Geology

In Northern Ireland

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CONTENTS

Where to from here?

Geology in Northern Ireland is one year old; the first issue appeared in June last year. The question is, 'What next?' I have not had a great deal of feed-back from people outside of my department but, as the next issue will not appear until about November, you have plenty of time to let me know what you think!

The Belfast Geologists' Society — Summer Programme

June	7	*The Glarryford Aquifer*	J.R.P. Bennett
June	21	*Glacial Features in Glenelly*	H.S. Black
September	6-7	*Glencolumbkille*	Dr T.B. Anderson
September	20	*Lower ORS Vulcanicity in Tyrone and Fermanagh*	A.E. Griffith
October	4	*The Ballycastle Region*	Dr I.S. Johnston
October	18	*The Slieve Gullion Tertiary Volcanic Centre*	The President

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THE IRON ORE AND BAUXITE MINES OF GLENRAVEL

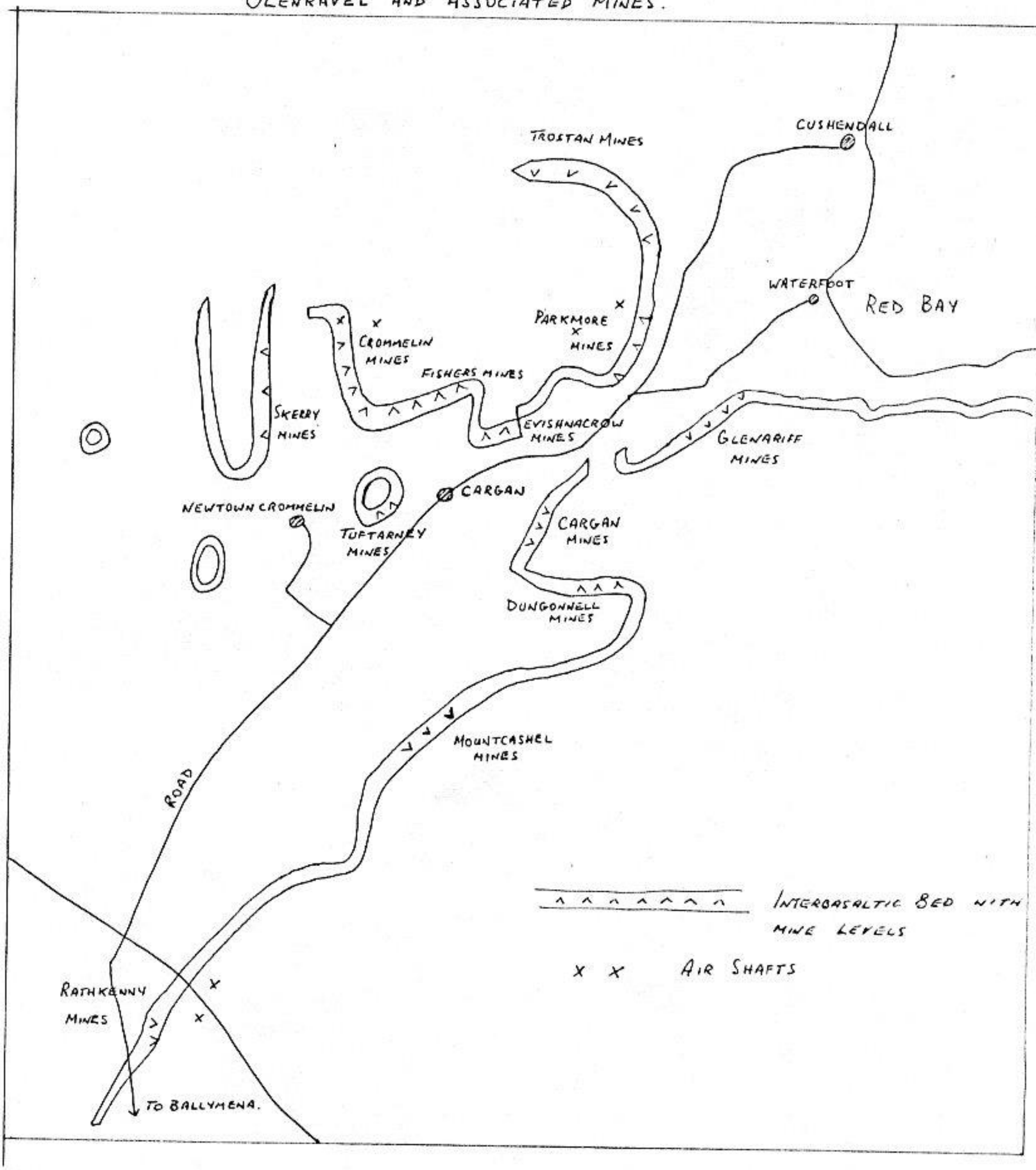
K.J. O'Hagan

Underground mining today is virtually non-existent in Northern Ireland save for the excavation of rock salt at Kilroot near Carrickfergus, but a vast reawakening of interest in our own mineral resources has been taking place over the past few years. New sources may yet be found and new uses may yet be discovered for those ores which years ago were considered unprofitable to work. Chief among these are bauxite and iron ore, the respective ores of aluminium and iron, two of the most common elements of the earth's crust.

A century ago, the mining of these ores was at its peak in the Glenravel area, having been commenced as opencast mining in 1866 by James Fisher Esq. of Cleggan House near Aughafetten. The first underground mine was driven in January 1867 by Fisher and the industry quickly mushroomed as newly-formed mining companies started operations. Aluminium at this time was still a virtually unknown commodity and it was only in 1870 that it was realised it could be obtained from bauxite. In 1871 Professor John F. Hodges discovered bauxite in the Cargan Mine in association with iron ore and this added new interest and potential to the mining industry. In the 1880's however, a slump in the iron and steel industry and the exhaustion of the better class ores, brought about a gradual decline towards closure in the early decades of the 20th century.

With the outbreak of World War 2 and a shortage of bauxite due to foreign imports being cut off, interest in the Antrim bauxites was rekindled and new mines were opened at Skerry and Templepatrick as well as some of the old iron mines being reopened for their bauxite content. With the end of the war the demand for local bauxite ceased and the mines were finally abandoned in December 1945.

