PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF GLASGOW

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1978

EDITORIAL

This issue initiates a change in direction in the Proceedings, intended to make the publication of more general interest. The annual reports of the officers and the full abstracts of the season's lectures are omitted, although they are still available in the relevant billets. Geological news items of both general and local interest are included and members are encouraged to submit any such items they encounter to the editor. Articles of interest to the general and amateur reader are required, plus excursion or locality notes, short letters, personalia, humorous geological sketches, verse etc.

OBITUARY NOTICE

William Roberts Flett, B.Sc., F.G.S., F.R.S.E.

William Roberts Flett, B.Sc., F.G.S., F.R.S.E., died on 22 August 1979 after a long period of failing health. He had been a member of the Glasgow Geological Society for over half a century, had served on its Council and in the late 1950's and early 1960's occupied the offices of President and subsequently Vice-President; as early as 1929 he is recorded as having been appointed Librarian. He is well remembered among the longer-standing members of the Society, by a still considerable number of friends and former colleagues at the Universities of Glasgow and Strathclyde, where much of his working life was spent, and by former students, as a very courteous and considerate gentleman.

Bill Flett, an Orcadian, was born in 1900. In 1918 he joined the Gordon Highlanders on leaving school and after the end of hostilities, worked in "Army Education" for a period in 1919. Thereafter he studied geology at Glasgow University as Demonstrator, subsequently holding posts as Teaching Fellow and Lecturer. His early interest in economic aspects of Scottish geology is reflected in consultancy work dating back to the 1930's, while earlier still, in 1927, he had contributed to the *Transactions* on the sand deposit at Hungryside, Torrance. He was interested in the Barnesmore Granite of County Donegal before transferring his attention to the granites of North Arran on which he again published in the *Transactions* in 1940. During the early years of the Second World War there were further geological consultancies of an economic nature and investigations were commissioned from him, for example, on Scottish peats and Scottish Carboniferous argillaceous rocks.

In 1943 Bill Flett joined the British Naval expedition code named "Operation Tabarin" (from which later developed the Falkland Islands Dependencies Survey) and worked in Antarctica until 1946. He carried out geological investigations on Deception Island, in West Graham Land and in the Hope Bay area of North Graham Land, wintering in two successive years at bases in the South. As an early geological worker there, he was one of that select circle of geologists experienced in pioneer Antarctic fieldwork before more modern facilities mitigated at least some of its rigours. His seniority in the expedition resulted in his appointment as "Acting Magistrate for the South Orkney and South Shetland Islands, Dependencies of the Colony of the Falkland Islands". Bill Flett was disappointed in not being authorised to publish on his geological work in Antarctica but his service there was recognised by his decoration with the Polar Medal in 1953.

Shortly after his return to Scotland, Bill Flett was appointed in 1947 as Senior Lecturer in charge of the Geological Section of the Department of Mining Engineering at the Royal Technical College, Glasgow (later the University of Strathclyde) where he remained until his retirement in 1965, a respected figure and a conscientious and effective teacher. Shortly after his appointment at the "Tech", there began a long association with S.A.N.C.A.D. as external examiner in Geology and his colleagues still recall the meticulous attention to detail that was brought to his work in this connection. During the earlier part of his tenure at the Royal Technical College, the bias of his interest towards economic geology led to his appointment as Secretary to the Mineral Resources Panel of the Scottish Council (Development and Industry), set up to collate information on Scottish mineral resources and advise on their utilisation. These interests no doubt held some of the seeds of the idea to develop the present Applied Geology degree course at Strathclyde University that was under consideration at the time of his retirement.

In recent years, growing infirmity prevented Bill Flett from active participation in the Society's affairs, but he is remembered with respect and affection. He was a devoted family man and is survived by his wife, a son and a daughter.

PERSONALIA

The members of the Society were delighted that the Council of the Geological Society of London, having awarded Professor Leake the Lyell Medal in 1977, decided to honour our Vice-President, Dr Rolfe, with the award of the Murchison Fund for 1978 for his work on fossil crustaceans, his contribution to the work of learned societies and the Hunterian Museum.

Dr Ingham was one of five Ordovician stratigraphers invited to visit geological sections in the People's Republic of China in October 1978. Of particular interest to him was a section across the Ordovician-Silurian boundary, containing many of the graptolite species which occur at Dobb's Linn, Moffat. Another visit to the Ordovician-Silurian boundary in previously forbidden territory, in this case in north-eastern Siberia, was made in August 1979 by Dr J. D. Lawson. Again the black graptolitic shales (and the weather) were strongly reminiscent of Dobb's Linn.

LECTURES 1977-1978

There was again a full programme of lectures during the winter. In October **Dr J. D. Hudson** (University of Leicester) lectured on **"The Geological History of Eigg and Muck, Inner Hebrides".** The Mesozoic rocks, the Tertiary basalts forming the higher ground and the form of the Sgurr of Eigg pitchstone were all discussed. The November lecture was given by **Professor D. V. Ager** (University College of Swansea) on the subject of **"The New Catastrophism".** Professor Ager discussed the battles between Catastrophism and Uniformitarianism in the 19th century and then went on to the new trend in the last 20 to 30 years towards "Neocatastrophism". Many aspects of geology imply that processes are episodic rather than continuous. Examples include turbidites, olistolites, punctuated equilibria in evolutionary palaeontology, astroblemes and plate tectonics. In December **Mr D. K. Smythe** (I.G.S.) gave a lecture on **"The Rockall Trough and the Early History of the Northern North**

Atlantic". He discussed firstly the configuration of the northern North Atlantic continents prior to the opening of the Rockall Trough and secondly the age of the intervening phase of sea-floor spreading which opened the Trough, as inferred from the regional geology. **Professor P. Mc.L. D. Duff** (University of Strathclyde) gave a lecture on **"Coal Exploration in British Columbia"** in January. He showed many slides illustrating the geology and scenery of this area where large reserves of Cretaceous and Tertiary coal are being explored and proved including the thickest coal seam so far discovered in the world.

