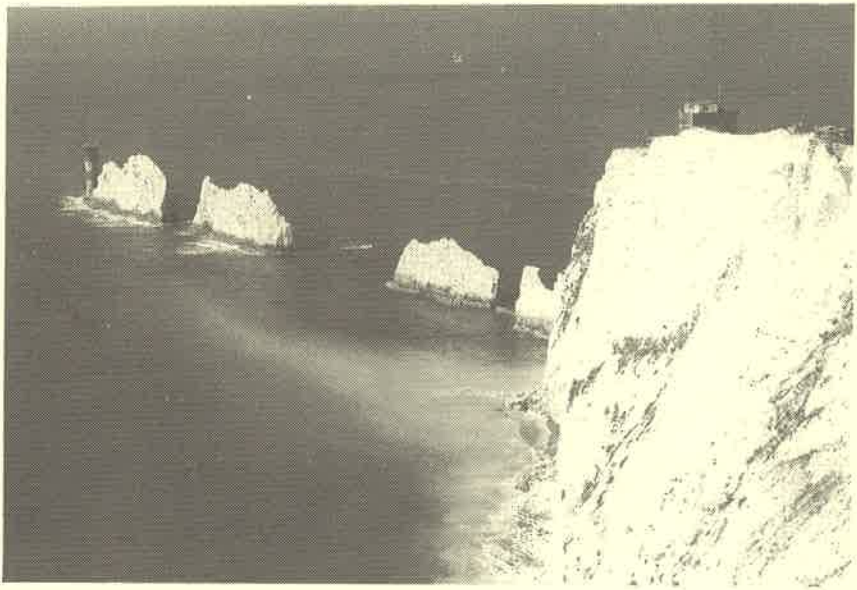
PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF GLASGOW



Session 140 **1997/98**

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Front cover photograph: The Needles, Isle of Wight

Edited by C.M.Leslie

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MEMBERSHIP

Session	**140**	**139**
Honorary Members	2	2
Life Members	1	1
Ordinary Members	348	340
Associate Members	64	61
Junior members	9	4
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Total	**424**	**408**
New Members	38	26
Deletions	(24)	(25)

J.Willing

LIBRARY REPORT

This session the temporary shelving in Room 320A, which holds our book collection, was replaced by purpose-built units and the books reshelved. My thanks go to Bill Bodie, Charles Leslie and Roy Smart who devoted two weekends to the reorganisation of the stock. The extent of the new shelving was such as to allow the possibility of our main journal stock being brought out of storage. The book stock is now organised and loans are proceeding as normal.

As a result of negotiations between the Division and the Department of Archaeology, two sets of shelves have been set aside for the collection of archaeology texts which members may consult but not borrow.

However, plans for the further development of the library have once again been upset by the University, since a further demand for the relinquishment of space was made at the beginning of October 1998, resulting in the loss of Room 215 which housed our collection of Geological Survey publications and the Division's thesis collection. This latter collection, being a valuable and irreplaceable asset had to be removed to Room 320A, where it occupies, temporarily, all the spare space (except that used by Archaeology), the Survey publications being now in store. It is hoped to reorganise space in the areas left to the new Division to allow the theses to be stored elsewhere and the plans for shelving the Journals to be carried out.

C.J.Burton

EDITORIAL REPORT OF THE SCOTTISH JOURNAL OF GEOLOGY

Progress of the Journal this year has been essentially similar to that of the past several years. The issue in press is likely to be slightly slimmer than usual reflecting both the rate of submissions and the vagaries of length of individual papers, but we shall return to our "standard" 96 pages in the issue following. The Board has made a conscious effort to clear away long-standing manuscripts by encouraging authors to complete their revisions or withdraw. We now hold a relatively small number "in progress" and are thus able to offer potential authors a more rapid publication of their work. We intend to maintain a high standard and to continue to promote the Journal as the vehicle for papers on the geology of Scotland.

The balance of income and expenditure for the year ending 31st December 1997, together with projections for both 1998 and 1999 are shown on the statement of account by the Board Treasurer David Gould and were included in the pre - AGM billet 141/2.* These provide the basis for increased subventions requested by the Board from the two Societies. A report by the Publications manager at the Geological Society, which was included with the pre - AGM billet 141/2 *, indicates an encouraging stabilisation of the number of our trade subscriptions after some years of slow decline. It also indicates a need for increased page charges of 3% that we will have to meet in the coming year. Journal price charges have risen in the past year in both North America and Continental Europe but remain higher in the UK (currently 12%) as a reflection of the buoyant pound. A similar rise is expected next year.

The Journal has continued to be well publicised on our behalf by GSPH in Geological Society publications and elsewhere, and we have been able to use space to more widely advertise other publications of the two Societies. The current contents of the Journal now appear on the internet on the Journal Home Page.

Colin Braithwaite

* Additional copies can be obtained on request from the Proceedings Editor

PUBLICATION SALES OFFICER'S REPORT

Last year I reported the exhaustion of stocks of the Arran Guide. Early in 1998, Council decided to reprint the Guide, since any new volume was not likely to be available for some time. The reprint was ready by the end of March. With a good price from the printer, we were able to put the reprint out at £6 retail (£5 for members).

Our President's involvement with the Open University resulted in a very worthwhile sale of our own publications during the O.U. Summer School in Durham during July and August.

Guide books and maps of the Isle of Wight were made available for those members going on the excursion to the island in September 1998.

Overall, sales to members and DACE classes accounted for 48% of our turnover. We are grateful to members for their direct support and for the "spreading of the word" in the latter classes.

Roy Smart

MEETINGS 1997 - 1998 (Session 140)

T. NEVILLE GEORGE MEDAL

At the meeting on 16th October 1997, the award of the T.Neville George Medal was made to **Professor William Stuart McKerrow**, University of Oxford by our Society President, Dr. J.G.MacDonald after the following citation was delivered by Dr.C.D.Gribble, University of Glasgow.

CITATION

Since the creation of the T. Neville George Medal a series of distinguished geologists have been brought to Glasgow, from Europe and North America, for its presentation. Today, Dr McKerrow, is more in the nature of a home coming. A careful check of the credentials of the previous recipients would reveal that we have been scrupulous in showing impartiality in that up till today this medal has never been presented to a graduate of the University of Glasgow. This has of course meant that many distinguished geologists have in effect been excluded - what better way to put this right than to add your name to the roll of honour. It is also a happy coincidence that 1997 is the 50th anniversary of your graduation as a Bachelor of Science in Geology in 1947.

You were one of that remarkable band of ex-servicemen who returned to their academic studies at the end of the Second World War. Having served with distinction in the Royal Navy in the struggle to free Europe from oppression you studied as an undergraduate under a professor new to Glasgow, none other that T.Neville George and, with your fellow student Bill Aitken, have the added distinction of being a member of TN's first Honours graduating class in Glasgow.

Appointed to a lectureship at the University of Oxford you embarked on an academic career which has coincided with revolutionary changes in the Science of Geology. In your initial research topic on the statistical study of variation in Jurassic brachiopods I believe it is correct to say that one can detect the influence of Professor George. This research earned you your Doctorate of Philosophy from the University of Oxford in 1953. Prior to this, however, your interests were already being diverted to more ancient rocks as you turned your attention to the Lower Palaeozoic of County Galway. But the West of Ireland could not satisfy your thirst for understanding of the nature of the Palaeozoic world as you extended your interest across the Atlantic to Eastern Canada where you spent 14 summers on field work. Despite this you did not neglect your home ground as you extended your studies into the Southern Uplands of Scotland.

Over this period, of course, Plate Tectonics emerged as an enormously significant factor leading to all sorts of reinterpretations of old ideas about geology and the creation of new horizons in research. You were in the thick of these new developments as is reflected in the many publications from the 1980s which bear your name. The breadth of your knowledge of Ordovician and Silurian stratigraphy on both sides of the Atlantic, combined with your insight into the field of palaeoecology and geological structures enabled you to play a leading role in the reconstruction of that legendary ocean which came to be known as Iapetus along with associated island arcs, olistostromes, plate sutures and displaced terranes. The major role which you played in developing these areas of research was recognised in 1993 with your contribution of one of the Volume 150 Celebration Papers of the Journal of the Geological Society, London, on the Development of Early Palaeozoic global stratigraphy.

