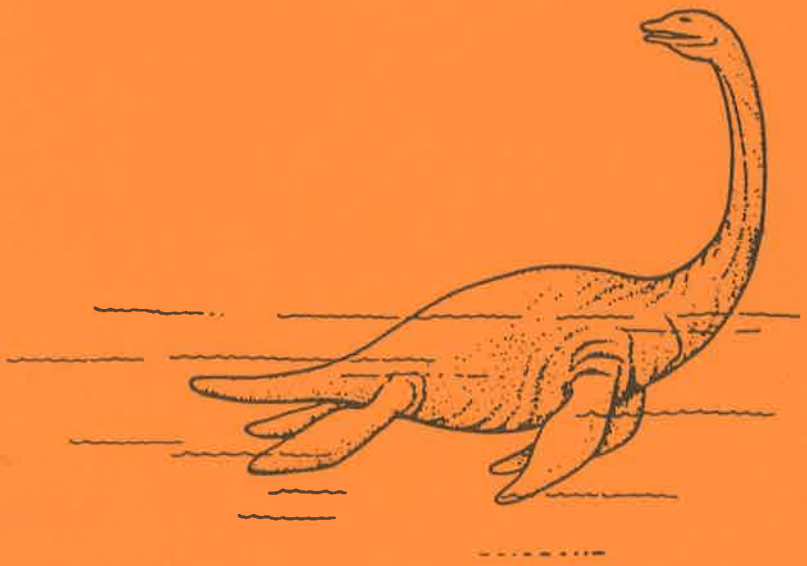
PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF GLASGOW



Sessions 124/125 1982/1983

PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF GLASGOW

Sessions 124 and 125

1982-1983

CONTENTS

MEMBERSHIP

The membership of the Society for sessions 124 and 125 was as follows:

	124	*125*
Honorary Life Members	3	3
Life Members	3	3
Ordinary Members	383	361
Associate Members	39	41
Junior Members	8	12
Total	436	420
New Members	32	36
Deletions	29	52

G. R. Thomson, A. Lawson

LIBRARY REPORTS

In **session 124** our steadfast band of regulars both consulted and borrowed books and periodicals, 24 members making a total of 158 loans between them. For these and, of course, all other Society members, a number of new books were added to the library ranging from marine geology and foraminifera, through small-scale structures to the geology of Hong Kong and to guides for selected areas of North Wales.

A major task, completed late in the session, has been the compilation of a catalogue of the periodicals in the combined libraries of Society and Department. The catalogue, now available to those requiring a copy, runs to 62 pages and includes over 700 entries covering the journals of amateur and professional societies, commercially produced journals, the publication of the Institute of Geological Societies and reports of the Irish Geological Survey and other foreign geological surveys. Theses produced in the department and the collection of bibliographical material complete the listing.

Finally, geology for holidays. I've received a number of requests during the session for geological details on holiday areas, some of which I have been able to satisfy at the time from our stock of guides. However other requests have been unsuccessful, the material not being directly to hand, although traceable given time. Therefore I have just begun to extract material of this sort and will add it to the library from time to time and issue a specialist catalogue as soon as possible. Meanwhile, I shall be glad to supply holiday geological details to members, but would be glad to be given advance notice in order to ensure success.

In **session 125** the Society's library was further expanded by the purchase of 15 new books covering a wide field; the subjects covered ranging from the evolution of plants to the interior of the earth with, of course, the usual crop of guides including one concerned with the volcanoes of the Canary Islands. These books formed part of the 230 loans to 31 members, the numbers of both loans and members being considerably higher than last year's totals.

A recent change in the library architecture is the piercing of a doorway in the far wall and the setting-up of a much-needed annexe in which to house the joint reprint collection of Society and Department. Members may like to be reminded of the fact that the collection contains upwards of 50,000 reprints on every conceivable geological subject, any of which may be borrowed in the usual way. The collection forms a valuable adjunct to the books and journals in our stock and often a reference unobtainable elsewhere may be found within the reprint range.

The penultimate stage in the cataloguing of the joint library has now been reached with the completion of the catalogue of the department's book stock — the catalogue being available for reference within the library. The remaining work involves the cataloguing of palaeontological monographs and treatises and should be completed shortly.

A recent sale of some of the books of the late Dr Adam McLean was held under the auspices of the Society, the sum raised to be put to the purchase of books on geophysics in memory of Dr McLean. £75 was raised, and the books will shortly appear on the shelves.

C. J. Burton

REPORT TO THE EDITORIAL BOARD

Volume 17 (1981) of the **Scottish Journal of Geology** was duly published in four parts totalling 306 pages and Volume 18 (1982) was published in four parts totalling 338 pages. Volume 19 (1983) will be completed in three parts, totalling 414 pages (33 papers and 11 letters). The lead time from the date of acceptance of a paper to that of its publication varied through Volume 19 in the range 4-13 months.

Financial savings of publishing only three parts per year and of printing manuscripts and plates on the same paper has enabled the editors to increase the number of pages published within the available budget. These savings, an increase in institutional subscription to £40, and the continued support of the Carnegie and Kilwarlin Trusts has kept the costs of Volume 19 to each parent Society below the £1500 target.

D. K. Smythe

PUBLICATION SALES

Session 124 was one of mixed fortunes. Although total sales (£1832) were considerably lower than in the exceptional session 123 (£3337) they did show an increase over session 122 (£1464). Sales were buoyed up by the sale of the remainder of "Geological Howlers" and the publication of "Building Stones of Glasgow" by Judith Lawson in December 1981 which sold slowly but surely.

Unfortunately there was a downward trend in sales of the Excursion Guides. Fewer Glasgow Guides were sold in the session, and there was a notable decline in orders for the Arran Guide particularly from Universities and Colleges.

This decline continued into **session 125** and led to that session being one of the Society's least successful.

The lowest sales figures for five years were the result of three factors:

firstly, the absence of the Arran Guide, the third edition of which only arrived in mid-August 1983 and was therefore too late in the season to attract much interest. All efforts will be directed to publicising the new Guide in the early spring of 1984; secondly, the continued decline in the sales of the Glasgow Guide; and thirdly, "Geological Howlers" is now out of print.

The true drop in sales of our own publications is masked to some extent by an increase in sales of other publications through the Bookshop. This increase of nearly £200 over the previous three years arises from improved sales to Extra-Mural classes and at various conferences held in the Geology Department during the year.

C. M. Farrow

LECTURES 1982-1983 (Session 125)

The first meeting of the 125th session was held on Thursday, 14th October 1982 when the inaugural award of the T. Neville George Medal was made to **Professor C. H. Holland** (Trinity College, Dublin) in recognition of his contributions to stratigraphy and palaeontology. Professor Holland then addressed the Society on **"Evolution and Time's Arrow"**, beginning by asking "What was time?". He suggested that the geological sciences provided the most impressive evidence that post time was not illusory and that evolution of living things must not be seen against the background of time's arrow (this in spite of the creationists). The beginning remained obscure but the early stages were now becoming clearer. Professor Holland declared that tempo and mode in Phanerozoic evolution were currently the subject of controversy involving the debate on punctuated equilibria verses phyletic gradualism and that the cladists were also tending to enter the ring. He presented some evidence for these arguments and concluded that the matter seemed essentially to be one of scale and that the biologists and palaeobiologists must come together in assembling, understanding, and clarifying the available data.

In November **Dr R. Hutchison** (British Museum Natural History) lectured on **"Meteorites and the Early Solar System"**. He opened by defining a meteorite as a natural object that survives its fall to Earth from space. Recent estimates suggest that the annual rate of fall is about 3,500 over the Earth as a whole, but only five or six observed falls are recovered. Some meteorites are undoubtedly fragments of asteroids, and it is possible that a few come from comets. The chondrites, stony types most commonly seen to fall, have not been melted since their formation some 4,550 million years ago. Thus they preserve evidence of conditions and events close to the time of formation of the solar system. For example, the presence in chondrites of daughter isotopes of short-lived radionuclides indicates that the matter from which the solar system evolved was seeded with debris from a supernova. The stellar explosion may have been responsible for the formation of the Sun and planets and, ultimately, ourselves.

In December, after the AGM, the retiring President, **Dr J. G. MacDonald,** gave his Presidential Address on **"J. E. Hibsch and the Radial Dyke Swarm of the Bohemian Middle Mountains".**

Professor J. E. Hibsch, a native of the village of Homole near Litomerice, in northern Bohemia (Czechoslovakia), was an important figure in central European geology during the early decades of the 20th century. This resulted almost exclusively from the detailed studies which he made of the geology of his home surroundings in the Ceske Stredohori (Bohemian Middle Mountains). One of the most remarkable features of this area is a radial dyke swarm centred on an intrusion of essexitic affinity at the hamlet of Roztoky on the banks of the Labe (Elbe). Dr MacDonald outlined the nature of these dykes, many of which are lamprophyric and undersaturated, and then described some of the new work being done on their geochemistry in conjunction with Charles University, Prague.

The fourth meeting of the session was held on the 13th January 1983 when **Dr G. B. Curry** (University of Glasgow) lectured on **"Recent Brachiopods — a Palaeontological Perspective".** In present oceans brachiopods are much more abundant and diverse than most palaeontologists and zoologists realise. As such there is considerable scope, as yet largely unexploited, for detailed ecological and growth-rate studies which would form a sound basis for palaeoecological and palaeoenvironmental reconstructions. In particular it can be shown that the structure of a population, as determined from length-frequency histograms, can distinguish between populations from different climatic zones. On a more local scale, growth variability can also be recognised by means of growth-line analyses. Such data demonstrate that fossil brachiopods would be ideal as palaeoenvironmental indicators as rates of growth can be correlated very precisely with prevailing environmental conditions. Dr Curry described examples of such growth history variability in Recent brachiopods from Scotland and New Zealand, in Mesozoic brachiopods from Antarctica, as well as examples from Palaeozoic successions in North America. He concluded with a short film on living brachiopods.

The February **Members' Night** included the following short talks:
Dr B. G. Cooksey — "The Vampire of Blairskaith Quarry"
Dr G. E. Farrow — "Cobb Seamount, N.E. Pacific"
Mr J. Jocelyn — "Recent Work on Agates"
Dr J. Lawson — "A Section at Nabb Hill"
Dr J. G. MacDonald — "Recent Volcanic Features in the Timanfaya National Park, Lanzarote (Canary Islands)"

The following exhibits were on display:
Dr M. C. Keen — "Some Carboniferous, Cretaceous and Tertiary Rocks and Fossils from Texas"
Dr J. G. MacDonald — "The Timanfaya National Park, Lanzarote"
Mr M. Simpson — "Lower Greensand Fossils from the Isle of Wight"
Mr J. Warrender — "Sulphide Ores from Outokumpu, Finland"
Mr A. Herriot — "Some Thin Sections of Igneous Rock from Lanzarote"
Mr S. Wood — "A New Shark from Bearsden"

The March meeting was a lecture by **Dr G. Evans** (Imperial College, London) on **"Mud, Sand and Shell in a Hot Salty Sea — the Persian Gulf".** In such a sea the supply of siliclastic detritus is restricted to a very small part of its coastline, and consequently it is dominated by carbonate sediments

which have been produced in situ. A distinctive suite of sediments and associated fauna is being produced which have many similarities to those found in ancient seas and which indeed have helped in the understanding of the latter.

The final meeting of the session was held on the 25th April at which **Dr C. H. Emeleus** (University of Durham) addressed the Society on **"The Evolution of the Rhum Tertiary Volcanic Centre".**

This Tertiary centre is situated on a structural high of pre-Mesozoic rocks between Mesozoic basins underlying Canna to the west and Eigg and Muck to the east. Geophysical studies show that the centre has a deep, steepsided root of dense gabbroic and ultrabasic rocks, radiometric dating places the igneous activity at c. 59 Ma.