At Members Night in February the following talks were given:–

The Geology of the Blackstones Igneous Centre, Western Scotland
G. P. Durant

John Macculloch on Palaeontology
D. A. Cumming

Scapolite in Caledonian Intrusions, Arran
A. Herriot

Flume Tank Experiments on the Hydrodynamic Stability of *GRYPHAEA*
A. O. D. Logan

The Extraction and Identification of Silicified Trilobites
D. A. Linn

Black Rock – a Volcanic Vent and its Inclusion Assemblage
R. Alexander

A Giant "Centipede" Trail from the Lower Carboniferous of Arran
D. E. G. Briggs, W. D. I. Rolfe and J. Brannan

The final lecture of the year, in March, was given by **Dr W. Mykura** (I.G.S.) on **"The Geology of the Shetland Islands".** Shetland contains within its small land area almost all the geological elements of the Scottish Highlands – Lewisian, Moinian, Dalradian and Old Red Sandstone, the Moine Thrust, large scale nappes, Caledonian plutons and a large fault possibly related to the Great Glen Fault.

NATURE CONSERVATION

(1) **Hagshaw and Lesmahagow Inlier.** Two Germans were admonished by a Scottish court for digging up fossil fish remains of Silurian age from near Douglas, Lanarkshire. The use of power drills was particularly criticised.

It should be noted that since this incident permission to visit the S.S.S.I.'s in the Hagshaw and Lesmahagow Inliers **must** be obtained from the Nature Conservancy Council at Balloch as local police have powers of arrest over anyone collecting at these sites.

(2) **Petershill Reservoir Quarry,** in Lothian, long renowned for its highly fossiliferous limestone has been drained and sandblasted so that the biohermal facies can now easily be studied.

(3) After a public enquiry in which the Fereneze Golf Club sought permission to infill part of **Boyleston Quarry** agreement was initially reached to fill part of the quarry leaving the most geologically valuable part available for study. However the Secretary of State for Scotland has refused planning permission, so that the quarry will remain as it is. It should be noted that permission to visit must be obtained from Fereneze Golf Club, Fereneze Avenue, Barrhead, Glasgow. (Tel. 041-811 1519).

(4) **Trearne Quarry,** Beith: This exposure of highly fossiliferous Carboniferous limestone is of great importance for teaching, research and regional correlation but has recently been threatened by partial infill with gypsum waste. Strong protests by the Nature Conservancy Council, the I.G.S., Glasgow University and individual research workers seem to have had some effect, and no dumping will take place in the near future although a long term threat still exists.

(5) **Craighead Quarry,** Girvan: This internationally famous quarry in Ordovician limestones is now threatened with partial infilling by Kyle and Carrick District Council. The Nature Conservancy Council have marshalled a powerful army of opponents to the proposal and there may be a full public inquiry. Additional expert protesters would be welcomed by Dr L. E. Richards of the Geology and Physiography Section, Nature Conservancy Council, Foxhold House, Thornford Road, Crookham Common, Newbury, Berkshire RG15 8EL.

(6) **Fossil Grove,** Glasgow: Plans are afoot to improve both the housing of this world famous locality and its educational value. A diorama and/or some other interpretative display may be designed.

GEOLOGY TEACHERS GROUP (STRATHCLYDE)

The second issue of this excellent magazine appeared in December 1978. Of particular interest to our members are the descriptions of excursions to Hartfell Spa, Moffat and to the Broadford area of Skye. The editor is J. B. Blair of Airdrie Academy and the secretary of the group is R. G. Ward, 28 Dunglass Road, Bishopton, Renfrewshire.

A VISIT TO THE HUNTERIAN MUSEUM 1812

This extract is from a notebook given to William Haworth, Designer, Carron, by the author, J. Rickards, teacher of mathematics in Arbroath. He made a journey lasting one week from Arbroath to Paisley and back in August 1812, travelling mainly on foot, but also by coach, the two-horse passage-boat on the Falkirk to Glasgow stage, and farm-cart.

It has been prepared by **Nancy Fowler** with the original spelling preserved.

"Thursday 20th August 1812".

Rose at 7 a.m. Went out to see the Observatory, about a mile west of the Town. . . .

At half past eleven, called on Mr. Neile, who went along with me to the University. Got a ticket of Commission to the Museum, for which paid 2/-. The Collection of Curiosities, which is very rich, is said to have cost upwards of £30,000; the Building which contains it may have cost £10,000. From the Outer Door you enter a Small Room, where the Ticket is delivered, and your Name and place of abode is Registered in a Book, after which you are ushered into the First Room, which contains a huge Collection of Metals and Minerals, Fossils, Shells and Petrifactions. Among these is a piece of the Meteoric Stone which fell at Possil near Glasgow, and a piece of Pompey's pillar from Egypt, etc. On some Stones are impressions of leaves, fishes and reptiles, said to be **Antediluvian.** On Shelfs on the Walls are a variety of the Serpent tribe,

preserved in Glass Phials and Bottles, and several Birds and small Quadrupeds neatly stuffed up. In going up to the Second Floor a few fierce looking Animals are placed in Corners adjoining the Stair-Case. The Second Floor is chiefly occupied with Anetomical Preparations for the Students. The Several parts of the human Body are kept in Bottles, and the Faetus is seen in difft. Stages. There are also some of the Monstrous kind. In the middle of the Room are the Skeletons of a little horse and the Boy who rode on him. There are also the Teeth of Mammoths, being large blocks of Ivory of a Square Shape, and blunted at the points.

On the N. & E. corners of the Room are several fine portraits by the Best Masters; Among these is Sir Isaac Newton & Dr Arbuthnot by Sir Godfrey Kneller, and other Drawings and Landcapes by older painters. The East side is occupied with a Library of rare and scarce Books & Manuscripts etc. Having satisfied myself here, was directed to a Room below the First Floor. On the Stair leading to it is an Egyptian Mummy in good preservation, said to be upwards of 3000 years old, but nothing of the features was discernible, for the quantity of canvas and leaves with which it was enveloped. On entering the Doors a huge Elephant stands before you, with a Young One by his side, a Zebra, a Hippotamus, an Alligator etc.