GLENRAVEL AND ASSOCIATED MINES.



Much has already been written about the origin of the Interbasaltic Bed which contains the ores of aluminium and iron. It appears that these were originally thought to have been lacustrine deposits which were subsequently covered by successive lava flows. It was also thought that the aluminous and pisolitic ores were younger than the overlying basalt because of the presence of what were known as stop dykes. In the Glenariff Mines it was noted that these did not displace or bake the ore seam and were therefore older than it. The iron ore, therefore, had been deposited in solution into shrinkage fissures between the lithomarge and the basalt, the solution being the result of leaching by surface water on the rock through which it passed.

We now know, however, that the Interbasaltic Bed was formed during a prolonged pause in the regional volcanic activity consisting mainly of fissure eruptions. During this pause the normal weathering agents of a sub-tropical climate reduced the surface lavas to a rich red soil. Many of the major elements of the rock were leached out by the chemical action of sun and rain with the result that the oxides of iron and aluminium remained in the soil and are thus found associated with each other in the Antrim hills. These deposits are known as laterites and if the parent rock is rich in aluminium the resultant laterite is known as bauxite; if it is rich in iron it is known as iron ore. These laterites vary greatly not only in composition but in appearance. Some iron ores are mottled and streaked with lighter areas while many are dark red and even almost black. Bauxite too varies from pale grey to red and purple. Because of these colour similarities it is difficult at times to distinguish by eye between iron ore and bauxite.

The Interbasaltic Period came to an end with the resumption of volcanic activity on an intensive scale and forming what we now call the Upper Basalts. The outpourings of lava eventually ceased and since then the continuous processes of weathering, glaciation and deposition have removed much of the upper lava series and the interbasaltic bed over much of the country and these now occur only in the isolated outliers and cliffs of Upper Basalt in N.E. Antrim. In a few of these the iron ore and bauxite concentrations were rich enough to be of economic value.

