Geology

In Northern Ireland

No. 5 Autumn 1980 **40p**

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Christmas Lecture

This year's Christmas lecture sponsored by the Geological Society of London was originally scheduled (by the Geol. Soc.) for 22nd December, but will be brought forward. The subject matter is not finalised yet but will probably be relevant to the G.C.E. Geology syllabi. Details will be available soon from the Geological Survey of Northern Ireland.

News from the Geological Survey

Mineral exploration in Northern Ireland, or at least press interest in it, tends to occur in waves. There are long periods of relatively little interest, then short factual statements followed by weeks of surmise on how rich the find is during which the very fact that it was an exploration programme that was announced, rather than a discovery, becomes lost in the verbeage.

Within the past few weeks we have witnessed a new upsurge in interest in the mineral potential of the Province. On 12 September the Department of Energy and Department of Commerce announced the DoE's intention to spend up to £2.12 million on drilling a borehole to assess the geothermal potential of the Larne basin. This work, which will be supported by EEC funds, will begin early in 1981 on a site in the Redlands Industrial Estate at Larne only a few hundred metres from the Larne No. 1 borehole which was drilled by the Geological Survey in 1962-1963. Unlike the Larne No. 1 hole which was abandoned at 1284m the Larne No. 2 Borehole (which is the designation by which this hole will be known) will, if conditions warrant, be carried down to about 3500m.

Northern Ireland's success in attracting this exploration to Larne arises from the work which has been done by the Geological Survey over a long period of time. In fact the story began in the late 1940's when it became clear that there were no large reserves of coal unworked in the east Tyrone and Ballycastle coalfields and attention was turned to exploring beneath the Tertiary and Mesozoic rocks. When both the Ballyalton and Langford Lodge boreholes failed to encounter any Carboniferous strata below the Permo-Triassic rocks it was decided to undertake regional gravity and aeromagnetic surveys prior to commissioning any further deep drilling. These surveys confirmed the existence of two major basins of sedimentary rock below the Antrim basalts one trending NE-SW through Church Bay, Rathlin, the other on a similar trend through Larne. Boreholes were subsequently drilled at Larne, Magilligan and Port More to the west of Ballycastle to explore the prospect that the northern basin might contain salts and the sub Mesozoic-might contain coal bearing Carboniferous beds.

During the drilling of the Port More borehole it was decided to measure the temperature and to keep the hole open so that temperature measurements could be made over a period of time after the borehole temperature had stabilized.

These measurements indicated that the geothermal heat flow in the area was higher than the average for the British Isles with a temperature gradient of 45°C/km through the Antrim Basalts. Subsequently, the Geological Survey too over some mining companies exploration boreholes to keep them open in order to monitor temperatures. In 1977 a borehole was drilled in the Mourne Mountains to test the geothermal gradient and heat flow, confirming the general nature of the high heat flow regime in the province.

Consequently, when deep drilling was undertaken in 1978 and 1979 at Killary Glebe and Ballymacilroy provision was made to test one of the boreholes, if either was drilled deep enough to be of value for geothermal research purposes. In the event the Ballymacilroy hole was taken to 2272m and several Drill Stem Tests were run. That at 1902-1920m indicated temperatures of 65°C.

With this test satisfactorily completed the potential of NI's basins was established as warranting further investigation so that when D.O.E. came to consider sites for the current phase of their geothermal exploration programme the Larne area rated high on their list.

Drilling of Larne No. 2 will probably take 3 to 4 months and testing, if sufficient hot brine is found, may take another few weeks.

Ulster Museum News

There have been two acquisitions recently of Irish interest.

Mr Roger Byrne of Whitehouse has donated a small collection of reptilian remains from the local Lias Clay. There are nine separate specimens, and they were all collected, lying loose on a stretch of beach near the Gobbins Cliff. Islandmagee, where they had been presumably washed out from nearby outcrops. There are 3 plesiosaur vertebrae (K 3989, K 3990, K 4903); 2 ichthyosaur vertebrae (K 3991, K 39999); ichthyosaur humerus (?) (K 3998); plesiosaur neck vertebra (?) (K 4900); a large lump of bone (K 4901); and a small nodule containing bones (K 3993). At first this nodule generated some excitement with Alan Charig at the B.M. (Nat. Hist.) where we sent it, but the latest news is that it is likely ichthyosaur. John Wilson intends to develop it in October.

Vertebrate remains from the local Lias rocks are scarce, and this donation has increased by half the number of such specimens in the museum.

The schoolboy brothers Colin and Philip Davison, of Larne brought into the museum in early January some Jurassic and Cretaceous fossils from the Larne area. The quality of their specimens showed that they were discerning collectors, and I asked Mr R.E.H. Reid of Q.U.B. to have a look at them (and some other Mesozoic material). He picked out one Cretaceous specimen, of "glauconitic chalk" lithology, as important identifying it as a turtle bone. This was confirmed by Dr Milner of B.M. (Nat. Hist.) who identified it as an ilium of indeterminate turtle. This is the first recorded find of turtle from the local Cretaceous rocks, known to me. Mr Davison will likely donate the specimen to the museum.

Belfast Geologist's Winter Programme

October	23rd	Field Exhibition and Tea.	
November	6th	The PreCambrian Rocks between the Solwezi and Lurwishi domes in North Western Province, Zambia	Dr J. Parkin
November	20th	The Carboniferous Geology East of Armagh.	Mr P.S. Doughty
December	4th	The Dorset Coast	Mr R.E.H. Reid
December	18th	Summer highlights	

All meetings in the Geology Department, Elmwood Avenue at 8.00 p.m. Enquiries regarding the Society to the Hon. Secretary Mr H.S. Black, 6 Gibson Park Avenue, Belfast BT6.

Queen's University Geological Society.