Around the room are several Articles of Dress & War used by the South Sea Islanders.

It is in no one's power to recollect every Article in this vast Collection, but if he pays Attention must go away with very pleasing Sensations and Reflections.

At 2 p.m. took of Mr Niele and went on the road to Hamilton with the intention of seeing the Falls on the Clyde.

VOLCANIC GEOLOGY IN THE SUN (AN EASTER STUDY TOUR ON TENERIFE)

by Dr Brian Cooksey

On Friday the 24th March a party of extra-mural students left for the Easter study tour on Tenerife. The party was a very mixed one which included botanists, geologists, a stone-turning beetle hunter and a tree-chopping cocoon catcher. All of us were glad to leave snowy Glasgow for sunny Tenerife.

The first day was not very successful for the geologists (although the botanists managed some useful grubbing around on a rubbish tip) as the promised coach waited at one hotel while the party waited at another! We stood around in the hot sun watched by a somnolent but sensible lizard sitting in the sun.

On Sunday we made a start, heading for Punta de Teno in the north west corner of the island. At Icod de los Vinos the botanists looked at a rather decrepit Dragon tree, supported by concrete carved to represent roots, and claimed unconvincingly to be one thousand years old. At Punta de Teno we finally got down to some geology. We examined the ash beds of a volcanic cone and collected lava bombs. On the road back we had fine views of multiple lava flows full of lava tunnels which are typical of the Pliocene lavas of Tenerife. These same lavas were also exposed in the cliffs of Playa San Marcos where the flows are separated by beds of red bole due to tropical weathering.

We finished the day drinking coffee watched by suspicious policemen armed with automatic weapons.

The following day at a road cutting on the road to Fasnia, in the south of the island, we saw exposures of the recent series of tephra deposits, and the unconformity between these and the Pliocene lava flows. This exposure illustrated the difference between an ash fall – a rather loose aggregation of pumice fragments which follows the shape of the erosion surface upon which it is deposited, and ignimbrites – partially molten lava fragments suspended in burning gases which flow down the line of steepest descent and which, when solidified consist of fragments of lava welded together and showing flow lines. Later we examined the ash cone of Punta Roja, saw the three cones of La Volcan de Guimar and examples of ropy lava, and studied a remarkable section through a Pliocene lava flow in a road side cutting, where the feeder dyke in the cliffs below the road could be seen to widen into the base of the flow. It was, of course, missing above the upper surface of the flow.

Tuesday morning was spent in the rain forest where Scottish geologists, used to heather two feet high were surprised to find it growing to forty feet in substantial trees (the botanists presumably knew better). In the afternoon we visited Taganana which is a village set in spectacular scenery of deeply dissected mountains. Here we examined a magnificent example of radiating columnar jointing decorated with wild Dragon Trees (these, by the way, are so called because of the red sap which was once thought to be dragons blood).

The next day we visited New Garrachico to see the cindery lava flow of 1706 which destroyed Old Garrachico. The new town was built on the delta formed when the lava flowed into the sea. Many other towns in Tenerife (Buenovista for example) are similarly built on lava deltas. Later, on the ridge behind Santiago del Teide we saw a phonolitic plug and collected augite crystals from an ash fall. In this tropical climate these crystals weather more slowly than the matrix and large perfect crystals are easily extracted. On the return journey we were amused by the spectacle of a herd of nanny goats tripping over their udders in their haste to escape the stones accurately thrown by the goat herd chasing them up the steep mountainside.

The final day was spent in the National Park formed from the caldera. On the way we stopped at Aquamansa to see a trout farm and a well known exposure of radiating columnar jointing, much smaller but more symmetrical than that at Taganana and euphemistically called a rock rose on numerous postcards! The park was undoubtedly the climax of our visit to Tenerife. Lavas of all kinds were seen: trachytic, vesicular flows at El Portillo, marvellous ropy lava in the caldera itself and siliceous pitchstone in the caldera of Montana Rajah. We had wonderful views of Teide with the congealed lava rivers running down the mountainside. These were emphasised by the snow which filled the hollows between the levées. There was also an eroded volcanic vent at Los Roques with lateral dykes, a central agglomerate and some remnants of the ash flows which originally formed a cone – a most convincing example to compare with the more familiar vents so common in the Midland Valley of Scotland. Whilst we were looking at the only example of copper mineralisation in the island we were caught, greenhanded so to speak, stealing specimens. The unenterprising botanists watched gleefully as the shamefaced geologists

reluctantly handed over their illicit stones to the warden. A hilarious end to a most enjoyable week.

BOOK REVIEW

by Julien Jocelyn

"The Making of Geology: Earth Science in Britain 1660-1815"
by Roy Porter

This is a new book (1977) which breaks new ground in that the approach to the history of geology accords with the modern trend to regard geology as a by-product of society. It is written by a historian (Roy Porter) as a thesis and so there is an impressive number of references. There are no drier forms of reading available than sociology or academic theses but nevertheless much of what is presented is cast in the form of a lively discussion. The author is as he would put it 'dramatically" involved.

We select one topic to illustrate the debunking spirit. Reference is made to Sir Archibald Geikie's "justly famous" essay on the Scottish School of Geology. Now this essay was a product of the enthusiastic younger man and the disregard of anything previous to Hutton, while in need of correction, was not the considered opinion of Geikie as a historian. In a (more famous) publication written in his mature style, Hutton is "one of the founders of modern physical geology."

The Scottish school of geology is also given its intellectual roots. Now this has been done before in Buckle's History of Civilisation, which devotes a dozen pages to Hutton. There are some telling quotations to show how Hutton sought confirmation of his ideas in fieldwork. No historian worth his salt neglects previous historians but the absence of references to them (and they are few enough in this case) does seem to be a case of the desire to make all things new. Exactly what is supposed to be wrong with those who suppose that no real geology was done very much before 1915!

