century prices in three years. The miners established the small village of Long Cleugh of which only a series of mounds remain. Gold for Scottish royal regalia was produced in the area. The party then climbed up

the Long Cleugh Burn and after some preparatory digging by Richard Gillanders and helpers, whilst everyone else had lunch, enough material was available from an old stream bed for all who wished to try panning. About half a dozen people were successful in finding gold.

We then travelled to the second stage, the Allan Ramsey Library in Leadhills. This is the oldest subscription library in the British Isles, and contains nearly 4,000 books covering classical and Victorian literature, as well as history and all the sciences. Perhaps most interesting were the bound volumes of contracts of work agreed with the eight man mining teams, which give a picture of the working life of lead miners over the years.

The third part of the outing was to the Susanna Mine above the town of Leadhills. Lead mining in this area started in the sixteenth century and in 70 mines have been worked since then. The Susanna was the outstanding British mine in the eighteenth century, and in addition to lead produced about 50 secondary minerals of worldwide interest. At its most productive period James Stirling was the manager and employed 200 miners in four shifts. The royalties paid on the lead formed the basis of the Hope family fortune, including Hopetoun House. The mine was abandoned as uneconomic in 1840. Members were shown samples of ore from the mine and also explored the spoil heaps which provided a wide range of specimens from discarded ore.

As well as explaining the mineralogy, Mr. Gillanders gave a detailed insight into the history and development of mining in the area - the successes, the legal battles, and the missed opportunities. Everyone present felt that on many levels this had been a very worthwhile day.

FIFE COAST, INCLUDING THE DISCOVERY OF BEACONITES AT KINGS BARNS:28th July 1990 (Leader Dr. George Farrow) *by the leader.*

The Glasgow contingent of about 26 members departed from the Boyd Orr car-park at 0935 and arrived in the car-park at Kings Barns at 1145. During a somewhat lengthy convenience stop necessitated by the exposed nature of the shore and by the small size of the portaloo, the party had the good fortune to be joined by Dr. and Mrs. Ian Rolfe and several additional

members who had arrived in cars; so the party finally numbered about 35 in total.

I began by explaining why I had chosen this particular coastal section as the one to visit. During my Britoil days I had taken parties of petroleum geologists here and found the shore very good for illustrating the style of folding associated with strike-slip fault movements. A further attraction was the Randerstone stretch of shore, for which my appetite was whetted by some truly magnificent stromatolite specimens in the Royal Museum of Scotland. I had unearthed these whilst preparing the brief for the museum's new Sands of Time exhibition. As I had never got as far along the shore as Randerstone before, I was as keen as the rest of the members to discover how these world-class specimens occurred in the field.

The first part of the excursion featured the structure of the area: the second, the sequence of sedimentary rocks and their fossils. Groups of members were invited to walk along the strike of particular sandstones until they could go no further. Eventually members confronted one another along the line of the Kings Barns Fault.

Discussion then ensued on the recognition and environmental interpretation of the cornstones, exposed immediately south of the fault. These rubbly rocks look like conglomerates but are in fact a type of calcareous concretion which formed by capillary action as the sun bore down on alluvial flats bordering the Old Red rivers.

After rounding Cambo Ness and crossing the wooden footbridge, the party turned their attention increasingly to the succession of strata. Members were soon able to predict the sequence because of the regular repetition of rocky sandstone ledges and shaly bays. *Stigmaria* roots were usually seen at the top of the sandstone units, and even from afar the telltale bleaching of the sandstone suggested where to look for the roots.

It was about 200m SE of the bridge, on this wave of mounting confidence, that Mr. Ted Kellock discovered the spectacular horizontal trace fossil immediately identified as *Beaconites* by Dr. Rolfe and myself. This trace fossil was described only in 1962 by the Russian Vyalov from the Devonian of Antarctica (Hantzschel, 1975, p 1045)

"Large horizontal segmented (septate) burrows, many of them

of giant size; 3 to 13 cm (max) wide; somewhat sinuous, large forms relatively straight; rather long (up to about 1 m); commonly crowded; associated with round pits of similar cross section; marginal welts 5 to 30 mm wide; curving "septal" ridges mostly remarkably equidistant; those of giant forms usually markedly crescentic."