Following a successful Fresher's Night on the 8th October and a Fresher's Field Trip to Wicklow on the 17th-19th October (despite petrol problems), the Society's next field trip is to Errigal on 21st-23rd November. Several lectures are at the moment being finalised including one by Dr. John Tipper from Galway and one from Professor McKarrow of Cambridge famous for his 'Community' concept in Palaeontology. Field trips next term are to Galway or Mayo on 6th-8th February 1981 and the Annual Dinner will be during the week-end of 1st-3rd May 1981 in either Donegal or Sligo.

GEOLOGICAL SURVEY OF NORTHERN IRELAND - MAP OF THE MOURNE MOUNTAINS

David N. Hood

A 'new' map of the Mourne Mountains area was published by the Institute of Geological Sciences in 1978.

This solid geology map, on a scale of 1:50 000, was compiled by the Geological Survey of Northern Ireland.

It is a successful attempt to combine the geological maps and research of various people who have worked in this region during the past 100 years since the publication of the Geological Survey of Ireland geology maps in 1881. However, the compilation has been greatly enhanced by the incorporation of relatively recent research on certain areas within the region, notably the eastern Mourne Mountain granites by I.G. Meighan (Q.U.B.) (1976).

The area covered by the map incorporates parts of the old Geological Survey of Ireland one-inch sheets 60, 61, 71, and 72 and is exactly 29 km by 23 km (667 sq. km). It includes the southern part of Co. Down from Newcastle to Narrow Water, Carlingford Lough and the part of Co. Louth around Carlingford Mountain.

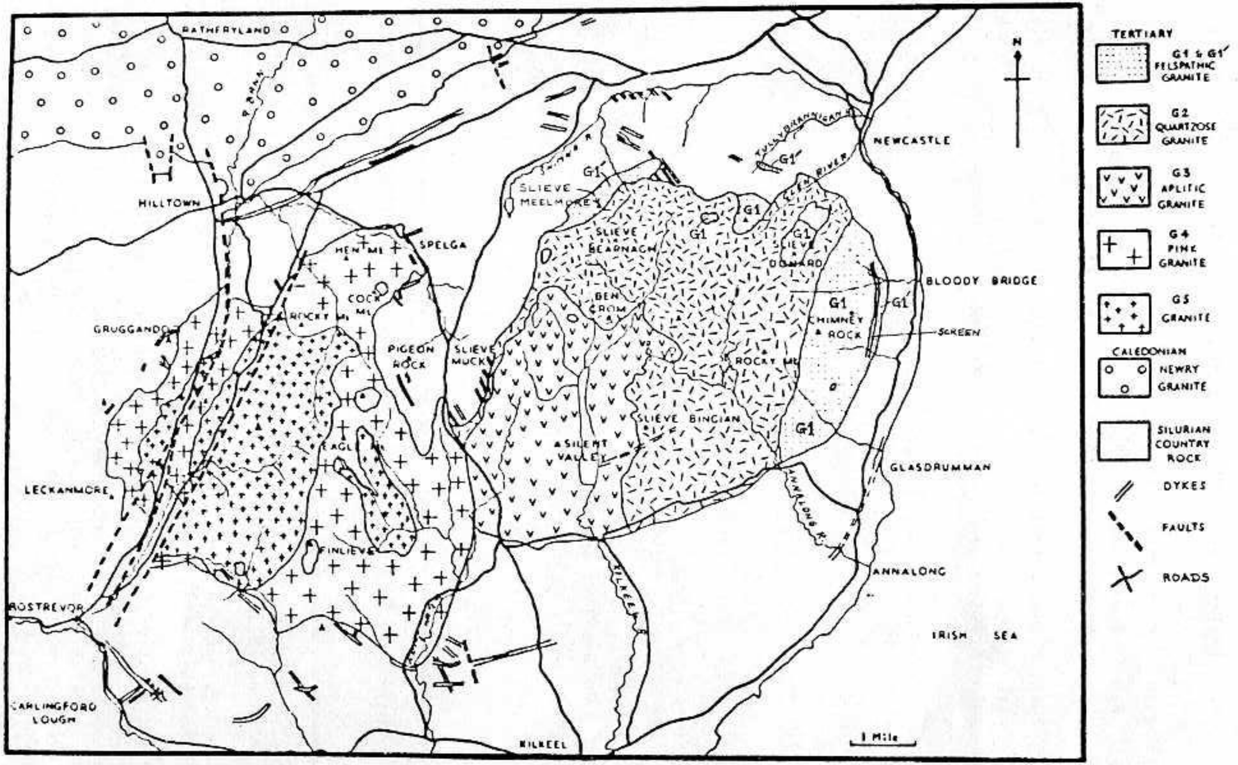

Fig. 1 Sketch-map of the Mourne Granites.
After Richey(1928) & Emeleus(1955)

Geologically the map covers the Tertiary igneous centres of:- The eastern and western Mourne Mountains, the north-eastern part of the Carlingford complex, and the south-eastern tip of the Slieve Gullion complex. It also shows part of the Lower Devonian Newry granodiorite intrusion. In comparision to the old Geological Survey of Ireland maps the large important igneous intrusions are clearly distinguished by bright colours. Minor intrusions which are very important in this region are also very clearly indicated on the map around the igneous complexes as are the country rocks (Lower Carboniferous limestone and shale, and Lower Palaeozoic greywackes and slates) into which the latter are intruded. The sediments are undifferentiated and no major structures are shown in the Lower Palaeozoics.

The immediate focus of attention on the map is the Mourne Mountains Tertiary Igneous complex. Within this complex five granites G1 - G5 are clearly shown.