Roy Porter does perhaps exaggerate his own claims to originality but to choose his opinions on the Founder of Modern Geology for critical comment only draws attention to a small part of a complicated subject, for much of which he is the best guide available. Geologists will find much to interest them even if the last word is far from being said in the history of British geology. The period under consideration is covered with extraordinary thoroughness. One can only commend the whole 222 pages.

The following account gives background information to the new exhibits on view in the Department of Geology, Glasgow University on the stairway down to the Lecture Room.

BLACK SHALE PALAEOECOLOGY IN THE LOWER JURASSIC

by George Farrow

Black shales have always fascinated geologists. I remember Dunham's enthusiasm for them as an economic geologist, with their spectacular enrichment of base metals. As a research student I revelled in being splattered

with Yorkshire oil from ammonites bursting from their Jet Rock concretions. The latest geologists to have become interested in black shales are the North Sea oil geologists, since Upper Liassic or Kimmeridgian Oil Shales seem to be the most likely candidates for source rocks. Much effort has therefore gone into trying to predict exactly what environmental conditions give rise to the widespread formation of black shales, and in what kind of plate tectonic setting. Palaeontologists, however, have always been interested in black shales simply because they harbour such magnificently preserved fossils.

The Hunterian Museum possesses a particularly fine collection of Liassic ichthyosaurs, and in 1975 acquired some large ammonites from the Holzmaden district of SW Germany, a locality almost as famous as Solnhofen. We therefore decided it would be both topical and ecologically instructive to put on an exhibit of fossils from Upper Lias black shales.

It was our original intention to mount one of the actual Hunterian ichthyosaur skeletons, despite the security risk, not to mention the weight problem! In the event, however, **Stuart Baldwin** (who supplies many of our high quality teaching casts) most generously donated one of his superb two-stage polyester resin replicas of the Hunterian specimen, along with two fish, one of them also cast from moulds of a Hunterian specimen; the *Lepidotes* in resin, the *Dapedium* in hard plaster. You will find it hard to tell them from the real thing, following the masterly cosmetic treatment they have received in the hands of Christina Haywood, a qualified archaeological conservator, who recently worked for the Museum. The tall crinoid, an old plaster cast again lovingly refurbished by Job Creation Personnel, used to stand sentinel in the corridor between the attic and the Museum after relegation from the Zoology Department. Again, the original is in the Hunterian; part of the suite bought with great foresight by J. W. Gregory in the 1920s.

A knowledge of the palaeoecology of these fossils can tell us a great deal about the depositional environment of black shales.

Conditions on the sea bed

The very fact that hydrocarbons are present in these shales (to the tune of 19 barrels per ton) suggests that insufficient oxygen was present for bacteria to decompose the steady rain of plankton falling to the bottom. This, together with the undisturbed nature of the vertebrate skeletons and their pyritization, and the absence of trace fossils that would indicate a bottom fauna, led to the notion that the black shales may have formed under euxinic conditions, i.e. in the total absence of oxygen at the sea bed, and in the presence of free hydrogen sulphide. This model (fig. 1), which compares well in its chemical conditions if not in its plate tectonic setting with the present-day Black Sea, has lasted for years. It has only recently been challenged by an American palaeontologist, Erle Kauffman, working with the Germans on the Holzmaden sections as part of their big project on Palaeoecology.

Kauffman's challenge comes from his careful centimetre-by-centimetre collecting, in the manner of Craig's classic palaeoecological work on the local Corrie Burn Carboniferous. This approach avoids being seduced into environmental modelling by a few exceptionally well preserved large vertebrates. His observations suggest that periodically truly euxinic conditions did occur, but

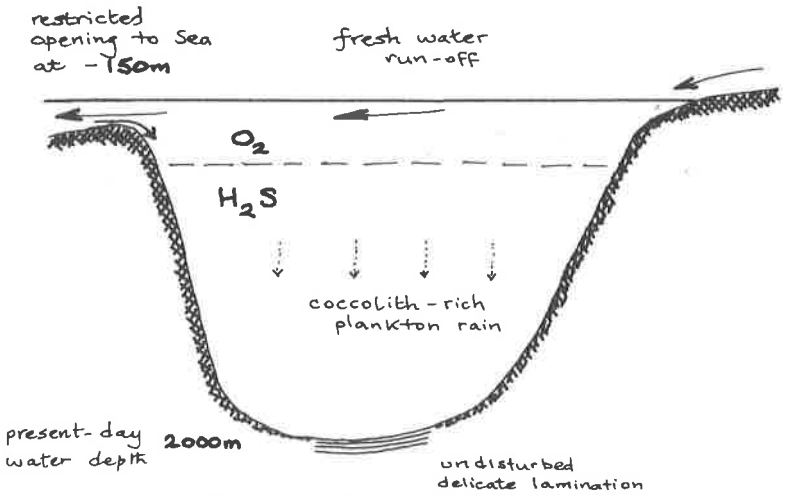

Fig. 1 The Black Sea model.

that bottom waters were often just sufficiently oxygenated for the mussel-like bivalve *Inoceramus* to become briefly established. At other times the critical oxygen concentration was reached a few centimetres above the bottom, so that bivalves and worms colonised only the **upper** surfaces of large ammonites partly embedded in the mud (fig. 3C). Careful work looking at flattened ammonites enables palaeoecologists to say whether they were encrusted while swimming or floating, or after they came to rest on the sea bed (fig. 2): it is in fact possible to study this on one of the ammonites in our display.