Early activity involved intrusion of gabbros and granites, and porphyritic felsites accompanied by explosive brecciation of country rocks. Numerous basaltic dykes and some inclined sheets were also intruded at this stage. Major movement within an arcuate ring fracture involved uplift of the early Tertiary igneous rocks and pre-Tertiary Torridonian sediments and Lewisian gneisses. In a second phase of activity, a thick sequence of layered ultrabasic rocks and associated gabbros was emplaced, the layered rocks are type examples of igneous cumulates. They have been interpreted as forming from basaltic liquids beneath the present level of exposure, then uplifted in an essentially solid state to their present position, lubricated by marginal basaltic liquid. Recent studies indicate that magmas more mafic than basalt may also have been involved in the formation of the ultrabasic rocks.

Severe erosion took place after formation of the ultrabasic and associated rocks, the centre was dissected to a level comparable to that of the present day to form a hilly landscape which was then buried (and is now partly preserved) beneath a succession of tertiary lavas and sediments. Studies on the lavas and sediments together with those of Canna and SW Skye, suggest that the Skye igneous centre may have post dated that on Rhum.

CELEBRITY LECTURE 1983

The joint celebrity lecture this year was given by **Professor K. J. Hsu** (Geological Institute, Zurich, Switzerland) in Glasgow on **"Rare Events, Catastrophic Extinction, and Punctuated Evolution".** Professor Hsu stated that rare events are not rare by their nature, but rare by their size. Storms, earthquakes, landslides and impacts of extraterrestrial objects take place every year, but the frequency of unusually large events is inversely proportional to their size or magnitude, expressable by linear plot on a log-log paper. Catastrophic extinction is defined by their magnitude. A magnitude 3 extinction event, for example, implies a rate 1,000 times faster than the Lyellian rate for the Tertiary molluscs, and such events happened probably a few times only during the last billion years, marking era boundaries. The terminal Mesozoic extinction is not apparently sudden, because of imperfections of the geologic record, as Darwin postulated; it was a magnitude 3 extinction event, very likely caused by drastic environmental changes consequent upon the impact of a large comet. Natural Selection is not necessarily dependent upon adaptability to a slowly evolving

world, as Darwin advocated, but may be a consequence of random chances. Catastrophic extinction opened up niches for accelerated evolution and punctuated evolution may thus be considered an expression of such rare events.

HUNTERIAN MUSEUM BICENTENNIAL CELEBRATION

The Society participated in a Natural Science Joint Symposium to mark the Hunterian bicentennial on April 14th 1983 held in the Glasgow University Department of Geology. Other participating societies were the Glasgow Archaeological Society, the Glasgow Natural History Society, the Royal Philosophical Society of Glasgow, the society for the Bibliography of Natural History (Scotland) and the Royal College of Physicians and Surgeons, Glasgow. The programme included a talk on "William Hunter's Rocks, Minerals and Lapidaries" by Dr G. P. Durant (Hunterian Museum, Glasgow University).

125th ANNIVERSARY SOIREE, 17th FEBRUARY 1983

Council spent a great deal of time discussing how to celebrate the Society's 125th Anniversary, and finally asked the Secretary to organise a Victorian style Soirée, with music, drink, refreshments and exhibits. The obvious place to hold such an event was the Hunterian Museum, which despite a great deal of modernisation still has a Victorian aura in places. The staff of the Museum were very enthusiastic about the project and permission was kindly given by the Director, Professor Willet. The first meeting of the Society was actually held on 17th May 1858, but a date in May was thought to be a little inconvenient, so February was chosen for the Soirée. Dr Rolfe arranged the music for the evening, with waltzes and such like, although few actually danced on the dance floor specially prepared amongst the dinosaur exhibits. Mrs Ramsay baked a beautiful birthday cake, and Mrs Milne, Mrs Sword and Mrs Wood prepared Victorian style sweets and tit-bits to go with the sherry. Members were asked to come dressed in Victorian costume, and about one-third of the 150 or so who attended came dressed in a variety of costumes, some in genuine Victorian gowns or clothes, others in rather more suspect 19th century styles. Our guests from the Edinburgh Geological Society, Mr and Mrs S. Hogarth, entered into the spirit of the occasion by dressing as Victorians. There was also a photographer, complete with camera and magnesium flare, whom some believed to be Count Dracula, while others thought him to be Dr Ingham. To while away the evening members were able to explore the Museum and look at the exhibits, including one specially prepared for the Anniversary by Dr Rolfe and Mrs Pearce. This exhibit recorded the history of the Society with photographs, field note books and other mementoes, and remains on view until the end of 1984.

Such an occasion involves a great deal of work by those concerned, and thanks are due to those listed above and to the Director of the Hunterian Museum, Professor Willet for allowing us to use the Museum.

M. C. Keen

OBITUARIES

The Society is sorry to record the deaths of four members who have supported it over many years and in many ways. Our tributes are presented here, so that all our members can share our appreciation and our memories.

JAMES A. CARRICK

James A. Carrick, born on 25th March 1943 and died on 24th April 1983 after a long illness. He resided in Milngavie until his recent move to Killearn, fulfilling a lifelong ambition to live in sight of the hills he loved.

James was educated at Kelvinside Academy and served his apprenticeship as a scientific instrument maker with Barr & Stroud at Anniesland. He then worked in the family business of James G. Carrick & Co until 1979 when he resigned following the death of his father. He was then able to study a three year certificate course in geology at Glasgow University. Latterly working at the Hunterian Museum, James continued his geology studies at Open University and also field archaeology at Glasgow University.

James had a great appreciation of the countryside, and an interest in music, art, archaeology, photography and sailing and sang in the tenor section of the SNO for a number of years . He became interested in geology in his early schooldays and joined the Society in 1958. A regular attender of the Society meetings and outings, he served on the Council for three years and later became an auditor.

James was a gentleman of upright character, who will be remembered by his friends for his kindness, friendly nature and his sense of humour.

He is survived by his mother and sister.

A.I.M.C.

JOE DAVIES

Joe Davies joined the Society on moving from Bradford, where he was employed as an industrial chemist, to take up residence in Bishopbriggs. A most pleasant and helpful soul, he quickly became a valued friend of the writer. At our meetings he believed in contributing to discussions. While in Yorkshire he contributed papers dealing with Post-glacial deposits and derived fossils in the Bunter to the Liverpool and Manchester Geological Journal. But archaeology absorbed more of his leisure time than did geology, no fewer than seven of Joe's publications being listed in "West Yorkshire: an Archaeological Survey to AD 1500". Unfortunately his extensive collection of artifacts was destroyed. This led to him losing interest in archaeology and taking up Gaelic instead. He is survived by a son.

A.H.

ADAM CUMMING McLEAN

Adam McLean died on 13th March 1983. His enormous contributions to the Society and to the University of Glasgow will be remembered by many with gratitude and affection.

Adam was trained as a geologist but worked in applied geophysics with a feeling for scale and accuracy characteristic of a physicist. This combination gave him a powerful ability to see a realistic role for geophysical studies of

geological problems. His enthusiasms for Scotland and particularly the West led him to apply himself to local problems, but always with a general question in mind. He pioneered detailed gravity surveys in the Midland Valley, demonstrating the association of sag synclines with displacements on bounding faults. The regional gravity field was shown to be higher than over adjacent areas: this was interpreted as a thin Midland Valley crust or a rise below the Midland Valley of a dense lower crustal layer. Twelve years later, and at much greater expense, seismological work confirmed the latter interpretation. He then moved to sea and from gravity measurements on the floor of the Firth of Clyde he discovered two Palaeozoic basins either side of Arran. From the pattern of gravity and magnetic fields he suggested that the Highland Boundary Fault does not extend beyond Arran but is replaced en echelon by a fault to the south, probably linked with the Dusk Water Fault in Ayrshire. He brought other geophysicists and techniques to bear on those problems while continuing with gravity work. The Hebridean area was studied at sea and on land in an attempt to understand the inter-relationships of a Caledonide framework and later sedimentary basins and Tertiary centres. This was a big nettle to grasp and only now are we beginning to recognise the reactivation of old thrusts as normal faults in basin formation. Meanwhile, nearer home, a big gravity anomaly was discovered as the likely remains of a magma chamber underneath the Campsies and from which their lavas were erupted, and Adam also grappled with models of a nebulous, dense and magnetised rock mass under the Central Coalfield syncline. He welcomed the chance to bring new techniques to bear on geological problems: for example he supervised finite element stress analysis of Tertiary igneous activity which explained the pattern of dyke swarms in western Scotland.

To all this work he brought a fine ability to get people working together — colleagues and students in the Department, collaborators in the Institute of Geological Sciences and crews of research vessels. His perseverance in difficult conditions — at sea with a broken ankle and land-lubber's tummy, for example — was an outstanding example to others.

Over a score of research students in geophysics benefited from Adam's help and guidance. Where his keenly critical faculty sometimes stifled research projects which he or others had initially thought plausible, it bore rich fruit when combined with his painstaking editing of student writing in promoting their geophysical training. It was typical of Adam to take so much time over this — he really cared for students in an involved, practical way which endeared him to postgraduates, and undergraduates too. As a teacher he was so thorough and clear in his presentation that sometimes students would be lulled into a false sense of understanding, to be revealed as error in later projects, but always carefully corrected in his comments. He had a particular interest in the teaching of geology to civil engineering students. The distillation of many years' experience is to be found in a text-book "Geology for civil engineers". It may have surprised Adam, but not others, that the book of which he was co-author has become a standard teaching text in many universities and in many countries. As well as being a Senior Adviser of Studies, he was a member of the University Appointments

Committee and worked very hard with the Careers Office and external employers in finding jobs for students. Many members of staff also gained from his sound counsel and encouragement. He had a rare facility for rapid analysis and for then presenting people with what he saw as the obvious options from which to attempt solutions to their problems. he was cautious of criticism but intolerant of misused authority and would, rarely, bubble over with indignation as he fought the cause of the injured. He put his help for others before self-advancement: a model of altruism. He also had a broad view of life and diverse interests, and read avidly. He stimulated debate in a wide range of matters in the Department's common room and, from his Fabian viewpoint, nearly always had an answer — he was departmental lead pundit!

The breadth of his interests, his perception of how scientists and projects could be fitted into a large framework, together with his benevolent attitude in critical appraisal, won many invitations to external examining (especially MSc courses at Leeds and Durham) and committee work in the Royal Society and Natural Environmental Research Council.

Adam's keen sense of professional responsibility credited the Geological Society of Glasgow with a large measure of support over many years. He was an editor of the Transactions of the Society from 1959; a founder editor of the Scottish Journal of Geology begun in 1965; President of the Society during 1967-70 and at various times Vice President or Council Member. These bald facts do scant justice to uncountable contributions in all aspects of the Society's affairs and while I remember especially those velvet-gloved questions posed to visiting speakers on wintry Thursday evenings, others no doubt would recall his interest in the "amateur" membership often expressed by his company on summer field excursions.

Adam Cumming McLean was born in Ayr on 19th December 1926. He was educated at Ayr Academy and graduated with First Class Honours in Geology at the University of Glasgow in 1948. He joined the Royal Dutch/Shell Group of oil companies and worked as a seismologist in Venezuela and the Netherlands. He returned to the University in 1954 to take up a Lectureship and was promoted to Senior Lecturer in 1962.

Adam will be sorely missed by us all. To Beatrice, an associate member of the Society, and to Colin, Eileen and Alan, we extend our condolences.

J.H.

TOM NAISMITH

The passing of Tom Naismith on 2nd January 1983 will be noted with deep regret by members of the Geological Society. Through the years he faithfully supported all the various activities of the Society. His cheerful, modest manner endeared him to all his many friends.

As a leading light in the very successful West of Scotland Mineral and Lapidary Club, he demonstrated his ability as an efficient organiser and also his own art as a craftsman. As a staff member of Scobie and McIntosh, his friendship was shared by all nationalities in the restaurant trade.

He will be long remembered, perhaps not so much for his many quiet talents, but for the happiness that he so lavishly spread amongst the many who knew him.

E.R.

EXCURSIONS 1982 (SESSION 124)

KILLIN/TYNDRUM: 21st August (Leader: Mr R. Willan)

This rather wet excursion was a follow-up to the successful Aberfeldy trip held in session 123, which was not completed. The first location visited was in Glen Lochay and provided an opportunity to study the Ben Lawers Calc-Schists. The second location was in the Middle Dalradian with not only an exposed pyrite horizon in the Ben Lawers schists, but also an altered carbonate rock in the Ben Lui schists containing unusual chromium and nickel mineralisation.