The most important, recent piece of research to be incorporated on the map of the Mourne granites is the new revision to the eastern centre granite G1 by I.G. Meighan (1976). Briefly, this research argued that the 3 Outer Felspathic granite (G1') outcrops mapped by Richey (1928) (FIG 1) - on the north-west margin (around Slieve Meelmore), on the northern margin (due west of Newcastle in the Tullybrannigan River) and on the eastern margin (east of the screen of lower Palaeozoic sediments), plus 1 Inner Felspathic granite (G1) outcrop (around Chimney Rock Mountain) (FIG 1.) differ on field, petrographic and geochemical evidence from the other 3 Inner Felspathic Granite outcrops on Slieve Donard, Slieve Commedagh and Slieve Corragh (FIG. 1); in fact the 4 former outcrops are indistinguishable from granite G2 as mapped by Richey (1928) (FIG. 1). Therefore Meighan reidentified these outcrops as G2 (FIG. 2).

The 3 remaining outcrops of G1 form a capping to the G2 granite. They have no connection (at the present level of erosion) with any "wall rock" of identical composition, mineralogy and petrography. Therefore their true status regarding Richey's ring-dyke model is now uncertain (FIG. 3), (cf. Walker 1975); although G1 granite "wall rock" may be present at depth below the centre.

As the G1 granite occurs as roof outcrops only, it has become known by research workers at Q.U.B. as the G1 Roof Granite.

Further recent research involving detailed remapping and geochemical studies on the eastern centre has confirmed Meighan's revision to the G1 and G1' granites (Hood, Meighan, Gibson and McCormick in press). Research is still in progress on both the eastern and western centre granites.

One obvious result of the revision is that it has considerably clarified but simplified the map of the eastern centre. All the granites appear as undifferentiated bodies on the map. However, several major compositional variations have been discovered within each of the granites G2 -5 accompanied by textural variations in G2 and G3 (Hood et al in press).

One of these is a relatively mafic-rich facies of granite G2 which outcrops in places along and at one locality crosses:- Richey's G1' (north-west outcrop) /G2 and G1 (eastern margin outcrop)/ G2 contacts (FIG. 1). This mafic-rich facies differs geochemically and petrographically from G1 Roof, normal G2 and G3. In places there is evidence to suggest an accumulative origin for this facies (Meighan and Hood 1980).

The major coarse/fine (petrographic) internal boundary within G2 which was added to the map of the eastern centre by Harry and Richey (1963)(FIG. 4) is now

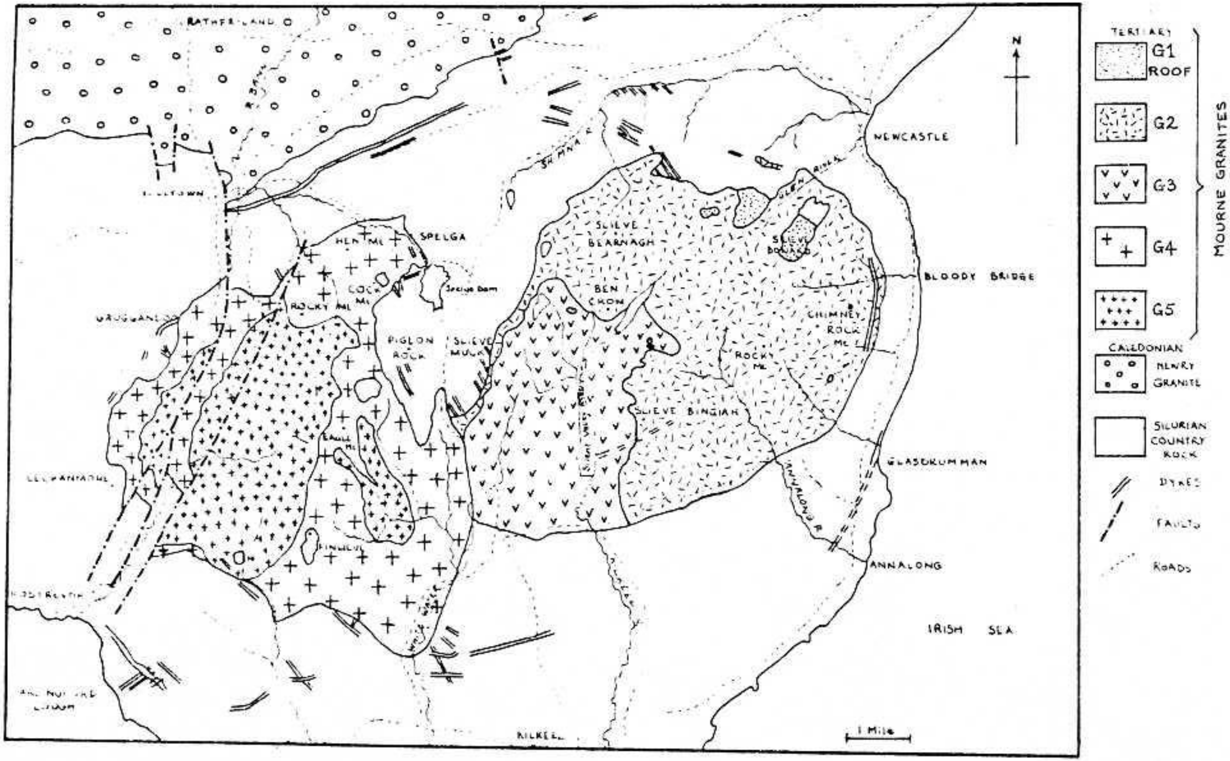

Fig. 2 Sketch-map of the Mourne Granites.

After Richey(1928) & Emeleus(1955)

With the revision of the eastern centre granites by Meighan (1976)

N.B. - Internal variations and contacts in the granites are omitted known not to be geochemically distinctive. Furthermore unpublished evidence suggests that the position of this boundary may have to be reconsidered on petrographic and geochemical grounds.

In other places, internal contacts within granites G2 and G3 are both petrographically and compositionally distinctive. These contacts may be major internal boundaries eg. the boundary between the mafic facies of G2 and the G2 granite on its inner side; and perhaps represent the margins of individual magmatic pulses within one intrusion. On the other hand other contacts may be minor internal boundaries representing the margins of relatively small auto-intrusions (including porphyritic microgranites, microgranites and aplites) within the granites.