The Interbasaltic Bed can still be plainly seen where it outcrops on the surface along the cliff path at the Giant's Causeway. It underlies the country from here to Broughshane and occupies an area of about 400 sq. miles. The average thickness of the No. I or pisolitic ore in the mines was about 14 inches and beneath this lay the No. 2 ore or ferruginous bauxite known locally as 'pavement', and about 5 feet in thickness. Where the good ore was compact or solid it was brought down by means of blasting and was known as 'shooting ore'. Where the ore was loose and crumbly it could be removed easily by pick and was known as 'hoking ore'. In Fisher's mines the best seams yielded 60% iron and the average yield was about a ton of ore per cubic yard. Similarly, at Evishnacrow the quality was good, and the peas of iron in the ore had the appearance 'when split of case steel'. At Cargan Mines the ore was up to 40% iron falling to 18% in the poorer seams. Reserves in 1885 were estimated at 185 million tons though most of these were thought to be uneconomical to work when compared to cheap sources of foreign ore. During the years that mining flourished before the War only about 5 million tons of iron ore were mined along with 182000 tons of bauxite but it should be remembered that this was all done by manual methods and by men and boys who were normally small farmers.

Associated with the ores of iron and bauxite are occasionally found seams of lignite probably formed from the vegetation which flourished during the interbasaltic period. In places, eg, at Ballintoy, this was in sufficient quantity to be mined but in the Glenravel area the only mine in which it can be seen is at Rathkenny, where it attains a thickness of between two and three feet and where pieces of carbonised wood can be picked from the walls of the mine. This lignite seam probably accounts for the presence of foul air in this mine which the writer experienced during two visits there in 1976. No foul air was detected in any of the other mines visited in the area. In 'The Geology of Ireland' Charlesworth mentions that sometimes the lignite in the mines caught fire and smouldered for several years.

In the roof of many of the mines large crystals of calcite can be seen in geodes in the basalt. In the Cargan Mines aragonite crystals have been found and many stalagmitic deposits have been formed since the mines were first driven. In places these take the form of flowstone on the mine walls and are most extensive in the Parkmore Mine and Salmon's Drift. These features are the result of gas pockets in the basalt formed on cooling and subsequently lined with crystals. With mining of the ore, cracks have opened in the basalt roof through which surface water seeps into the mine, leaching out the calcite and depositing it as calcium carbonate as it would in a natural cave. In addition calcium charged droplets of water have formed calcite pearls on the mine floor. In one passage in Salmon's Drift the floor is completely calcitised for a considerable length.

Dykes are also a common feature in some of the mines and often caused considerable problems when mining the ore. The intrusion of a volcanic dyke through an ore seam inevitably delayed mining as the miners had to bore through much harder rock to relocate the seam on the other side. They had no way of knowing how deep the dyke was and in one case, the Cargan Mine, they bored through for 200 feet before it was decided to abandon the mine. In other cases they searched for the seam in the roof where it had been displaced by as much as 20 feet upwards. Needless to say a passage driven through a dyke required no shoring because of the hardness of the rock and such a passage is easily recognisable by its arched shape. In fact the mines themselves were considered very safe to work in because the roof rock was so sound and very few timbers were required in the workings. The timber requisite for these mines was estimated at a penny per ton whereas in the Furness district of England the cost was 1/= per ton. This was therefore an inducement for English companies to start operations here and in fact most of the mining companies were English.

Inevitably however roof collapses have occurred since the mines closed, mainly through settling of the basalt roof over the years and the decay of supporting timbers, but it could now be said to have reached a state of equilibrium where no further sagging will occur. As a visitor to these mines on countless occasions over several years the writer has never seen any fresh falls of rock and these appear to be the exception rather than the rule in view of the general soundness of the roof.

Most of the mines today contain vast quantities of water caused by seepage through minute cracks in the roof and backed up behind blocked adits. Flooding was also a problem for the miners in those mines which were driven with a slight dip and closure of some mines was entirely due to this. In others the best ore had been worked out and it became uneconomical to mine lower-grade deposits because of foreign competition. This is the situation with the Antrim ores today.