Another area of work in which you were central was your initiation of the Oxford School of Community Studies in the Welsh Borderland. Starting with Robin Cocks and Fred Ziegler you inspired a procession of research students who greatly expanded our understanding of the ecology of the Ordovician and Silurian in that area. With Fred Ziegler you went on to undertake much productive collaboration on Palaeozoic maps of the world.

During a long and distinguished career your contributions to geology have been recognised many times. You received the Lyell Medal of the Geological Society of London in 1981, the Clough Medal of the Geological Society of Edinburgh in 1988 and the Foumarier Medal of the Geological Society of Belgium in 1995. You have been President of the Palaeotological Association and a vice-president of the Geological Society of London. In 1977 you gained your DSc from the University of Oxford which added another distinctive feature to your curriculum vita. Having been awarded the Distinguished Service Cross during the Second World War, you could then add DSC and bar to your qualifications.

Since your first appointment at Oxford and your creation as a fellow of Wolfson College your career has taken you to many parts of the world. You have been visiting Professor at the University of Chicago several times and have occupied similar appointments at the University of Alberta, the University of Auckland and at Williams College, Massachusetts. And in your relentless pursuit of things Palaeozoic you even spent a summer mapping the Caledonian thrust belt in north-east Greenland. Although you have adopted the honourable title of emeritus since 1989 you have continued to set an example to your younger colleagues and still have your mind focused on the Palaeozoic. We look forward to your further elucidation of that great Era. It is 50 years since you set out from Glasgow to widen your horizons and enlarge the scope of geology. It is singularly appropriate that we should honour you now by linking your name with that of T. Neville George. I now ask the President of the Society, Dr. James G. MacDonald, to make the presentation of the Professor George Memorial Medal.

After being presented with the medal, **Dr. McKerrow** then gave the following T. Neville George Medal Lecture-

EARLY PALAEOZOIC CONTINENTAL DISTRIBUTIONS

Subsequent to the Pan-African collisions, the components of Gondwanaland had become fused by the Early Cambrian. By contrast, Laurentia, Baltica and Siberia were drifting apart. Faunal similarities between Siberia and Morocco and between Laurentia, Baltica and Avalonia (supported by palaeomagnetic data) suggest how these smaller continents were distributed around Gondwanaland.
In the Early Ordovician, Laurentia and Siberia shared the same shallow marine bathos, but they were distinct from Baltica and much of Gondwana. During the later Ordovician, many oceans contracted, so that, apart from ostracods and fresh water fish, most biogeographic data from the Silurian and the Devonian merely provide evidence of climate and latitude.

Thursday 13th November 1997
Dr. Colin Braithwaite, University of Glasgow

TROPICAL ISLANDS, CORAL REEFS AND POSTCARDS ABOUT THE WEATHER

Although holiday travel is becoming increasingly exotic, there is a peculiar magic attached to the Tropics, with images of gleaming white sands, palm trees and coral reefs. However, ever since Darwin, we have realised that in addition to being beautiful, coral islands have much to tell us about changing sea level which is intimately linked to changes in climate. Coral colonies also carry a detailed record of ocean temperatures in the isotopes preserved in their skeletons. These relationships mean that corals and coral reefs retain brief messages, effectively postcards, about past climate that allow us to place present predictions about climatic change in a proper perspective.

Thursday 11th December 1997
Out-going President's address by **Dr. J.G.MacDonald**, University of Glasgow

ISLANDS THAT TILT & ISLANDS THAT COLLAPSE

Oceanic islands that occur in "within-plate" situations are commonly composed of lavas belonging to alkali-basaltic or transitional basaltic suites. In those islands where the principal mode of activity is by fissure eruption either a single dyke swarm or radiating dyke swarms feed eruptions at the surface. Two common forms of instability associated with such islands were examined. The principal examples were drawn from Madeira and the Canary Islands but comparison was also made with Hawai'i where the present Pu'u O'o eruption, which is in its 15th year of continuous activity, could perhaps lead to a major collapse.

Thursday 15th January 1998
Dr. David Harper, University College of Galway.

THE EARLY DEVELOPMENT OF DEEP-WATER BRACHIOPOD BIOFACIES - SLIM PICKINGS ON A DARK MUDDY SEABED.

During the early Caradoc the *Foliomena* fauna, a deep-water brachiopod association of minute, thin-shelled taxa apparently originated in a series of isolated basins on the South China Plate. The fauna diversified in the mid Caradoc to early Ashgill and spread to occupy a range of depth zones, commonly on the ocean-facing margins of most palaeocontinents; the typical *Foliomena* fauna occupied deep-water benthic zones whereas atypical *Foliomena* faunas invaded more shallow-water environments. The distribution and morphology of the faunas suggest an early Palaeozoic ecological experiment, with small thin-shelled brachiopods expanding into vacant deep-sea benthic niches to occupy soft substrates associated with dark, oligotrophic conditions. This phase of colonisation was abruptly terminated by the first strike of the end Ordovician extinction event.

12th February 1998
Dr. Alistair Ruffell, Queen's University, Belfast.

PALAEOCLIMATE CHANGE IN THE MESOZOIC OF NW EUROPE.

Current interest in palaeoclimates has done much to promote research and discussion into the timing, causes and effects of past climate changes. The wealth of new data has augmented some of the original ideas concerning Mesozoic climates and those new and old data sources were integrated during this talk. The range of climate indicators available in the Phanerozoic broadly supports Fischer's (1984) concept of icehouse and greenhouse modes, although these are now somewhat refined by Frakes, et al., (1992).
Parts of the Mesozoic were characterised by the optimum development of the greenhouse Earth. Short-term climate changes within the greenhouse climate state were summarised as humid and arid.. Temperature changes also occurred at similar times and although discussed, were not highlighted.
The generally arid latest Carboniferous, Permian and Triassic of NW Europe was followed by more humid conditions in the Jurassic and Early Cretaceous, punctuated by periods of aridity. Late Cretaceous aridity, concomitant with cooling, developed in the terrestrial borderlands to NW Europe, after which more humid climates returned in the Early Tertiary. These changes were summarised in an aridity/humidity curve for NW Europe. Some aridity/humidity changes were gradual and appear to be related to extremes of seasonality. Other times of change were rapid and characterised by intervals of fluctuating climatic conditions. These arid-humid phases are not always coincident with the cool and warm phases of other authors, although certain periods of sea-level fall were often coincident with cooling and aridity, causing drought and the reduction of shallow marine seaboard.
While the Mesozoic greenhouse Earth was host to the successful dinosaurs, biotic crises did occur, some of which were coincident with times of climate change.

Thursday 12th March 1998
Professor Ken McClay, Royal Holloway, University of London

ANALOGUE MODELLING OF FAULT SYSTEMS

The use of sand-box models to duplicate in the laboratory the processes of crustal extension has led to a better understanding of the geometry and kinematics of fault movements in rifting environments. Illustrating his lecture with excellent examples from the well exposed areas of the northern Red Sea and the Yemen margin of the

Gulf of Aden as well as from the USA, Professor McClay explained how the strains at the fault tips and in the overlap regions between faults is taken up by ductile strain rather than by direct fault linkage. Faults in these extensional areas are rarely very long and the throw of an individual fault dies out laterally but that on an adjacent en echelon fault increases. The region of overlap is characterised by a relay ramp where it is possible to walk on a single stratigraphic horizon from the hanging wall round the fault tip and down the ramp to the footwall.
Many good examples of rift margins, such as the North Sea, are under water! However, at the northern end of the Red Sea there is the best exposed rift margin in the world. Here, the fault structures and their relationships may be studied in detail. Together with the sand-box models which allow the progressive developments of faults to be studied, they provide conceptual models which may be used to interpret the structures observed in seismic sections from areas such as the North Sea basin.

Thursday 23rd April 1998
Dr. Steve Wickham, Galson Sciences Limited, Rutland

THE DEEPEST LAKE AND THE BIGGEST BATHOLITH: Phanerozoic magmatism, rifting and cratonisation in East Central Asia

Lake Baikal, in East-Central Siberia, is one of the deepest freshwater lakes in the world and contains some 20% of the Earth's liquid fresh water. The Baikal Rift Zone is an active zone of extensional tectonics, characterised by limited recent volcanism. However, this and adjoining regions have also been subjected to intense igneous activity throughout the Phanerozoic. The plutonic belts of Transbaikalia and Mongolia represent one of the largest concentrations of silicic magmatism on Earth, outcropping over more than 500,000 square km. These rocks share many similarities with Precambrian anorogenic granitoid provinces, such as the Mid-Proterozoic granite- syenite- anorthosite belt of North America, but they are better preserved, and show systematic compositional variation with time over a wide geographic area. The repeated cycles of magmatism involved remelting of igneous material formed during earlier episodes, significant crustal growth and gradual cratonisation of the crust of East Asia. Similar processes may be a key feature of the cratonisation of intercontinental regions.

