GEOLOGISTS' ASSOCIATION

SOUTH WALES GROUP

THE WELSH GEOLOGICAL QUARTERLY

VOL. 1 NO. 3 SPRING 1966

Geologists' Association - South Wales Group

WELSH GEOLOGICAL QUARTERLY

Volume 1. No.3. Spring 1966.

CONTENTS

Cardiff : April, 1966

EDITORIAL

The appearance of the Welsh Geological Quarterly is the result of a feeling on the part of some of the officers and members of the South Wales Group of the Geologists' Association that a cyclostyled periodical would be useful in providing an agent for disseminating news to members of the Group. It was also felt that it might provide a link between the professional geologist, the teacher, the student and the amateur and help to keep everyone up-to-date with developments in geology both inside and outside the principality.

The format of the third number, like that of the first and second, is experimental, and the compilers - D.A. Bassett and J.N.M. Firth - would welcome suggestions and criticisms. Please send them to D.A. Bassett, Department of Geology, National Museum of Wales, Cardiff.

If the members feel that the periodical is worthwhile, then steps can be taken to make it a regular quarterly publication. The cost to members would be no more than two shillings and sixpence per copy. For the first four numbers the cost will be the same for non-members. For subsequent numbers, however, it will have to be increased.

Acknowledgements. The cover was designed and printed by Vivian S. James, Barry; the text prepared and cyclostyled by Mrs. Jean Parsons; and the notes dealing with current research at the various institutions co-ordinated by Professor W.G.V. Balchin, Dr. D.E.T. Bidgood, Dr. R.H. Cummings, Professor C. Kidson, Mr. T.R. Owen and Professor A. Wood.

Employment of Geologists: 1961-1963

The University Grants Committee have, with the assistance of the Universities, collected information for a number of years on the various kinds of employment entered into by university graduates. In recent years the results have been sufficiently comprehensive to warrant publication. The following tables are based on two such publications - First employment of University Graduates 1961-1962, H.M.S.O. 1963, and First employment of University Graduates 1962-1963, H.M.S.O. 1965.

DISTRIBUTION BETWEEN FURTHER EDUCATION, TRAINING AND EMPLOYMENT OF MEN AND WOMEN WHO QUALIFIED FOR FIRST DEGREES IN GEOLOGY IN 1961-62, AND FIRST DEGREES AND HIGHER DEGREES IN GEOLOGY IN 1962-1963.

	1961-1962		1962 - 1963			
	1st Degree		1st Degree		Higher Degree	
	Men	Women	Men	Women	Men	Women
Total graduating	189	13	228	18	101	7
Undertaking further education or training:						
Research or further academic study						
Home	58	4	76	7	4	-
Overseas	10	1	10	1	3	1
Teacher Training	11	1	22	3	1	-
Other Training	1	1	2	-	-	-
Overseas students returned to own countries	3	-	5	-	10	3
Otherwise not available for employment	3	1	6	-	11	-
Balance	103	5	107	7	72	3
Gained employment:						
Home	59	5	61	6	41	3
Overseas	22	-	26	-	25	-
Seeking employment	9	-	13	1	1	-
Unknown	13	-	7	-	5	-

ANALYSIS OF EMPLOYMENT CATEGORIES FOR MEN AND WOMEN WHO QUALIFIED FOR FIRST DEGREES IN GEOLOGY IN 1961-62, AND FIRST DEGREES AND HIGHER DEGREES IN GEOLOGY IN 1962-63.

Employment Category	1961 - 1962		1962 - 1963			
	1st Degree		1st Degree		Higher Degree	
	Men	Women	Men	Women	Men	Women
H.M. Home Civil Service and Foreign Service	4	-	3	1	3	-
Local Government Authorities & Hospital Services	2	-	-	-	1	-
Schools	16	1	7	3	5	-
Universities, Technical Colleges and places of Further Education	7	2	2	1	23	2
Oil, Chemical and Allied Industries	9	-	12	1	1	-
Engineering and Allied Industries	5	1	7	-	1	-
Other Manufacturing Industries	6	-	6	-	-	-
Public Utility and Transport Undertakings, U.K.A.E.A. and N.C.B.	6	1	6	-	2	-
Commerce	4	-	2	-	-	-
Others	15	-	16	-	5	1
TOTAL	74	5	61	6	41	3

Welsh Geological Quarterly, v.1, no.3, pp.3-4.

DEFINITIONS OF GEOLOGY (3)

"The science of the earth is what is implied by the term geology,[1] but no single science is comprehensive enough to embrace the entire study of the earth. We can only hope to deal with such parts of it as are accessible to our observation, or to our study by reasoning. We may define the earth's crust as so much of the outer part of the earth as we can see in quarries, cuttings, mines, or borings, or reason about by means of conclusions drawn from our observations. It is the business of geology to ascertain what this crust is made of, and to employ the conclusions of chemists and mineralogists as to its composition; to observe the arrangement of these constituents and their relation to one another; then to go a step farther and endeavour to ascertain how each part of it was made and how it came to be where it is. If this can be done, a history of those parts of the earth can be written, and it is with this past history we have to deal. Geography tells us about the outlines and relief of the earth's surface at the present day; it is for geology to ascertain whether these have always been the same or different in past times. Botany and zoology tell us about the plants and animals now found on the earth; geology tells us whether they have always existed, or whether the earth has ever supported kinds of animals and plants different from those now living on it. Physics tells us about forces now at work on the earth's surface, of climates, tides, currents, and rivers; geology tells whether there has been any change in these forces in the past. Pursuing these studies we are brought into contact with constituents of the earth's crust which are of value in the arts and manufactures, and it is our business to learn about them, where they are found, and how they were formed, and if possible to point out where similar things may be found elsewhere."

W.W. Watts - Geology for beginners, 1926, pp.1-2.

"For geology is pre-eminently the layman's science. In it more than in any other science there is opportunity for a beginner to make original observations, to weigh up evidence, to co-ordinate his facts and in general to acquire a truly scientific outlook, whereas a layman can do no more in many sciences than accept ready-made conclusions, often explained by clever but dangerous analogies, without any prospect of understanding the steps by which they have been reached."

A.E. Trueman - Geology and scenery in England and Wales, 1949, p.10.

---

[1] Gr. ge = the earth, and logos = science

"Modern geology has for its aim the deciphering of the whole evolution of the earth and its inhabitants from the time of the earliest records that can be recognised in the rocks right down to the present day. So ambitious a programme requires much subdivision of effort, and in practice it is convenient to divide the subject into a number of branches which also indicates the chief relationships between geology and the other major sciences. The key words of the four main branches are the materials of the earth's rocky framework (Mineralogy and Petrology), and their dispositions, i.e. their forms, structures and inter-relationships (Structural Geology); the geological processes or machinery of the earth, by means of which changes of all kinds are brought about (Physical Geology); and finally the succession of these changes in time, or the history of the earth (Historical Geology)."

Arthur Holmes - Principles of Physical Geology, 1965, pp.9-10.