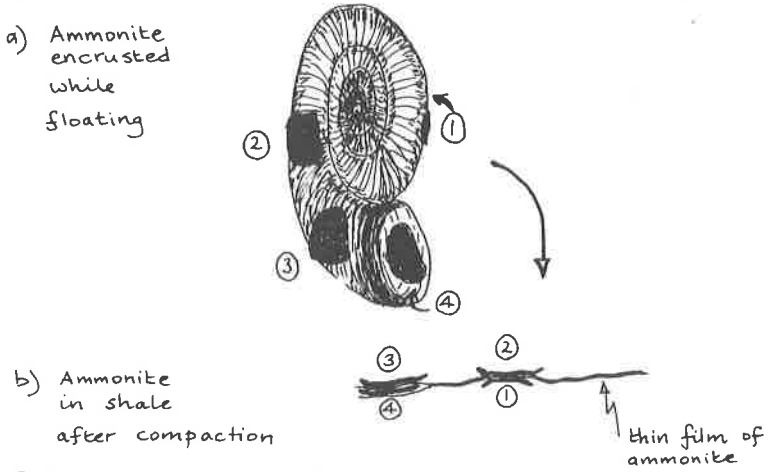

Fig. 2 Preservation of ammonite encrusted while floating.
N.B. Only **(2)** and **(3)** positions would be possible had the ammonite been encrusted whilst lying on the bottom.
Position **(4)** would have been impossible during the ammonite's lifetime!

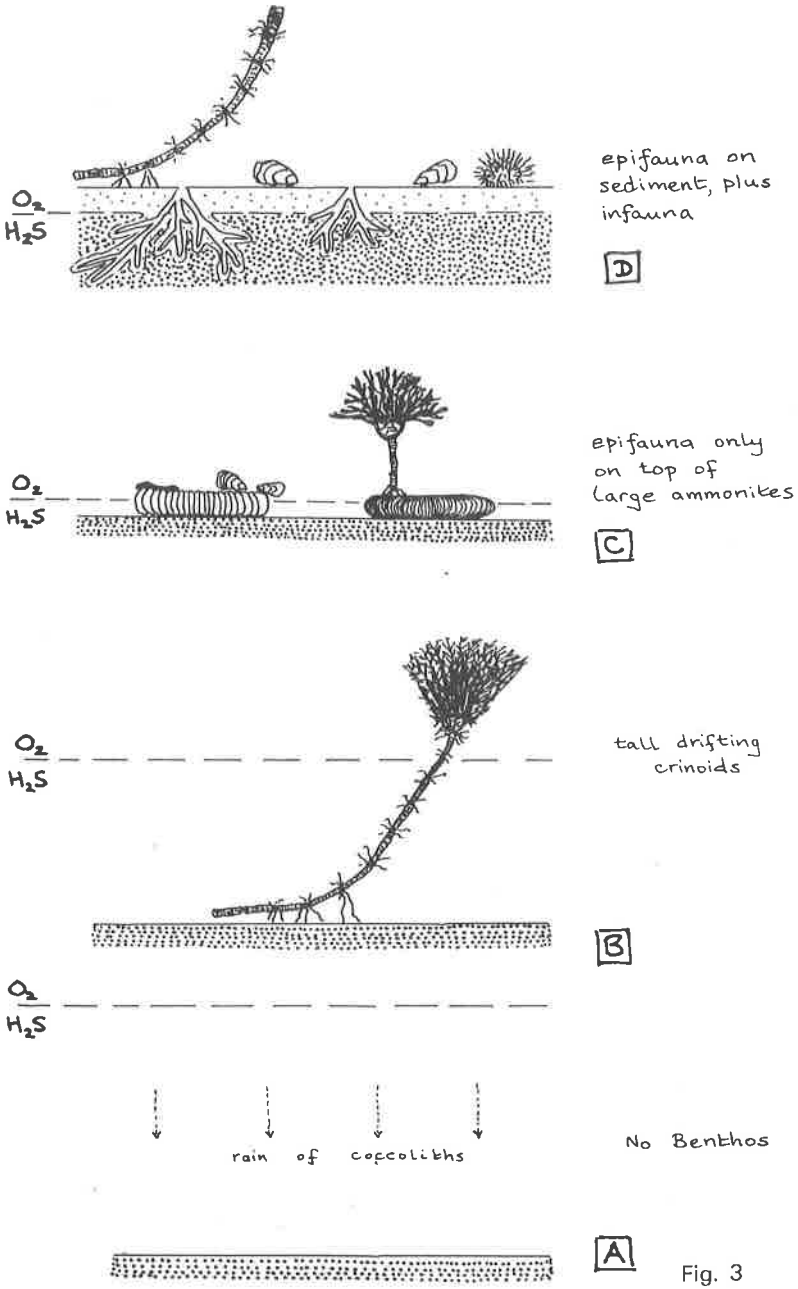

Fig. 3 Black Shale benthos as indicators of near-bottom.

Just how long these temporarily favourable conditions lasted is indicated by two things: by the life span of the mussels – they are normally very small – and by a trace fossil, *Chondrites*. Only rarely do we find fully developed examples of this feeding burrow: more typically a shallow depth, narrow-bore system testifies to an early death of the would-be coloniser. (fig. 3D).

Amongst the other organisms to become briefly established on the bottom were very small sea urchins, and crinoids, the latter group providing us with a truly outstanding example of a "living fossil" – the living *Pentacrinus* species dredged by Agassiz from the Gulf of Mexico being virtually indistinguishable from Liassic examples. The abundant cirri along the stems of the adults show that after surviving the juvenile 'anchor' stage these crinoids would have been