MEMBERS' NIGHT

This, the final meeting of Session 140 was held on 14 May 1998, with the following short talks being given by members :-

David Evans - The University of Glasgow Expedition Society's 1997 expedition to the Canadian Rockies, to which the Society made a financial contribution, studied present day geomorphological processes of sedimentation and glaciation with more recent deposits from frost shattering of adjacent rocks sliding over snow fields to the bottom of the valley being studied to compare and contrast with the older moraine sediments.
The Robinson Glacier which has been retreating since the last ice age leaving thick sediment sequences on either side which are now undergoing rapid readjustment to deglaciation was studied.
Athabasca Glacier was also visited, where each moraine system, dated by lichen growth, is being used to determine rate of retreat.

Brendan Hamill - Devonian tetrapod tracks from Southwest Ireland.
Slides were shown of trackways in Devonian volcanic tuff on Valentia Island (35 miles WSW of Killarney) said to have been made by the earliest land animals or amphibians.

Maria-Teresa Fontao - Geological mapping in the Pyrenees

Sally Rowan / Mervyn Aiken - Kitchen sink petrography
The speakers took up the late Alec Herriot's offer last year to show interested amateurs how to make thin sections and are developing their own skills.

Michael Pell - A "young" geologist's view of the geology of Petra, Jordan.
Petra is located in southern Jordan just off the Red Sea rift zone. The site was founded about 5000 BC by a nomadic group of Arabs. Later Arabs built their monuments in the Cambrian sandstone in sections free from the generally heavily faulted and jointed Lower Palaeozoic rocks of the area. This faulting has provided the only access route through a narrow easily defensible ravine. The Romans settled the region, near to the main trade routes and built the temples and amphitheatres typical of their settlements. The site was "discovered" by Westerners in 1812.

Neil Clark - The Elgin Marvel
Before the time when dinosaurs were on the Isle of Skye in the Jurassic period, small mammal-like reptiles were living in the Moray Firth area in the Permo/ Triassic. The discovery of a mould of a dicynodont skull was described and slides shown.

David Wilkinson - Excursion to South Kintyre
Personal recollections of the 1994 expedition. An Excursion Guide was prepared by

the leaders C.J.Burton and J.J.Doody and published in the Proceedings for Sessions 136 and 137 for 1993/95 and has now also been published as a guide by the Society.

In addition, the following displays were mounted :-

Ben Doody - Geological courseware from the Earth Science consortium

Julian Jocelyn - Spherulites from Jersey and Oregon

Craig Main - Display of fossils

Michael Pell - Photographs and specimens from Petra

Sally Rowan / Mervyn Aiken - Practical demonstration of "kitchen sink" petrography

Jane E. MacDougall - Namibia, a geological safari in a land of sky, sand, stone and space - Descriptive folder of Photographs and rock samples.

Council sub-commitee - Competition entries for the design of the covers of a new publicity brochure for the Society were displayed for members' comment.

EXCURSION REPORTS

NORTHEAST GRAMPIANS : 8th - 11th May 1998
Leader : Dr. J.R.Mendum, British Geological Survey, Edinburgh
Participants : 26
Report by : *David Wilkinson*

The aim of this field trip was to look at the stratigraphy and structure of the Dalradian Sequence, the Old Red Sandstone, and the major basic-ultrabasic intrusions of the Northeast part of the Grampian Highlands, concentrating on the Banffshire Coastal section. The leader was assisted on the 10th May by Alan Crane of the University of Aberdeen.

The Bridge of Avon and the Ailnack Gorge
The geology started on Friday 8th May when, travelling north on the A9, we crossed the Highland Boundary Fault and Dr. Mendum pronounced us to be in the Highlands. Our first real encounter with rocks, however, was at the Bridge of Avon

where we looked at the Appin Group in the river and on its banks. Here we saw beds of very white limestone, quartzite and calcareous schists which, near the bridge, were tightly folded. The pure limestone here contrasted with the muddy meta-limestone of the Blair Atholl Subgroup we saw not far away in a disused quarry near Tomintoul.
A diversion south of Tomintoul gave us the opportunity to see the spectacular glacial meltwater gorge cut by the Water of Ailnack through an Old Red Sandstone (ORS) outlier which sits unconformably on the Blair Atholl Subgroup rocks.

We reached our base for the trip, Cullen on the Banffshire coast, in good time to sample its Skink, a delicious creamy smoked haddock soup. The fine day was crowned with a glorious red sunset over the Moray Firth.

The Coastal Traverse

The following account (with one inland diversion) describes our visits over three days to sections of the Banffshire coast, traversing from Portknockie in the West to Macduff in the East. In spite of the apparent complexity of some of the exposures we saw, John Mendum assured us that the Dalradian metamorphic rocks in this sequence were easier to understand than those we were perhaps more familiar with in the Western Highlands.

Saturday 9th May

Portknockie and Cullen
Saturday morning, fine but cold, saw us looking at the Grampian Group of rocks on the foreshores of Portknockie and Cullen.
At Portknockie, we saw psammitic metamorphosed rocks with sedimentary structures clearly visible. These were originally lenticular sand deposits which, Dr. Mendum said, were very mature as shown by the signature of their accessory minerals. This pointed to them being probably 2nd generation sand, poor in exotic minerals and derived from another sandstone. The sedimentary features, probably enhanced by compression, showed cross bedding and revealed that the rocks were the right way up. A band of pelitic rock, in which Garnets had been developed, had lost all traces of its original sedimentation and showed that the metamorphism was concentrated in the silty bands.
Travelling east along the coast we looked at the rocks in Cullen harbour. Here we saw thick beds of Quartzite, dipping steeply to the Northwest, inverted and younging to the East (~700Ma) interspersed with thin tidal ripple beds, interleaved, or anastomosed. The sedimentary features of the pale Quartzites were enhanced by wetting.
Whilst walking along the shore to the east of the harbour, as we passed a dog's graveyard between the cliffs and the beach (carefully tended and surrounded by a border of white painted rocks) we were amused by the incongruous scene of a

diminutive terrier and a huge St. Bernard out for a constitutional with their owner.

Sandend Bay

Next, eastwards along the coast to Sandend, we looked at the Appin Group of the Ballachulish Super Group. These were a sequence of limestones, graphitic schists (very dark, indicating the presence of carbon) and pelites which indicated a period of quieter sedimentation. In the harbour the limestone cleavage was parallel to the bedding plane, whilst west of the harbour where the limestone was tightly folded the cleavage was penetrative. This increased complexity of metamorphism indicated that they had been buried deeply (~25km) and had suffered temperatures of the order of 600 degrees C. As we walked further east, a thick sequence of black graphitic schists and dirty limestones marked a significant change to quieter deposition conditions in deeper water. We were now in the Lochaber Super Group, which here were represented by beds of Actinolite schists that in places consisted of over 80% of Actinolite (calcium aluminium silicate) in the form of needle like crystals, a quite rare occurrence of this mineral in Scotland.

At the east end of Sandend Bay the graphitic schists under the sands were studded with crystals of Kyanite, evidence of fairly high grade metamorphism. We could also see where the ORS made unconformable contact with the schists. Slightly further to the east was the Blair Atholl limestone, folded and whose basins were filled with ORS and angular conglomerates of Dalradian in an ORS matrix.

At the side of the steps up the cliffs at the east of the bay we saw thin clays - the sediments formed in a glacial lake which existed here about 13,000 years ago.

Keith and Huntly Bin Quarry

Later in the afternoon we went on to Keith where, at the beautifully manicured Strathisla Distillery, we examined deformed Augen Granite used as building stone. Adjacent to the Tesco supermarket there was a large block of Keith Granite on one bank of the river which had inclusions of sedimentary clasts.