These variations in texture and composition should be borne in mind when the MOURNE MOUNTAINS map is employed in the field. However the petrographic characteristics of each granite as noted in the map key (or explanation) are a useful guide in distinguishing the granite types in the field - but for clarification purposes a few other important characteristics may be added to the key:-

G1 (hG^1) (G1 Roof)	- the most mafic and characteristic granite of the entire complex in appearance (and geochemistry). Usually very coarse grained or locally porphyritic. Weathers deeply to a dark brown colour. Blue/grey when fresh.
G3 (fsG^3)	- Usually contains sparse, relatively large, rounded grains of quartz.
G4 (bG^4)	- the form of the quartz and feldspar tending towards idiomorphic is very characteristic. Quartz is usually dark.

For details of the geochemistry and origins of the Mourne granites G1 - 5 and their minor variants the reader is referred to the following references:- Meighan (1979), Meighan and Hood (1980), Hood et al (in press).

One or two other features on the new map are of note:- The map incorporates a comprehensive synopsis of the geology of the region together with 24 easily accessible field localities where the nature and structure of the various rock types can be observed. 21 of these localities are in and around the area of the Mourne Mountains. The map also refers its user to the "Field Excursion Guide to the Tertiary Volcanic Rocks of Ireland" by C.H. Emeleus and J. Preston (1969) where a more comprehensive and detailed treatment is given of the Tertiary igneous rocks of this region.

A geological cross-section across the Mourne centres is included beside the map. This shows one possible relationship of the granites and lower Palaeozoic country rock at depth. It is similar to the cross-sections of Richey (1928) and Emeleus (1955) who both employed the ring-dyke model to explain the intrusion of the Mourne granites. However the emplacement of the granites and the attitude of the contacts at depth is now controversial (see Walker 1975 p. 137).

Detailed remapping by workers at Q.U.B. in and around the Mourne Mountains has shown that the boundaries of certain features on the new map are also controversial but space here does not permit these to be commented upon in detail - perhaps this could be done at a later date?

Diagram illustrating the mode of intrusion of the Mourne Granites 1,2,& 3, on the hypothesis that the spaces which they occupy have been provided by successive sinkings of a block of country-rock bounded by a ring-fracture. (cf.Walker 1975).

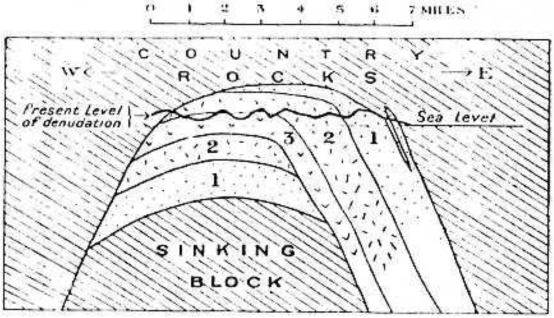

Fig. 3 from Richey 1928

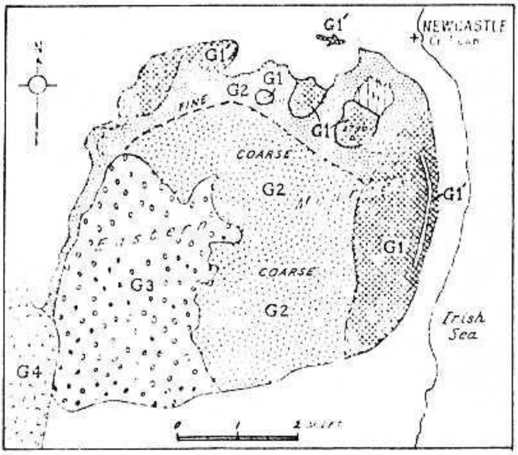

Fig. 4 from Harry & Richey 1963

To summarize then, the publication of this new map represents a major addition to Irish and indeed British Tertiary igneous geology. It has clarified some of the most important recent developments in the geology of the Mourne Mountains and therefore should provide a most useful 'tool' or base map for the field geologist. However the above points regarding variations within the granites etc. should be borne in mind when using the map in this way.

The most startling revelation concerning the geology of this area over the past 100 years (especially the Mourne Mountain granites), is the number of occasions on which important changes or additions have been made to the old Geological Survey of Ireland one-inch maps by subsequent workers. With further research, new important facts may emerge (some already have!) which may merit an addition or a change to be made to the new Mourne Mountains map. Hopefully this can still be achieved (where necessary) in the future.

Perhaps, due to lack of space, only parts of the Slieve Gullion and Carlingford Tertiary igneous complexes are shown on the new map. Both of these areas are rarely visited by geologists due to their proximity to the N. Ireland/Eire border but nevertheless they are classic areas of geological interest in their own right and contain certain rock types which cannot be seen in the Mourne Mountains. Therefore it would be nice to see this special publication on the Mournes expanded into a series which included a map of the Slieve Gullion and Carlingford centres and perhaps one or two maps of parts of the much larger Newry granodiorite complex; of which the latter has been studied in some detail by two research workers at Q.U.B.!!

The map of the MOURNE MOUNTAINS is available from the Ordnance Survey, Ladas Drive, Belfast in flat copies at £1.35 each or folded copies at £1.45 each.

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ASYMMETRY IN BRACHIOPODS

A.D. Wright

While it is a widespread misconception that brachiopods have declined in abundance since the Mesozoic and are only an insignificant element in the benthos of present day seas, it is nevertheless true that their shells are only rarely found washed up along the coast lines of north-west Europe. Conversely, bivalve shells are commonplace and so readily available for teachers to use in comparisons with the abundant extinct brachiopods, for at first sight the two groups appear similar in possessing exoskeletons consisting of a pair of calcareous valves of approximately similar dimensions. One of the more obvious differences between bivalves and brachiopods relates to the orientation of the plane of symmetry. In the Bivalvia the plane of symmetry lies between the two valves so that the left and right valves are essentially mirror images of each other whilst in the Brachiopoda the two valves are differently shaped and the plane of symmetry bisects the two valves longitudinally.