Compare our Cambo Ness specimen with this description and you will appreciate what a giant we indeed discovered! Our specimen was on average 30 cm wide (34 cm at its greatest) and 6.5m long! Dr. Rolfe measured 9 successive septal ridges (1.4, 2.4, 1.5, 1.5, 1.4, 1.8, 1.5, 1.3, 1.4 cm) thus confirming their remarkably equidistant spacing. A feature of our specimen was the presence of many carbonised plant fragments 0.5 to 4.0 cm long roughly parallel to the curved septal ridges. At first sight it appeared that the rather straight trace had been obliged to divert around a *Stigmaria* root. A second glance showed in fact that the trace has been offset by a sinistral tear fault. In one additional respect the Cambo specimen is unusual, apart from its size. It is not part of a crowd. Search as we did, we could find no other example.

Dr. Alex Hall revisited and photographed the site on 4 August and has confirmed our measurements. He notes that Map 19 in McGregor's Fife and Angus Geology deals with this part of the shore. Dr. Hall's photographs (inside the front and rear covers) give a good impression of the huge size of this burrow, which immediately begs two questions. Is it known elsewhere in Scotland, and what kind of animal made it?

Beaconites is recorded in the East Fife Memoir (Forsyth and Chisholm 1977, p 19) but not specifically from the Kings Barns section, though other trace fossils are mentioned (*op. cit.* p 32). A specimen from the Lower Old Red Sandstone at Auchensail, Dunbartonshire, is recorded by Scott *et al.* (1976) who thought that the burrow might be the seasonal work of amphibians or reptiles living on stream beds in a desert area. Aestivation burrows of lungfish provide an alternative explanation. In his comprehensive review of early terrestrial arthropods, Rolfe (1985, pp 212-213) entertains the possibility that *Beaconites* was the work of eurypterids or scorpions.

Whatever the identity of the producer we can be fairly sure that the environment was one where a broad river, with transverse sand bars shallow enough to be colonised by *Stigmaria*, debouched in ancient Lake Cadell.

Further along the shore the party, particularly the younger members, found museum quality shell beds and algal limestones. In no time at all terms like oncolite and stromatolite were tripping off ten-year old tongues. Dr. Rolfe reminded the party that polished tables of the spectacular shelly ironstones could be seen in the Hunterian Museum.

After a lunch delayed by the excitement of *Beaconites*, the party turned its attention to a discussion of the quicksand structures developed in several of the sandstones and further noted the extraordinary complexity of the ferruginous veining, which frequently enhanced original depositional bedding but equally often took the form of spectacular cylindrical tubes.

After the leader had pointed out that these features would represent a topic well worthy of more detailed field and experimental study, the party repaired to the bus which was waiting in the car-park short of the golf club at Fife Ness.

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EXCURSION TO BEN LAWERS 2 June 1990 (Leaders Jack Treagus and Philip Knowle) *by David Williams*

This was a joint excursion with the Edinburgh Society and was led by Jack Treagus and Philip Knowle of Manchester University. About twenty-five members from Glasgow attended, our journey through the pleasant countryside somewhat marred by the bus' Land Rover-like suspension.

The excursion introduced us to the intricacies of the complex folding associated with the Ben Lawers Synform. After examining various localities at the Burn of Edramucky near the National Trust for Scotland' s nature trail, the party visited Lochan na Lairige in order to look at the very fine outcrops of Ben Lowers Schist and the evidence of the various deformations that had occurred locally. On following the lochside road northwards, the participants were able to study the changes the angle of dip of the relevant strata that indicated the position of the synform.

This was a most enjoyable outing; as well as being treated to some fine geology we were able to look at some very interesting flora. In addition, although there were some ominous black clouds our Excursion Secretary managed to arrange some rather good weather.