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LOWER CARBONIFEROUS FORAMINIFERA

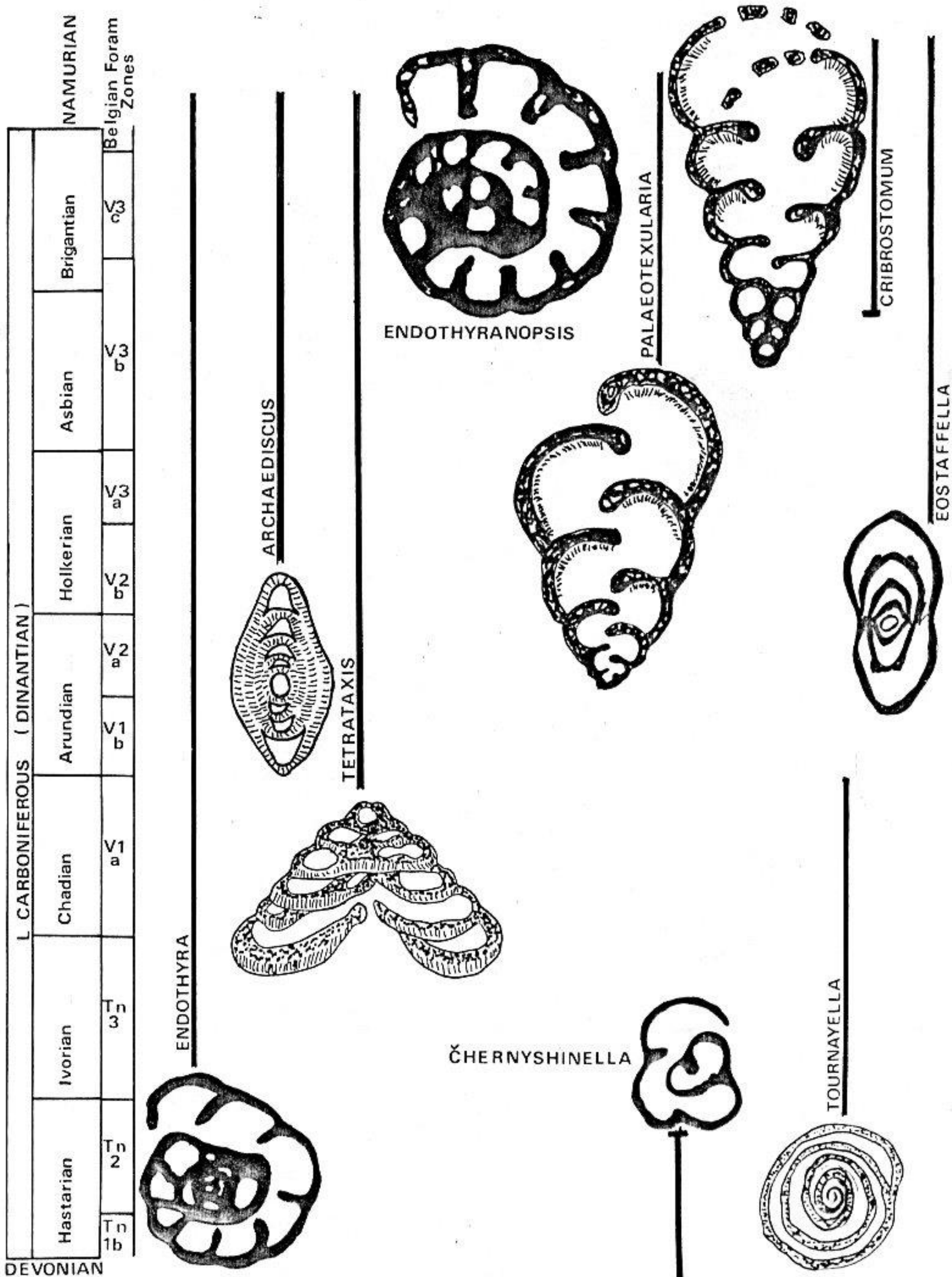
John Wilson

The importance and utility of microfossils for the relative dating of rocks has been recognised for more than half a century. Of all the microfossil groups the foraminifera are probably most used. They are usually abundant in carbonate marine sediments and a very small sample can yield a large number of individuals in situations where macrofossils are either absent or can not be collected. They are therefore particularly useful where the sample is a borehole core.