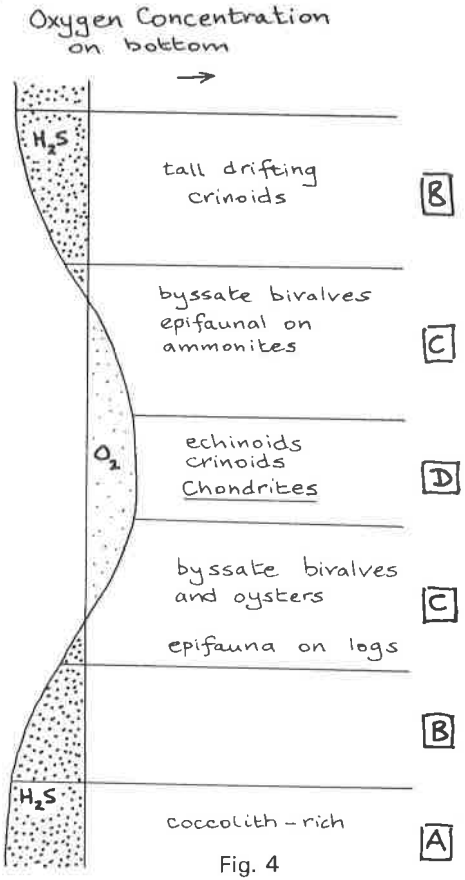

Fig. 4

Fig. 4 Palaeoecological interpretation of a 20cm. stratigraphic section through an Upper Lias black shale showing a minor cycle of oxygenation.
Refer to Fig. 3 for illustrations.

essentially free to drift along the bottom, occasionally aided by weak swimming movements of the arms, the prehensile cirri gripping whatever suitable obstruction they encountered, possibly a log or other individuals of their own kind. Modern pentacrinids have been photographed simply propping themselves up on a distal tripod of cirri in very low energy areas, much as they might have done in the Lias. With their cups borne atop long stems (some of them up to 15m) they would have outlived the bivalves and sea urchins when conditions of reduced oxygen supply set in near the sea bed (fig. 3B).

Putting this palaeoecological information into its stratigraphic sequence enables us to recognise subtle cycles of oxygenation, revealed by a regular pattern of faunal change as the bottom becomes more oxygenated. So diversity increases, and *vice versa,* giving true cycles of the ABCDCBA kind (fig. 4). It is the repetition of these small cycles through much of the *Posidonia* shales that makes the Black Sea model with its critical oxygen level well up the water column inappropriate, for even the famous vertebrates themselves, when critically examined, support Kauffman's modified notion. It has long been known that all the best specimens were (and still are) prepared **from below.** Often the upper part of the carcass is in fact poorly preserved, having decayed or having had ribs displaced by carrion feeders; so only that part embedded in the mud was really well preserved.

Acknowledgements

I am grateful to Ian Rolfe for his comments on an early version of the manuscript, and to him and Stuart Baldwin for their willingness to provide the specimens displayed. Ron Harrison devised the layout.

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This review was based principally on the following works:–

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BOOK REVIEW by Julien Jocelyn

Hydrogeology by J. B. Lamarck (University of Illinois Press, 1964).

Professor A. V. Carozzi has translated and edited a number of classic books on geology, of which Lamarck's Hydrogeology is the most readable, and of the greatest interest to the general reader. The original was published in 1802 and is now rare. To quote from the editor's introduction: "Indeed, Hydrogéologie is concerned with basic geological problems such as the action of terrestrial waters, the existence and possible displacement of the ocean basin, the immensity of geological time, the origin of mountains, the significance of fossils, and the action of living organism on the earth's crust. These preoccupations at a time when geology had hardly taken definite shape are a characteristic illustration of the extent of Lamarck's genius."

One does not have to be very familiar with the teaching of Hutton and Playfair to detect an astonishing resemblance to the Scottish school of geology. Even more interesting are the differences which may be ascribed to Lamarck's ignorance of geology outside his own particular area. Lamarck's most telling and original statements concern not the relationships of various rocks but the nature of geological time, however. A contemporary historian has remarked "there are few greater revelations, if any, in the history of thought, than the change within a few decades from a prevailing view of geological time that could be grasped imaginatively to one which, like astronomical distances, could be grasped only mathematically." Lamarck's calculations were the first to deal in millions of years.

Have the historians of geology been fair to Lamarck? Sir Archibald Geikie drew attention to Hydrogeology in the first place but his treatment of the geological time calculation was to overlook it. In view of current controversy he was perhaps suspicious of the results. His account of Darwin's contribution to the same subject is too generous, as geologists were slow to take up his points, which were asides to his main argument. All this is perhaps unfortunate but Lamarck has fared better with biologists. To the millions of years of change required by Lamarck all Darwin had to describe to make up evolution was the geographical speciation observable at the present day. Hydrogeology was the first step in all this.

EXCURSION TO THE ENOCH VALLEY

by James K. Archibald

Eleven members and one youngster attended a quickly organised visit to the Enoch Valley, Eaglesham, on one of the best spring days of the year. Starting at about 11 a.m. the party followed the itinerary of Dr Bassett's Glasgow District Guide from Eaglesham to Carrot Farm and the disused barytes mine near Myres.

During the course of the day the glacial sand and gravel terraces surrounding the area were traversed at various levels corresponding to the various stages of ice front retreat. Sand, silt and gravel deposits were well exposed at the quarry S.E. of Netherton Farm. Exposures of the underlying solid rock were studied in a number of burn channels where the basalts of the Clyde

Plateau Lavas were in close contact with ash and volcanic debris. Finally at Myres the party investigated the two visible workings of the old barytes mine, but no particularly fine specimens of the mineral were recovered from the spoil.

After a pleasant three mile return walk by the Ardoch Burn the excursion was concluded at about 5 p.m.

A FIELD GUIDE TO SOME DALRADIAN STRUCTURES ON LOCH LOMONDSIDE

by J. G. MacDonald

Introduction

The excellent new exposures of Dalradian rocks opened up by recent roadworks along the west bank of Loch Lomond during improvements to the A82 Trunk Road, have revealed more clearly than before many structures that are of great use in demonstrating and elucidating the sequence of polyphase deformation that has taken place in that part of the Tay Nappe (Bowes, *in* Bluck 1973, 81-87; MacDonald *in* Tippet 1974, 18). A feature of the fold belt is the increase in complexity and the number of readily recognisable fold phases northwards from Luss towards Tarbet (Fig. 1a). By the time the road cuttings at Rudha Mor are reached north of Inverbeg (Bowes, *ibid.* 84-5) the earlier phases of deformation begin to be obscured by the later ones but south of Inverbeg absence of most of the later deformation allows a much clearer view of the early structures to be obtained.