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Although not strictly within the period appropriate to this volume, the following is included because it effectively stands alone as a mini-guide to the area covered.

THE GEOLOGY OF THE ISLE OF MAN Expedition report for the visit by Glasgow Geological Society to the Isle of Man in August 1991 David B. Hollis 29 August to 2 September 1991

The geology of the Isle of Man

Since Lamplugh (1903), Robinson and McCarroll (1990), and Ford (1993) have already described the geology in detail, only a summary is provided here. Figure 1 is a simplified geological map of the Island, which lies about 40km South of Scotland, and 75km west of the English Lake District. As would be expected, the geology of the Isle of Man is similar to that of the two nearby mainland areas. A hill range of Ordovician Slate runs from north-east to south-west. Simpson (1963, 1964, 1965) has described three folding sequences and accompanying metamorphic features, all of which are of Caledonide origin. Three major Caledonide granites underlay the slates, at Dhoon in the north-east (Nockolds,

1931) at SC459872, Foxdale in the centre (Dawson,1966, Simmons, 1911) SC291771, and Oatland in the south east of the Island SC325725 (White, 1911). A hitherto unpublished granite is inferred by D. B. Hollis from pieces found in the dumps of Ballacorkish mine in the south west, O.S. grid reference SC218705. The Old Red Sandstone appears north of Peel, at SC250845 and is exposed on the coast as far as White Strand SC268860 (Ford, 1972, Crowley 1981, 1985). The facies are similar to, but earlier in date than, those of the Clyde estuary and the coast as far south as Ardrossan (Bluck 1973 pp 91-99). It is steeply inclined to the west, and faulted out against the slates in a manner similar to that recently observed on the M74 construction site in south west Scotland (Floyd, Stiven 1991). The south-west of the Island is a flat area of Dinantian Carboniferous limestone (Dickson, Ford, and Swift 1987, Smith 1911). The relatively shallow dip of these shows their post Caledonide origin. Beneath these lie basement red conglomerates visible on the south end of the Langness peninsula, south of Castletown (Clague 1887) In former times, metals were mined at Laxey mine, SC431853, Foxdale SC271780 and a number of smaller mines (Lamplugh 1903). Ineson and Mitchell (1979) have shown that these veins have a late Carboniferous to Permian age. The veins contain lead, zinc, and some silver, copper, and iron.

Most of them have an east-west, or north-south strike which seems to be associated with a fault system visible in many parts of the Island. For example, at the Chasms, SC196662 near Port St. Mary north and south fissures have opened up on the sea cliffs. At the Niarbyl, SC210775 and at Glen Maye, SC225800, compression thrusts of rocks to the north over those to the south form an east-west striking crush zone, and along the northern edge of the hills, from Ballaugh to Ramsey there is a drop of 500m in about 4km, along another east-west fault line. In the Dinantian limestone area south of Castletown at Grid ref SC 245670 to SC 260670 lie the Scarlett Volcanics, a remarkable series of tuffs, pillow lavas, and ash beds with bomb sag features. This has a late Dinantian age (Durant, Dickson and Grant 1992), rather like the formation at the Head of Ayr, Ayrshire, Scotland (Bluck, 1973 pp 93-99). Permian and Triassic Strata are not visible at the surface on the Island, but boreholes, north of the Ballaugh-Ramsey fault (Gregory, 1920, Smith 1931) have revealed a sequence of Namurian shales (roughly corresponding to the Yoredale series), Permian desert sands, (Todd 1895) and Triassic marls containing brines. Jurassic and Cretaceous sediments are entirely missing. Furthermore the slate hills demonstrate plateau features at 150 metres and at 450 metres which could be Cretaceous peneplains.

It appears that, in common with the Lake District of England, the Isle of Man

was eroded during Jurassic and Cretaceous times. Quaternary Sediments are well represented. The entire area north of the Ballaugh-Ramsey fault is a triangular area of land composed mainly of Devensian glacial till (Thomas 1976a, 1976b, Tooley 1977). North of the Bride hills (SC380999 to SC460999) the late Devensian re-advance has made further sediments, and pushed the earlier sediments southwards, to form the Bride Hills.