A final visit in the afternoon was to Huntly, where in the Bin Quarry, we were able to see an impressive exposure of basic cumulates. This was Gabbro of about 450 Ma old rotated some 120 degrees from its original position at a depth of about 15 km. We saw very clear banding in the 20 metre high quarry face due to successive intrusions in which the larger crystals settled out on to what had originally been the bottom surface of each pulse of magma. (This was a good exposure of one of the so-called 'Younger Basic' plutons. This name was originally used to differentiate the un-metamorphosed basic intrusions, widespread in this area, from earlier pre-metamorphic basic igneous rocks. It is now understood to refer to a suite of basic intrusions which were emplaced at or about the time of the peak Dalradian metamorphism and includes some basic rocks which are deformed and metamorphosed.)

Sunday 10th May

The day was all spent on the shore in the region of Portsoy where there was a great variety of metamorphic rock to be examined and pondered over. We were told that the Portsoy lineament separates two crustal blocks and that the minerals in the rocks must have been formed under pressures which could only have been generated under about 15 km of cover. There was now no record of what had been on top.

John Legges Well – West of Portsoy

We were joined by Alan Crane for the day and went first to the west of Portsoy, at John Legges Well. Here the shore was very rugged and the rocks were eroded into a jumble of blocks and stacks. We were able to climb one large stack on which there was isoclinal folding of the strata. The bedding was difficult to determine as the rocks in this area were highly stretched and folded, although it was probable that it was sub-parallel to the cleavage.

There were dark bands of graphitic schists which were thought possibly to be the result of bacteria fixing carbon. (We were told that this interpretation avoids the problem of "anoxic sediments".) Crystals of Pyrite were found in the heavily graphitic layers.

Moving towards Portsoy near Castle Point Swimming Pool we looked at the Phyllites which were graphitic at the base. In the small scale tight folds we found Sillimanites. Near the basic intrusion (Gabbro) at the east edge of the pool we could see graphitic crosses showing where Andalusite (Chiastolite) had been replaced by Kyanite. There were also Staurolite crystals, which with the Kyanite, was evidence of the high pressures the rocks had been subjected to.

The Portsoy 'Marble'

As we moved further east we came to the 'Soy Limestone' which is highly folded and dolomitic. Accompanying it was an intruded pod of 'Younger Basic' igneous rock which was very porphyritic. This was aged about 470 Ma and again was emplaced at a depth of about 15 km. This intrusion was associated with a big shearing event which manifests itself as the Portsoy 'lineament' – a line which separates the high grade metamorphic rocks on the west of Portsoy from those to the East which are of a much lower metamorphic grade.

Moving eastwards we then came to the Portsoy 'Marble'. This is an attractive black to green rock veined with red jasper and white quartz. It has been much quarried in the past and was used in the construction of the Palace of Versailles. The beach at this point is a treasure trove of attractive pebbles, many of which found their way into our rucksacks. The rock is actually Serpentinite and was originally an Olivine rich ultrabasic rock which, as the result of low grade metamorphism, has been converted to Serpentine. The hydration of the ultrabasic rock caused it to expand thus letting in fluids which gave rise to the veining.

Following the Serpentinite there was a vertical section of stretched out psammitic

Quartzite which then showed a clear contact with a series of graphitic schists. Following a Limestone and more Quartzite there was a pod of Anorthosite (Plagioclase Feldspar). Together with the deposits on Harris (which caused the controversy over the proposed super-quarry) and some on the Lizard, this is only other substantial deposit of Anorthosite in Britain.

Portsoy Harbour to Cowhythe Head

In the old harbour at Portsoy there is a massive Amphibolite, which has been formed from sheared Gabbro. Alongside there are occurrences of unmodified Gabbro, and Gabbro with amphibolatised edges.

The new harbour wall was constructed of Portsoy (and perhaps Keith) Granite blocks. On the east of the harbour wall we saw sheets of Limestone and Pegmatite Granites.

As we worked round Links Bay we crossed the latest (465 Ma) igneous element in the Portsoy shear zone (which is thought to be dextral.) On the Eastern side of Links Bay the shoreline was very rough with large blocks eroded out. Here we were out of the shear zone and the aptly named 'Cowhide' rocks were well exposed. These are actually high-grade metamorphic psammites/semi-pelites in which a segregational 'sweating' of quartz with a selvedge of biotite gives rise to their distinctive appearance. An earlier classification for these rocks was gneiss and in the Aberdeen Excursion Guide they are referred to as the Cowhythe Gneiss (the name comes from the locality.)

At East Head there were lenticular pods of Quartzite dissected by a maze of Pegmatite veins rich in large black Tourmaline crystals.

Around Strathmarchin Bay the shore was paved with a quite smooth platform of grey and white Agmatite, a very churned up metamorphic rock. There were bands of very contorted limestone with large scale folds and parasitic small scale folds in the noses.

On Cowhythe Head there is a pod of Anthophyllite. This fibrous mineral is a high temperature modification of ultrabasic magnesium iron silicate. This pod occurs in a background of impure Limestone which has been serpentinised in parts at the contact with the ultrabasic. This assemblage poses the problem of how did the ultrabasic get in? It had to be hot, but the surrounding rock has not been much affected by heat. There is a Pegmatite associated with Biotite at the altered edge - this is a metasomatic rock.

There is also a pod of Pegmatite which has a band of Muscovite round the edges and is Feldspar rich in the centre.

Monday 11th May

Whitehills and Boyndie Bay

On the way to Whitehills we paused to look at a distant view of Boyne Bay Quarry where we could see the Boyne Limestone overlaid by a substantial glacial till.

On the shore at Whitehills we looked at rocks in the Southern Highland group. These were turbiditic, formed on a deepening shelf with a fringing Limestone reef.

About 500 Ma this was originally the edge of the Laurentian Continent and lower pressure metamorphism resulted in the formation of Andalusite and Cordierite minerals. The rocks in Boyndie Bay form an extension of the Turriff Syncline. They are steeply dipping and have graded bedding in places showing the typical Bouma sequence. As we walked eastwards the rocks had a 'poxy' look where they were studded with crystals, first of calcareous Garnets, followed by Cordierite and then Andalusite all separated by considerable thickness of turbidite.

MacduffJust east of Macduff we looked at the Greywackes known locally as 'Macduff Slates'. These have cleavage at a sharp angle to the bedding. The most interesting thing here was a well exposed syncline which had boulders embedded in the fine grained turbidites. These boulders were of completely different material to the country rocks and have been interpreted as 'drop stones' resulting from the melting of icebergs in warm water. The boulders were of varying sizes, a particularly well exposed one being about 1.5m high.

Synclinal structure East of Macduff
(light coloured pointed dropstone at bottom left)

Further east, at Tarlair swimming pool, a natural bay in which a large open air pool had been constructed, there was a continuation of the turbidites and sedimentary structures could be seen at low tide. For the author the depressing sight of the now disused and unsafe swimming pool brought back memories of better days for the pool some thirty years ago, when it was thronged with children, and entertainment was provided by the town band. Today, however, the sun shone and the party enjoyed their lunch sat on the grass away from the pool

Conclusion

This geological field excursion was an example of how a well planned and organised trip can keep the interest of a group whose geological knowledge ranged from expert to beginner. John Mendum was an enthusiastic geologist and a good communicator of his subject. This article has relied almost entirely on notes taken from John's descriptions in the field. Any errors, however, are entirely the responsibility of the author.

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THE WHANGIE : 30th May 1998
Leader : Dr. J.G.MacDonald, University of Glasgow
Participants: 56 (30 from Glasgow : 26 from Edinburgh)
Report by : *Sally Rowan*

This, our annual joint excursion with the Edinburgh Geological Society was a popular and successful excursion to this unusual and dramatic group of igneous rocks attended by around sixty people - Glasgow 30, Edinburgh 26.

Most people met at the Queen's View car park on the Drymen Road, just north of the Carbeth Inn. The large turn-out entailed some good-natured car-arranging before we set off . The weather was mild, although overcast, and remained a pleasant walking day.

A **Whang** is a slice or crack (of a whip?) and one legend has it that the Whangie was created by the Devil's tail cracking the ground open. Oddly enough, this legend seems to be relatively recent - the 18th century Statistical Account of Scotland mentions the area but refers to no legends. There are descriptions of fissures which had to be infilled to prevent sheep falling in. This apparent lack of history could be because the area was pretty inaccessible until the Agricultural Revolution, or could indicate a relatively recent formation in the early 17th Century.