"1. Richard de Bury, Bishop of Durham, in his book Philobiblon, published at Cologne in 1473, used Geology as applicable to the Law (earthly science) as opposed to Theology (heavenly science). Aldrovandus is said to have used it in manuscripts as early as 1605. First used in its present sense by Escholt in 1657 (in Danish) and first published English use was by Lovell in 1661. (After Adams, F.D., p.166, 1938)

2. "In the year 1778 there appeared at the Hague the first imperfect edition of De Luc's Lettres Physiques et Morales sur les Montagnes, in the introduction to which the author states that for the science that treats of the knowledge of the earth he employs the designation of Cosmology. The proper word, he admits, should have been Geology, but he 'could not venture to adopt it because it was not a word in use'" (Preface, p.viii.). In the completed edition of his work, published the next year, he repeats his statement as to the use of the term Cosmology, yet he uses Geology in his text notwithstanding (vol.1, pp.4,5). In the same year (1779) De Saussure employs the term Geology in his first volume without any explanation or apology, and alludes to the geologist as if he were a well-known species of natural philosopher. (See his Discours Preliminare, pp.vii, ix, xiv, xvi.) (De Saussure, H.B., 1779; Geikie, A., The founders of Geology, p.186, footnote, 1901)

3. The science of the earth, which includes, in a large sense, all acquired or possible knowledge of the natural phenomena on and within the globe. Werner made geology comprehend geognosy, geography, hydrography, meteorology, and geogony. (Roberts, George, Etymol. and Explan. Dict. Geol., p.68, 1839)

4. Earth science including physical geology and geophysics; the history of the earth, stratigraphy and paleontology; mineralogy, petrology; and engineering, mining and petroleum geology."

Glossary of Geology and related sciences, A cooperative project of the American Geological Institute - with supplement, 1960, p.121.

CURRENT RESEARCH IN GEOLOGY AND ALLIED SCIENCES IN WELSH COLLEGES, LABORATORIES, ETC.

Members of staff and research workers at the four colleges of the University of Wales and at other institutions in Wales were invited to contribute a brief note on their current research projects in geology and its allied sciences. The replies are arranged alphabetically - by town, by institution and by person, respectively. An author, subject and locality index is provided.

References to recent publications have been omitted because of lack of space. They can, however, be consulted in the first four numbers of British Geological Literature, compiled by E.L. Martin and A.P. Harvey and published by the Coridon Press.

ABERYSTWYTH : UNIVERSITY COLLEGE

Department of Geography

Dr. B. Davies and Dr. G.M. Howe: Water pollution and health.

New laboratory facilities are making investigations possible into the contents of lead and associated elements, including radioisotopes in waters, sediments, soils and herbage, especially in north Cardiganshire.

Dr. G.M. Howe: See Davies, B.

Professor C. Kidson: (i) Sea level fluctuations during the Pleistocene in the Parett and Tawe Torridge estuaries.

An examination of raised beach and submerged forest deposits is well advanced and samples obtained by an extensive programme of augering are being dated by palynological and C^{14} methods. Geophysical exploration of the extent of buried marine abrasion platforms and river channels is under way.

(ii) Dune structure and morphology.

At Braunton Burrows, Devon, an examination of the growth of dunes, their structure and morphology, in terms of wind strengths and directions and of the surrounding topography is almost completed.

Mr. O. Slaymaker: Sediment yield of Mid-Wales catchments.

Research based on the Elan-Claerwen-Wye catchments north and west of Rhayader (Radnorshire). An assessment of the relative importance of the various slope and channel processes and their areal distribution within catchments. A consideration of the rate of morphometric transformation as indicated by areal variations in sediment yield. The study area contains within it three small catchments (c. 1 sq. mile) which are being closely observed in connection with the Vigil Network Programme, a project initiated for the International Hydrological Decade to increase the availability of basic hydrological data in small catchments.

Mr. G. Thomas: The periglacial landforms and structures, and the relation of the periglacial to glacial deposits, in the northern part of the Manx Uplands.

Mr. E. Watson: The periglacial landforms and structures, and the relation of the periglacial to glacial deposits, in the area: Barmouth to Cardigan and inland to the main watershed.

The preferred stone orientation is proving very useful in demonstrating the periglacial origin of many of the deposits in an area where glacial deposits may be entirely of local debris. In the uplands, evidence for three phases in the deposition of these slope deposits is growing but so far material for a radio-carbon or pollen dating has not been found. In the press are papers on involutions and wedge structures; on nivation cirques, and on stratified screes.

Mr. R.A. Yates: Coastal studies at Borth, Cardiganshire.

An extensive reconnaissance has been carried out of recent movements of beach material with a view to finding if more detailed work would be profitable. This would entail the setting up of an accurate and detailed framework of surveyed points covering Borth Bog and the Dovey Estuary in furtherance of the reconnaissance work, and also to facilitate vegetation and other types of mapping. The projects are essentially long term and it is envisaged that the work will be in the nature of a team project.

Department of Geology

Dr. D.E.B. Bates: The Lower Palaeozoic rocks of Anglesey.

The brachiopod faunas, particularly those of the early Ordovician, are of considerable interest, and include a number of hitherto undescribed forms. The stratigraphy also differs from that previously described, in that the succession is not as complete as was believed, and locally derived slide breccias occur in the Arenigian, Llanvirnian and Caradocian. The Caledonian structures reveal a polyphase deformation comparable with neighbouring areas.

Work has begun on the Lower Ordovician stratigraphy of the Aran mountains, from which a new crinoid has been described. Early Ordovician shelly faunas from other parts of Wales are also being investigated.

Dr. A.V. Bromley: (i) The geology of the area between Ffestiniog and Arenig.

Many of the flow banded and fragmented rocks of the Moelwyn Volcanic Series can be shown to be of intrusive origin (quartz latites and autobreccias) although previously they were thought to be extrusive lavas, ashes and agglomerates. Thus, previous estimates of the thickness and the extent of the volcanic rocks need considerable reduction. New faunal evidence suggest that most of the Moelwyn Volcanic Series is of Lower Caradocian age.

(ii) A petrographic and geochemical study of the Tany-Grisiau microgranite and its metamorphic aureole.

The microgranite is made up of two principal rock types, one the direct result of magmatic crystallization and the second, forming the roof of the intrusion, produced autometasomatically by the operation of an extrusive volatile phase when crystallization was very far advanced. The hornfelses in the aureole of the microgranite are polymetamorphic and show evidence of an early hornblende hornfels facies metamorphism, equated with the initial intrusion, overprinted by a retrogressive albite-epidote facies metamorphism related to post-magmatic metasomatism. The hornfelses are further complicated by extreme retrogression imposed during the main Caledonian orogeny. This work is now being extended to an examination of a number of other granitic rocks in Snowdonia.

(iii) Geochemistry.

Work is in progress (with Mr. R. Furze) to scale down certain standard spectrophotometric methods of analysis for trace elements so that they may be readily applied to small quantities of separated minerals. So far some success has been achieved for chromium (as chromate); vanadium (phosphotungstovanadate), tungsten and molybdenum (toluene - 3 - 4 dithiol) and cobalt (3 - methoxy - 2 - nitrosophenol).