After lunch at Anchertyre Farm the party visited the Tyndrum area.

TURNBERRY/DUNURE: 11th September (Leader: Dr G. Durant)

Starting from Turnberry harbour, this stimulating excursion to the Lower Old Red Volcanics coastline of Ayrshire gave us the opportunity to study the relationship between the volcanic action and the sedimentary rocks. There was some evidence to suggest that the volcanics were not in fact lava flows, but sills emplaced in the wet sediments.

Lunch was taken at Culzean before going on to Dunure where searching for agates provided the most entertainment if not reward.

JOINT MEETING OF THE GEOLOGICAL SOCIETIES OF THE BRITISH ISLES

The Society provided excursions on 26th and 27th September as part of the 5th meeting of the Societies. Drs Bluck, Curry and Ingham led a party to **Balmaha** and **Aberfoyle**; Dr Lawson led a party round the Lower Carboniferous of the **Glasgow** area, and the next day Dr Bluck and Dr Ingham led the Society to **Girvan** on an eventful excursion.

EXCURSIONS 1983 (SESSION 125)

DUNOON-INNELLAN-TOWARD: 7th May 1983 (Leader: Mr W. G. Henderson, IGS)
by I. Allison

On a wet, misty Saturday morning five members assembled in North Frederick Street for the first excursion of the 125th session. Our numbers swelled to six as we took the ferry across the Firth of Clyde to our first locality at Hunter's Quay. Here we saw deep water sedimentary rocks, the Ben Bheula Schists, which, from evidence of graded bedding, were inverted. The dominant cleavage crossed bedding at a low angle and was downward facing. At the second locality some 300m south of the pier Mr Henderson pointed out that the dominant cleavage was a second tectonic fabric and in the microlithons between the cleavage planes traces of the earlier cleavage could be seen. Mr Henderson explained the various techniques that are used

in the structural analysis of such multiply deformed rocks and how, in this case, the second deformation had the same symmetry or kinematic framework as the first.

The party drove south through Dunoon to Bethania House to examine a short section of Dunoon Phyllites. Graded bedding again indicated inverted strata. Some 100m south we viewed a large quarry worked in the Bullrock Greywacke which, we were told, has right-way-up bedding and in this short distance we had crossed the axial trace of the Aberfoyle Anticline.

Lunch was taken at Innellan where 100m or so south of the pier we encountered the first rocks of the Highland Boundary Complex which have been the subject of a number of publications by our leader. Here there occurs a sheet of foliated antigorite serpentinite and the party found the contact metamorphic effects in the metasandstones within a couple of metres of the contact of particular interest. A mineral lineation defined by elongate porphyroblasts in the contact metamorphic rocks is parallel to the dominant mineral lineation in the Dalradian rocks elsewhere and implies that the rocks of the Highland Boundary Complex share a considerable period of deformation with the adjacent Dalradian. Moving south to Toward we saw three separate sheets of serpentinite in contact with metamorphosed Dalradian greywackes.

As the day progressed the morning mist broke up and we experienced a warm sunny day until at Toward we were caught in heavy showers. The final stop was a visit to the talc mine at Toward-Taynuill where we saw an adit and two shafts, now filled in. Samples of the ore which is not pure talc were found on the adjacent dumps. If any member has any information about the working of talc here in the 1920's I would be interested to learn of it and to pass on the information to Mr Henderson.

ISLE OF MULL: 27th-30th May (Leader: Dr G. Durant)
by J. Jocelyn

A party of eight travelled by train, boat and car to arrive at Tobermory for the Whitsun weekend. We stayed at the Tobermory Guest House which proved very satisfactory in both catering and comfort.

Saturday saw us away at the break of dawn to the south shore of Loch Na Keal to view differential erosion of dykes in the Tertiary lavas through glaciation. From Griben for a look at Moinian psammitic gneisses, we went on up a burn to view a lovely series of Triassic agglomerates which overlie unconformably the Pre-cambrian rocks and are succeeded by Rhaetic, Upper Cretaceous and Tertiary sediments. The last stop was at Carsaig Bay where a wide variety of fossiliferous Lower Liassic sediments were examined along with the xenolithic Radh' a' Chromain sill.

We visited the Central Tertiary Complex on the Sunday and, in new road cuttings north of Craignure, saw the layering in the Corra Bheinn gabbros, dykes cut with pegmatitic patches, ring dykes, together with cone sheets and composite sheets. We also saw, would you believe, eight cuckoos sitting on a telephone line close to the cutting.

On the final day we visited the Ross of Mull granite near Bunnessan,

kyanite gabbros at Visken and the Ardtun Peninsula where our last stop was to examine interbasaltic sediments and columnar jointed lavas.

The weather was excellent throughout. The group, though small, was most enthusiastic and our leader most patient and extremely helpful.

KILPATRICK HILLS: 18th June (Leader: Dr J. G. MacDonald)
by Bob A. Hill

About 25 members assembled in Old Kilpatrick on 18th June, a fine but slightly hazy morning. After leaving the vehicles at the foot of the Kilpatrick hills, we began a leisurely ascent, with pauses to admire the view of the Clyde and the Erskine Bridge.

At our first location we examined a fine example of a red bole situated below a Jedburgh basalt lava flow while a few adventurous members investigated nearby ashy shales containing thin coal and plant remains. We next looked at evidence of faulting in an old quarry and remarked at the folly of the location of this quarry.

After stopping for lunch on the banks of Loch Humphrey, we followed the Loch Humphrey Burn pausing to examine coarse bedded ashes. Members enjoyed the warm June sunshine while searching for an elusive barytes vein in a burn running into Greenside Reservoir, however we were more fortunate in our search for zeolites below the reservoir.

The party then climbed up to Burnbrae Reservoir, which fortunately had been emptied for repairs allowing us to examine the outcrops that occurred on the reservoir bed. We were shown some curious structures including evidence of ropy lava (pahoehoe). We then returned to the vehicles after an excursion that had been an excellent survey of features of the Clyde Plateau lavas that was enjoyed by all.

WESTPHALIAN A SEDIMENTOLOGY IN CLACKMANNAN AND AROUND AIRDRIE: 25th June (Leader: M. Kirk)
by Mrs E. Henderson

We were favoured with a bright sunny day for our visit to the Lower Coal Measures, and 13 members presented themselves for a nine o'clock departure at North Frederick Street. First stop was at Thornyhill Opencast Mine (NS 992934), where work was in progress and surface mining techniques were briefly outlined. After a "chassis"-testing journey by Landrover to the main exposures, we gathered for an on-the-spot interpretation of strata associated with the Glenfuir to Coalsnaughton Main coals. Our leader pointed out structural evidence for a very varied assemblage of depositional environments, and assisted us to the conclusion that the sediments had been laid down in a fluvial rather than a deltaic setting.

After picnic lunch at the Pine and Oak (complete with Pipe Bands), we proceeded to Greengairs Opencast Site (NS 770770), where ripple-marked sandstone, extensive lake deposits and low-alumina seat-earths suggested a rising water level in the basin under study. Dalmacoulter Quarry (NS 767678), provided us with rarer brackish-marine environments, including the Queenslie Marine Band, and finally at Shoots Burn (NS 802625) we

returned to floodplain and lake deposits at levels equivalent to those already encountered at Thornyhill and Greengairs. The overall picture was of deposition on a coastal alluvial plain.

Finds included plant fossils, marine and non-marine bivalves, and at Dalmacoulter, some excellent cone-in-cone structures. Happily the "black rats" failed to put in an appearance at locality 4, where we were advised to tuck our trousers tight into our wellies!

FALKIRK AREA: 27th August (Leader: M. G. E. Browne, IGS)
by Rosemary McCusker

On the 27th August five worthy members of the Society set off from North Frederick Street hoping that our number would be increased at Kincardine Bridge where we were to meet our leader.

Mr Browne had brought four children with him and also present were three Society members and one child. With our numbers thus increased we set off in lovely sunshine — the sort of weather we had come to expect as the norm for the summer of 1983.

The rocks of the area visited are of Upper Carboniferous age belonging to the Lower Passage Group and consisting of a number of cycles of upward fining sandstones, grading to silts and muds. The mudstones in some areas contain more than 40% alumina and are worked as fireclay.

Our first stop was at the drowned Birkhill Fireclay mine. Mr Kane, the former manager, showed us round and we had an interesting discussion on different mining methods. In this particular mine the stope and room method had been used. Stigmarian rocks, some very large, could be seen in the walks and the roof.

After our spell in the mine we were quite happy to return to the lovely sunshine and eat lunch, all the while being attacked by wasps.

We then took a short walk to the River Avon to look at a typical marine band limestone before going off to Grangemouth where we became archaeologists. We spent an interesting time examining a kitchen midden left by our Palaeolithic forebears some 6,000 years ago, when the level of the Forth estuary was considerably higher than it is today.

We finished this most enjoyable day at Bo'ness with a demonstration of how things can go wrong in mining. We stopped at the spot where part of the Town Hall disappeared in 1885 due to a cave-in in the underlying coal mine. The rest of the building had to be demolished.

In all we had a most interesting day with a pleasant mix of geology, archaeology and history. As this was the third in a series of trips conducted by Mr Browne it is to be hoped that we can look forward to number four next year.

DALRADIAN AT ABERFOYLE: 10th September
(Leader: Dr R. Anderton)
by Nancy MacGregor

The weather was atrocious when we started this excursion; however at Aberfoyle it had improved slightly and at our first exposure on the Duke's

Pass the rain stopped and we were blessed with an excellent day for some rough walking.

The geology of the Dalradian is very complex and it was thanks to the excellent explanations from Dr Anderton that it became understandable. It was not long before we were all finding the dip of bedding, the way up of the bedding, first cleavages, later cleavages, sedimentary characteristics, graded bedding etc. in the Aberfoyle Slates, the Ben Ledi grits, and Ben Leny grits. Outcrops on a forestry path revealed many features of the shales, and the grits were well exposed in a quarry. As the normally narrow burn was in spate, a longer detour was necessary to start up the arduous climb of about 600 ft through the forestry to the Craigmore Hills.

The view from the top was quite fabulous. We could see as far as Grangemouth in the east, Callander, Ben Ledi, and the mountains of Perthshire on which Stobinian had its first winter snow. From this ideal position looking towards the start of the River Forth, and towards Glasgow you could see all the relationships of moors, agriculture and forestry with the ORS, schists, and the Dalradian rocks. All the Quaternary features were explained and the HBF discussed and for good measure we were given a history of the Tramline which transported the shales from the large quarry on the Pass.

Mapping out the Aberfoyle anticline is extremely difficult, but we did see traces of graded bedding and traced the junction of the grits and the shales; the opinions of the 12 students who climbed the hill was of tiredness, but extreme pleasure at having had such clarity of weather, such good interpretations from Dr Anderton and such excellent geology.

HOWLER

"... the other method would be to randomly drop a geologist from a helicopter ...'

— an exam answer recorded in a lecture programme supplied by RN lecture team.

T. NEVILLE GEORGE MEDAL

At the opening meeting of the 125th session on 14th October 1982 the first award of the T. Neville George Medal was made in the Geology Department Lecture Theatre, University of Glasgow.

The citation was delivered by Professor B. E. Leake who said: Mr President, Professor Holland, Ladies and Gentlemen: It gives me exceptional pleasure to present the citation to accompany the first award of the T. Neville George Medal to Charles Hepworth Holland, Professor of Geology and Mineralogy at Trinity College, Dublin University.

In preface I would remind the Society that this is a memorial medal, subscribed to and founded by the very many friends, old colleagues and former students of Professor George with the formal phrasing being "The T. Neville George Medal will be awarded from time to time for distinguished contributions to any field of geology, with preference for stratigraphy and palaeontology".

Professor Holland has a most distinguished record of stratigraphical and palaeontological research on Silurian rocks and I am sure that everyone here tonight will agree that it is hard to think of a more appropriate person to whom to make the first award of this medal.

Professor Holland graduated from Manchester University in 1950 under Professor W. J. Pugh achieving a first class Honours degree in Geology. He became a postgraduate student and then assistant lecturer at Manchester but in 1953 he accepted a lectureship in palaeontology and stratigraphy at Bedford College, London where he remained until he was invited to the chair at Trinity College in 1966.