One of the best places to study these early structures is at a new road cutting immediately north of the layby, one mile south of the Inverbeg Hotel, locality 1 (350963) (Fig. 1a). Here there is over 100m of continuous exposure running northwards from a small quarry cut into a lamprophyre dyke on the west side of the road.

Also briefly described are outcrops a mile north of Inverbeg, locality 2 (352994), where graded bedding in coarse schistose grits demonstrates that the rocks have been inverted. This contributes to the conclusion that the structures seen are on part of the lower limb of a major recumbent fold.

Dalradian lithologies and structures

The Dalradian rocks between Luss and Tarbet range in lithology from quartz-chlorite-schist to schistose-grit although in the schists the proportions of quartz and chlorite vary so much that some layers are virtually pure quartzite. This has greatly influenced the way in which the rocks have reacted to stress. Thus in the coarser schistose-grits the massive nature of the original bedding has resulted in resistance to small-scale folding and shearing, and while a schistosity is present the original sedimentary structures remain partly intact.

At the main locality described (Fig. 1) on the other hand, the finer grain size of the rocks and the more thinly bedded nature of the original sediments has permitted a great deal more small-scale folding although even here the degree of intensity of this varies locally according to lithology. Thus in the parts of the section, where chlorite is more abundant, a strong cleavage has tended to

obscure some of the earlier structures but in other places where the rocks are quartz-rich, chlorite is somewhat restricted to distinct foliation planes. As a result within the latter lithologies not only can clear evidence for two structural events be seen but there are also clearly recognisable vestiges of original bedding. The structural elements that can be studied include folding, two sets of foliation, lineation, boudinage and streaked-out bedding remnants.

These structures are most easily recognised and understood if they can be related to a theoretical model (Fig. 1b) in which a large fold has a series of secondary folds on each of its limbs. On the left and right-hand limbs, looking down the plunge direction of the fold axis, the secondary folds are z-shaped in cross section. On the centre limb they are s-shaped: thus there is a systematic, easily recognisable difference between the secondary structures on adjacent limbs of the main fold. Also, in this example, the secondary folds are asymmetrical in that they have long and short limbs. In the long limbs the beds are thinned by stretching but in the noses of the folds the beds are thickened while in the short limbs there is less change in thickness and there may be much less stretching than in the long limbs. There is a tendency for bedding to be stretched out at right angles to the main compressive stress that is causing the folding. This can produce **boudinage** or pinching out of bedding and may also be accompanied by elongation of mineral grains to give a lineation along the principal direction of stretching.

Where the lithology is dominantly quartz there is a resistance to shear but where chlorite is present the flaky habit of this mineral has favoured the formation of fracture planes parallel to the axial planes of the folds. This has resulted in a prominent **strain-slip-cleavage** in which the individual shear planes are set a few mm to a few cm apart, depending on the abundance of chlorite and the intensity of the stress (Fig. 1; c, d and e).

Detailed structures at Locality 1

Good examples of s-folds are exposed on near-vertical surfaces about 64m N of the northern edge of the lamprophyre dyke (Fig. 1d). Note in this and other folds in the vicinity, how the long limbs are thinned relative to the fold nose and short limbs. Also the strain-slip cleavage, parallel to the fold axial plane occurs only in the more chlorite-rich lithologies (darker areas). If you look carefully you will also see that there is an earlier foliation making an oblique angle with the strain-slip cleavage. This earlier foliation follows the folds round although less tightly than the folded bedding. Looking along the outcrops, particularly to the south for a few metres, it should be possible to find at least one place where z-folds occur indicating that a major fold axis has been crossed.

Bedding remnants occur in the cutting about 30m north of the lamprophyre dyke where they are associated with z-folding. Good examples of boudins are exposed about 1.8m from the base of the outcrop (Fig. 1e). You will notice that the boudins are cut obliquely by the earlier foliation and that here the direction of this foliation corresponds to the short limb direction of the z-folds that occur nearby. Lower down at the same place there are elongate bedding remnants parallel to the long limbs. Other examples of bedding remnants showing the

same relationship to the earlier foliation occur higher up the rock face to the right of the ones described here.

The nature of the bedding remnants serves to underline the observation that maximum stretching has taken place on the long limbs of the secondary folds with much less distension on the short limbs. Also the fact that the earlier foliation does not coincide with the bedding remnants is consistent with the fact that it must have been produced by an earlier phase of folding so that the folds which we see at locality 1 must be at least the second phase of folding. In fact they correspond to F_2 of Bowes (*ibid.* Fig. 17a) and the earler foliation (S) which has been folded by the F_2 folds must have been produced by the corresponding F_1.

Although lineations occur widely on foliation planes exposed in the section the most easily studied examples occur on the large rock surfaces immediately to the north of the lamprophyre dyke quarry opening. These include several sets of **crenulation lineations** resulting from puckering of the chlorite-rich surfaces of the foliation planes. This type of lineation is normally parallel to the associated fold axes. **Mineral lineations** may occur on bedding or foliation planes at right angles to fold axes (Fig. 1b). Good examples of the latter type of lineation can be seen in the same vicinity.

Graded bedding at Locality 2

Locality 2 is on the loch shore beside a large layby on the east side of the A82 about 1 mile north of Inverbeg (Fig. 1). At times, when the level in the loch is high the outcrops are partly awash. This has helped to keep them clean and free from obscuring lichens. The rocks are schistose grits, with clasts up to 5mm or so across including a proportion of the bluish quartzite grains that are characteristic of Upper Dalradian grits. A careful examination of the outcrops indicates that the beds are consistently younging to the NW and hence must be overturned as they dip steeeply to the SE. This is consistent with the hypothesis that this part of the Dalradians consists of the lower limb of an overturned anticline.