Mr. P.J. Cattermole: See Jones, A.S.G.

Mr. H.J.E. Convery: The stratigraphy, structure and metamorphism of the Upper Dalradian rocks of the Ben Ledi area, S.W. Perthshire.

The development and origin of planar and linear structures, and the chronological relationship of deformation and metamorphism of the Dalradian rocks of the S.W. Highlands. The significance of plagioclase development and composition in regional metamorphism.

Dr. M.R. Dobson and Professor A. Wood: The Cardigan Bay - Irish Sea Research Project.

The project was established in 1962 with the aid of a grant from D.S.I.R. to investigate the origin and configuration of the sediments on the sea floor, the fauna, waters, geological structure and tectonics of this typical shelf sea.

An extensive off-shore collecting programme conducted from 1962-64 has covered the inshore bottom of Cardigan Bay from St. Tudwal's Island to New Quay. This extends over 3 Ph.D. areas. In each, the texture, chemistry and mineralogy has been examined in detail. A detailed examination of the microfauna has been carried out supplemented by salinity and temperature measurements. Thirty square miles of the sampled area has been subjected to heavy mineral analysis to give a clearer picture of sediment provenance. In June 1965, an oblique Asdic was added to the growing list of equipment, this enables one to map the sea bed by radar waves and because of the tight sediment

control, calibration of the equipment was completed during the autumn. In consequence, it is hoped that during the coming season sediment-texture maps will be completed for the rest of Cardigan Bay. Co-operation with Birmingham University on geophysics this season will indicate the thickness and vertical distribution of the sediment types and at the same time will offer an opportunity to study the solid geology, which will be verified by gravity coring.

The geochemistry of the clays and authigenic minerals coupled with chemistry of the sea water will be studied in 1966.

Complementing the work in the bay is detailed examination of the cliffs with respect to recent erosional history and a study of the texture and mineralogy of the associated boulder clays: it is hoped that part of this work will be extended to Ireland during 1966.

Mr. R. Furze: See Bromley, A.V.

Dr. J.R. Haynes: Studies in Recent, Tertiary and Carboniferous Foraminifera.

The distribution of foraminifera in the sediments of Cardigan Bay and St. George's Channel and their ecologic relationships; the relation of foraminifera to the marsh sequence in the Dovey Estuary; and supervision of graduate research work on foraminifera in Tremadoc Bay and in the 'Trawling Grounds' off Aberystwyth.

Work on the Tertiary faunas of Libya, Cyprus, Nigeria and Peru as well as on faunas in the Carboniferous shales of Anglesey.

Mr. A.S.G. Jones: The study of an area of Cardigan Bay from Sarn Wallog to New Quay (extending about 10 to 12 miles out to sea).

A total of about 130 samples have been collected from the Bay, beaches and the rivers draining into the area. The bathymetry is now known in detail and sand waves have been found in the southern part of the area.

The textural and mineralogical analysis of all the samples has been completed and this data is now being processed. It is hoped that X-ray diffraction analysis of the clay minerals and chemical analysis of a few selected elements will be completed in the coming year.

Working in conjunction with the Marine Research Station, Menai Bridge, parachute droges have been dropped at selected stations around the area. These droges have been dropped in an attempt to gain some preliminary information on water movements.

The stratigraphical and structural mapping of an area of Lower Palaeozoic rocks between Nantlle and Snowdon (with Mr. P.J. Cattermole) is nearing completion.

Dr. Nancy H. Kirk: The geology of the area between Llandrindod, Rhayader, Bleddfa, Llanbadarn Fynydd, etc.

Mapping the "Anticlinal Area" between Pont Faen and Presteigne revealed some interesting features in the nature of the attenuated Llandovery, of the Llandovery-Wenlock boundary and of the Wenlock-

Ludlow boundary. In order to try to understand these features the mapping has been extended round the Builth Ordovician inlier and into the area mentioned in the title.

Within the latter area the Ordovician-Silurian boundary is usually faulted but traces of Lower and Middle as well as Upper Llandovery have been found. The Llandovery-Wenlock boundary, a conglomerate overlain by Limestone at Dolyhir, has become a worm-bored disconformity overlain by shelly mudstone north east of Builth and a passage within mudstone to the north west. The Wenlock shows considerable lateral variation, the mudstones of the Builth district having intercalations of grit (Denbigh Grits) and some pebble layers from the line of the Llandrindod fault belt northwards. The Wenlock-Ludlow boundary, drawn at the sharp contact between the "Olive Mudstones" and the M. nilssoni shales in the Dolyhir area, has a similar character around the Builth inlier where the "Olive Mudstones" with M. vulgaris and G. nassa would seem to be a facies of the C. lundgreni shales. Locally, at Penybont, the "Olive Mudstone" facies seems not to be developed and shales with C. lundgreni pass up into shales with M. nilssoni.

Structurally the northern area now under investigation shows the same interplay of NE-SW and N-S trending folds of faults as was seen in the Pont Faen - Presteigne area, and it is hoped that, in spite of the poverty of exposure, enough evidence will be forthcoming to form the basis for an understanding of the tectonics of the whole area.

Mr. A.J. McKenzie: The igneous intrusions of the area: Clynnog-fawr to Llanbedrog to Criccieth.

The main intrusions are situated in, and are the reason for, the line of hills running from Bwlch Mawr, through Yr Eifl, to Nefyn. The detailed petrology and geochemistry is being studied in order to work out the petrogenesis of these obviously related intrusions. The country rock - Ordovician sediments and lavas - is also being studied. This normally forms the lower ground. Mapping has been started at the northern end of the area and has included the hills of Bwlch Mawr, Gurn Ddu and Gurn Goch. It is interesting to note that the names of the last two reflect the colour of the different rock types found: a black granodioritic rock and a red granite respectively.

Work is also continuing on a Caledonian granite from N.E. Scotland. This involves a study mainly of the feldspars.

Mr. K.J. O'Reilly: The geology of an area around Tongue, North Sutherland.

The area consists of a metamorphic complex of Moinian and Lewisian rocks, overlain by small outliers of Old Red Sandstone and intruded at its southern end by the Ben Loyal Syenite.

The metamorphic rocks show evidence of five distinct phases of folding, the style and orientation of which has been investigated by detailed structural mapping. The main Caledonian metamorphism of

amphibolite facies, accompanied the second folds and was followed locally by slight retrogressive metamorphism. Within the Lewisian, small masses of basic gneiss preserve original Scourian granulite facies minerals and textures. The separation of these metamorphic events on petrological and structural grounds has been confirmed by radiometric dating carried out by Dr. J.A. Miller at Cambridge.

The Ben Loyal Syenite has been found to display greater variation in rock type than has hitherto been recognised. In particular, much of the mass east of Loch Loyal consists of red granite. This material has been correlated with the granite boulders occurring in the local Old Red conglomerates, the provenance of which has puzzled previous investigators.

Dr. W.J. Phillips: (i) Deformation of quartz.