The living foraminiferan is a unicellular or acellular animal, related to Amoeba but with the ability to secrete or pick up a shell from its surroundings. This shell or test is preserved on the death of the animal. The vast majority of fossil foramifera can only be seen with the aid of a microscope but a few attain a size of up to 5 mm; for example, Numulites a Tertiary form, which was assumed by early historians to be fossil lentils eaten by the builders of the pyramids where they were found, or Saccaminopsis fusulinaformis which is common in the L. Carboniferous rocks of the N. of England and parts of Co. Tyrone. The most common environment for this group of animals is marine, and most are bottom dwelling. Some planktonic groups have existed since Jurassic times when this mode of life is thought to have evolved, so all the L. Carboniferous foraminifera are considered to be bottom dwellers, with the ability in a few cases to encrust or attach themselves to other animals either living or dead. The test of the L. Carboniferous foraminiferan was, in the main, secreted by the protoplasm, although grains picked up from the surroundings are commonly included in the test. We can be fairly sure of this origin of the test by the intricate patterns of deposits within the test and the presence of different layers in the test

Fig 1

Appearance in thin section and stratigraphic range of some common Lower Carboniferous Foraminifera



wall of many species. The shell is frequently divided up into a series of chambers by extensions of the wall known as septa. This misled early palaeontologists causing some to classify them with ammonites or gastropods which they superficially resemble; in miniature.

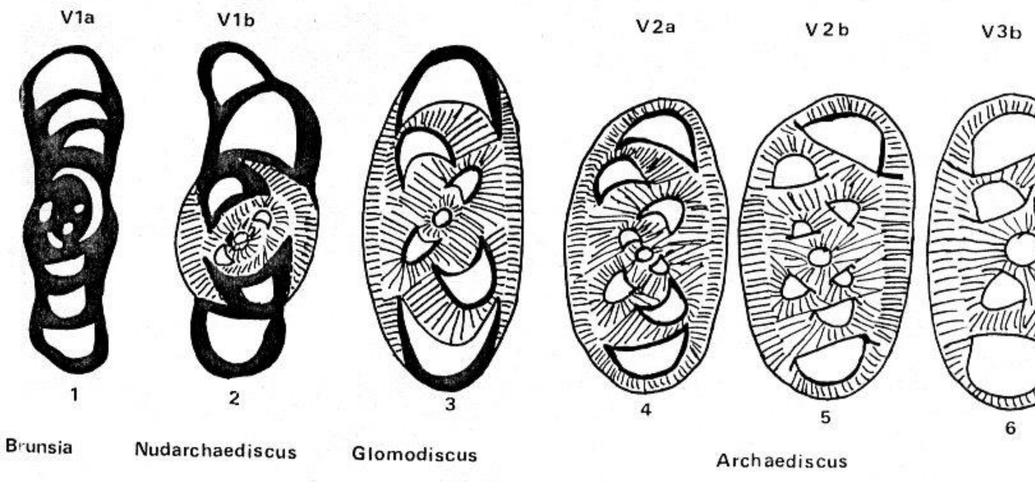
The presence of forams, (as they are commonly known), in Carboniferous limestone rocks has been known for a long time. By 1829 species were being described from the Russian Carboniferous, and in 1841 Buckland read a paper announcing their discovery in the Derbyshire limestones. The first major British work on the subject was a Palaeontographical Society monograph on Carboniferous and Permian foraminifera by H.B. Brady, one of the most celebrated early micropalaeontologists; this was published in 1876. Until the end of World War II, despite the explosion of interest in economic micropalaeontology, mainly for petroleum exploration, no major research on Carboniferous microfaunas was published. But by the late 1940's Soviet micropalaeontologists such as Reitlinger, began to describe new species from random thin sections and determine their stratigraphic ranges. This methodology represented two major advances; firstly it was no longer necessary to look for a lithology from which specimens could be extracted in their entirety and secondly and more importantly a zoning system based on forams was being established. In the west biozones for the L. Carboniferous were not published until the middle 1960's when Conil and Lys in Belgium, and Mamet in N. America defined foraminiferal zones. In Britain, Cummings worked on a system of zonation for the British L. Carboniferous but his scheme never reached publication. In Ireland the only significant work to be published is by T.R. Marchant, on the foram faunas of the Dublin Basin. The Belgian system of zonation devised mainly by Conil can be applied to the British Carboniferous with little amendment.