Tyrrell considered it possible the Whangie was formed following an earthquake described in Church of Scotland records in 1609. This quake was felt as far afield as

Edinburgh, St Andrews, Dundee, Aberdeen and Dumbarton. There was a lot of panic - a day of penitence and fasting was declared - and scapegoats such as Sabbath-breaking fishermen were sought. The magnitude of the earthquake seems therefore to have been much greater than anything since.

The Whangie is a slice of microporphyritic Jedburgh basalt detached from the Western edge of the Kilpatrick Hills. Its most obvious feature is huge vertical slices of grey rock towering at least 10 metres high, separated by narrow fissures. Many of the rock slabs display conchoidal fractures. There are three main sections, all narrowing towards the South. The last is the narrowest, with nearly vertical sides, while in the second the outward slope of the structure decreases. Overall, the main slabs and fissures seem to have a radial pattern - inner ones narrower and steeper, outer ones wider and shallower, all appearing to meet at a central point deeper down. There are several "mini-Whangies" nearby. Some of their fissures pinch out, and when covered over by tussocky grass make good ankle traps. They are also disconcertingly deep and tallied with old descriptions.

Modern geologists still dispute its origin but the outcrop nestles beside and slightly downhill from what seems to be a volcanic plug of porphyritic Markle basalt with large phenocrysts, although the exact nature of their association is unclear. Current researchers are trying to obtain a magnetic profile of these rocks. Usually, plugs are fresher and so have a stronger magnetic signature. It is possible that the Whangie is part of one very thick lava flow which was later intruded by the Markle basalt.
The most likely cause of the Whangie's formation is the Ice Age, when huge sheets of ice must have flowed past and around and maybe even under the Jedburgh basalt. Its pre glacial extent is unknown, but the ice must have put tremendous stress on this corner. There is very little jointing in the Whangie's basalt, except for some on a small scale at the top, suggesting it was extruded. It seems that as it was stressed, the basalt has peeled off in big slabs and fallen away from the cliff rather than a landslip, which could account for the fissure pattern.

Dr. MacDonald was thanked for his thorough preparation, handouts and enthusiasm. After an enjoyable and thought-provoking day, almost fifty of us from both Societies descended on the Kirkhouse Inn, Strathblane for a good meal and more conversation.

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LOCH DOON AND CARSPHAIRN : 13th June 1998
Leader: Dr. J.D.Floyd, British Geological Survey, Edinburgh
Participants: 23
Report by : *Ken Smith*

This well attended excursion enabled members to examine the contact zone caused by the intrusion of the Loch Doon granite into Southern Upland Ordovician greywacke country rock. Opportunity was also taken to examine evidence of local Lead/ Zinc mineralisation and briefly to understand the industrial and social history relating to its extraction.

The first traverse commenced on the shore immediately to the east of Doon Castle. The igneous exposure proved to be of Tonalite composition into which fragments of more basic igneous material had been caught up and embedded. Evidence for this earlier and more basic phase was said to lie a little way to the south. An age of 405 Ma has been given to the pluton. Proceeding a little way northwards, N - S trending fracture zones were seen to contain increasing inclusions of sedimentary material and a few yards further on, exposures of hornfeldised greywacke appeared showing clear sedimentary structures - remarkably clear evidence therefore of a contact margin. In addition, it could be assumed from the pattern of jointing, that the intrusion had come close to, but not broken through, the surface of the host country rock. Thin Aplite veining was confirmed as a late stage feature. Several kilometres north, and adjacent to the dam of the loch, south dipping sections of coarse grained greywackes and siltstones were seen. Structures within these Marchburn Formation rocks indicated the beds to be younging to the North and that they were overturned. The rock surfaces also proved to be good examples of ice polishing with remarkable striae.

Finally, the remains of the Woodhead Lead Mines and their associated workings situated to the North West of Carsphairn were visited. The spoil heaps still proved a good specimen source for Galena, Blende and other gangue minerals but also attracting interest was the surviving evidence of the processing and smelting facilities including the means by which water was harnessed for energy. The ore source was identified as coming from two veins running parallel to and part of a NW - SE series of faults. The country rock of the area revealed in a small local quarry within the mine complex consisted of north dipping and north younging well sorted, laminated, fine grain turbiditic greywackes showing flute casts on their base.

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TWO EDINBURGH HILLS: 27th June 1998
Leader: Mr A. David McAdam, British Geological Survey
Participants : 22
Report by : *Margaret Greene*

The two Edinburgh hills were Blackford Hill and Corstorphine Hill and they both serve to illustrate David McAdam's statement that everything that sticks up in the Lothians is igneous. They are also both good examples of the work of the ice during the ice ages of the last 2 million years. Blackford Hill is the result of an Andesite lava flow in the Devonian times and its present day shape is of a crag-and-tail formation. Corstorphine Hill is capped by the remains of a dolerite sill intruded during the Carboniferous times which has been tilted and eroded and the surface of the dolerite is scratched and moulded by the movement of the ice on the western slope while there are tail features on the eastern slope.

The excursion started at a point on Blackford Hill just above the Royal Observatory with a wonderful view over Edinburgh and the surrounding area, where David explained the formation and moulding of Blackford Hill. He was able to point out other examples of igneous rocks and the effects on them of the ice flow, particularly Arthur's Seat, the Castle rock, Berwick Law etc. Despite the presence of a fine rain many familiar landmarks lying further afield were identified. We made our way down the Corbie Craig, another example of crag-and-tail formation and hence along the Braid Burn which runs along a valley carved out by the ice, past a quarry in the thick Andesite lava flow and on to Agassiz Rock. This rock is an SSSI and is where, in 1840, the Swiss geologist Louis Agassiz identified the erosive action of ice in Scotland. Unfortunately since then further weathering has destroyed the horizontal ice scratches or 'striae'.

Lunch was in the company of the ducks at Blackford Pond where we arrived just as the rain stopped.

After lunch we were taken by bus to the car park at the top of Cairnmuir Avenue and then into the woods on Corstorphine Hill. Here David explained that at the beginning of the Carboniferous times Corstorphine was the site of a large river delta. The mud and sand laid down by the river were subsequently buried and turned into mudstone and sandstone. Later when volcanic activity reached Corstorphine, magma was intruded between the strata to form a dolerite sill. This was then tilted and over the millennia the overlying rocks were eroded. The recent ice then polished off the top of the dolerite leaving a striated glaciated pavement. This pavement on the western slope is quite spectacular with ice-smoothed and moulded dolerite. Corstorphine Hill does not lend itself to all round views as well as Blackford Hill due to the trees, but we nevertheless had a good view west which took in a sweep from the Five Sisters bing to the Forth Bridges. We carried on

round the Hill where there are a number of large and small quarries. The larger tended to be in the dolerite sill on the western slopes while below the sill on the eastern slopes we visited a small siltstone quarry where small shell fossils can be seen in the rock, and further down, a sandstone quarry.
On the summit stands Corstorphine tower, built in 1871 as a memorial to Sir Walter Scott. Unfortunately it is surrounded by tall trees so cannot be viewed to its full advantage, however we were informed that a magnificent all-round view could be obtained from the top. We were not able to take advantage of this as David had been unable to obtain a key for the tower, and if he had, most of the party by this time were probably not too keen to climb to the top. However further round, with Edinburgh Zoo at our backs and the Murrayfield Golf Course in front, we had views to the North, East and South.

The weather threatened all afternoon with the odd flash of lightning or rumble of thunder but the rain stayed away and thanks to David McAdam's usual apparently very simple but very comprehensive explanations everyone went home with a much clearer understanding of the hills of Edinburgh.

References: A Guide to Blackford Hill and its Geology: A.D.McAdam 1986
Corstorphine Hill, Geology and Panoramas: A.D.McAdam 1993

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KELTIE WATER : 11th July 1998
Leader: Dr.S J Cribb
Participants : 31
Report by: *Evelyn Lennie*

The weather was dull and the forecast "showery" but our large party , almost filling the bus, left promptly and in good spirits.