South of the Bride Hills, late glacial outwash from the slate hills, and lagoonal features dating from Flandrian times overlie the Devensian sediments. Holocene activity is manifest by continual erosion of the sandy north coast of the island, and a tidal system which carries material north. This is extending the Point of Ayr (NX468051) northwards with Shingle banks (Jones, 1980). The Douglas-Peel valley (SC3677 to SC2482) is slowly filling with alluvial deposits which make good farmland when drained. (Kear, 1976).

Present human activity will no doubt give future geologists plenty of new material for investigation in about a million years time!

Eleven people flew down to the Island from Glasgow on the Thursday, and arrived at Port Erin in fine weather. While others explored the area, the leader spent the afternoon preparing the notes and itinerary. The Marine Biology station staff kindly allowed us the use of their lecture theatre for the introductory lecture which has been summarised in the previous section of this report. After this, the party adjourned to various hostelries to recount the events of the day, including views from the aircraft of the Scarlett volcanic lava flows, and a visit by a few adventurers during the afternoon to the South Bradda "treacle" (copper) mines below the cliffs at Port Erin. There, Dr. MacDonald found an excellent specimen of galena in quartz.

From this point, the excursions followed the pattern set on previous visits by Ford (1984a, 1984b, 1987) and Simpson (1966). Friday was spent on the Castletown limestone and Scarlett volcanics. A visit to the Flats (SC205672) South of Port St. Mary revealed the Castletown formation (Dickson, Ford, and Swift 1987, Smith 1911, Lewis, 1930). A specimen of the rather rare coral - *Hexagoniara* - was seen lying on its side, as well as *Caninia* and *Lithostrotion* which were abundant here. The party proceeded to Port St. Mary harbour (SC214674). The tide had already filled the inside of the harbour where the slate - limestone boundary lies. On the seaward side of the harbour wall, a broken open anticline revealed the bryozoan beds, and a number of productids including one identified (Shiels 1969, plate 2, item c) as *Kochiproductus coronus*. Also there were *Syringapora* corals. A solitary coral - *Dibunophyllum* - gave a few specimens. On the road to Castletown, we stopped in Gansey Bay at Strandhall

Farm, (SC238687). Lunch was taken, some returning for much needed liquid refreshment to the Shore Hotel. Below Strandhall Farm the *Caninia* beds similar to those of the "Flats" are again evident. Dr. MacDonald and Dr. C. Burton discovered a fine "Vug" in the rocks, containing the characteristically curled crystals of dolomite. Unfortunately, this particular piece of rock was partly concreted, and could therefore be a "foreigner" - brought in from elsewhere for wall building. In the afternoon, the walk from Strandhall to Castletown round the coast took us through several formations in the Dinantian limestones. First, the Poyll Vaaish marble quarry (SC244677) and the remarkable folding and dolerite dykes, (Smith 1911) gave rise to much discussion about the folding. There were en-echelon crack systems which indicated post Carboniferous wrench faulting, superimposed on which were Tertiary dyke features. Foundered reef blocks which had compressed the underlying layers were the next "exhibit" encountered (Quirk, Ford, King, Roberts, Postance, Odell, 1990). Dolomitisation was evident in many places including Strandhall, and the area just after Poyllvaaish (Dickson, Barber, 1977, Dickson, Barber, 1976). However, the most spectacular feature was the Scarlett volcanic sequence in the *Posidonia* shales (upper Dinantian) where ash beds, bomb-sag, and pillow lavas, indicated sub-aerial, and partly submarine volcanic activity. Large areas were overlain by volcanic tuff (Durant, Dickson, Grant, in preparation 1991). The Stack of Scarlett is a basalt Stack with hexagonal columns similar to, and previously believed to be of the same age as the Antrim lavas of Fingal's cave and the Giant's causeway (Jones 1910), but now known to be of the same age as the rest of the Scarlett volcanics (Durant *et al.*, 1992). Hollis (1992) has shown that the Scarlett volcanics are syngenetic with the Heads of Ayr vent, Ayrshire. Scarlett visitor centre SC258663 had an interesting display of the local rocks and fossils, and gave an insight into the rich flora and fauna of the area. Many cans of drink were eagerly devoured before a quick visit to the southern area of the Langness peninsula. Here, the unconformity between the Manx slates and the basement conglomerates of the Carboniferous strata was seen below the light house, (SC282651). The Arches - places where the conglomerate has been holed through by the sea to provide passageways - were found in the south west of the peninsula (SC282655).