Due to the fact that Carboniferous forams have the same chemical composition as the enclosing limestone, and because of their small size, extraction from the matrix has, so far, not been practical. As a result work is concentrated on the examination of prepared thin sections. Whilst the description of species determined by this method is considered by some to be a doubtful taxonomic practice much useful knowledge has been gained in the last decade, and stratigraphic ranges of different forms are becoming more effectively delineated.

The most common forams occuring in the L. Carboniferous belong to the superfamily endothyracea and within this superfamily the genera Archaediscus, Endothyra, Tetrataxis and Palaeotexularia are probably the best known (See Fig. 1). Many other genera are described but the taxonomy is complex and the system of classification within this limited group is changing rapidly. During this period the fusulinids, which are the dominant forams during Permian times, began to evolve and their most frequent representative is an ozawainellid belonging to the genus Eostaffella (See Fig. 1).

Evolutionary lineages can be traced during L. Carboniferous times and one of the most easily demonstrated is within the archaediscids, which have a test consisting of an initial chamber or proloculus followed by an open coiled tube without chambers. Fig. 2 shows a simplified line of evolution within this group. This particular line can be traced, with a few gaps, by examination of the forams from the rocks in the area east of Armagh city amongst many other places throughout Britain and W. Europe.

Fig 2 Evolution of the archaediscinae



after Conil and Pirlet 1973

Stage 1 shows Brunsia which could be the archaediscid ancestor but consists onlyof a single dark layered wall throughout the shell. Stage 2 shows a similar shell type but with the addition of a limited fibrous layer. By Stage 3 a proper archaed iscid has appeared in which the fibrous layer almost completely covers the dark layer. Stage 4, 5 and 6 all show stages within the genus Archaediscus where the dark layer gradually disappears and the base of the coiled tube progressively changes from convex to concave. This means that this group can be particularly useful determining the age of the rocks in which they occur.

Carboniferous rocks underlie approximately two-thirds of Ireland and occur in all counties with the exception of Wicklow, so opportunities for finding fossil forams are great, In areas where drift or peat cover precludes the collection of corals and brachiopods which are used to zone L. Carboniferous rocks, small outcrops can yield many individual microfossils and hence make age determination a possibility. Examination of forams of this age is not however limited to those who can have thin sections prepared. Entire specimens can frequently be collected from shaly partings between more massive limestone beds by washing and the use of a fine mesh sieve. These can then be viewed using an inexpensive light microscope. In some instances good specimens can be collected from the soil immediately overlying an outcrop of limestone if samples of this soil are washed and sieved.

Interest in Carboniferous micropalaeontology has greatly increased and zonation systems based on other types of microfossils such as conodonts, spores and ostracods have complemented and in some cases proved more useful than the original coral, brachiopod scheme.

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GEOLOGY AT THE ULSTER POLYTECHNIC

G. H. Nevin

One of the distinctive features of the Polytechnic course is that it is a Combined Science course, which means that two main subjects are studied simultaneously, to either pass degree or honours level. A range of subject combinations is available with geology including:-

- Biology
- Chemistry
- Economics
- Mathematics
- Physics

and currently the most popular combination, Geography. A combined course not only leads to a wider career choice, but also allows some degree of personal specialisation through interdisciplinary project work in fields such as geochemistry and geophysics. Against this however must be set the fact that students have to reconcile the different approaches and conflicting demands of two subject areas, while of necessity, the content of each subject will be less extensive than in a single subject course. In geology, the latter point has been met, as befits a Polytechnic, by concentrating on those areas of particular relevance to industry.

Broadly speaking, entry requirements for the course are two A-levels, along with O-level mathematics and English, but there are some specific pre-requisites for various subject combinations. (Full details are available on application to the Course Director). The geology course is designed for students with little or no previous knowledge of the subject, and so there are no formal course pre-requisites, although a good scientific background would be a clear advantage, with chemistry, physics and biology all providing not only subject knowledge which can be usefully applied to geology, but also an understanding of scientific principles and methodology. Geography has always been a popular A-level subject for potential geology students and provides a useful foundation in geomorphology and in the use of maps and statistics, but past experience suggests that where geography has been studied along with arts-type subjects, the strongly scientific bias of geology may lead to difficulties.