From the beginning of his researches the main thrust has been concerned with the stratigraphy, palaeontology and sedimentology of the Upper Silurian and Lower Devonian rocks. His PhD work, started at Manchester under Dr Straw and completed at Bedford, was concerned with the Ludlovian and Downtonian rocks of the Welsh Borderland near Knighton, Radnorshire. From these early days he has had close friendship and collaboration with Dr James Lawson of this Department — indeed no less than six of his first dozen publications were co-authored with Jim Lawson. Vic Walmsley was another early collaborator. This group were the prime movers in establishing the very well known Ludlow Research Group which has been so active for over 25 years.

This research focussed Charles Holland's interest on stratigraphical classification in general and the problem of defining the Silurian to Devonian boundary in particular. This problem led him into international work involving much travel and contact with biostratigraphers on a worldwide basis. Although his published work — now reaching about 80 papers and books — is largely concerned with British and Irish rocks he has visited Belgium, Czechoslovakia, France, East and West Germany, Hungary, Italy, Poland, USSR including Siberia and the famous Estonian sections, Spain, Sweden, Switzerland, Yugoslavia, Canada, United States, Morocco, China, Norway and Australia so that he has acquired a worldwide synoptic view of parts of the Lower Palaeozoic and Devonian successions of the globe.

Two most important papers were the 1965 Geological Magazine articles in which he proposed that the boundary between the Silurian and the Devonian should be the now internationally-accepted solution of using the *Monograptus uniformis* zone. As Chairman of the Geological Society's stratigraphy committee Professor Holland took the lead in the preparation of the Special Report series dealing with the stratigraphical guides to the British Isles and the Silurian Report was the first published in 1971 — "A correlation of the Silurian rocks in the British Isles". He also has the distinction of being the only senior author to be involved in the preparation of three of these Special Reports and the best seller "A guide to stratigraphical procedure", published in 1978 was largely based on an earlier paper by Professor Holland. Without his continuing efforts it is doubtful if the series would have been completed by now. Concern with stratigraphical nomenclature was of course a matter very close to Professor George's interests and indeed Professor Holland published joint papers with Profes-

sor George on this subject. At present Professor Holland is Chairman of the Subcommission on Silurian stratigraphy which has been attempting to standardise Silurian chronostratigraphy.

1971 also saw the publication of the first volume of the ambitious series "Lower Palaeozoic rocks of the World" entitled "Cambrian of the New World" in which he is the series editor. This was followed in 1972 by the "Cambrian of the British Isles" and in 1981 by volume three concerning the Lower Palaeozoic rocks of the Middle East, Eastern and Southern Africa and Antarctica. As if editing this series was not taxing enough he has also jointly edited the Geological Society's massive exposition on "The Caledonides of the British Isles — reviewed" and he was the prime mover, instigator and editor of the recently published "A geology of Ireland" which is part of the Scottish Academic Press's three volume series on the geology of Scotland, England and Wales and Ireland. The Silurian rocks of England and Wales are also dealt with by Professor Holland in the volume of that title but this has yet to appear.

It would however be misleading if I were to give the impression that editing and sitting on stratigraphy committees constitutes an exclusive chronozone in Professor Holland's career. He has made very substantial contributions to the geological mapping of the Silurian rocks of Ireland and indeed set up the Irish Silurian research project which has resulted in the re-mapping of most of the Silurian inliers in Ireland by himself and with a succession of research students. He has mapped in the Dingle Promontory, the Slieve Bloom mountains and recently in the Cratloe Hills. He has also worked on the Old Red Sandstone in Ireland — unable, you observe, to stray far from the problems of the Siluro-Devonian boundary; attracted back in an almost symbiotic relationship.

His palaeontological work must not go unmentioned. He has been specially concerned with the graptolites and nautiloids and a measure of the standing in which his work is held is simply made by the fact that he has been President of that very exclusive group of enthusiasts — the Palaeontological Association. He is also a member of the distinguished Royal Irish Academy and he has an MA degree from Dublin University.

Throughout all this research activity he has run the Geology Department at Trinity, served on numerous Irish and British and College committees, is currently Dean of Science for instance, has been Chairman of the Irish National Committee for Geology and yet is reputed to be always approachable by his staff and students.

Professor Holland: You have made an outstanding contribution to the advancement of British and Irish stratigraphical and palaeontological geology and you are a worthy recipient of the First award of the Thomas Neville George Medal. Moreover I am confident that if Professor George could have been consulted he would have unreservedly approved the choice of your name.

The President, Dr J. G. Macdonald, presented the medal and certificte amid sustained applause. Professor C. H. Holland replied briefly recalling in particular his association with, and admiration for, the late Professor T. N. George.

SANDSTONE QUARRIES IN GLASGOW

by Judith Lawson (Paisley College)

Introduction

In Glasgow many quarries both large and small were worked to extract sandstone for building purposes. For the majority of these there is now no surface expression of their presence and it is only by studying old maps and records or by obtaining information from new site investigation that their position can be located. This paper is an attempt to record the positions and geological horizons of some of the larger, longest worked quarries and to trace the pattern of development as it related to the growth of Glasgow as a major city. Only the sandstone quarries are described although a few other rock types were also quarried: there were, for example, large dolerite quarries in the neighbourhood of the Necropolis hill. Quarries are ephemeral and there would certainly have been many small ones which were never recorded. Others are known by name but their sites are not known. The main area covered here is shown in Fig. 1. "Glasgow" is used in a wide sense to include many of the burghs which had, or still have, a separate existence from Glasgow *sensu stricto*.

History of quarrying

In Glasgow a rapid increase in population occurred in the 17th to 19th centuries. After serious fires in the mainly thatched timber or wattle and daub houses in 1652 and 1677 it was decreed by the authorities that all buildings should be built of non flammable materials: bricks, stone and slate. Before this time only a few larger, more important buildings in this, then, small town had been built of stone. Glasgow Cathedral, Provands Lordship and Haggs Castle are such examples still in existence. Extensive good brick-clay deposits were fairly rare so that much use was made of the local sandstone which often occurred near the surface. A common operation was to dig and make bricks with the surface drift deposits and then to quarry the sandstone exposed underneath, an added bonus occurring if coal was also present. It was possible for Defoe (1727) to write that "The houses are all of stone — 'tis the cleanest and beautifullest, and best built city in Britain, London excepted".

The earliest quarries which supplied the cathedral appear to have been in the area north of George Square and there is also a record of a court case in 1574 (Regality Club Vol. 1, p. 123 in a reference to old records) concerning "a querrell hoill of Ramishorne" in the same area, although the exact locations are not known. By the beginning of the 18th century the rapid growth of the city (the population rose from c. 12,000 in 1700 to 80,000 in 1800) and the consequent demand for stone resulted in new quarries developing. In Glasgow itself Cracklinghouse quarry, near the area where the candlemakers rendered the carcases for tallow, and the Town quarry (Figs. 1 and 2) probably date from or were much enlarged at this time. Cracklinghouse was exhausted by 1790 but the Town quarry continued to operate well into the 19th century. These quarries were situated uphill of the main building area so that transport, always a costly item in the production

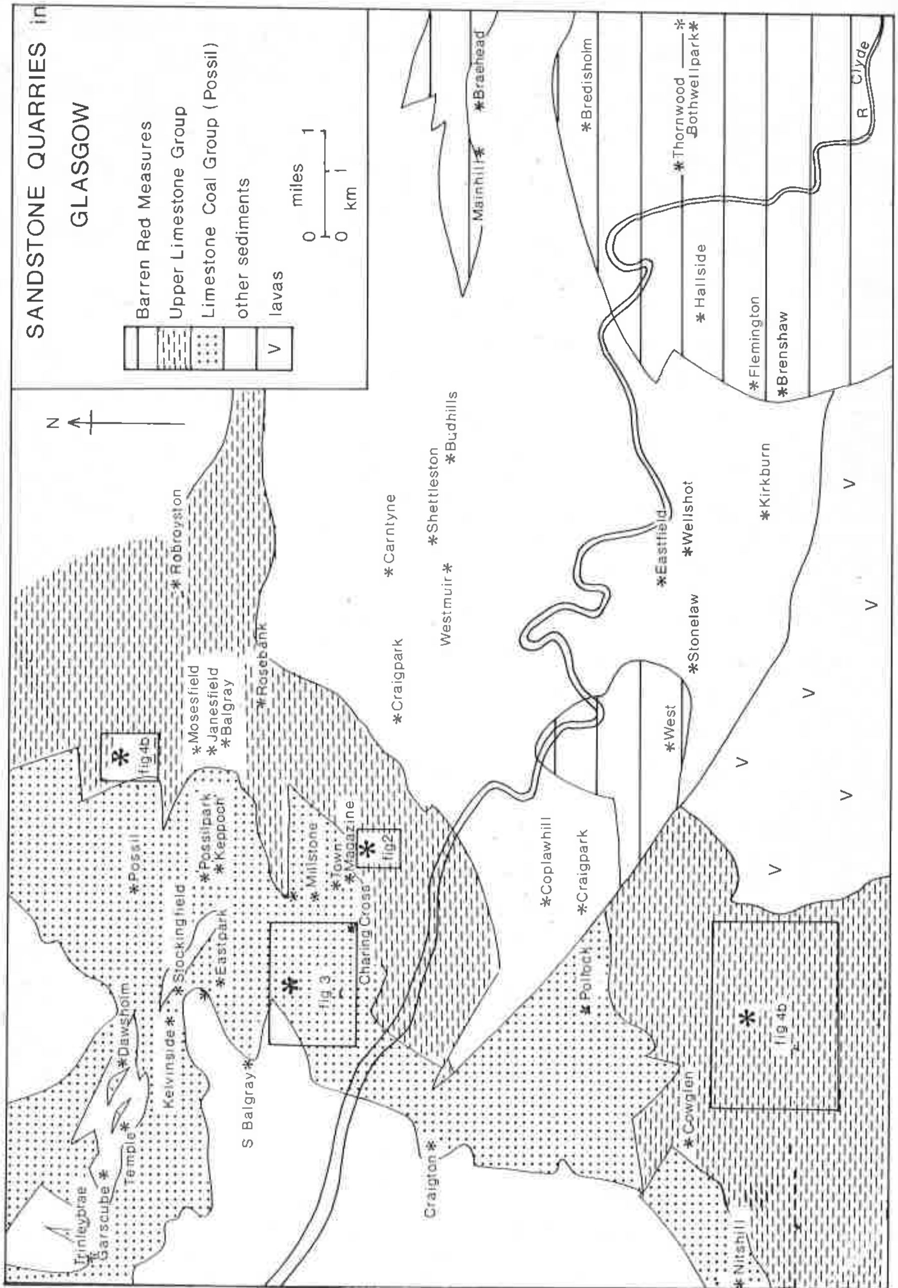


Figure 1: Sandstone Quarries in Glasgow. The positions of the larger quarries and also the relation of the other figures to the Glasgow area are shown.