Work is being continued and distortions of the crystal structures are being studied by X-ray diffraction techniques.

(ii) The Dalbeattie granodiorite complex.

A detailed geochemical and mineralogical study of the granodiorite and associated rocks has been started, and will provide a number of interesting related topics for several research students.

(iii) Textural and mineralogical studies of alkali basic intrusions in N.Wales and the Midland Valley of Scotland.

Work has been completed and provides valuable new information on the course of crystallization of these rocks.

Mr. G.M. Power: Geochemical studies on igneous rocks and associated sediments from North Wales.

Mr. R.C. Whatley: The Ostracoda of the British Callovian and Oxfordian.

Work is being continued with special reference to palaeoecology, phylogeny and ontogenetic studies. The taxonomic part of this work is completed and is being prepared for publication.

A detailed study of the ecology and distribution of the Recent Ostracoda of the Dovey Estuary has recently been undertaken. It is hoped to compare the distribution of these forms with those occurring in Quaternary deposits in the area.

Professor A. Wood:

In addition to the joint work on Cardigan Bay and the southern part of the Irish Sea described above, research is being continued on the Palaeozoic Calcareous Algae. Also a comprehensive survey of the coastline of Wales is in progress, with particular reference to old shore lines and the evolution of cliff form.

ABERYSTWYTH

Mr. J. Challinor: (i) The preparation of geological dictionaries.

(ii) Bibliographical investigation into the history of British geology particularly during the earlier half of the nineteenth century.

(iii) The philosophical aspects of geology, particularly structural geology, geomorphology, and palaeontology.

BANGOR : THE NATURE CONSERVANCY

Mr. D.F. Ball: (i) A review of the glacial geology of the area: Vale of Clwyd to Lleyn (with J. Whittow, University, Reading).

(ii) Clay mineralogy of the soils, drifts and rocks of Snowdonia - particular attention to chlorite clays of pumice tuffs and illites associated with shale and rhyolite.

(iii) Notes on N.Wales minerals, including actinolite asbestos, and a study of "weathered" granite in Snowdonia containing gibbsite (with D.A. Jenkins).

(iv) "Six-inch" soil surveys in connection with Nature Conservancy research areas in Snowdonia: particularly of Snowdon and Conway Valley.

(v) X-ray fluorescence spectrography, etc.

BANGOR : UNIVERSITY COLLEGE

Department of Botany

Dr. W.S. Lacey: (i) Permo-Carboniferous, Triassic, Cretaceous and Tertiary floras from Central and Southern Africa.

Joint work (with P.Williams, Beckenham, Kent) on petrified woods from Rhodesia and South-west Africa, and on cuticle-yielding compressions from the Transvaal is nearing completion.

(ii) Upper and Lower Carboniferous floras from North Wales.

Studies of (a) Lower Carboniferous and Namurian palynology of North Wales (with F.A. Hibbert, Botany School, Cambridge), nearing completion; (b) cuticle-yielding seeds from the Lower Carboniferous of the Menai Straits (with J.M. Pettitt, British Museum (Natural History));

(c) Lower Carboniferous Megaspores (with E.G. Spinner, Geology Department, University, Sheffield), projected; and (d) macroflora of the Lower Brown Limestone.

(iii) Devonian plants in the Rhynie Chert of Aberdeenshire, Scotland.

Studies of (a) the morphology of newly-discovered plants in the Rhynie Chert; (b) a stratigraphy of the plant-bearing beds (with W.E. El-Seadawy and A.G. Lyon, University College, Cardiff).

Marine Science Laboratories

Dr. D. Taylor Smith: Geological/Geophysical research.

Until the arrival of the Laboratories research vessel, expected in October 1966, most of the research work is of a fundamental nature, involving experimental and theoretical studies of the physical and mechanical properties of natural materials. Most of the materials so far examined have been marine sediments of Recent age, although work has just begun on London Clay.

The investigation consists of three separate parts: (a) a measurement of acoustic attenuation and velocity in situ accompanied by a few basic mechanical tests. These measurements are made with an in situ acoustic probe newly developed at the laboratories; (b) the collection of 3in. core samples from the site for a whole range of laboratory tests, both acoustic and mechanical; (c) an examination of the bulk properties of the medium by the use of an acoustic profiler recording the information on magnetic tape and subsequently subjecting this to frequency analysis. It is found that all materials act as acoustic filters, the frequency dependence of which vary from sediment to sediment.

Department of Soil Science and Biochemistry

Dr. F. Smithson, Dr. D.A. Jenkins and Dr. N.T. Livesey: The mineralogy

(i) The mineralogy of rocks, superficial deposits, and soils in North Wales.

Such studies are based mainly on the heavy minerals of the fine sand fraction, and are aimed at establishing the nature, origin and distribution of the different soil parent materials: of particular interest at present are the Ordovician rocks of Northern Snowdonia, the Silurian, Carboniferous and Triassic rocks of Denbighshire, and the "Red Northern (Irish Sea) Drift".

(ii) The geochemistry of rock weathering.

The investigations are concerned with the stability of mineral species and redistribution of major and trace elements in different weathering environments, using spectrographic and microprobe analytical techniques.

CARDIFF : NATIONAL MUSEUM OF WALES

Department of Geology

Dr. D.A. Bassett: The Upper Ordovician rocks of the Derwen anticline.

The Caradoc and Ashgill rocks of the area between Bala, Llangwm, Cerrig-y-druidion and Yspytty Ifan are being mapped in conjunction with Professor A. Williams (Queen's University, Belfast) and Professor H.B. Whittington (Harvard).

Mr. D.E. Evans: Denudation chronology of the Avon Lwyd and Clydach valleys including the Agen Allwedd cave system.

The work consists mainly of field studies involving morphological mapping with some solid and drift geological mapping, together with levelling and aneroid barometer surveying.

CARDIFF : SOIL SURVEY OF ENGLAND & WALES

Dr. C.B. Crampton: (i) The glacial geology of Glamorgan and Monmouthshire.

During the penultimate glaciation in the W. Vale of Glamorgan, local bouldery drifts were deposited in depressions occupying the Lower Lias outcrop. During the following interglacial period, locally there evolved soils of the kind today associated with a Mediterranean climate. In Monmouth during the more intense glaciation associated with the penultimate times, a powerful glacier carried debris from the widely separated areas of the Brecon Beacons and Radnor Forest and down the Usk valley, onto the Monmouthshire Plain. There is evidence that during the ultimate glaciation conditions were much less severe, and ice in the Usk valley debouching onto the Monmouthshire Plain was derived only locally, from the Coal Measures through the Clydach Gap. This has had a pronounced effect upon the distribution of soils.

(ii) Terraces in S. Wales valleys.

Within the approximate altitudinal range 1500 to 500ft., terraces are mostly periglacial in origin, and from 500 to 0ft. are mostly alluvial in origin. There is an intermediate zone, however, in which terraces of either origin may be present. It is useful to discover distinguishing features associated with each type of terrace: alluvial terraces commonly have a hard, stony subsoil rarely thicker than 6 inches; a compact zone which has developed because of variations in river volume and rate of flow during post-Glacial times; periglacial terraces have been compacted by pressure from water freezing through a considerable depth of the deposit during late-Glacial times.