These symmetries are well illustrated by those common forms listed in the N.I.G.C.E. Advanced Level syllabus, which includes such fossil brachiopods as Chonetes, Leptaena, Spirifer and Tetrarhynchia and extant bivalves like Cardium, Trigonia and Venus. But the Jurassic bivalve oyster Gryphaea, popularly known as "Devil's toe nails", will be recognised by all with an interest in Northern Irish fossils as possessing valves which are anything but mirror images, for while the left valve is highly convex the right valve is flat or concave and lid-like. These shells show further asymmetry in the twisting of the umbo and the presence of a surface groove related to the position of the siphons, both useful attributes when it comes to orientating the valves correctly.

But it may not be so well known that brachiopods do not always adhere to their characteristic symmetry either. One may come across pathological or teratological specimens of brachiopods just as much as in any other living creatures, and damage to shells by predators may also result in an asymmetrical appearance as subsequent shell secretion has to repair asymmetrical breakage. Such occurrences are, however, of little consequence to the gene pool of populations; but asymmetrical morphology which is replicated by succeeding generations does also occur in brachiopods. Such asymmetry may be associated either with the relation of the animal to its environment or with genetic factors which do not bear any obvious relationship to the environment. Shells in the former category include those brachiopods which, like the bivalve oysters, are directly cemented to the substrate. Growth is conditioned by the nature of the surface on which the larva has settled, so that should increasing the size of the animal cause it to abut against an edge of rock or another shell, the direction of growth will be deflected to produce an irregular or deformed asymmetrical shape. This is well illustrated by the Recent brachiopod Crania, which occurs off the mouth of Strangford Lough and is known from many other localities in the Irish Sea area. Crania does not possess a pedicle and the ventral valve is cemented directly to stones and shells on the sea bed. Although the low, cone-like dorsal valve is not directly attached to the substrate, its growth is intimately related to that of the ventral valve so that any irregularities of growth are duly reflected in the dorsal valve. An Ordovician craniid, Petrocrania, reflects the nature of the substrate even more perfectly so that where it grows across a strophomenide shell the fine details of the characteristic strophomenide ornament are traced by the growing edge and reproduced on the surface of the dorsal valve (Fig. 1). By contrast, other craniids of widely differing ages simply lay loose on the sea floor as in the Ordovician Orthisocrania, which occurs in Caradoc siltstones of County Kildare,

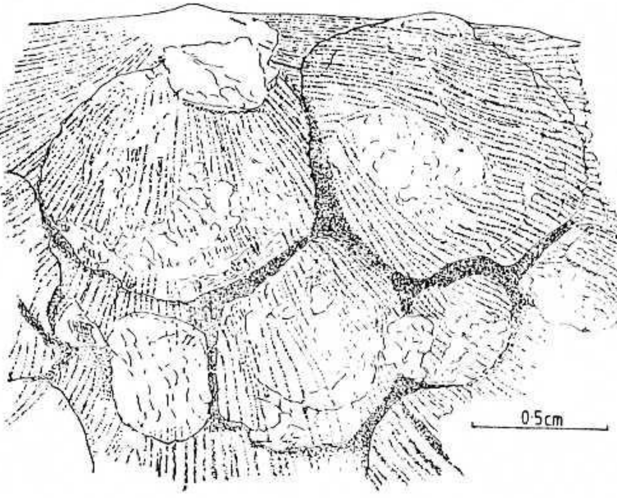

Fig 1 Petrocrania

or as in the Cretaceous Isocrania, which occurs in the White Limestone of County Antrim. In the case of the latter at least, the larva attached itself to a sand grain or similar fragment on settling but became free living as the animal grew. A result of this changed habit was that these craniids became quite symmetrical in form.

More magnificently cemented brachiopods that display asymmetry are those of Permian age and which are particularly abundant in the Permian reefs of West Texas. These include forms like Scacchinella and Richthofenia, related to the familiar Productus of the local Carboniferous Limestone. Like Productus these creatures are attached by spines, but are also cemented to the substrate by the apex of the ventral valve which develops into a tall irregular cone, producing an appearance much more like a solitary coral than a brachiopod. The dorsal valve is situated at the top of this cone and essentially acts as a lid, similiar to the operculum of the Devonian slipper coral Calceola. Another bizarre group of cemented strophomenides is the oyster-like Oldhaminidina, with genera such as Collemataria (Fig. 2) which shows a very wide range of form and distortion, controlled to a large extent by its host within the reef.

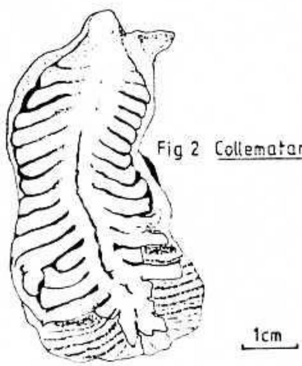

Fig 2 Collemataria

In addition to the effect of the substrate, contortion or asymmetry may be induced by crowding. This factor is most apparent in cemented forms, but may also occur in those brachiopods with a standard pedicle if growth is impeded by the tight packing of shells in a cluster or "nest" resulting from dense spat fall on a restricted substrate. But one group of pediculate brachiopods in particular develops asymmetrical shells which are not apparently the result of overcrowding but have the asymmetry as part of their genetic make-up. This group is the superfamily Triplesiacea, the species of which are not uncommon in the shelf sea deposits of Ordovician and Silurian age. The asymmetry is epitomised by the genus Streptis, a name derived from the Greek streptos, meaning twisted. In Ireland, this genus has been described from the late Ordovician Chair of Kildare Limestone, the Portrane Limestone of County Dublin, and the Killey Bridge Formation of County Tyrone. The type species, Streptis grayii (Davidson) occurs fairly abundantly within the Silurian Wenlock Shale of Shropshire. The shells of this species show little sign of a fold in the dorsal valve; instead, the valves are twisted along their length to give a sinuous curve to the anterior commissure (Fig. 3).