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DALRADIAN STRUCTURES ON LOCH LOMONDSIDE

J. G. MacDonald

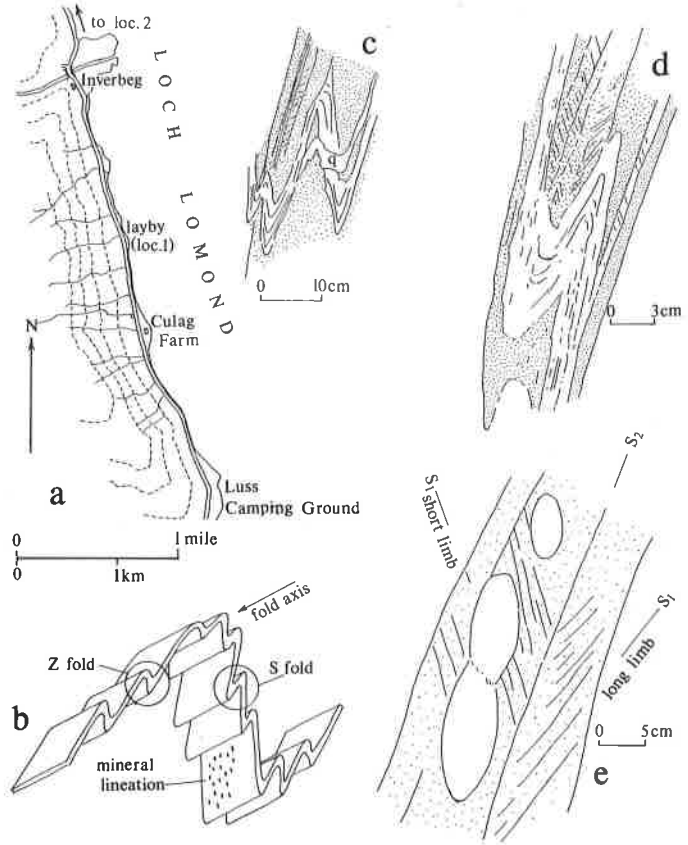

Fig. 1

a: Map of Loch Lomondside between Luss (359930) and Inverbeg (345979). Contour interval 250ft. (76.25m).

b: Diagram showing asymmetrical plunging fold. The arrow indicates the angle of tilt or plunge of the fold axis.

c: Z fold at locality 1 with hinge area on the left hand side. The change in style of the folding indicates presence of a major fold axis. Note the quartz vein q, which has not been folded as tightly as the bedding.

d: S fold at locality 1. The strain-slip cleavage (S) is parallel to the fold axis. Vestiges of the earlier foliation (S) are clearly visible in the upper half of the drawing.

e: Detached boudins at locality 1 due to pinching out of a quartzite bed. The two directions of the earlier foliation (S) are related to the style of the later folding (F), i.e. Z folds.

GENERAL NEWS ITEMS

These items are gathered from newspaper cuttings and magazines such as "Open Earth" and "Geotimes". Members are requested to submit similar items to Dr J. D. Lawson for the next issue.

World's oldest fossil fish

The discovery in Wyoming (and since in other localities including Alaska, Greenland and Spitzbergen) of fragmentary remains of a bony jawless fish in marine calcareous siltstones about 510 million years old extends back the age of the earliest known vertebrates by around 40 million years.

Baby dinosaurs

Fragmentary remains of at least 15 baby duckbilled dinosaurs (averaging 75cm in length) have been found in a nest in Montana, together with fossilised eggshell fragments and a nearby adult skeleton. They are dated at abut 75 million years ago. The find suggests the possibility of a parent-sibling relationship similar to that of birds.

Microfossils

Microfossils dated at 3,500 million years old have been reported from Australia which makes them some 200 million years older than the previously "oldest" samples from South Africa. However American molecular biologists now claim that 4,000 million years ago a previously unknown type of organism lived in the extremely harsh conditions then obtaining on the earth. These organisms, neither plant nor animal but extremely primitive, are christened "archaebacteria".

Seasonal growth rings

Seasonal growth rings in the teeth of late Cretaceous dinosaurs from Alberta suggest that they may have been cold-blooded after all. Fossil teeth of crocodiles (known to be ectoderms) from the same area show similar growth rings. Admittedly, teeth of mammals from Arctic or temperate regions show annual layers but severe seasonal contrasts are not postulated for the Alberta area in late Cretaceous times, which appears to have been enjoying a subtropical climate at this time.

Baby mammoth

A baby mammoth called Dima has been discovered by workmen operating a bulldozer in the permafrost of Siberia where it has been preserved in almost perfect condition for more than 10,000 years. The mammoth was about six months old when it died, stood more than five feet tall and had reddish fur, big feet and very small ears, plus two "fingers" at the end of its trunk very similar to those shown on prehistoric cave paintings.

The Piltdown Skull

The Piltdown skull saga continues. The latest report is of a tape recording by the late James Douglas which alleges that the actual perpetrator of the hoax was William Sollas, Professor of Geology at Oxford University! Smith

Woodward once ridiculed Sollas, who is then supposed to have recruited Douglas to assist him in making a fool of his scientific rival. One of the experts who exposed the hoax, J. S. Weiner, disputes this version however – mainly on the grounds that the hoaxer never took any of several opportunities to publicly humiliate Smith Woodward and thereby wreak full revenge.

Extinction of the dinosaurs

Some American geologists have postulated that iridium in limestones from the late Cretaceous rocks in Italy may have been produced by a supernova explosion of a relatively nearby star some 65 million years ago, and that the bombardment of cosmic radiation may have been responsible for the extinction of the dinosaurs.

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ERRATA

Page 16 para. 2 line 7 for (S) insert (S_1)

Page 17 Caption for Fig. 1.

d: line 1, for (S) insert (S_2)
line 2, for (S) insert (S_1)

e: line 2, for (S) insert (S_1)
line 3, for (F) insert (F_2)