(iii) Coastal sands in South Wales.

During post-Glacial times much material has been blown inland by wind, to become incorporated in the soils. Higgins (1933) describes the 13th to 14th centuries as the latest period of maximum storm activity and accompanying aeolian transportation along the S. coast of Wales. There is evidence that most of the aeolian material in soils in the Vale of Glamorgan was incorporated during the latest phase of storm activity.

CARDIFF : UNIVERSITY COLLEGE

Department of Botany

Dr. A.G. Lyon: A re-investigation of the Aberdeenshire Rhynie Chert (Middle or (?)Lower Old Red Sandstone).

Since its discovery by Mackie in 1912, this unique and very localised deposit has become famous for the beautifully preserved (silicified) early land plants which it contains. Algae and fungi are also known to occur as well as several kinds of small arthropods.

As there are no natural outcrops, exposures have to be made by excavation. During the last few years this has been done by means of a trench digging machine and with the aid of a grant from the Royal Society.

The original investigation of the flora of the chert by Kidston & Lang (1917-21) resulted in the recognition of three genera of vascular plants - Rhynia (2 species), Horneophyton and Asteroxylon (1 species each). Recent work has yielded new information regarding the fertile region of Asteroxylon and has established the presence of two other generically distinct types. For one of these the name Nothia aphylla has been proposed. Germinated spores have also been found and the fragmentary remains of an organism referable to the Nematophytales (Nematoplexus rhyniensis) have been described.

Department of Geology

Professor J.G.C. Anderson: (i) The glacial geology of South Wales.

A great deal of new information concerning the buried valley system and glacial and post glacial drifts has been gained by using a boring rig operated by the Department. This work is in conjunction with Dr. Blundell.

(ii) Research on the Caledonian Chain and its margins in Ireland and in Arctic Norway; and on the nature and continuity of the Highland Boundary Fault in Ireland.

(iii) The geology of Blainau Ffestiniog Hydro-Electric Scheme.

Following consulting work on the Scheme, an account is being prepared of the geology around the pumped-storage works.

Dr. R.M. Appleby: (i) The shoulder girdle of ichthyosaur Opthalmosaurus monocharactus.

The approach has been both morphological and functional and the holotype was so well preserved that most of the musculature could be inferred from the osteology. This led to an account of the way in which the species moved its fore limbs and altered course horizontally and vertically. A number of shoulder girdle bones,

showing fractures which had healed during life were examined and it was found that the fractures occurred in the parts of the girdle where stresses would be at a maximum when certain functions were being performed, e.g. in stopping suddenly. When taken with the great size and speed of the ophthalmosaurs, it seems possible that a funtional limit was reached which may have contributed to their extinction. Parallel trends are seen in the other major groups of ichthyosaurs which may have suffered the same fate.

(ii) The Moore Collection of ichthyosaurs.

The collection - now on loan to the National Museum of Wales - has remained unexamined since the second half of the last century. Representatives of many Liassic species are present and attention is being concentrated on the Longipinnati. New functional information has been collected. A detailed study of a large skull of Leptopterygius will also be published.

Dr. J.W. Baker: The geology of South-east Co. Wexford, Eire.

It has been shown that the Rosslare Series originated as a group of sediments with associated gabbroic intrusions. During polyphase metamorphism these became porphyroblastic gneisses and amphibolites, but were later recrystallised as mylonite-gneisses, blastomylonites, etc. Minor basic intrusions are not involved in the earlier metamorphic episodes and may in fact separate distinct orogenic periods (as in the Lewisian). These rocks are pre-Ordovician since: (a) mylonite micropebbles occur in the unmetamorphosed Ordovician sediments (with Arenig graptolites); (b) the Lower Palaeozoic Carnsore Granite contains xenoliths of gneisses and basic dykes; and, (c) unmetamorphosed dykes (probably Ordovician) intrude the mylonites near Rosslare.

Consideration of the Lower Palaeozoic history within the Irish Sea area suggests that the Rosslare Series and its metamorphism is not Pre-Cambrian (as previously supposed). It is hoped that further work by the writer and others will establish the relationship between the Rosslare Series, the Bray Series (Leinster) and the Mona Series (North Wales).

The Carnsore Granite shows some similarities to the Coedana Granite (Anglesey). Its petrological characteristics accord with geophysical data in suggesting that it has an extensive off-shore outcrop.

Dr. C.R.K. Blundell: The stratigraphy and structure of the eastern portion of South Wales.

In addition to the evidence available from studying exposures at the surface, attempts are being made, by drilling and by using geophysical methods, to ascertain the main features of the subsurface geology. Especially important in this direction are: (a) the buried geomorphology masked by the superficial deposits, and (b) the nature and structure of the sub-Devonian basement rocks.

Dr. D.E.T. Bidgood: Arctic geophysical work.

Work on the palaeomagnetism of the sedimentary rocks of Central East Greenland continues (with Mr. W.B. Harland, Sedgwick Museum, Cambridge and Mr. H.R. Spaull, Dallas, Texas). Current research is concentrated on examining magnetization stability in A.C. demagnetizing fields.

Field geophysical surveys commenced by the Cambridge Spitsbergen Expedition of 1964, are to be continued this summer. It is hoped to extend the inshore magnetic surveys to the west coast. The proton magnetometer, depth sounder and radio equipment is carried on a diesel-engined cabin cruiser which has been specially developed.

Mr. J.A.D. Dickson: The Carboniferous rocks of the Castletown area, Isle of Man.

The area has been re-mapped: the coastal sections on a scale of twenty-five inches to the mile. The lowest horizon, the Basement Conglomerate, has received little attention in comparison with the overlying limestones with subsidiary shales. Sedimentary structures, both primary and secondary, within the limestones and shales, have been studied in an effort to reconstruct environmental conditions of sedimentation. The detailed petrology of the limestone has been studied and in this matter, the use of a staining technique has been found to be profitable. The wide range of lithology present in the Manx rocks has yielded a great variety of sedimentary structures and petrological types. A special study is being made of the diagenetic changes the limestones have been subjected to. The Volcanic Series, the youngest Carboniferous rocks of the area, are structurally very complicated. Only a brief study of their rather monotonous petrography has been attempted, but an attempt to solve their petrogenesis and their complex structure has been made.

Mr. R.A. Gayer: (i) The stratigraphy and structure of the Pre-Cambrian rocks of Ny Friesland, Spitsbergen.

The work, now nearing completion, entailed making a topographical map (scale 1:20,000) before plotting the geological data. The main aspects of the research have been: (a) the petrology of the metamorphosed sediments and included volcanics, leading to an understanding of the sedimentation in this part of the Caledonian Geosyncline; (b) the petrology of two sets of meta-dolerite intrusions; (c) the analysis of the structures leading to the formulation of a sequence of tectonic regimes in the Ny Friesland phase of the Caledonian Orogeny.