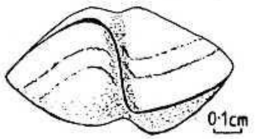

Fig 3 Streptis grayii

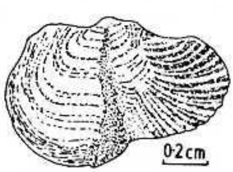

Fig 4 Streptis grayii

But the asymmetry may also be apparent in the surface ornament (Fig. 4); on the left half of the illustrated ventral valve the well defined concentric lamellae show little sign of radial ornamentation, while on the right half radial ribs are abundantly developed. Taken independently, the ornaments of the two halves present totally different aspects, at least in the more adult stages of growth. A similar contrast exists on the dorsal valve of this shell, with the strongly ribbed half diagonally opposite to its counterpart in the ventral valve.

While the characteristic twisting of the commissure is common in one Ashgill species, in most species of Streptis, including those noted above from Irish localities, the degree of asymmetry is less marked than in the type. Nevertheless even in a Llandovery form described as perfectly symmetrical, examination of a sample of fifty shells showed one-fifth to be asymmetrical to some extent with one individual possessing a twist developed to the degree of that in S. grayii. This indicates a genetic propensity for asymmetrical development which can be expected to manifest itself in other triplesiids. And indeed this is so; for the sinuous anterior commissure characterises another, as yet undescribed, Ashgill genus which is a large form with an ornament quite distinct from that of Streptis (Fig. 5). Again, the long claw-like Silurian Onychotreta commonly shows asymmetry, in this case clearly indicated by asymmetrical rib development (Fig. 6) as well as

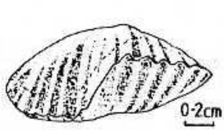

Fig 5 Genus & sp.nov.

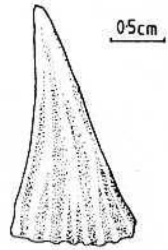

Fig 6 Onychotreta

a general tendency for irregular form. By contrast, Triplesia itself is a smooth form which is generally symmetrical, with a standard fold and sulcus producing a plicate anterior commissure. Occasionally however, one comes across an asymmetrical individual of this genus which, because of the clear evidence noted above in related stocks, causes one to suspect that some genetic factor is at work. But one must be careful in interpreting such cases as the distortion may be no more than the common effects of overcrowding, post-depositional crushing or even tectonics, should the containing sediments have been subjected to deformation.

Robert John Welch - an early geological photographer

Kenneth James

In 1897, W.F. Hume of the Royal College of Science for Ireland, published in the Quarterly Journal of the Geological Society of London a paper on "The Cretaceous Strata of Co. Antrim," (Vol. 53 p. 540-606). It was an important paper, and became a standard reference work which was to appear in bibliographies, of the geology of Ireland. The paper was also noteworthy because it was illustrated with a photograph. The first photograph in this journal had appeared in volume 45 for the year 1889, and no more appeared until 1894. The photograph in Hume's paper showed a close up of the geological sequence in the cliffs at Murlough Bay, Co. Antrim, - red Triassic sandstone overlain by a Cretaceous basal pebble bed and chalk. Included in the photograph was the figure of a man standing in the middle of the cliff, at once showing the scale of the section. This was a practice of the photographer, who clearly knew how difficult it was to tell the size of geological features from photographs alone.

He was Robert John Welch of Belfast who had established himself as Ireland's foremost photographer of natural history and geology. A restless and and energetic man, where interest fell on everything his eye beheld, he travelled the length and breadth of the country, and his studies of Ireland and Irish life at the end of the last century and in the early years of this are justly famous. In his lifetime his work was also greatly in demand, and he was employed by the local ship yards, railway companies, industrial and commercial firms and government bodies.

He was a gifted naturalist and a prominent member of the Belfast Naturalists Field Club. He was also a member of the Conchological Society of Gt. Britain and Ireland, for his life long passion was shells, and he amassed a large collection from all over Ireland. He discovered a spider new to science, and a mollusc new to Ireland. As well as collecting, he published many articles on every aspect of natural history, and for about forty years from 1893 onwards there was scarcely a volume of the "Irish Naturalist" and its successor the "Irish Naturalists Journal" which did not contain an article or photograph of Welch's or some reference to him. But he was too impetuous to submit to the discipline required for a major piece of scientific enquiry, and his chief contribution was the huge number of photographs which he took of the flora, fauna, and geology of Ireland, of which his companion for many years Robert Lloyd Praeger said, - "were often the best part of other peoples scientific articles - if he had done more, and neglected his photography ours would have been the greater loss".

He was born in Strabane, Co. Tyrone in 1859. His father, of Scottish extraction, was in the textile trade, but took up photography as a profession, being employed mainly by the landed gentry. As a boy he learned not only photography from his father, but moving around Ireland with him, he became keenly interested in the countryside and natural history. He recorded that on holiday in Bundoran he collected wild, flowers, and fossils from the local limestone. His mother was artistic, and helped her husband by painting photo miniatures - perhaps from her Welch inherited his artisitc eye which was to be a feature of his photographic compositions.

In 1874 the family moved briefly to Bangor, and in that year the British Association for the Advancement of Science paid their second visit to Belfast. Welch's father took him to some of the meetings, and the young Welch recorded how he was attracted by the display of flint implements arranged by the Belfast Naturalists Field Club. The Field Club had been formed in 1863, when, following the success of Professor Tate's outdoor classes in geology, (which had attracted hundreds to the slopes of Cave Hill) a number of Belfast people decided to join themselves together for "the practical study of natural science and archaeology". It was to be a club devoted to outdoors observation and field work, and eminently suited the temperament of Belfast - practical and hard-working. The growth of railways allowed excursions to be made, and on such excursions - a feature of the club - the flora and fauna, geology and antiquities of a district would be investigated and recorded. So much information had been amassed, that the Club was able to publish for the 1874 meeting of the British Association a compendious "Guide to Belfast and Adjacent Countries" for the enlightenment of visiting scientists.