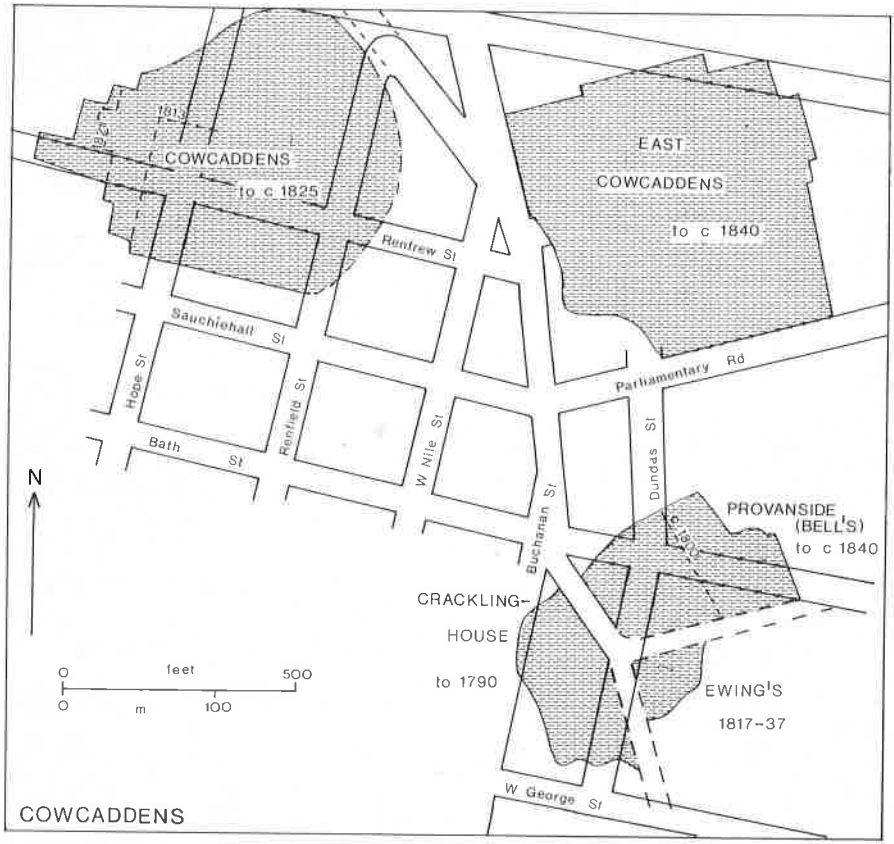


Figure 2: The sites and approximate dates of working of the Cowcaddens area north west of George Square. Present roads (solid lines) and some of the older roads (dashed lines) are also shown.

of stone, would have been relatively cheap. For the same reason of cost some quarries which increased in importance in the second half of the 18th century were those conveniently placed near the newly cut canals. Garscube quarry (Fig. 1), owned by the Campbell family, close to the Forth and Clyde canal and only seven miles from Bowling, the port on the Clyde, flourished for many years. Its "warm, creamed coloured" stone was exported to Ireland and the West Indies. It was used for many mansions including Garscube and Blythswood Houses and can still be seen in Greenock Custom House built in 1820. In 1845 (New Statistical Account, vii p. 57) 20,000 cubic yards (nearly 40,000 tons) were produced and 68 men were employed. The Humbie stone used in the extension to the Royal Exchange in 1828-29 was presumably also transported by river and canal from Linlithgowshire (now in West Lothian).

Towards the end of the 18th and in the early part of the 19th century there was an even greater rise in population, to 395,503 by 1861, and many more quarries were opened or again expanded, including the vast quarrying area of Cowcaddens (Fig. 2). East Cowcaddens, Provanside (also known as Bell's Park) and James Ewing's quarry opened in 1817 in the grounds of his newly acquired mansion at the head of Queen Street, were situated to the east of Buchanan Street and Garscube Road. Stone from these quarries, including "a large quantity of very fine" (i.e. good) "white stone — many fronts were made out of it" (Cruikshank, 1879, p. 82) from Provanside, was widely used in the centre of Glasgow and can still be seen in many buildings including St Andrews Church (1756), and many of the houses on the hill rising up to Blythswood Square. The larger Cowcaddens quarry to the west produced a rather coarser stone which was not of such good quality. This was visible recently during excavations for the new Skean Dhu Hotel. Stone also came into the city from Possil and Woodside (it was used in Hutcheson's Hospital in 1802) but only very occasionally from further afield. Giffnock stone, later to be so well known, from Eastwood quarry, was however used for the column on which the statue of Sir Walter Scott, erected in 1837, stands in the centre of George Square. The quarries in Cowcaddens became exhausted and in the 1840's, with the various railway companies competing for space for their new termini, Provanside and Ewing's quarries became part of Queen Street station, while East Cowcaddens was sold to the Caledonian Railway for Buchanan Street station. A network of new streets, created as Glasgow continued to spread westwards, covered the area so that no surface trace was left of the quarries.

In the towns formerly (or still) beyond the city boundary there were many quarries. In the east, near Cambuslang and Rutherglen, there were many quarries, mainly used locally. In the west, quarries at Nitshill and Craigton, and particularly in Partick supplied much stone. In Partick (Fig. 3) there is a long history of quarrying until the 1870's. In the early part of the century Archibald Bogle, who had bought the land on the west of Gilmorehill, opened a quarry in the NE corner of what is now the Western Infirmary which had become "a bush fringed pool" (Regality Club, iii, 1899) by 1850. The east side of Byres Road was extensively quarried by James Stewart (near Great Western Road) and by R. Cruikshank a little further south. The first was filled in in the 1870's while the latter was built over by 1860. James Dick operated the Woodside and Kelvingrove quarries at about the same time (Cruikshank, 1879, p. 80).

There was a quarry at Partick Bridge, whose stone was analysed by Bloxam (1862, p. 45). Dowanhill quarry, shown on Napier's (1873) map of Partick in 1820 was later recorded as producing about 8,000 tons in 1858 (Hunt, 1860). When the new University was being built a quarry was opened on Gilmorehill very close to Bogles quarry and worked from 1867-71. This produced stone for the main walls of the University at a rate of about 200 tons a day (Young, 1869).

With the arrival of the railways in the 1840's transport of low value, bulky materials like stone immediately became much easier and quarries some distance from the city developed greatly at this time, also there was less

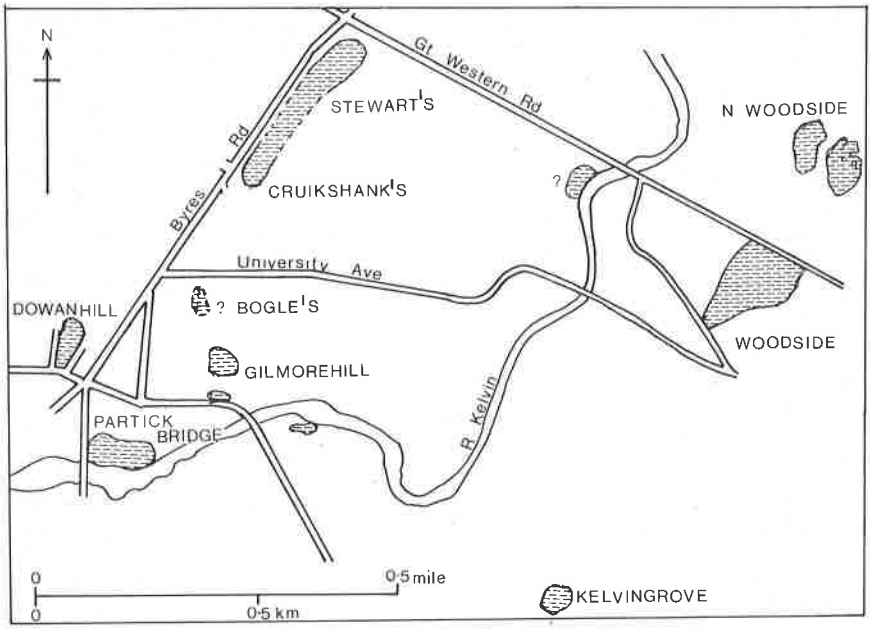


Figure 3: Quarries in Woodside and Partick in the 19th century. Some of the roads are shown as they were when the quarries were operating.

demand for building land further from the centre. Giffnock, Bishopbriggs and the area south of Stirling produced enormous quantities of stone, particularly in the 1860's and 70's. At Giffnock in 1845 (New Statistical Account, vii, p. 35) only three quarries are mentioned and one of them is "newly discovered". However by 1858 (Hunt) when figures were first published eight quarries, producing between them some 144,400 tons p.a. are listed. As building continued apace in Victorian times the quarries expanded enormously. A comparison of the area of quarries shown on the 1st and 2nd edition O.S. 6″ Maps shows this clearly. Virtually the whole area of Giffnock had been quarried by the end of the century when most of the quarries had been worked out. Only Braidbar quarry continued to any extent and finally closed in 1910. Figure 4a summarises this information.

A similar pattern is shown by the area of Bishopbriggs. Crowhill quarry was opened in the early part of the 18th century by Carmichael. Later he tried, not very successfully, to get damages from the railway company when the new line was built through the middle (Cruikshank, 1879, p. 81). In 1858 116,000 tons were produced, the area became covered by quarries but by 1900 only one quarry, Huntershill, was still operating, finally closing after a roof-fall, in 1908. Both of these areas probably employed over 1,000 men in their heyday. For comparison, only 79,400 tons were produced from all the smaller quarries in the centre in 1858. So much building was going on in Victorian Glasgow (the population had reached 565,829 by 1891) that a

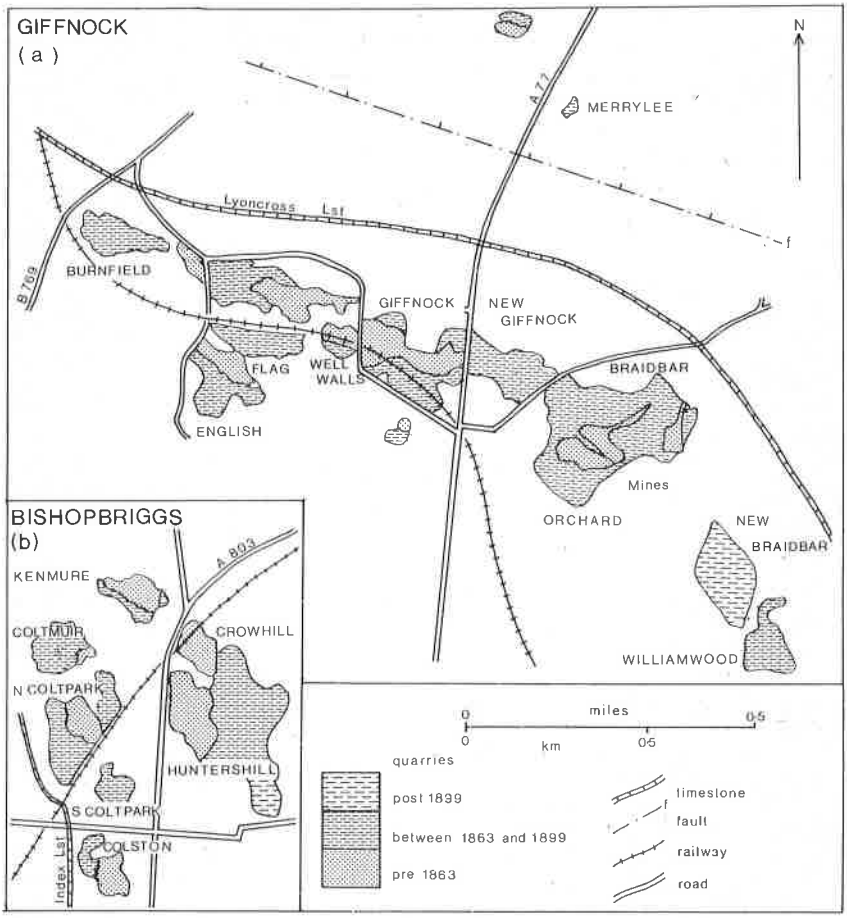


Figure 4: Giffnock and Bishopbriggs showing the sites of the earliest quarries, the maximum extent in the second half of the 19th century and those which were still being worked in the 20th century.

considerable volume of stone was also brought from the Dunmore/Polmaise quarries near the village of Cowie in Stirlingshire and from Overwood, near Stonehouse in Lanarkshire. Many buildings using these sandstones can be seen in George Square and the centre of Glasgow including the City Chambers and the Stock Exchange.

By the 1890's many of these quarries were running out of reserves and again new sources of stone were sought. In the 1890's red sandstones from Ayrshire and Dumfriesshire were commonly used. Quarries which in 1858 were only producing about 16,000-20,000 tons p.a. for local use (and perhaps employing about 100 men) were in 1898 (List of Quarries) employing 309

men in Mauchline and 1,194 men in Dumfriesshire. In Giffnock the numbers had been reduced to about 200. Other stone was brought in from the north of England, from Blackpasture, Prudham and Blaxter. After the First World War very little stone was used.