The course lasts for three years, of which the first two provide a general coverage of theoretical and practical geology with an emphasis on petrographic and mapping skills, aiming to prepare students to carry out individual mapping projects in the vacation preceding the third year. For each year of the course students have a field week in western Scotland, north Wales or southern England. At the core of the final year for all students, is the economic geology course which shows how the geological principles studied in earlier years can be applied to mineral resources. The course includes both the theory of the origin of mineral deposits and the practice of locating, evaluating and exploiting them, and tries to place this in the context of the economic and environmental factors associated with present and future mineral production. In addition, honours students carry out a supervised laboratory project over two terms, and follow several specialist theory courses, while those students who have opted for the pass degree cover a more practicallly orientated course.

By any standards, the Polytechnic geology section is small, and it offers facilities less impressive than those of most universities. Its aim is to provide not so much a competing course, but an alternative course, differing in structure and orientation from the majority of university degrees. While the extension of knowledge through research is an important part of its work, it is primarily committed to teaching and to extending its already extensive links with the mineral extraction industries in which employment opportunities seem to be favourable.

GEOLOGY AT QUEEN'S

Ian. S. Johnston

Entrance Requirements

Anyone wishing to enter the Faculty of Science at Queen's will need at least C and D grades in scientific 'A' Level subjects. Some departments require two C's and some insist on specific 'A' Levels being taken. The Geology Department requires the basic C + D and they may be in any scientific subject. Candidates obtaining two B's or three C's or better may enter the Faculty directly into the second year, and will do a three year course instead of four.

However, although these are the basic requirements, this department strongly recommends that those who wish to take Geology at this University choose 'A' Level subjects from amongst the following:-

Physics
Chemistry
Maths
and Biology

These are the subjects which are of greatest value as a background to an undergraduate course in Geology. Other subjects, for example, Geography, are of little value, a fact which is often ignored. Geology itself, taken as an 'A' Level subject represents time which this Department and most others in the British Isles feel could probably be better spent on one of Physics, Chemistry, Maths or Biology.

In the first of the four years at Queen's an undergraduate in the Science Faculty will take three subjects as well as Geology. Again the Department strongly recommends the basic sciences Physics, Chemistry and Maths or perhaps Zoology, or Botany. Many students will wish to take Geography as well as Geology, but these two subjects have little in common, and something more useful is suggested. There are a number of other subjects which can also be taken eg:-

Computer Science
Archaeology
Psychology
Astronomy
Economics etc.

and if one of these is chosen as a fourth subject supported by the main science subjects this is acceptable. However, those who take, for example, Geology plus Geography, Archaeology and History and Philosophy of Science are wasting their time and doing little to further their scientific training for Geology.

Geology cannot be taken as a degree subject in the Arts Faculty, although first and second year Arts students may take Geology as a subsidiary subject. Joint degrees with any subject are almost unknown there being so much to learn in Geology as to keep most people quite busy enough!

The Geology Course

The course at Queen's is designed to give students a general training in Geology. Thus graduates will have a broad knowledge of the subject and will have the widest choice of careers available to them. This has been found to be most acceptable to employers who tend to retrain new personnel in techniques particular to their company anyway, and may dislike specialist graduates who may be too unadaptable or have only a limited background knowledge of geology.

Specialisation is, however, included within the course at Queen's. This exists in two forms. Firstly those taking an Honours Degree have a choice of final year subjects, apart from Sedimentology which is compulsory. Three subjects are chosen from:-

Stratigraphy
Palaeontology
Structural Geology
Ordinary Petrology
and Advanced Petrology

This allows those who have become particularly interested or knowledgable in one branch of the subject to concentrate on it to a certain extent. Field excursions are linked to these subjects there being separate trips to Scotland to look at Igneous and Metamorphic rocks and structures and to Wales to look at and map Precambrian and Lower Palaeozoic sediments and igneous rocks.

The Thesis

Work for an Honours Degree includes the submission of a thesis based on field mapping. Students choose a field area to map within the British Isles, either one with a variety of topics to be considered or one with an emphasis on one or two. This department places great emphasis on this aspect of assessment and, as a result, students put considerable effort into their thesis, field mapping projects and the writing up of their findings back in the library and laboratory. This emphasis on field work may be said to be a form of specialisation but the ability to produce a good map and report is a good recommendation for any geologist.