Our route to Callander unusually went through Killearn as two more members were to be collected there. After a brief stop in Callander the bus bore us up to the special car park for Bracklinn Falls. Here we met our leader and five more people. By this time it was "standing room only" on the bus. After a further climb we abandoned the bus at the approaches to Braeleny Farm. A walk along the track took us to the bridge over the Keltie Water.
At this point our leader told us we had just walked across the Highland Boundary Fault and explained that this location is one of the very few where the Highland Boundary complex can be examined (The next location is at Loch Turret, a long way off). The object of the excursion was to study the rocks on either side of the fault and find out from the rocks themselves as much as possible about the structure and the history. "Geology <u>is</u> observation " as our leader kept telling us.

Our task was to observe but we were promised a handout at the end of the day.
At our first stop, in the stream, we found flaky beds interbedded with thicker sandstones. Their red colour proved to be only superficial and was due to iron in the water. We found no traces of igneous rocks and only mild metamorphism. In spite of all our efforts we couldn't detect graded bedding in the sandstone so simply had to accept that it had been found in the past and that it proved that the strata were younging upstream.
At our second stop further up the stream we found veins of quartz in a fairly massive sandstone and noticed that as there were no outcrops visible in the area immediately downstream the rocks there must have been of much softer material.
At our third stop at the dam for the little reservoir we were shown how the change in vegetation and the rocks exposed on the hillside traced the edge of the glaciation. Dr.Cribb explained that the dam had to be positioned over impermeable rock.
We climbed over a conveniently sited stile then up the hillside to a small abandoned quarry containing a wide band of shale, probably used for roofing locally. By this time the rain and all our wet weather gear had been on and off several times so it was difficult to tell if we were indeed looking at flakes of mica or merely raindrops glistening in the bright sunlight.
For our final stop before lunch we assembled on top of a hillock to review the evidence we had amassed so far. We accepted that the sandstones to our south were upside down but the beds to the north at the reservoir were right way up. At the hillock the beds were younging in both directions therefore we were looking at the nose of an anticline. From this vantage point we also had superlative views across the Forth valley the Campsies and the Ochils.

By now the rain had gone for good so a leisurely lunch stop in the warm sunshine was greatly appreciated.

As we set off further downstream we spotted a large island in the stream. It proved to be a fine-grained felsite dyke intruded into the Dalradian rocks in the Old Red Sandstone period. The different varieties of trees and plants growing on this island as well as its very existence in the middle of the stream helped to identify it as being of totally different material.
We studied several dykes as we went further downstream. All were very fine-grained proving they had been intruded fairly near the surface. We left the stream to climb up a ravine to inspect another old quarry. This one contained a black graphitic shale as well as the limestone, the reason for the quarrying.
Back down the stream we noted a felsite dyke and a dolerite dyke before passing through the Highland Boundary Complex into the Old Red Sandstones, conglomerates and lavas. The lavas were contemporaneous with the sediments and contained vesicles filled with minerals. A beautiful specimen of calcite was found as well as one of quartz.

At this point our leader decided, much to our relief, to negotiate a crossing of the stream. We had not been looking forward to the proposed paddle at the end of the day, but, thanks to many helping hands, all of us crossed without harm.

The Crossing of the Keltie Water

In the climb back up to the path we stopped to examine outcrops of a very frothy lava but could not decide whether the vesicles were filled with minerals, mud or ash. Back at the bus our Leader utilised a heap of gravel and someone's umbrella to draw a map of all that we had seen and then summarised what it all meant.

Ben Brown thanked Dr. Cribb for all his preparation and planning of our route and for encouraging us to become better observers.

EAST LOMOND HILLS & EASTER BALBEGGIE OPEN CAST SITE:
25th July 1998
Leader : M. A. E. Browne, British Geological Survey.
Participants : 23
Report by : *Ben Browne*

Twenty three members of the Society and guests from Edinburgh arrived with Mike Browne by coach at the car park (NO 227061) at the pass between East and West Lomond Hills. It was a dry overcast day with misty distant views.

Craigmead Quarry was entered on the left about 100m south of the car park. Here a face of the Midland Valley Quartz-dolerite Sill (Permian) last worked about 200 years ago showed spheroidal weathering. At the base of this face a leaf of the sill had intruded and baked sandstone then crystallised to a basalt. This in contrast showed fresh columnar jointing.

Old Royal Coal Adits were found after scrambling through thickets on the left of the road a few hundred metres north of the car park. They lie beneath the Hurlet Limestone which forms a waterfall. These coals heated Falkland Palace in the 16th and 17th centuries but now are best marked by the ochre deposited by the draining water.

Mapsie Den Walk was joined after a short drive further north. A delightful path winds down the burn past a sequence of undercut waterfalls. Where the path passes under a large overhang quartz pebbles can be seen in the sandstone roof marking the base of the Pathhead Formation and a major unconformity. Lower down in the Kinnesswood Formation we found mud clasts and pinstripe laminations indicating respectively water and wind worked sandstone on a land surface. We emerged from the woods to meet the bus on the minor road (NO 239072)

Lunch at the aerial mast car park (NO 252058) was followed by a walk up the path to the summit passing over poorly exposed agglomerates. Further on we found fresh dolerite with visible olivines. The unresolved question of the time relationship of the olivine-dolerite vent and the quartz-dolerite sill was discussed.

The summit view gave an opportunity to summarise the geology extending from the Dalradian Highlands in the North to the Pentlands in the South.

East Lomond Quarry (NO 238059) was worked in the Blackhall Limestone and the stone burnt in a now restored lime kiln. Corals were found in the limited remaining exposure of limestone, and the surrounding area including flooded workings was a garden of wild flowers illustrating the agricultural virtues of the lime that has dusted the area during so many years of hard labour on this site.

East Balbeggie Opencast Coal Site (NT 292963) reached after a drive past Glenrothes and Thornton provided an unexpected and almost unique opportunity to see dramatic exposures in a 45m vertical section through thick sandstones filling big river channels. Beneath these the Dysart Main and Lower Dysart coals were exposed and within them old mine workings within which men had toiled in darkness not many years before. Collapse structures above these workings were giving rise to active rock falls. These were not faces to inspect closely. The tracked digger used to make this excavation had a ladder to get to the base of the staircase that led up to the driving cabin. It was big. In the debris under our feet we found laminated ash deposits reminding us of the volcanicity of that rather more dramatic Carboniferous era.

Once again we were pleased to thank Mike Browne for a stimulating day out , and the less nimble of us to forgive him his long legs.

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KINGSBARNS : 15th August 1998
Leader: Dr. C.J. Burton, University of Glasgow
Participants : 43
Report by : *"Jasper"*

The purpose of this excursion, led by Dr Chris Burton, was to examine the sedimentary beds of the Upper Devonian (U.O.R.S.) and Lower Carboniferous on either side of Kingsbarns in the coastal section between Randerston Farm and Airbow Point with the view of interpreting the depositional environment.

The weather on the day proved to be exceptional for the summer of 1998 - the sun shone!. In anticipation of the interesting geology 43 members from Glasgow and Edinburgh met at the shore side car park.

Before lunch we took the North shore towards Babbet Ness where Dr Burton guided us into finding pieces of evidence. Fossils of all descriptions from logs, bivalves and trace fossils were found in the regular sequence of shale, mud and limestone gradually building up a picture of a fluviate system with meandering rivers. The whole area alternating between a marine and non-marine environment.

The synclinal and anticlinal periclines of the Lecks were pointed out clearly visible above low water.

On the way to the Randerston Shore time was taken to examine the Humlie, an igneous erratic. This together with the amphibolites and garnetiferous schists were pointers to past glacial activity in the area indicating ice movement from the North.
The Randerston Shore is a classical cyclothem sequence, so using knowledge gleaned from the morning, we were able to identify the regularity of the sequences. Not all cycles were complete, coal deposits being found in only one of the three sequences examined.
The sequence is repeated so regularly that it was apparent that external influences had played a part in the formation of these beds. Having advanced this far we were treated to a clear, concise exposition of the Milankovitch Hypothesis, detailing how periodic vacillations in the earth's orbit gave rise to climatic variations. These variations in climate produced glacial cycles which in turn resulted in variations in sea level manifesting itself in sedimentary depositions.

The final "exhibit" was fossilised Stromatolites.

Our return to the bus skirted a huge new golf course under construction, the off shore wind lifting the sand from unseeded links subjecting us to a good sand blasting, a first hand example of deflation.

The verdict, a superbly interesting day, our thanks to Dr Chris Burton for his patience and concise descriptions.