A year later Welch's father died, and with his mother and sister, he moved to live at 49 Lonsdale street on the lower Antrim Road in Belfast, now demolished. This was to be his home and photographic laboratory for the rest of his life.

He was employed for a short while by the photographic firm of E.T. Church in Donegall Place, but set up in his own business in 1883, and about the same time joined the Belfast Naturalists Field Club, which was to be the major stimulus to him for the rest of his life.

It was during this time, the 1880's and 90's, that Welch took most of the photographs that made his reputation as a geological illustrator. The excursions of the Field Club undoubtedly provided many photographs, but Welch was also employed by the railway companies and large hotels to take scenic

Opposite: Welch's photograph of Scrabo with G.W. Lamplugh lower centre views and many of his finest coastal and rural views came from such trips. He had now taken hundreds of photographs, and in 1894, he produced a catalogue of 118 of his own "Geological Irish Views" which he offered for sale to the public at prices ranging from 9d to 1/6 each (4p to 7½) depending on size and quality. Certainly the first such catalogue in Ireland, and possibly in the British Isles, it received a warm response in the Irish Naturalist in 1894 (Vol. 111, p. 116) -

> "We welcome this catalogue as being a useful and original piece of work, and one which will be a boon to the student of Irish geology . . .. There are terse descriptions of the geological features exemplified in each, contributed by Professor Grenville Cole, F.G.S. Even in the absence of the photographs, these descriptive notes form interesting reading, and when taken in conjunction with the views, which are all up to Mr Welch's well known high standard of merit, the result is a production of much educational value."

Most of the photographs were taken on the Co. Antrim coast, which is not surprising due to its proximity to Belfast, and the wealth of the geology exposed.

Photographs first appeared as illustrations in textbooks about 1890, and Welch's photographs, which as he had stressed in his catalogue, "had been taken with a view to their being used for Geological purposes" were amongst the earliest used. Six of them appeared in the most popular textbook of the period "Geology for Beginners" by W.W. Watts, which was first published in 1898 and ran for six editions until 1935.

The Geological Survey of Ireland also recognised Welch's expertise, and employed him to take photographs to illustrate the specially published Memoirs of 1903-1905, of the geology of the Dublin, Belfast and Cork areas, and the 1912 Memoir of the Interbasaltic Rocks of N.E. Ireland. Mr G.W. Lamplugh, an officer of the Survey who contributed to the Memoirs, accompanied Welch on his Cork and Belfast trips, and appears in several of these photographs.

Welch contributed photographs as early as the 1890's to the "National Collection of Geological Photographs" formed by the British Association, (now deposited in Southampton University). He also had a remarkable link with three of the Association's meetings in Belfast - he attended the 1894 meeting, helped to organise the 1902 meeting, and two of his geological photographs appeared in the guidebook "Belfast in its regional setting" published for the 1952 meeting, some 16 years after his death.

Welch early realised the educational value of his photographs, and made his best ones into glass lantern slides, which he used in the many talks he gave to meetings of the Field Club. He was also ahead of his times in his attitude to preserving important geological sites. In 1928, he urged in an article in the Irish Naturalists' Journal, (accompanied by one of his photographs) the public protection of the metamorphosed Liassic beds at Portrush, stressing their importance in the history of geology. This area is now one of two protected sites in N. Ireland.

Welch was a pioneer in photography, and one of the first to photograph geological features for their use as illustrations. He recognised their educational value, and their use in textbooks. He was an innovator in the inclusion of figures in photographs, to provide scale, a practise which soon became obligatory. He particularly understood the play of light and shade on surfaces, and was expert at positioning his camera, to get the best from a photograph. He set high standards, and his work is characterised by the good quality of composition clarity, attention to geological detail and scale. He also had the eye of an artist, which made his finest photographs truly memorable.

After his death in 1936, his photographs were left to the Belfast Naturalists Field Club who deposited them in the Belfast Museum, on condition that they were catalogued and made available to the public. After many delays these conditions were finally met, and today there are 555 of R.J. Welch's geological prints, made from the original glass negatives, catalogued, arranged in file, and available for consultation in the Geology Department of the Ulster Museum.

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THE ADVANCED LEVEL GEOLOGY PROJECT

Michael B. Reid

In the GCE examination at advanced level in Northern Ireland the individual research project and the oral examination which is based on it together gain a possible 20% of the total marks for the subject. This percentage reflects the importance which the examiners attach to fieldwork and they recommend that certain periods during the course be given over to work in the field and its subsequent follow-up in the geology laboratory. The GCE Examinations Board provides guidance in the form of notes additional to the printed syllabus and teachers entering pupils for the examination should obtain a copy from the Board. It may be, however, that experience in preparing pupils for the examination over a number of years at one particular centre may be of interest to others in a similar situation.

Probably the most difficult part of the whole process is the selection of the subject for the individual project; pupils need guidance and encouragement in order to make an early decision. Fortunately the field is wide and, provided that the end product has sufficient geological relevance, personal preference, accessibility and convenience of the subject to be dealt with will allow at least a firm decision to be made in general terms, leaving the final details and title to be confirmed later. It is desirable that work on the project should commence early; laboratory work, drawing of maps, sections and diagrams are time consuming and re-writing is often required. The type of fieldwork suitable to an areal survey has been covered by S. Magowan's article in a previous issue and this will also serve as an indication of the approach necessary in other types of project. Pupils should be discouraged from choosing bizarre locations (one of ours proposed an area in Switzerland) since frequent visits often become necessary once writing begins, and they should also be dissuaded from selecting well-known and documented sites where it is extremely unlikely that they will find anything original to describe and will be tempted to use the published material.