Methods of quarrying

An interesting source of information about the older quarries are the plans produced by the Kyle firm of surveyors over many years. Some plans show how the land was rented out to masons or builders while in some an estimate of the volume of rock is given. A very detailed plan of Cowcaddens quarry in the Glasgow City Archives department shows how the area was worked from 1811, when nine plots, each 36.3′ by 113.2′ were set out. Each of these measured 12 Scotch Falls, a unit often used, which was 36 square Scotch Ells, a Scotch Ell being 37.2″ long, so that each Fall had an area of about 346 square feet. Later, more irregular additional plots were added up to 1821. Working continued a little after this time but a map of 1828 shows the area covered by roads. Other quarries were surveyed in a similar way. Provanside (Bell's) quarry was surveyed in 1821 and 1822 as new working faces were rented out in its eastern part. A water colour by William Simpson (1899) of this quarry before it was filled in shows clearly its appearance and method of working. The vertical walls were about 60′ (20m) high. Rectangular blocks of sandstone partially cut out can be seen at the bottom of the eastern face. It was common to dress the stone roughly *in situ* before cutting out the blocks by plug and feather methods. Simple cranes (there were five here at one time) were used to lift the stone, which was then transported by horse and cart. About 20 men were employed here at this time (Cruikshank, 1879, p. 82). A tunnel is shown connecting this quarry with the adjacent Ewing's quarry to the south. Rottenrow Loan which is shown isolated on a narrow spine of rock between the quarries was eventually lowered and the quarries filled in or made into stations. Parliamentary Road was then built over them.

Most of the quarries were wholly opencast but if a particularly good "post" i.e. bed of sandstone was found it would often be mined. A Kyle plan (1820) of Coplaw Park on Pollockshaws Road has a note that some stone was wrought by mining. Nitshill, Huntershill at Bishopbriggs, where a roof fall finally brought about its closure, and Giffnock were all, in part, mined. At Huntershill galleries 50′ (16m) high occurred while at Braidbar in Giffnock the galleries were 40-50′ (13-16m) in height and about 16′ (5m) wide (Bell, 1881). The galleries had straight walls and a semicircular arched roof and were lit by naphtha lamps. At Giffnock the mines connected Braidbar and New Braidbar quarries, completely undermining the hillside between. The mines were first opened up by miners who cut in horizontally and then by quarrymen who worked downwards (Clough *et al*, 1911, p. 237). Visits to the Giffnock mines appear to have been a favourite excursion for Glasgow Geological Society members.

Building stone would originally have been cut with hand tools, but later compressed air tools and mechanically driven saws would also have been used. A more detailed account of quarrying in Scotland is given by Fisher

(1976). The stone was roughly dressed *in situ*. A variety of finishes were possible ranging from smooth, polished ashlar blocks to those tooled in parallel lines, punched or picked with a chisel, vermiculated or left with a rough rock facing. Probably much of the rock quarried would have been unsuitable for building and would have been used as fill or crushed for sand.

Geological horizons of the sandstones

The sandstones which were quarried were often individually quite thin beds. The section given for the University quarry at Gilmorehill (Young, 1869, p. 301) shows five beds of sandstone ranging in thickness from 3¾′ (1m) to 12′ (2 fathoms, 4m) amongst 28 other beds which included coals, fireclays and shales. In the Town Quarry (Kyle plan) three beds of sandstone made up a total thickness of about 30′ (10m) with coal and fireclay also present. Very seldom were beds as thick as those at Giffnock (30′, 10m), Bishopbriggs (60′, 20m), Kirkburn (35′, 11m) or Nitshill (26′, 8m), although these quarries produced a far greater total volume.

Sandstones were quarried in all formations of the Carboniferous but some horizons provided more, of better quality, and the larger quarries were concentrated in these. An important group, mainly of fairly small size, occurred in the upper part of the Limestone Coal Group, the Possil Sub-group. These supplied much of the stone used in the west of Glasgow, for example, in Partick, Craigton and Woodside. The beds are relatively thin and frequently show ripple laminations marked by organic layers (Lawson, 1981, pl. 4b). Typical stone can be seen in the walls of the University of Glasgow (Lawson, 1981, pl. 7b). Some beds, particularly near the Knightswood Gas Coal, were more uniform, a section at Eastpark quarry (Clough *et al*, 1911, p. 31) showed 14′ (4m) of hard sandstone below the coal and 5′ (1.5m) above. Near the top, just below the Index Limestone, there is often a coarse, gritty layer. This was quarried for millstones at John Baird's Millstone quarry (Fig. 1).

Some of the largest complexes of quarries occur above the Index Limestone in the base of the Upper Limestone Group. At Bishopbriggs up to 60′ (20m) of white, weathering honey-coloured freestone was quarried and Garscube, the Cowcaddens area and also Plean, in Stirlingshire, were at the same horizon. At Bishopbriggs a basal conglomerate occurs but is only a few inches thick but further south its thickness increases considerably. A conglomerate occurs in the Cowcaddens quarry and to the south of the CLyde where it is known as the Barrhead Grit. A little higher in the succession, just above the Lyoncross Limestone, very good quality freestone, the Giffnock Liver Rock, outcropped locally in Eastwood parish, at Giffnock. Higher again, below the Calmy Limestone, the area around Cowie, in Stirlingshire, was extensively quarried.

All these quarries produced white or cream stone. St Andrews Church (1756) clearly shows that more than one source could be used in a single building as both freestone and the characteristic ripple-laminated stone can be seen. Around Blythswood Square and in West George Street the contrasting sandstones can often be seen in adjacent buildings. All the stone for these older buildings had a very local origin.

Further east it is the Productive Coal Measures which provide many quarries. Many of those in the lower part were of white colour, for example, at Kirkburn or Overwood. Towards the top however red iron staining increases until the more uniformly red Barren Red Measures are reached. Stonelaw, Eastfield and Westmuir quarries all show some mottling while Bredisholm is all red. In the Barren Red Measures there are some thick beds of red or mottled sandstones. At Bothwell Park about 100′ (33m) of white and reddish sandstones occurred (Smellie, 1912). At this quarry the white stone tended to weather pink. Many of these eastern quarries, in areas where there was less competition for land continued in production until after the First World War.

Conclusion

Although plans and maps do exist which show the sites of many quarries often their presence is only discovered by accident in the course of site investigations for new works. The number of quarries which are known clearly indicates that quarrying was once a thriving industry and indeed some villages must have depended very largely on the local quarry for providing work.

Acknowledgements

I would like to thank Mr Douglas Maclean for photographing the figures.

REFERENCES

Bell, D. 1881. Among the Rocks around Glasgow, Maclehose, Glasgow.
Bloxam, T. 1856, On the composition of the Building Stones of Craigleith, Binnie, Giffnock and Partick Bridge. *Trans. Geol. Soc. Glasg.* **1**, 42-47.
Broughton, *et al*, 1950 Survey of building in sandstone in Scotland. National Building Studies Special Report 20.
Clough, C. T. *et al*, 1911. The Geology of the Glasgow District. *Mem. Geol. Surv.* **1st ed.**
Craig, G. 1892. On Building Stones used in Edinburgh. *Trans. Geol. Soc. Edin.* **6**, 254-273.
Cruikshank, J. 1879. Sketch of the Incorporation of Masons and the Lodge of Glasgow St John. Ferguson. Glasgow.
Defoe, D. 1727. A tour thro' the Whole Island of Great Britain. Ed. G. D. H. Cole. London.
Fisher, I. 1976. Building Construction in Scotland. Scottish Vernacular Buildings Working Group.
Hunt, R. 1860. Memoirs of the Geological Survey of Great Britain. Mining Records. Mineral Statistics Pt. 2 for 1858.
Kyle, Plans of sites in Glasgow. Kyle Collection in Glasgow City Archives.
Lawson, J. A. 1981. Building Stones of Glasgow. *Geol. Soc. Glasg.*
Macnair, P. 1900. On the Physical Geology and Palaeontology of the Giffnock Sandstones, and their Bearings on the Origin of Sandstone Rock generally. *Trans. Geol. Soc. Glasg.* **11**, 199-231.
New Statistical Account, 1845.
Regality Club, 1899.
Simpson, W. Glasgow in the Forties.
Smellie, W. R. 1912. The sandstones of the Upper Red Barren Measures to the east of Glasgow. *Trans. Geol. Soc. Glasg.* **14**, 258-278.
Young, J. 1869. Notes on the Section in the Gilmorehill Quarry, and Boulder Clay, on the Site of the New University Buildings. *Trans. Geol. Soc. Glasg.* **3**, 298-308.

CHITINOZOA AND THE AGE OF THE MARGIE LIMESTONE OF THE NORTH ESK

by C. J. Burton, C. Hocken, D. MacCallum and M. E. Young (Dept. Geology, University of Glasgow)

Abstract

A chitinozoan assemblage from the Margie Limestone (northern outcrop) of the North Esk section (Tayside Region) contains *Pogonochitina of spinifera intermedia*, Taugourdeau 1961; *Desmochitina (Desmochitina) juglandiformis*, Laufeld 1967; *Velatachitina* sp; *Lagenochitina?* cf *prussica*, Eisenack 1931; *Siphonochitina* sp., *Clathrochitina?* sp., and *Conochitina?* sp. This assemblage is of markedly southern European provenance, suggests a mid-to-late Caradoc (Ordovician) age for the Margie Limestone and suggests that this limestone must be much younger than the adjacent Dalradian rocks.

Introduction

Prominent among a number of lithologically similar limestones within the Highland Border Complex is the Margie Limestone of the North Esk section near Edzell (Tayside Region). The age of this limestone, first described in detail by Barrow (1901), has always been critical to the interpretation of the relationship between the Highland Border Complex and the Dalradian Supergroup and, in wider application, to the understanding of the Caledonian orogeny. Hitherto, in spite of structurally-based assumptions of a very early Palaeozoic age for the limestone by Johnson and Harris (1965) and Henderson and Robertson (1981), no accurate age has been produced for it. Previous work has placed the Margie Limestone at a number of different points in the early Palaeozoic and has linked it with other Highland Border limestones, including the Leny Limestone of Callander. Barrow (1901) assigned the Margie Limestone to the "Silurian?" (Ordovician of present usage), although he later (Barrow 1912) changed this to "?Cambrian". Campbell (1911, 1913) considered it to be doubtfully Upper Cambrian, and Jehu and Campbell (1917) assigned the Margie Limestone of the North Esk to the "later Ordovician" and correlated it with the Dounans (or Aberfoyle) Limestone of Aberfoyle. An Ordovician age was generally accepted until Pringle (1941), for structural and lithological reasons, relegated the Margie Limestone of the North Esk to the Middle Cambrian, correlating it with the Leny Limestone of that age. Anderson (1947) accepted this correlation and placed the Margie (= Leny) Limestone in the Upper Psammitic Group of the Dalradian Supergroup, although detaching the Dounans (or Aberfoyle) Limestone and placing it in the Upper Ordovician. Johnson and Harris (1965, 1967) continued the association of Margie Limestone and confirmed Stubblefield's age of the upper part of the Lower Cambrian for them (Stubblefield 1956). Downie (1971) while doubting Anderson's correlation of the Margie Limestone with the Leny Limestone was unable to throw any further light on the age of the former.

Chitinozoa

This element of doubt in its stratigraphical position, added to its tectonic importance, prompted the authors to examine the Margie Limestone for organic-walled microfossils as a possible means of resolving the age-problem. Accordingly a small slab of black Margie Limestone was obtained from a locality within its northern outcrop, at a point where it crops out on the edge of the River North Esk (M.R. N0585734) a short distance south of the North Esk Fault. The broken-up sample was treated with acetic acid and the resulting residues picked for microfossils. The residues consisted of plentiful dark organic fragments among which were a number of recognisable chitinozoans, some broken, some complete, but all flattened. The chitinozoans are a mixture of plain and decorated tubes and flasks of a dark, but not black, organic material. Their colour suggests that they cannot have undergone any great heating, and certainly not a metamorphic episode of a magnitude comparable with that affecting the adjacent Dalradian rocks. The following taxa are present:

1. *Pogonochitina* cf *spinifera intermedia* Taugourdeau 1961 (Plate 1, Figs. 1 and 4).