A rendezvous at the car park site of an old copper mine (SC285660) where chalcopyrite specimens are still occasionally found was most welcome, and twelve dusty, tired geologists set off home for a wash, dinner, another short slide show and talk at the marine station, and then returned to bed or else to the local hostelries. My thanks are due to Dr. Chris Burton for pointing out much of the

interesting fossil flora and fauna of the limestone area. The second day, Saturday, was as fine and sunny as those previous. The first port of call was Foxdale "Spar" quarry, a quartz pegmatite, (SC288773) which had an area containing phenocrysts. Even though recent digging had removed much of the phenocryst mass, one vein yielded a fine plagloclase feldspar with several crystal planes well developed, and some small euhedral quartz hexagonal crystals. The party then drove to Peel on the West coast to examine Ordovician slates and the Old Red Sandstone. At Peel, the folding axes described by Simpson (1966) were examined in the vicinity of the Castle (SC241843) on the slate outcrop which forms St. Patrick's Isle. It was difficult to distinguish detail, but the major axes could be followed by reference to other hill features on the main Island of Man around Peel. The Old Red sandstone is exposed at the north end of Peel seafront SC250843 where ripple marks may be seen. A hasty visit to Traie Fogog SC252845, just north of Peel before the tide cut it off, revealed signs of volcanicity including ash beds, and possible plastic flow during and after deposition. These beds are very like those of the Renfrewshire and Ayrshire cost of south west Scotland (Bluck, 1978 pp 93-99). Lunch was taken in the sun on Peel Seafront. At White strand about 1 km north of Peel (SC265855) fine exposures of the Old Red sandstone show ashy beds, from which a piece looking like pitchstone was retrieved by Dr. Burton. Flow beds indicated a provenance north west of the Isle of Man, and the angularity of the pieces indicated a short distance of transport, (Ford 1972). The presence of agates, rounded carnelians, and pebbles bearing fossils of a Salopian or Wenlock age hints at the possible landscape from which the material was derived (Crowley 1981, Lewis 1933, Crowley 1985, Dawkins 1902). A large silicified piece of the red sandstone containing a *Syringapora* coral was found; however this coral could not be used to date the sandstone because it was in a piece of rock separate from the cliffs, and because this coral species existed from Silurian to Carboniferous times. The steep slope of the Old Red Sandstone north of Peel suggests a pre-Caledonide, lower Old Red Sandstone age, similar to those of South Kintyre, Arran, and Southern Ayrshire (Craig 1983, pp 208ff), rather older than those of the Clyde estuary. Further north at Will's strand slumped structures (Ford 1972) were plainly evident, and between White strand and Wills strand was a horizontal thrust plane showing syn-tectonic movement. At Will's strand the Tertiary dyke cutting the sandstone off from the slate, and the unconformity between the sandstone and the slate were already inaccessible because of the incoming tide.