(ii) The structure and the genesis of the Llanharry ore-body.

The structures in the Glamorgan Haematite Company Iron Ore mine at Llanharry are being mapped and a model, representing them, is being built. In conjunction with Dr. J.I. Langford (Physics Department, Cardiff), it is hoped to put forward new data bearing on the genesis of the ore body.

It is proposed to start research this summer on some aspects of

Caledonian stratigraphy, structure and metamorphism of the Porsangerfjord area of North Norway with a view to comparing this region with other areas of the Caledonian geosyncline, in particular Spitsbergen.

Mr. G.G. Lemon: The Pre-Cambrian of the Central and North-east Ox Mountain inlier, Eire.

The rocks are Moinian and are mainly high grade quartzo-felspathic granulites and subordinate schists, all characterised by the presence of kyanite. The granulites include a series of meta-basic igneous rocks - garnet pyroxenites rather like eclogites in appearance. Both these and the associated granulites are intensely deformed into many small, irregular folds of the so-called wild migmatite type. The apparent irregularity and complexity may be resolved into order by current studies on very small areas of ground - i.e. areas ten yards square with folds of the order of a few inches to one foot across.

The garnets in the schistose horizons contain inclusions which make patterns suggestive of growth during movement - the inclusions make spirals and 'S' shapes.

Small serpentinites also occur in the area. Some may be part of the Highland Boundary Fault association. The whole area of granulites is injected by pegmatites of possibly two distinct ages.

Mr. D.P. Price: Geology of the Porsangerfjord area, Finnmark, Norway.

The rocks being studied are psammites and pelites of fairly low metamorphic grade. They have been thrust during the Caledonian Orogeny onto unmetamorphosed, but strongly folded, sedimentary rocks of late Pre-Cambrian age (which are being studied by Mr. B. White - see below). The area is in many ways comparable to the Moine Thrust area of Scotland. It is hoped that the research will throw some light on the structural and metamorphic history of the area.

Mr. H.J. Webber: The structure of the Cardiff-Cowbridge anticline and its effects upon Mesozoic sedimentation.

Parts of the anticline have been studied in some detail by previous workers, but mainly from the stratigraphic angle. The present work sets out to determine the nature of the anticline as a whole; for example, is it basically a simple anticline, or a complex one, as suggested by the nature of the small Avonian inliers around Barry, etc.? When did movement occur? Was it entirely post-Carboniferous or did movement commence well before the main Hercynian orogeny, in which case, did sediments derived from this area contribute to a greater or lesser degree to the Upper Carboniferous coal basin to the north? It is also of interest to determine the eastward extension of the anticlinal axis; it seems probable that it follows a line of weakness in the basement to link up with the Usk anticline to the north-east, but

it remains to be determined whether movements of the two anticlines were closely connected in time and also in magnitude.

Mr. P.J. Whitcombe: Stratigraphy and palaeontology of the Upper Devonian and Lower Carboniferous boundary in South Wales.

It is hoped to show evidence which enables comparison to be made with the Devonian-Carboniferous sequence in northern France and southern Belgium, and hence to correlate the boundary in South Wales with that recognized in Europe. However, it is hoped that the study may produce evidence in South Wales which points to the location of the boundary at any position even if this cannot be co-ordinated with that adopted on the continent of Europe.

Mr. B. White: The geology of an area west of Porsangerfjord, northern Norway.

Investigations have been concentrated on a group of sedimentary rocks of Late Proterozoic to early Cambrian age. Sediments include conglomerates, tillite, sandstones, shales and stromatolitic dolomites; most having been formed in shallow stable shelf seas sometimes within the intertidal zone. As well as the algal stromatolites other trace fossils have been found, including horizontal worm burrows and trails.

The sediments were deposited in basins at the margin of the Caledonian geosyncline and were later involved in the Caledonian Orogeny. During these earth movements the rocks were folded asymmetrically along northerly strike axes and in some cases they are overturned towards the east. Numerous thrusts occur within the succession and the whole mass of sediments has been thrust towards the south-east and east. The sediments now lie between the craton and an exotic nappe of fairly low grade metamorphic rocks (being studied by Mr. D.P. Price - see above).

Department of Microbiology

Mrs. Ann M. Williams: The role of microorganisms in geology and biology.

Several aspects of this are under investigation:- (a) the decomposition of calcium carbonate deposits, by biological action; (b) the deposition of calcium carbonate in various crystalline forms by the combined actions of bacteria and algae; (c) the deposition of iron and manganese (experiments carried out to date show that at least three biological mechanisms for iron deposition in streams and in bog land are possible under laboratory conditions and in nature); (d) the biogenic origin of oil (no microbiological proof of such an origin has been obtained to date. Recently, however, bacteria have been isolated from a shale band in the Carboniferous Limestone at Ogof Ffynnon Ddu cave. These when grown in laboratory culture produce a halo of oil-like material around their colonies).

Department of Mining Engineering

Dr. J. Platt, Mr. F.D. Pooley and Mr. W.J. Henderson: Examination of mineral surfaces by replication electron microscopy.

Conventional thin sections of minerals are far too thick for beam penetration in an electron microscope. Thicknesses in excess of about 0.1 micron will only result in particle silhouettes which are of little use for interpretation. The difficulties of preparing reliable ultra-thin sections of friable materials for electron microscopy are well-known, as the technique demands special embedding and microtomes to avoid introduction of confusing artefacts.

Single and multi-stage replication methods have been used at the Department for several years to examine surface details of a variety of minerals and other materials. Clean surfaces of individual pieces of mineral have been examined where these exceed about 1 cm; alternatively, samples have been crushed to below 100 mesh to present a variety of freshly-cleaved surfaces.

Coating of particles with a water-soluble plastic, such as polyvinyl alcohol, has been found to be a convenient method of replication. When hard, this film can be stripped with cellulose tape and coated with carbon and platinum shadow-casting by vacuum evaporation in the normal manner. The compound replica can then be removed by dissolving the plastic substrate in successive water baths followed by mounting on copper grids. The process takes some two to three hours, depending on drying and evaporation times, although several replicas can usually be prepared simultaneously.

Using such methods the surfaces of coals of different ranks, carbonaceous shales and underclays, pyrites, galena, mica, asbestos and several other minerals have been observed and recorded. Direct magnifications up to about 10,000 times have been found suitable for general surface features; high magnification studies in the region of 100,000 times have been necessary for examining coal micellular structure. The limit of resolution with the replication method described appears to be about 50 A^{o}.

The work is being conducted with A.E.I., E.M.3A and E.M.6 instruments.

Department of Physics

Dr. J.I. Langford and Mr. B.W. Delf: Research with application in mineralogy.

Research in the Department is mainly concerned with the study of crystalline materials. Various new experimental techniques have been developed and many of these are directly applicable to mineralogy. Methods have been devised for measuring the dimensions of the unit cell of a crystal structure to an accuracy of $\pm$ 0.002%, for studying imperfect structures, and for determining the particle size in a cryptocrystalline specimen. The correlation between the composition of isomorphous minerals and small changes in the unit-cell dimensions is also being investigated.