The pre-Honours years

The structure of the first three years of undergraduate study is as follows. The first year (known as Level 0) is mainly an introduction to Geology and is perfectly comprehensible to those who have not tackled the subject before. All the basic elements are covered with a lot of practical time spent on map interpretation. Field excursions visit some of the sites of classic geology in the northeast of the Province.

The second year (Level 1) continues the basic geology theme and there is a considerable amount of both palaeontology and microscope determination of rocks and minerals as well as stratigraphy, structural geology and sedimentology. The main field excursion is to Donegal where 10 days are spent on learning and practising basic mapping techniques.

The third year (Level 2) is rather different. As well as further study of some of the Level 1 topics, several applied geological subjects are introduced. These include:-

Geophysics,
Geochemistry
Geotechnics
Petroleum Engineering
Photogeology
Hydrogeology
and Micropalaeontology

Some of these subjects are taught by specialists from outside the Department, especially from the Geological Survey of Northern Ireland. Field excursions include several in-term trips around the Province as well as 10 days in the south of England looking at Mesozoic rocks.

This Level 2 course is designed to give all graduates' including those who leave without attempting to gain Honours, a broad knowledge of applied Geology. The Level 3 course is more academic Geology and takes students to a high level of understanding in a relatively few topics. Many, having obtained good Honours Degrees, then do a postgraduate course in, for example, Petroleum Engineering or Geophysics at one of the regional centres for these subjects such as Imperial College. Others stay on at Queen's to do research. The Department is the regional centre for some of the very expensive research machinery including the Electron Microprobe and the X-Ray Spectrometer as well as having expertise in fields not so dependent on high technology.

In short the Geology course at Queen's is a broadly based one, and graduates have proceeded, without much difficulty to date, to jobs in a wide variety of situations.

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GEOLOGICAL TEACHING MATERIAL

Noel McCann

Open University books, specimens etc. have long been dipped into by by Geology teachers and their A-level pupils. Perhaps some of the material. listed below are not as widely known.

With reference to Plate Tectonics and other advancing Geological fronts, I have found that the articles which occasionally appear in the monthly "Scientific American" are very useful. If there is not a collection of back-numbers around, a worth-while purchase would be the three volumes of their Resource Library - "Readings in the earch sciences" (Freeman, ISBN 0-7167-0988-0). These cover papers published between 1948 and 1972.

In addition to the Resource Library volumes, Scientific American has published the following single-theme "Anthologies" of papers.

"Continents Adrift" - (ISBN 0-7167-0858-2). This covers papers on this topic published between 1952 and 1972 with introductions to groups of them by J. Tuzo Wilson.

"Planet Earth" - (ISBN 0-7167-0506-0). Papers published between 1958 and 1974 have introductions by Frank Press and Raymond Siever.

"Continents Adrift and Continents Aground" - (ISBN 0-7167-0280-0). Papers published between 1963 and 1976 with introductions by J. Tuzo Wilson.

Three conventional books which have been much used at A-level are:-

Gilluly Waters and Woodford: "Principles of Geology"
(Freeman ISBN 0-7167-0269-X)

Mears: "Essentials of Geology"
(Worstrand, 0-442-25316-8)

Press and Siever: "Earth"
(Freeman: 0-7167-0261-4)

Of these "Earth" is probably the most useful, with "Essentials of Geology" giving a more elementary treatment and "Principles of Geology" the most widely known.

The Irish Association for Economic Geology:-

(Secretary:-
K.J. Chew,
Petroconsultants Ltd,
Cumberland House,
Fenian Street,
DUBLIN. 2)

sells an excellent collection of 12 minerals of economic interest. These are decent-sized hand specimens of typical, rather than museum, material.

Also the Irish Geological Association:-

(Secretary:-
Dr. S. Daly,
Department of Geology,
Trinity College,
DUBLIN. 2)

sells a collection of 12 Irish rocks - sedimentary, igneous and metamorphic, along with a splendid set of notes.

In view of the present banking difficulties, it is suggested that one should make one's own arrangements to pay the few punts for these worth-while collections.

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I would like to thank Miss Gail Cheatley of QUB Geology Department for typing this issue.

Ian S. Johnston