On our way home a visit to Niarbyl (SC210775) on the south west coast of the Island gave a view of one of the thrust zones in which rocks to the north were

driven over those to the south. Time did not allow a visit to the similar feature at Glen Maye. On Niarbyl shore, series of sinistral wrench faults indicated shear as well as crush in this fault system. The spectacular stepped coast line to the south of Niarbyl was obscured by mist, so the stepped north-south and east-west faulting down the coast could not be demonstrated. The group departed for home. As we passed the Sloch (SC212735), the story of the discovery of "gold" in the old Falcon cliff mine there about forty years ago by two men from Port Erin was related by the leader. When the men returned, the vug they had broken open some weeks previous had gone black on exposure to the sea air! Nor have they been the only "fools" after such "gold". An exploration company in the 1950's spent much money on Sleiu Whuallion near St. Johns, (SC265805) and at Shughlaquiggin near Baagarrow (grid ref approx. 31-88-).

Similar "gold" (iron pyrites) came to light during the building of the reservoir in Tholty Will (SC370887). Dr. MacDonald pointed out that the zoning from the quartz-pyrite belt through the quartz-calcite-zinc lead belt to the few copper bearing mines on the Island was a typical mineralisation sequence and indicated a hot source to the south east of the Island. We arrived home in the late afternoon. At this point, we should thank Mr. Ian Bridson of Arbory, Isle of Man for showing us later that evening, a pre-print of Durant, Dickson and Grant's paper (1992) on the Scarlett volcanic formation and also a young, genuine Manx tail-less cat!

Our final day was spent in the north of the Island, viewing Quaternary features (Thomas, 1976, 1977). An early start after breakfasting on Manx kippers brought us to Glen Wyllin (SC310906) by 10 a.m. The kettle holes to the north which were formed at the end of the late Devensian re-advance, and covered by Holocene sediments, have gone in to the sea, along with Glen Wyllin Mill, whose notice "private property - keep out" had apparently had no effect on the sea. However, below the kettle hole layers, remains of *Turretella*, the sub Arctic shellfish were found by several members of the party. Our petrologist, Dr. MacDonald, showed us samples of granite brought from south west Scotland by glacial action. Dr. Burton demonstrated fossil material in some of the stones washed out of the glacial material.After viewing post glacial outwash south of the Glen Wyllin river, the expedition headed to the northern tip of the Island (Point of Ayre) (NX468052) where an informative talk was given by Mr. Ken Smith on how the pebbles are flattened rather than a random mixture of round, angular, tabular, etc. These flat pebbles offer least resistance to the waves and are accumulated because they are moved less than the round ones. The storm terraces and the "wall" of water where the tidal currents coming up the east and west coast of the island meet were both evident. The sea currents have a strong ebb and a weak flow

superimposed upon the north flowing Gulf Stream. Thus the loose material on the coast is transported northwards. After trying to work out how large Ailsa Craig was before its riebeckite granite was spread out all over the Irish sea, and as far as the Point of Ayr by glacial action, the party headed south again, by the east coast of the Island. After a drive to Phurt (NX 468028) lunch was taken on the beach. The attraction of sea paddling overcame the original intention to walk up to the spectacular seaward end of the Bride Hills (SC460999) at Shellag point. At Shellag, late Devensian glacial action had pushed the earlier sediments into a concertina formation up to 90 metres high. At Phurt, the lower Phurt beds were obscured by recently fallen sandy material and storm debris. Thus it was not possible for us to see the early Devensian phase of sedimentation. The lagoonal structures and post glacial outwashes were evident. These were full of tiny pieces of slate bound together by clay which was cohesive and malleable like putty, and dark grey blue in colour. They were some way up in the sandy cliffs. After an ice cream stop in Ramsey (yes, the temperature was still over 70F), the expedition made its final pilgrimage - to the Lady Isabella Waterwheel at Laxey Mines. (SC431852).

Mr. Kneale, who saved the wheel from the scrap merchants in 1930 was visiting and had a short conversation with some of the party before they went round the Laxey mines trail. Buildings have been made safe, and an adit opened to the public. Signboards give information to the visitor at strategic points. All good things have to come to an end. The following morning we left the Island in misty sunshine, flying over Port Erin as we left. The leader wishes here to thank Mrs. Rosemary McCusker for organising the hotel, air tickets, etc. and the treasurer, Mrs. Dorothea Blake for organising such matters on the Island, and Dr. Chris Burton and Dr. James MacDonald of Glasgow University for their expert and patient explanations of the Island's geology. Finally, thanks to the Marine Biological Station and to Grosvenor Hotel, Port Erin for giving us welcome and hospitality.