A flattened and damaged specimen in which part of the neck is broken off and in which the surface is covered in crystals of iron pyrites (Plate 1, Fig. 4). However the characteristic features of the genus are recognisable, these being the slightly elongated pear-shaped body passing insensibly into a poorly differentiated neck with peripheral to the base, a ring of processes. These features clearly differentiate the genus from those most closely comparable — *Ancyrochitina* with its clearly differentiated neck and *Clathrochitina* with its more purely conical shape. Within the genus the body shape and type of peri-basal process, together with size, differentiate the species. The Scottish specimen has a very definite pear-shape with peri-basal processes which are flattened and resemble a torn membrane, these being the essential characteristics of *Pogonochitina spinifera intermedia* and which differentiate it from the similar but much less bulbous *Pogonochitina? secunda* (Schallreuter) of the Llanvin-Llandeilo of Normandy (Paris 1981). However the Scottish specimen while being similar in all other respects to *P. spinifera intermedia* is larger than the latter, a difference which prompts the above assignation. The stratigraphical range of *P. spinifera intermedia* is Caradoc-Ashgill (Taugourdeau, *et al* 1967, p. 85), and it occurs only in Aquitaine, SW France.

2. *Desmochitina (Desmochitina) juglandiformis,* Laufeld 1967 (Plate 1, Fig. 3).

A broken and almost completely flattened specimen, but one in which the essential features are still preserved. The bowl-shaped body is characteristic of *Desmochitina* and the wide well developed collar, the wrinkled surface, the broken remains of an alien operculum at the base and the dimensions of the specimen are all characteristic of *D. (D.) juglandiformis.* The alien operculum is not found in any other desmochitinid. The stratigraphical range of *D. (D.) juglandiformis* in Sweden is from the Soudleyan to Marshbrookian stages of the Caradoc Series (Laufield 1967, Grahn 1982),

whereas in Spain its range is a little longer — Soudleyan to the lower part of the Onnian (Paris 1981, p. 366).

3. *Velatachitina* sp. (Plate 1, Fig. 2).

A crumpled cylindroidal shape with a conspicuous thin, translucent area at the aboral end. These characteristics are diagnostic of *Velatachitina* Poumot, especially the translucent aboral sleeve which is the continuation of a very thin periderm, the crumpling of which provides the crumpled sock shape of the fossil. When compared with the three species described by Poumot (1968) the Scottish specimen cannot be assigned to any of them since, besides being smaller than all of them, it is broader and shorter than *V. copulata,* has a much longer aboral sleeve than *V. veligera,* and has a much shorter sleeve than *V. nebulosa.* The aperture of *V. nebulosa* is also less conical than that of the Scottish specimen. The stratigraphical range of *Velatachitina* is from the Arenig to the Ashgill, and the genus is found in Algeria, Tunisia, Normandy and England (Jenkins, in Poumot 1968).

4. Other members of the fauna include:
   Lagenochitina? cf *prussica* Eisenack 1931,
   Siphonochitina sp.,
   Clathrochitina? sp.,
   Conochitina? sp.

Stratigraphy

The presence of *Desmochitina (D.) juglandiformis* and *Pogonochitina* cf *spinifera intermedia* confirms a mid-to-late Ordovician age for the Margie Limestone with the evidence of *D. (D.) juglandiformis* being further able to confirm a Caradoc age. The range of *D. (D.) juglandiformis* in Sweden (Laufeld 1967) is within the "Skagen" Formation and thus within the range of Soudleyan-Marshbrookian, whereas in Spain (Paris 1981, p. 366) its range is a little wider, Soudleyan to the lower part of the Onnian. Thus the Margie Limestone in its northern outcrop lies within the range of stages from Soudleyan to Onnian of the Caradoc Series of the Ordovician. Furthermore the correlation of the Margie Limestone with the Leny Limestone (Anderson 1947) is thus rendered untenable and should be abandoned, as should the correlations with any of the other limestones of the Highland Border Complex, since recent palaeontological work (Curry *et al* 1982) combined with this and previous identifications suggests a wide range of ages for these rocks.

Biogeography

The assemblage shows a strong affinity to assemblages known from southern Europe and North Africa, the genera *Pogonochitina* and *Velatachitina* being largely from that region. *Desmochitina (D.) juglandiformis* has a wider range being known from Balto-Scandinavia and southern Europe, while *Lagenochitina?* cf *prussica* is the only form which is solely Balto-Scandinavian. This sets the assemblage apart from the other chitinozoan assemblages (Burton and Curry 1984, in press) and macrofossil assemblages of all ages (Curry *et al* 1982) from the Highland Border Complex which all

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4

EXPLANATION OF PLATE

All specimens are from the Margie Limestone of the North Esk (northern outcrop), Tayside Region.

Figure 1. *Pogonochitina* cf *spinifera intermedia,* Taugourdeau 1961. Photomicrograph. Hunterian Museum specimen X383; magnification x 230.

Figure 2. *Velatachitina* sp. Photomicrograph. Hunterian Museum specimen X384; magnification x 320.

Figure 3. *Desmochitina (Desmochitina) juglandiformis* Laudfeld 1967. Electron micrograph. Hunterian Museum specimen X385; magnification x 230.

Figure 4. *Pogonochitina* cf *spinifera intermedia,* Taugourdeau 1961. Electron micrograph showing an overgrowth of crystals of iron pyrites on the surface of the fossil. Hunterian Museum specimen X383; magnification x 230.

exhibit pronounced affinities to the Balto-Scandinavian and North American faunas. However the Margie Limestone assemblage consists of characteristically thin-walled chitinozoans likely to have been pseudoplanktonic (Laufeld 1984, in press) and a close proximity for northern and southern continents, or alternatively, an allochthonous origin for the North Esk unit, while not being ruled out, should be treated with caution.

Structure

Johnson and Harris (1965) and Henderson and Robertson (1981) have made the point that the Highland Border rocks and specifically, in the case of the former authors, the Margie Limestone of the North Esk, formed an integral part of the Dalradian Supergroup and took part in their folding. However a Caradoc age for the Margie Limestone would seem to preclude such an interpretation, since it comes too late for the main phase of folding (D1 and D2) of the Dalradian, thus adding weight to the contention of Curry *et al* (1982, p. 453) that the Highland Border Complex cannot be part of the Dalradian Supergroup.

REFERENCES

Anderson, J. G. C., 1947. The geology of the Highland Border: Stonehaven to Arran. *Trans. R. Soc. Edinburgh* **61**, 479-515.

Barrow, G., 1901. On the occurrence of Silurian(?) rocks in Forfarshire and Kincardineshire along the eastern border of the Highlands. *Q. Jl. Geol. Soc. Lond.* **57**, 328-45.

Barrow, G., 1912. On the geology of Lower Dee-side and the Southern Highland Border. *Proc. Geol. Ass.* **23**, 274-90.

Burton, C. J. and Curry, G. B., 1984. Chitinozoa and miscellanea from the Highland Border Complex. *Trans. R. Soc. Edinburgh Earth Sci.* (in press).

Campbell, R., 1911. Preliminary note on the geology of south-eastern Kincardineshire. *Geol. Mag.* **48**, 63-69.

Campbell, R., 1913. The geology of south-eastern Kincardineshire. *Trans. R. Soc. Edinburgh* **48**, 923-60.

Curry, G. B., Ingham, J. K., Bluck, B. J., and Williams, A., 1982. The significance of a reliable Ordovician age for some Highland Border rocks in Central Scotland. *J. Geol. Soc. London* **139**, 451-54.

Downie, C., Lister, T. R., Harris, A. L., and Fettes, D. J., 1971. A palynological investigation of the Dalradian rocks of Scotland. *Rep. Inst. Geol. Sci.* **71/9**, 1-29.

Grahn, I., 1982. Palaeobiology and biostratigraphy of Ordovician Chitinozoa from Sweden. *Acta Univ. Uppsala.* **629**, 3-16.

Henderson, W. G., and Robertson, A. H. F., 1981. The Highland Border rocks and their relation to marginal basin development in the Scottish Caledonides (abstract). *Newsl. Geol. Soc. London* **19**, 23-4.

Jehu, T. J., and Campbell, R., 1917. The Highland Border rocks of the Aberfoyle district. *Trans. R. Soc. Edinburgh* **52**, 175-212.

Johnson, M. R. W., and Harris, A. L., 1965. Is the Tay Nappe post-Arenig? *Scott. J. Geol.* **1** (2), 217-29.

Johnson, M. R. W., and Harris, A. L., 1967. Dalradian — ?Arenig relations in parts of the Highland Border, Scotland, and their significance in the chronology of the Caledonian orogeny. *Scott. J. Geol.* **3** (1), 1-16.

Laufeld, S., 1967. Caradocian Chitinozoa from Dalarna, Sweden. *Geol. För. Stockh. Förh.* **89**, 275-349.

Laufeld, S., 1984. Palaeoecology of Silurian Chitinozoa. Spec. Pap. Palaeont. (in press).

Paris, F., 1981. Les Chitinozoaires dans le Paléozoique du Sud-Ouest de l'Europe. *Mem. Soc. Géol. Minéral. Bretagne.* **26** (412), 1-411.

Poumot, C., 1968. *Amphorachitina, Ollachitina, Velatachitina;* trois nouveaux genres de Chitinozoaires de l'Erg Oriental (Algérie-Tunisie). *Bull. Centre Rech. Pau — SNPA.* **2** (1), 45-55.

Pringle, J., 1941. On the relationship of the Green Conglomerate to the Margie Grits in the North Esk, near Edzell; and on the probable age of the Margie Limestone. *Trans. Geol. Soc. Glasgow* **20**, 136-140.
Stubblefield, C. J., 1956. Cambrian palaeogeography in Britain. *Int. Geol. Congr.* **XX**, 1-43.
Taugourdeau, P., 1961. Chitinozoaires du Silurien d'Aquitaine. *Rev. Micropaleontol.* **4**, 135-154.
Taugourdeau, P., Bouché, P., Combaz, A., Magloire L., Millepied, P., 1967. Microfossiles organiques du Paléozoique. I. Les Chitinozoaires. Paris, Editions du Centre National de la Recherche Scientifique.

NOTES ON THE OCCURRENCE OF TRILOBITES IN THE LOWER CARBONIFEROUS OF LUGTON, AYRSHIRE.

by Martin Simpson

Carboniferous trilobites can be found at many localities in the Midland Valley of Scotland, although they are usually represented by isolated pygidia or headshields. Of the small number of Scottish species so far described, only a few are known by their complete exoskeletons, while some descriptions are based merely on individual pygidia. The following taxa have been recorded from the Carboniferous of Scotland:

Eocyphinium bivium Reed, 1942, Namurian; Linn Spout, Dalry, Ayrshire.

Griffithides (Particeps) scoticus scoticus Reed, 1943, Brigantian Namurian; Invertiel & Bogie, near Kirkcaldy, Fife.

Griffithides (Particeps?) brevispinus Woodward, 1884, Brigantian?; Langside, Beith, Ayrshire.

Griffithides (Griffithides) longiceps longiceps Portlock, 1843, Brigantian; Brockley, near Lesmahagow, Lanarkshire.

Paladin (Paladin) mucronatus mucronatus (M'Coy, 1844) (syn.: *Weberides mucronatus)* Brigantian, Namurian. Ayrshire: Garple Burn, Muirkirk; Swindridge, Bowertrapping & Linn, Dalry. Lanarkshire: Gallowhill, near Strathavon. Stirlingshire: Sculliongnour, near Lennoxtown, Campsie. Fife: Craigston; Leslie; Elie; Ladedda & Wilkieston, near St Andrews. Kineswood in Kinross.

Paladin (Paladin) dalriensis (Reed, 1942) Namurian; Linn Spout, Dalry, Ayrshire.

Paladin (Paladin) cuspidatus (Reed, 1943) (syn.: *Weberides parilis* var. *cuspidata)* Brigantian; east of St Monans, Fife; High Blantyre, Lanarkshire.

Paladin (Paladin) eichwaldi parilis (Reed, 1942) (syn.: *Weberides parilis)* Brigantian, Namurian. Ayrshire: Auchenskeith, Bowertrapping & Linn Spout, Dalry; Gateside, Beith. Lanarkshire: Auchenbeg, near Lesmahagow; Capelrig, East Kilbride; High Blantyre; Boghead, Hamilton; Gair, Carluke. Robroyston, near Glasgow; Lennoxtown, Campsie.