Minerals can be identified by means of x-ray diffraction data. The x-ray 'fingerprints' for the majority of known crystalline substances are contained in the Powder Diffraction File, and the Department is concerned in obtaining data for substances that are not included in the file, and also in keeping it up to data. Considerable use is made of the file for identifying mineral specimens for other departments in the College and for the National Museum of Wales.

Work is also in progress, in collaboration with the Pathology Department of the Welsh National School of Medicine, on the identification of minerals found by ingestion or as a result of natural processes in human tissues.

Mineral structures may be determined by means of x-ray diffraction from single crystals and by optical diffractometry. The former method has been used in the Department for many years, and Professor C.A. Taylor, the newly-appointed Professor, will be continuing his work on optical methods.

LLANDDULAS : ROBERTSON RESEARCH COMPANY LIMITED

Programme of research 1965/66.

This summary covers both the pure research programmes and the applied research programmes which are being conducted at the present time but excludes details of certain secret research which is being carried on, both for Government agencies and various industrial organisations.

The Director, Dr. R.H. Cummings, maintains overall control of the activities of the laboratories and continues his personal studies in Upper Palaeozoic micropalaeontology and Lower Carboniferous stratigraphy. During the past year he has published various papers on Malayan limestones, Scottish Lower Carboniferous, Bryozoa and the economic usage of certain Welsh limestones.

The Assistant Director, Dr. W.W.M. Brown, specialises in limestone petrography and studies of diagenesis, this work being largely conditioned by the needs of petroleum exploration. He has carried out an extensive review of the relationship between tectonics and limestone diagenesis throughout Eire and it is planned to publish this work in the near future.

Geological Division.

The Head of this Division, Mr. N.B. Brown, continues his personal research into the geology of Jordan and the instrumentation of equipment for hydro-geological surveys.

Petroleum Exploration Section.

Various geologists, including Messrs. G.C. Aylward, J.B. Thomas, L.K. Forsey, R.J. Greenwood, have been engaged in petroleum exploration work in the North Sea and others, including Mr. N.H. Dewhirst and Mr. R.L. Brian have been engaged in similar work in Northern Ireland. In addition, Mr. Aylward has continued his investigations of the dolomitisation of the Cambrian limestones of North West Scotland and Mr. J.B. Thomas is preparing a summary of the economic usage of slate waste in various industries.

Other geologists of this Section have been engaged in petroleum exploration work in Turkey and in the Persian Gulf areas, and several

members of staff have been on extended training courses with Exploration Logging Inc. of Sacramento, California.

Micropalaeontology Section.

This unit has been engaged on a wide variety of work for the petroleum exploration industry extending from Britain and the North Sea, through Europe, into the Persian Gulf, Red Sea and Ethiopian areas. It has also actively participated in the hydro-geological surveys in Jordan and in the location and delineation of high grade limestones in the British Carboniferous.

Mr. R.W.L. Oldroyd continues his personal research on the Lower Carboniferous stratigraphy of Fife and will soon submit his Doctoral Thesis to the University of Glasgow. Dr. C.W. Haskins specialises in work on the English Tertiary ostracods and has also carried out a special investigation of the stratigraphy of the Permian of the North Sea area. At the present time a great deal of his work is concentrated on the zonation of the Miocene from the Red Sea Graben and its correlation to similar horizons in the Gulf of Persia. Mr. J.W. Church is working on Albian foraminifera from the Gault Clay as well as Cretaceous planktonic foraminifera, though his main interest is in palynology, particularly that of the British Coal Measures.

Overseas Survey Section.

During the past year the work of the overseas exploration teams has largely been confined to Turkey and the Middle East where they have been carrying out detailed investigations of evaporite minerals and various mercury, lead and scheelite occurrences. Compilation reports on the world distribution of lithium deposits have been prepared and similar reports covering tellurium are now being summarised. Mr. K.D. Jones continues his research on the mineralogy and distribution of borate and Dr. E.B. Wolfenden has published the results of his studies of the bauxite and laterite deposits in Sarawak and Malaysia.

Home Survey Section.

The work of this unit has covered a wide variety of topics ranging from the development of small quarries to regional surveys for particular rock types and minerals. It has covered almost the complete stratigraphical column and its activities have ranged from Cornwall to the North West Highlands and into the Hebrides. A great deal of its work has been concerned with the geological assessment and geotechnical exploitation of such Scottish rocks as the anorthosite of Harris, the Cambrian marbles of Skye and Assynt, the Fucoid Beds, and the nepheline syenites of the Loch Borolan region. Special studies have been made of the economic usage of the Carboniferous limestones over the North Wales Coast and detailed surveys have been made of various metalliferous deposits including Welsh lead and zinc, copper at Avoca and tin in Cornwall.

Mr. J.R. Coffey is finalising his Doctoral Thesis for submission to the University of Sheffield on the Namurian sequence of part of the Southern Pennines and Dr. C.W. Claxton is preparing a review of Pre-Cambrian rocks from Ireland for publication. Similarly, Mr.

J.E. Crabtree is finalising a Doctoral Thesis for submission to University College, London, which deals with exploration work in Chile.

Rock Technology Section.

A great deal of petrographical and mineralogical studies have been carried out by this section as part of their programme of research on the application of diamond tools in the mineral and stone industries. Mr. L. Lombos has had various papers published which deal with his type of geo-technical work and great advances have been made by this section during the past twelve months.

Geochemical and Minerals Processing Division.

Chemistry Section.

Though the great part of the geological work of this section is devoted to routine assay and analytical work, various other research items have been developed. Special methods have been produced for the analysis of carbonate rocks and Dr. J. Clements has established new techniques for the chemical separation of rarer metals. Some of this work, concerning tungsten and bismuth, has already been published and it is hoped that more will be released in the near future. Mr. M. Haynes is developing a research project which deals with the geochemical exploration for metals in the mineralised areas of North Wales, and Mr. P. Croft continues his work on the spectrographic analysis of tungsten - antimony - mercury ores.

Minerals Processing Section.

The Minerals Processing Unit, under Dr. A.J. Wright, have a very full programme dealing with the beneficiation of British pegmatites, felspars, and borate minerals. They are developing, in association with various industrial organisations, new electronic sorting methods for upgrading limestones, marbles and various types of roadstones.

Engineering Division.

This Division is concerned primarily with foundation engineering, soil mechanics, concrete technology, etc. Nevertheless, a proportion of work is undertaken in association with the Geological and Geochemical Divisions and covers such topics as motorway construction, top surface dressings for roads, the petrographic analyses of the polished stone values for road aggregates, etc. The Head of the Division, Mr. G.W. Tate, continues his personal research into the thermal strains of concrete and Mr. P. Roberts is engaged in a study of the use of boulder clay and limestone waste for the production of synthetic materials for road building.

SWANSEA : UNIVERSITY COLLEGE

Department of Geography

Mr. E.M. Bridges: (i) Land classification (using the information contained in Soil Survey maps and memoirs).