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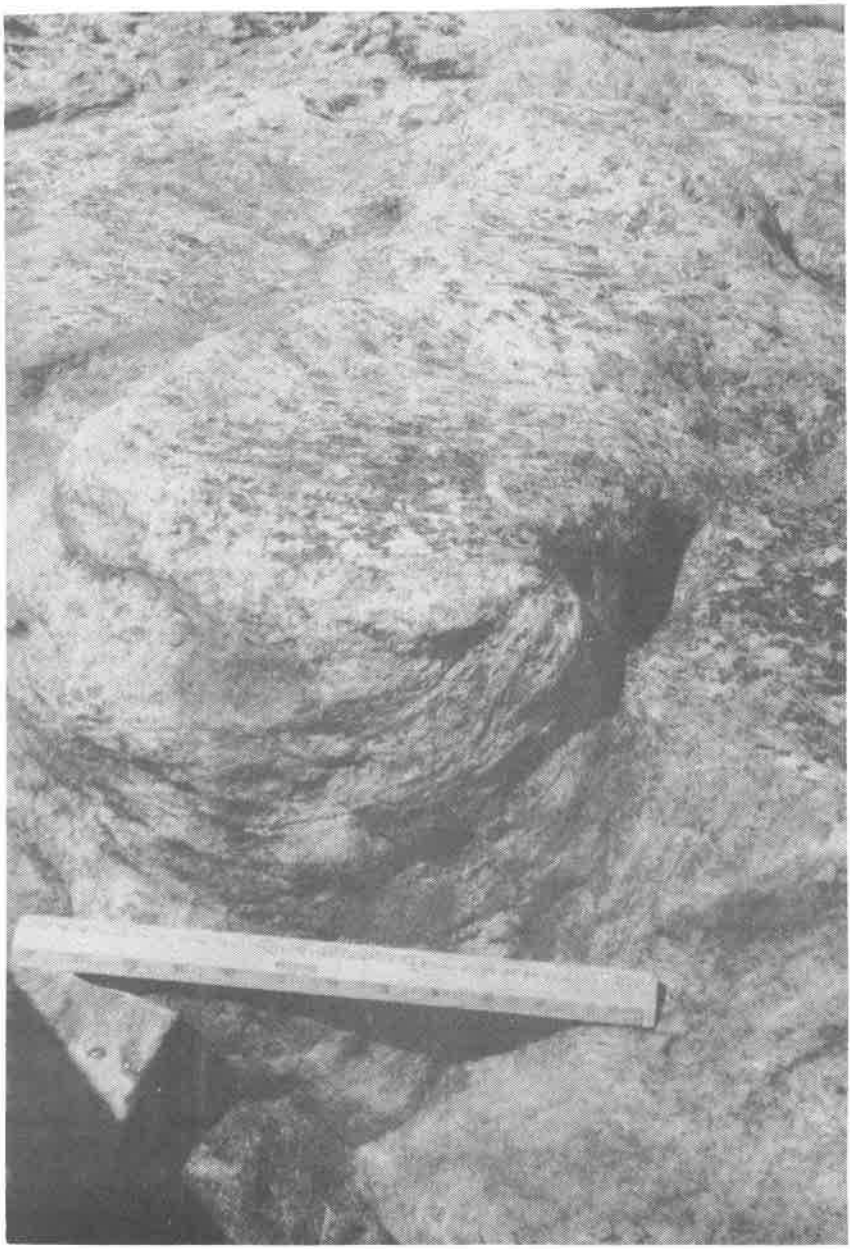

The trace fossil *Beaconites*, from Kings Barns, Fife. See Page 50
Photograph by Dr. Alex. Hall

Front Cover Illustration:-
The Norber Erratic in the Yorkshire Dales, *drawn by Nora Liberi.*

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