A popular choice of subject is the geological description of a local area such as a quarry, stream section or shore section where rock is exposed at the surface. The teacher must ensure that proper permission is obtained for visits to the site and that safety precautions are taken. However, the potential of the site should also be checked; unless there is some variety in the outcrops (as, for instance, in Belshaw's quarry) such sites may be limited and the report somewhat thin. Laboratory work, of course, can extend the treatment, but this will obviously depend on the facilities available to the pupil. Since the emphasis is on personal work - observation, measuring and recording, analysis, interpretation and presentation - the site chosen should offer interest and scope to the pupil. It is here that the teacher's role of guide and mentor can be valuable, but it should be restricted. As they become more and more involved with their individual project pupils develop a proprietary attitude to "my project" and their enthusiasm should be encouraged and, in certain cases, restrained! The academic standard of individual projects will vary with the abilities of the pupils, but enthusiasm and interest, which the teacher ought to share, is a great asset, and is not to be equated with geological competence.

Apart from the description of a local site, the fieldwork project can be based on economic geology (water supply, building materials, use of local stone for road metal, sands and gravels for concrete, etc.) or on fossils or minerals, on geological influences on scenery, land use and so on. The teacher can play a useful part at this time by suggesting possible subjects and encouraging pupils to suggest others. Writing general descriptions of group outings, using hand-outs prepared by the teacher or plagiarism of published work should be discouraged in favour of original work. The poorer pupils often find the prospect of choosing a subject and writing it up a daunting task and the necessity of starting the project early is obvious. They find, as most of us do, that the hardest part is the beginning of it!

We are informed, and the pupils should be told, that the examiners look for careful and accurate observation and treatment, but that they cannot award marks for anything other than geological content. A neatly written and drawn piece of original work, well presented, simply but adequately bound is acceptable. One should restrain pupils' desire to use all the facilities of modern design and book production in the mistaken idea that a lavish presentation will influence the examiner. It won't! Our projects have been written on A4 paper with the maps and diagrams to the same size, stapled together with a plain cover in manilla to form a booklet.

The limit of 3000 words given in the syllabus should not be exceeded and editing may be necessary; conversely some projects may not have given sufficient scope for the pupil to write 3000 words and thereby present a different problem. 'Padding' should not be part of the project because, like Letraset and fancy binding, it will not gain marks. When it appears that a project is likely to fall short it is better to try to expand the original subject, or abandon it, rather than to supplement it by the addition of a second unrelated additional project. It is frequently possible for the pupil to enlarge one or more aspects of his first choice, particularly when he has already done a lot of work on it, and this also will give him more confidence in the oral. Detailed work on minor structures, comparison with neighbouring sites, more refined statistical treatment of the material, and similar lines of research may provide the required makeweight and will provide additional subjects for the oral examination. To many pupils the oral can be a daunting prospect, but, by talking to pupils after their oral, it has been found that those who have become more deeply involved with their project have been able to talk more confidently to the examiner. The very nervous have found some comfort in having samples of their rocks or fossils to hand, and examiners may also find these a useful aid in drawing out the pupil.

It is in some ways unfortunate that the marks awarded for the project are not revealed by the examiners so that we could use them as examples to be emulated or avoided. However, perhaps that might tend to limit the choices open to the pupils in that they would choose the familiar rather than the less familiar, and imagine that one type of report would gain more marks than another. As it is, the real value probably lies in the doing of it, rather than in the marks awarded, important though that undoubtedly is. When a pupil has presented a piece of original research, on which he has spent a lot of his spare time, that in itself is a useful exercise, whatever the final mark may be.

Book News etc

The Antrim Plato

The Antrim Plato, as you have presumeably guessed, received this name from a harassed exam candidate this summer. This etherial, geological philosopher (shall we call him 'The Bard of the Basalt'?) is obviously the inspiration for all the geological howlers committed in this province. He must sit, like come cheeky demon, amongst the rafters of exam halls waiting for some poor unfortunate to stare upwards with blank or quizzical expression. "Got it!" thinks the examinee as he jots down 'porphorblast' or 'trillobite'. "Got you!" chuckles the Antrim Plato.

An authoratitive encyclopedia of geological howlers has just been published by the Geological Society of Glasgow. I shall leave it to the Antrim Plato himself to review this excellent little book.

'You might wonder why someone as cheeky as myself has such an imposing title as "The Antrim Plato." Well, when you read "Geological Howlers" edited by Ian Rolfe you'll see how philosophical people can be when making mistakes. None other than Freud, not Sigmund but his daughter Ima Freud ('Imafreud I don't get that one' - get it?!) realised the importance of what we know in the trade as Freudian Slips, or in this case Dip-Slips.

Here are some examples from this superb book of geological near misses, or as I say 'A miss is as good as a smile!' (Groan).

Boulder clay speaks for itself.

The mineral resources of the area are negligent.

Rocks have the ability - not all of them - to pass water at high pressure.

Ground water can be obtained in four main ways: the first is from meteorites.

Worthless rock associated with ore is called mange.

Gold is found in nougat in placer deposits.

Moulten lava flows out of the Mid-Atlantic rift from time to time and covers the surrounding sea floor with sea floor spread.

An example of a great Caldera is the formation of Lough Neogh, County Antrim where part of the volcano that occupied that space was blown into the channel to form the Isle of Man.

Volcanic tuffs fall into three main catagories.

During metamorphism, water is squeezed out of rocks; such rocks are said to be incontinent.

Symmetrical ripple marks are produced by alternating current.

The age of the Dalradian has been established by the use of fossil mermaids, known as Aquatarts.

Darwin's theory is based on three points - the struggle for exits, survival of the fattest and maternal selection.

Geological Howlers, edited by Ian Rolfe, published by the Geological Society of Glasgow. 54 pages, 28 drawings (two reproduced here). £1.15 post free from Dr G.M. Farrow, Geology Department, University of Glasgow, Glasgow G12 8QQ

Antrim Plato

Miss Gail Cheatley typed this issue.