In addition to the above list there are numerous records in the literature of trilobite "fragments" or "tails" (eg. Forsyth, 1978; Forsyth & Chisholm, 1977; Forsyth & Wilson, 1965; Francis *et al* 1970; Wilson, 1966, 1974, 1979). Where the species have been quoted, however, the identifications may often be unreliable; records of *Brachymetopus* spp. from North Ayrshire (Geikie, 1869; Richey *et al* 1930) have not been authenticated.

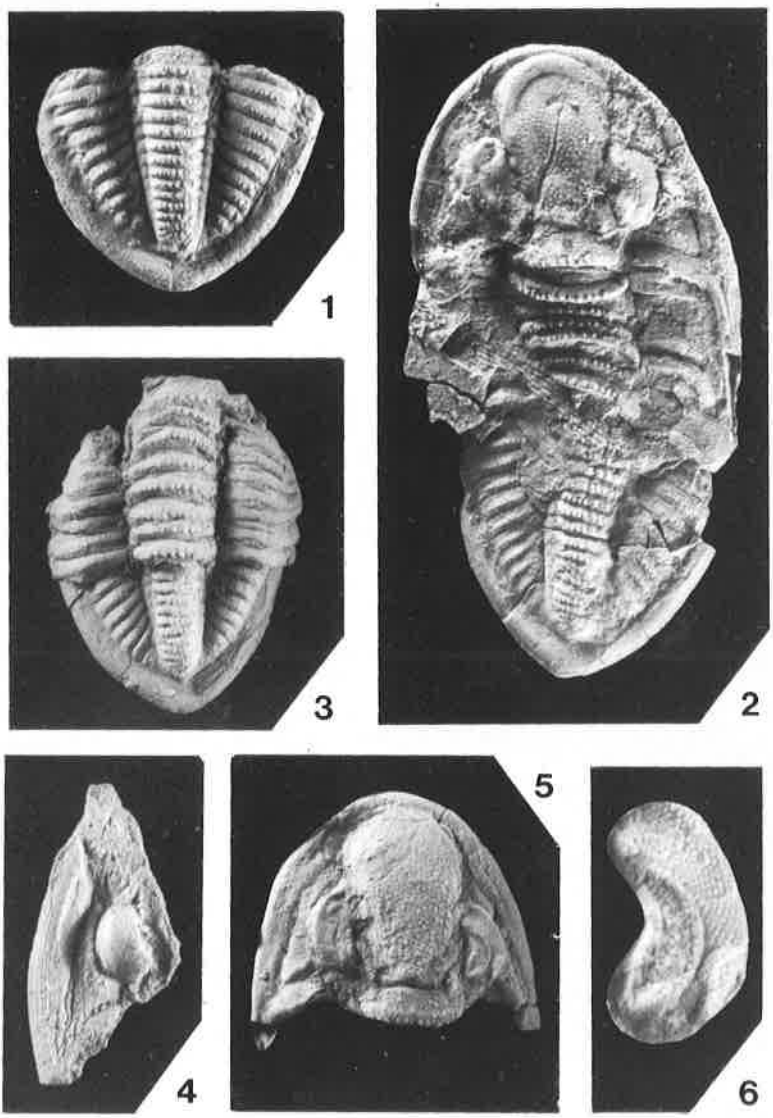

Plate 1. *Paladin (Paladin) cuspidatus* (Reed, 1943).
Fig. 1. pygidium, A21243 (author's coll.), X4.
2. complete specimen, A21244 (J. A. Lawson coll.), X3.
3. flattened enrolled specimen, A21245 (author's coll.), X3.
4. left free cheek from same specimen, A21246, X3.5.
5. cephalon, A21247 (C. J. Burton coll.), X3.
6. right eye of same specimen, X12.
All specimens are in the Hunterian Museum, Glasgow.

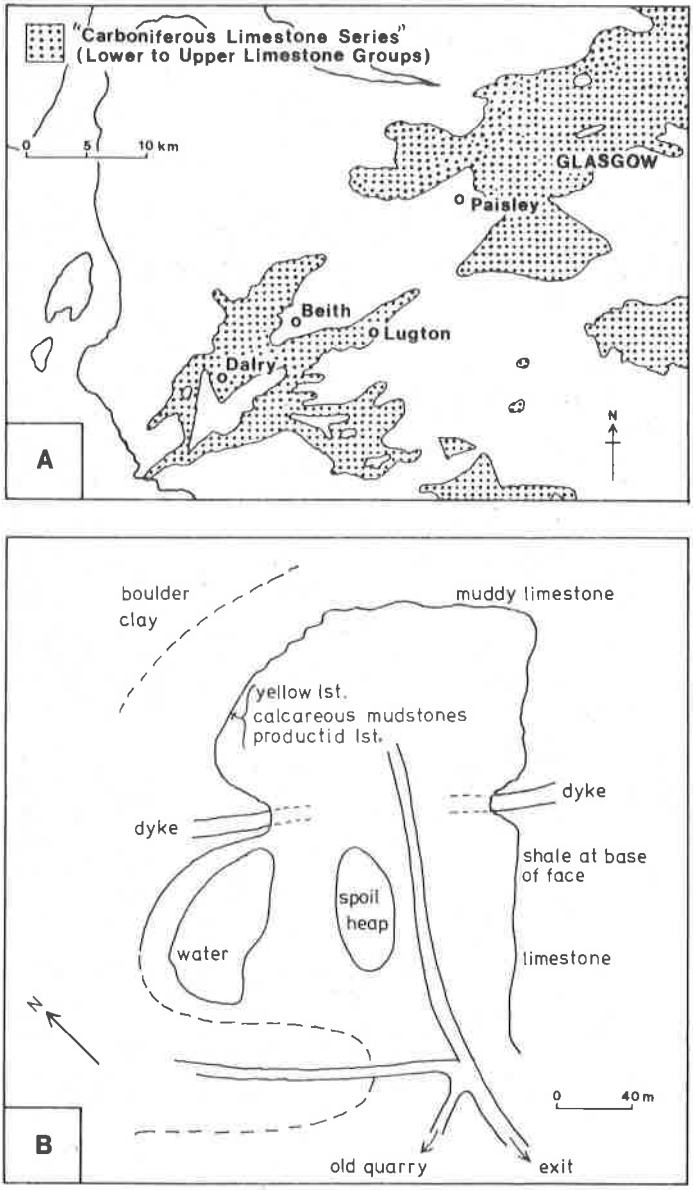

Figure 1a. Locality map.
Figure 1b. Sketch map of new part of Lugton Old Mill Quarry (after Lawson, 1973). The plan may change considerably due to working operations in the top part of the quarry.

The paucity of museum material does not reflect the potential for the collection of further Scottish trilobites, for they have long been known to be abundant at certain localities. In particular, the quarries at High Blantyre, Boghead and Carluke are said to yield perfect, "coiled up or extended" trilobites (Young, 1871), while "detached pieces" are abundant at Bowertrapping, Dalry (Craig, 1869). The present situation merely highlights the taxonomists' reliance upon old collections which were often made by local amateurs. in Scotland the earliest collectors were Craig, Young, Traquair, Thomson and Smith, who supplied some of their choicest specimens for Woodward's classical monograph (1883-84) on British Carboniferous Trilobites: later collectors such as Begg (see Currie & George, 1963), Tripp and Wright provided material for description by Reed (1942, 1943). Since then most of the work relating to Scottish Trilobites has been confined to the redescription of existing material.

The main purpose of the present paper is to bring to the attention of the Society the abundance of trilobites in the Lower Carboniferous of Lugton, 22 km SW of Glasgow (Fig. 1a). These occur in the calcareous shales which underlie a sequence of mudstones and muddy limestones exposed in the new bay of Lugton Old Mill Quarry (391 524); at present they can be collected from a large spoil heap of the shales in the centre of the quarry (Fib. 1b). A full account of the geology of this locality is given by Lawson (1973). The beds here are laterally equivalent to the Dockra Limestone, which is the basal unit of the Lower Limestone Group, and which is of Brigantian (P2) age.

Although trilobite pygidia have previously been recorded from the limestones at Lugton (Lawson, 1973, p. 51), the richly fossiliferous shales yield pygidia, cephalons and more importantly, complete specimens. Brachiopods, crinoids, bivalves (including *"Pinna"*) bryozoans and occasional sharks' teeth can also be found. The trilobites from Lugton (Pl. 1), which are deposited in the Hunterian Museum, are here identified as *Paladin (Paladin) cuspidatus*. The tuberculation of the axial rings and pleurae, the shape and granulation of the glabella, the nature of the pygidial border and the number of pygidial rings and ribs all agree with the descriptions of that species (Reed, 1943; Hahn & Hahn, 1972; see also Woodward, 1883-4, Pl. 4, Fig. 2). However, *P.(P.) cusidatus* is very similar to *P.(P.) eichwaldi parilis* and since both forms occur together in the Lower Limestone Group of High Blantyre, near East Kilbride, they may possibly be conspecific.

The presence of complete specimens of *Paladin* at Lugton is of considerable importance, not only because they constitute a new record of this genus in the Lower Carboniferous of Ayrshire, but also because further collecting may prove useful for future work on the Scottish trilobite fauna as a whole.

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REFERENCES

Craig, R., 1869. Sketch of the Carboniferous basin of Dalry, Ayrshire. *Trans. Geol. Soc. Glasgow* **3,** 271-97.

Currie, E. D. & George, T. N., 1963. Catalogue of described and figured specimens in the Begg collection in the Hunterian Museum of the University of Glasgow. *Palaeontology* **6,** 378-96.

Forsyth, I. H., 1978. The Lower Carboniferous sequence in the Howwood Syncline, Renfrewshire. *Bull. Geol. Surv. G.B.* **60,** 1-8.

Forsyth, I. H. & Chisholm, J. I., 1977. The Geology of East Fife. *Mem. Geol. Surv. G.B.*

Forsyth, I. H. & Wilson, R. B., 1965. Recent sections in the Lower Carboniferous of the Glasgow area. *Bull. Geol. Surv. G.B.* **22,** 65-79.

Francis, E. H., Forsyth, I. H., Read, W. A. & Armstrong, M., 1970. The Geology of the Stirling district. *Mem. Geol. Surv. G.B.*

Geikie, A., 1869. Geology of Ayrshire, south-western district. *Mem. Geol. Surv. G.B.*

Hahn, G., & Hahn, R., 1972. *Fossilium Catalogus.* 1: Animalia, Pt. 120. Trilobitae carbonici et permici 3.

Lawson, J. D., 1973. Excursion 4: Trearne and Lugton, pp. 43-53. *In* Bluck, B. J. (ed.) *Excursion Guide to the Glasgow District.* 1973. Glasgow.

Reed, F. R. C., 1942. Some new Carboniferous trilobites from Scotland. *Ann. Mag. Nat. Hist.* (II) **10** (63), 176-86.

Reed, F. R. C., 1942. Some new Carboniferous trilobites. *Ann. Mag. Nat. Hist.* (II), **9** (57), 649-72.

Reed, F. R. C., 1943. Some Carboniferous trilobites from Scotland. *Ann. Mag. Nat. Hist.* (II), **10** (63), 176-86.

Richey, J. E., Anderson, E. M. & MacGregor, A. G., 1930. The geology of North Ayrshire. *Mem. Geol. Surv. G.B.*

Wilson, R. B., 1966. A study of the Neilson Shell Bed, a Scottish Lower Carboniferous marine shale. *Bull. Geol. Surv. G.B.* **24,** 105-30.

Wilson, R. B., 1974. A study of the Dinantian marine faunas of south-east Scotland. *Bull. Geol. Surv. G.B.* **46,** 35-65.

Wilson, R.B., 1979. The base of the Lower Limestone Group (Viséan) in North Ayrshire. *Scott. J. Geol.* **15,** 313-19.

Woodward, H., 1883-4. A monograph of the British Carboniferous Trilobites. *Pal. Soc. [Monogr.].*

Young, J., 1871. On the Carboniferous fossils of the west of Scotland. *Trans. Geol. Soc. Glasgow* **3** (suppl.) 103pp.

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