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ISLE OF WIGHT : 19th - 26th September 1998
Leader: Dr. Judith Lawson, University of Paisley
Participants : 27
Report by : *Judith Lawson*

A party of 28 assembled on Saturday 19 September at the Sandhill Hotel in Sandown having arrived by various land, sea and air means.

The geology of the Isle of Wight (IOW) is rather different from that seen on many previous trips by the Society as it is entirely sedimentary and has a relatively simple structure. The rocks are very fossiliferous and many collections were made. Ammonites were particularly popular with one large specimen being carried home via a holiday in France! In the IOW, the relatively simple, though dramatic, monocline structure has given mainly northward dipping beds. The island has, since the Hercynian Orogeny at the end of the Carboniferous, been situated on or near the edge of a land mass with high ground to the West and lower ground or sea to the East. The position of the coast line has varied with changes in sea level so that sometimes the IOW has been a land area with rivers, sometimes near the coast with estuaries and lagoon and sometimes the open sea. The superb exposures on the coast, with good access (tides and landslips permitting!) allow the succession of Cretaceous and Tertiary rocks to be studied in detail. Using the lithology and palaeontology, convincing environments of deposition can be decided for many of the beds and a picture of the palaeogeography built up.

On Sunday, the morning started off with a visit to the Culver Headland to gain an overview of the island and the first two day's geology. Unfortunately, for the only time in the week, clouds enveloped the headland and the view completely disappeared! However, by the time the party had arrived at the Yaverland section, in Sandown Bay, warm sun had appeared - a warm sun which was to remain with us for the rest of the week.

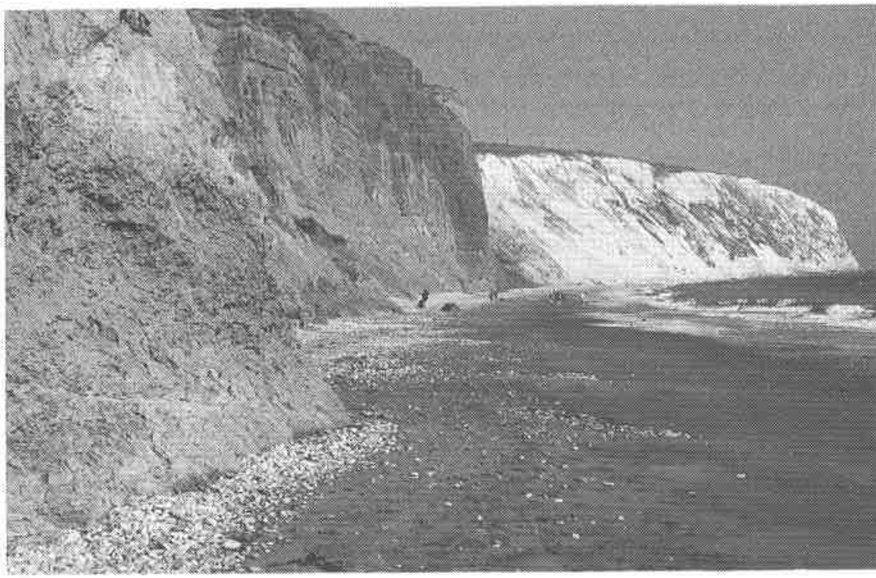
At Yaverland, the oldest rocks seen in the IOW, the **Wessex Marls** of the Wealden Formation, of Lower Cretaceous age, outcrop in the core of the Sandown Anticline. There is considerable landslipping in the form of mud flows and rotational slips.

About 50m of red mottled mudstones and medium grained white sandstones with a low dip to the North were exposed in the low cliffs at the head of the beach. Some beds are full of plant debris, mainly from conifers but with some cycads and tree ferns. In the plant debris beds, vertebrate fragments of bone and teeth may be found and some beds are known to contain dinosaur footprints and trackways (but we weren't very convinced). More convincing were depressions viewed in cross section which were formed in the layers below the surface when dinosaurs walked across wet sediments. Some beds contained fresh water molluscs. No marine fossils have ever been recorded from these beds.
The environment in which these sediments were deposited is thought to be a coastal plain with low gradient, with meandering rivers and wide flood plains. Occasional floods brought in plant debris and vertebrate fragments (whole skeletons are very rare). At other times, muds were deposited on the flood plains and later soil formation gave the mottled red colour. Sandstone beds may be the point bars of the rivers.

Above the Wessex Marls there is an abrupt change in colour to the grey **Vectis Shales** of the Wealden Formation. The darker colour indicates wetter conditions. A fossil common at certain horizons is *Filosina*, a bivalve characteristic of brackish water. These clays were deposited in a brackish lagoon near the coast, with occasional inflow from the sea. In the middle of the Vectis Shales is the **Barnes High Sandstone Member** which shows some cross bedding and coarsening upwards sequences which were probably formed in a prograding delta formed by a river flowing into a lagoon. Towards the top of the succession *Ostrea* occurs probably as a result of storms sweeping in and washing the more marine fauna in. Ostracods are common at some horizons.

The marine influence gradually increases and in the **Perna Bed**, at the base of the **Atherfield Clay Formation** of Aptian age, the fauna is fully marine. This bed outcrops on the beach but the sand had shifted so that the bed was hardly visible. A typical coral, visible only a few days earlier had disappeared from view! The well cemented limestone contains numerous large oysters *Aetostreon latissimum* as well as corals and reworked teeth and bone fragments from the Wealden Beds below. No *Mulletia mulleti*, a spectacular bivalve, formerly known as *Perna* were seen. The Perna bed is interpreted as a beach deposit marking the base of the important marine transgression of the Aptian.

Above the Perna Bed is the **Atherfield Clay**, a marine clay with, here, only very occasional ammonites.



Northern end of Sandown Bay with Red Cliff in middle and Culver Cliffs beyond

Continuing northwards the Red Cliff (subject to frequent rock falls) was viewed from a distance. The cliffs, some 50m high, are formed of brightly coloured, yellow, red and brown sandstones and muddy sandstones of the **Ferruginous Sands Formation** of the **Lower Greensand**. When fresh they have a distinct green colour due to the presence of the mineral glauconite but this is oxidised on the weathered surfaces. The beds are almost devoid of fossils at this locality. The dip could be seen to steepen to the North as the monocline was neared. Occasional pebble beds contain derived, rolled ammonites from the Jurassic indicating that at least some of the older rocks were exposed in the vicinity. At the top is the paler **Sandrock** and the red-brown **Carstone**. These sandstones were probably formed in a fairly shallow offshore environment.The **Gault Clay** of Albian age formed a depression in the cliffs but was only poorly exposed. It is about 30m thick and overlain by 30m of the **Upper Greensand**. To the East the clay thickens at the expense of the sandstone while to the West there is more sandstone. This diachronous boundary shows that coarser sediments came from the West.

At the northern end of the bay the Culver Cliffs rise to a height of 100m and the dip has steepened to nearly vertical. The lower part of the Chalk is quite muddy but gradually the proportion of calcium carbonate increases until the pure white of the **Middle and Upper Chalk** is reached. A conspicuous feature of the **Glauconitic Marl**, the **Chalk Marl** and the grey, **Middle and Upper Chalk** is the markedly rhythmic banding visible as colour differences in the cliffs and harder bands on the foreshore. The time scale of about 40,000 years suggests a link with the

Milankovitch cycles but the process is not clearly understood. Chalk is largely made of the minute remains of calcareous algae - Coccoliths - which lived in the surface waters of a warm, clear sea possibly 200 to 300m deep. The party spent some time "getting their eye in " for finding fossils in the Chalk. Brachiopods, bivalves, ammonites, echinoids and numerous sponges were among the fossils found.

The second day was spent in Whitecliff Bay. After parking near the entrance of the Whitecliff Caravan Park the party walked into the middle of an American Civil War flag-raising ceremony. The beautifully costumed participants were as surprised to see us as we were to see them!

The party then walked to the southern end of the bay to the vertically dipping **Upper Chalk**. Layers of flint were prominent. In many cases the silica, probably derived from sponges, had an irregular knobbly shape and it was easy to see it was deposited in, and took the shape of, burrows in the limy mud. The top of the Chalk at beach level is obscured by landslips and scree. The highest Chalk is not preserved here and a gap if about 15 Ma occurs, with erosion before the lowest Tertiary bed - the **Reading Formation** was deposited. The unfossiliferous, red mottled clays are subject to much slipping and mud flows. They are formed on land, probably with waterlogged (hence the mottling) soils.

Above the Reading Formation is the **"London Clay" (Thames Group)**. In this, and the **Bracklesham Group** above, cycles of sediment can be recognised. These were formed by successive transgressions and regressions by the sea on to the land. In the London Clay each cycle starts with a sharp base, often pebbly, followed by clays which gradually coarsen upwards into sands. The sands stand as cliffs with the clays forming valleys between. Each cycle represents a flooding by the sea onto a land surface as the sea level rose followed by shallowing as sea level fell and sand was washed in from the West. Marine fossils and glauconite (formed only in marine conditions) occur. Near the top of the London Clay, sands are common and were formerly called the **Bagshot Sands**.

After lunch (and sunbathing and ice-cream!) the upper part of the succession was studied. This Bracklesham Group shows cycles of glauconitic sandy muds or sands followed by thinly bedded, often lignitic, beds at the top. A massive lignite, 1m thick, with its accompanying seat earth with rootlets beneath, outcropped vertically in the cliff. In the third cycle the large foraminifera *Nummulites laevigitus* was found. In general the pattern of cycles was repeated but with more continental influence. Near the path down to the beach, the **Barton Clay** and **Becton Sands** were seen. North of a more northerly path a change from sands to green clays marks the base of the **Headon Hill Formation** of the **Solent Group**. The sediments, of a variety of colours, vary from freshwater with *Viviparus* and *Galba*, through brackish with *Potamya*, to occasionally, marine, with (in the Brockenhurst Bed), *Ostrea, Venericor, Pelycora*, etc. The environment of deposition was in an extensive low lying area near the coast with estuaries, fresh water lakes and brackish lagoons. The **Bembridge Limestone**, widely used as a building stone, is first seen at the top of the cliff where the dip is vertical. A sudden change to nearly horizontal bedding then occurs so that it forms the back of the beach for some distance. It was deposited in a fresh water lake and contains numerous moulds of *Galba* and *Planorbina*. Above the limestone is the **Bembridge Marl Member** of the **Bouldnor Formation** with the marine **Bembridge Oyster Bed** near the base.

Some members decided to walk along the cliff path to the last locality of the day at Bembridge Foreland, (one member walked with such enthusiasm that he later had to be retrieved from Bembridge itself!) Higher beds of the Tertiary outcrop on the beach and are overlain by the pebble beds of the Bembridge Raised Beach, formed some 115,000 years ago during the Ipswichian Interglacial.

The third day was spent exploring the Needles area in the west of the island. After parking at the Needles Pleasure Park the party walked onto the Chalk ridge at Tennyson Down. An excellent overview can be seen from here and it is easy to imagine the ridge continuing to the Dorset Mainland. The deep valley in which Freshwater lies can be appreciated as a former river valley flowing North with its head waters now lost to the English Channel. The party then walked to the Needles Battery for a closer view of the Chalk cliffs with their near vertical bedding, picked out by the lines of flints, and the Needles themselves.

After lunch, Alum Bay was visited. Some of the party took a boat ride to view the bay and the Needles from the sea. This gave an excellent overall view of the area. The rest of the party made their way to the Chalk exposed at the southern end of Alum Bay. The contact of the Chalk, here slightly higher in the succession than in the East, is visible with deep solution hollows in the upper surface filled with the basal Tertiary sediments. Rock falls are common in the steeply dipping Chalk where it is being eroded at the base by the sea. Numerous fossils were found in the Chalk, including the belemnite *Belemnitella mucronata* and the echinoid *Echinocorys*. The Tertiary sediments here have less marine influence than in the East. Their brilliant colours are superbly seen in the late afternoon sun.

The "day off" started with a visit to the excellent, although small, Sandown Museum. An introductory talk was given by Martin Monk, who explained the fossil collections and discussed the problems of over-enthusiastic or mercenary collectors removing vital specimens. A balance has to be struck between the loss of material to the ever eroding sea, the loss of specimens to serious students and commercial activities.

The party then split up to pursue personal activities including visits to some of the tourist attractions of the IOW including Brading Roman Villa, Osborne House and the Ventnor Botanic Gardens.

The next day was spent in the south of the island. The viewpoint carpark is situated above Blackgang Chine in an old quarry. Here the top of the Upper Greensand, the Glauconitic Marl - a glauconitic calcareous sand with a basal bed of reworked Upper Greensand cobbles, and the base of the Chalk Marl are exposed. Some time was spent looking for fossils and a good collection was made including the ammonites *Schloenbachia* and the uncoiled *Turrilites*. The party then walked along the coastal cliff path above Gore Cliff - noting with some alarm that the upper part of the cliff was overhanging the more easily eroded lower part of the Upper Greensand ! From this path there are good views of the active slip area to the South. The remains of the old road and recently (1994) destroyed houses emphasised the instability of this whole area. The rotated Upper Greensand and Lower Chalk ridge, with its inwardly dipping upper surface, near Knowles Farm, was also clearly visible

Lunchtime was spent at Dinosaur Farm where recent dinosaur skeletons are being worked on and preserved by a team of volunteers. It was interesting to see the various techniques involved. The team patiently answered our many questions.

In the afternoon we met Martin Simpson who has a rock shop at Blackgang and who has lived and worked for many years on the Wealden rocks of the IOW. He took us onto the beach at Shippard's Chine (where half the car park has collapsed onto the beach). It is easy here to appreciate how fast the coastline is receding. There was a constant rain of dry sand down the cliffs and mud flows across the beach. The "find of the day" was an *Iguanodon* tail vertebra found among the pebbles on the beach.

As the tide receded, Hanover Point reef, formed of the **Hanover Point Sandstone** of the Vectis Group, emerged from the sea and we were able to see the dinosaur footprints on a bedding surface. Large tridactyl footprints formed a trackway here (and were a lot more convincing than those of the first day !). Unfortunately the rapid erosion by the sea will soon obliterate them. Also visible was some of the famous **Pine Raft** - gymnosperm tree trunks up to 3m long and 1m in diameter. Many of these are preserved as 3D calcium carbonate impregnations. These are derived from the plant debris beds well exposed in the nearby cliffs.

The last day started near Shanklin Chine. The upper part of the Lower Greensand - Ferruginous Sands Formation are seen forming the cliffs and dipping at a low angle to the South. The highest part of the cliff is formed of the **Sandrock** and **Carstone**. The main part of the cliff is the **New Walpen Chine Member**, here a reddish brown sand with large scale cross bedding and the oyster *Aetostreon*. On the beach are numerous ironstone boulders, full of bivalves and gastropods, which have fallen from Member XIV above and also of fossil wood fallen from the Sandrock. At Horse Ledge a dark green glauconitic muddy sandstone is very fossiliferous at the top with examples of the brachiopod *Rhynchonella* thought to be in life position.
At this point the party had a very good lesson in the inadvisability of standing beneath vertical cliffs as, with a deep rumble, a large chunk of the Ferruginous

Sands fell some 30m onto the beach nearby. A hasty retreat was beaten to Shanklin Chine where some recovered with cups of coffee while others explored the chine - a deep, vertically sided valley cut very recently when sea level fell to its present level. Such is the rapid erosion on the island that some chines have been eroded away - at Blackgang there has been 275m lost in the last 150 years.

In the afternoon Martin Simpson led us down the 200 - 300 (sorry - count lost) steps of the staircase down Whale Chine. These steps have to be renewed each year because of constant landslides and already the lower part was partially obscured by a mud flow. Whale Chine itself is cut in the middle part of the Ferruginous Sands. Very large ammonites including uncoiled ones are (fairly) common here and one member of the party did find a well preserved example of one of these. The party then walked westwards along the beach towards Atherfield Point - the type locality of the **Atherfield Clay** - here much more fossiliferous than on the east coast. **Crackers**, spheroidal calcareous concretions in a matrix of sand and which can yield superbly preserved fauna were found. Below this is the **Lower Lobster Bed**. Thousands of examples of the small lobster *Meyeriella* have been collected from this bed - unfortunately we were not spectacularly successful.

The party left the Isle of Wight on the morning of Saturday 26 September (in the pouring rain) having enjoyed six days of warm sunshine and an experience of rather different rocks and fossils from what they are used to in Scotland.

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