The inadequacies of the more straight-forward land utilisation survey have become more apparent as increasing demands are made upon it for planning purposes. Consequently, the regrouping of soil mapping units is being considered. A system similar to the American Capability Classes appears to offer a more fundamental approach, and has the additional advantage of conveying the importance of pedological work to other disciplines without detailed consideration of every soil mapping unit occuring within an area.

(ii) The impact of opencast mining operations on the landscape, on soil formation, agriculture and amenity.

The effects of opencast mining operations in the East Midlands are probably more widespread even than those in South Wales, for in addition to coal extraction in Derbyshire and Nottinghamshire, the mining of ironstone from the Jurassic rocks of Lincolnshire and Northamptonshire has disturbed many hundreds of acres.

(iii) The soils of the Swansea area.

The soils of the Lower Swansea Valley have been surveyed, and a report submitted to the Director of the Lower Swansea Valley Project. Studies of soil erosion in the area are planned. Field and laboratory studies of soil development on the Gower have commenced.

Miss E.A. Grinter: The geomorphology of the sand dunes of South Wales, with special reference to Gower.

The work is being dealt with under four headings:- (a) mapping the dune morphology of South Wales by field survey and photogrammetric methods; (b) investigations into aeolian activity on beaches and dunes, using sand traps; (c) measurement of beach profiles in relation to the dune landscape found behind the beaches; (d) analysis of sand grain size in samples taken from different positions and at various depths below the surface of the beach and dunes.

Mr. A.J. Potts: A geomorphological study of the periglacial features of a portion of Central Wales.

The study is concentrated in the valleys of the Upper Tywi, Upper Irfon, Elan, Claerwen and Upper Ystwyth. The periglacial features are being mapped on a scale of six inches to the mile. They include: ice-wedges, involutions and similar features. Solifluction deposits and stratified screes are being studied; the former with the aid of aerial photographs.

The field studies are being supplemented by laboratory experiments involving the freezing and thawing of local rock specimens in an experi-

mental deep freeze under specific temperature regimes. The rates of weathering of different rock types are then being compared by the use of graphs.

Mr. E. House: Application of engineering techniques to the study of slope stability in west Glamorgan.

The slopes under consideration are natural ones, where the pore-water-pressure distribution has equalised. Basic to any stability analysis are the strength parameters of the slope material, which in the natural slope are best represented by the effective stress parameters ϕ^1 (angle of shearing resistance) and C^1 (cohesion intercept of envelope of Mohr circles). In the case of natural slopes where movement can occur for a long period of time prior to failure over a large slip surface area, the strength of the material (peak strength) reduces to the residual strength, where ϕ^1_r represents the residual angle of shearing resistance, and the cohesion intercept is zero. The samples are taken from a multitude of localities on slopes classified as to (a) underlying rock, (b) direction of dip, and tested to residual strength in a direct shear box. Some work is also carried out for peak strengths with a 10-ton triaxial compression machine. In addition mechanical analysis and limit tests are carried out on all samples. The experimental results are combined with field information from bore holes, and used in a stability analysis. The two forms of stability analysis used are: (i) plane failure surface of infinite slope taking into consideration water table, and (ii) a general slip surface analysis which is non-iterative and can deal with boundary conditions, non-circular slip surfaces, and can be programmed for a computer.

Department of Geology

Mr. J.W. Barnes: Aspects of economic geology.

Current investigations include the replacement of scheelite by iron in the genesis of certain ferberite deposits in Uganda, East Africa.

Mr. A.C. Benfield: (i) Sedimentological studies of the Huddersfield White Rock Cyclothem (late Namurian) in the Central Provinces.

Provisional results of facies analysis, palaeocurrent determination and thickness measurement present a pattern of sedimentation consistent with that associated with the growth of a large deltaic complex. Thus the well established ideas of Central Pennines Millstone Grit sedimentation are confirmed for this part of the succession.

(ii) The Recent sediments of the Burry Estuary, South Wales.

The purpose of the study is to set up a model of sedimentation against which ancient estuarine deposits may be compared. Hence particular emphasis is being placed on those characteristics which seem most likely to be preserved geologically.

Dr. T.W Bloxam: (i) Geochemistry of Cambrian and Coal Measures sediments in North and South Wales respectively (with particular reference to their natural radioactivity).

This radioactivity correlates with the content of organic matter and environment of deposition. The precise nature of the organic material is being investigated, particularly the amino acids and hydrocarbons. Possible new indicators of palaeosalinity such as bromine and fluorine are being investigated and better techniques for their determination being tested.

(ii) Other projects.

Work is continuing on the Franciscan metamorphic rocks of California and some new analyses of the "type" mineral crossite have been made. The results suggest a reappraisal of this division of the amphiboles.

Dr. M. Brooks: Geophysical work in North Norway.

A number of gravity reference stations (connected directly to Hammerfest Pendulum Station) have been established in coastal areas of West Finnmark. These have been used for the conversion to National Datum of a gravity survey of the island of Söröya and surrounding areas. The Bouguer anomaly map reveals large positive anomalies overlying Caledonian gabbros and associated metasediments, but the amplitude of anomalies (peak values approach +100 mgals.) and their precise distribution preclude a simple explanation in terms of the subsurface distribution of exposed gabbros. The regional gravity picture is similar to that of the Lofoten Islands 350 kms. to the south-west and it is becoming apparent that a zone of persistent gravity highs extends along the coastal region of North Norway.

A number of detailed magnetic surveys have been carried out on the island of Söröya and in the stretch of water known as Söröysund. These have been useful in: locating magnetite concentrations within a carbonatite complex; outlining magnetic variations within gabbro bodies; and giving information on the nature of bedrock under Söröysund. In addition a large number of readings have been taken in order to outline the regional magnetic field and it is clear that the areas of large gravity anomaly mentioned above are not magnetically distinctive.

Mr. P.N. Chroston: Geophysical work in North Norway.

As an extension of Dr. M. Brooks' work on Söröya, a regional gravity survey was commenced in Summer 1965, on the Øksfjord peninsula. A number of gravity reference stations have been set up linked to those on Söröya. All gravity stations have been read at or near sea level.

The Bouguer anomaly map of the Øksfjord peninsula shows a prominent regional effect with an anomaly of +40 mgals. near to Söröya, rapidly decreasing to -40 mgals. further inland. Superimposed on the regional trend are small positive anomalies due to individual gabbros.

A sea magnetic traverse, carried out between Söröya and the Øksfjord peninsula, has revealed large positive anomalies of the order of several thousand gammas. These are believed to be due to magnetic

segregations within a carbonatite complex. Magnetic traverses have also been taken across gabbro intrusions using a proton magnetometer in an attempt to determine their subsurface form.

Future work includes: extension of the gravity survey south of Tromsö; more sea magnetic traverses; and further studies on the gabbros. It is hoped that palaeomagnetic investigation of gabbros will assist in structural studies.

Dr. J.C.W. Cope: The ammonite fauna of the Upper Kimmeridgian rocks of Britain and correlation with continental localities.

The first part of the project, now nearing completion, involved systematic collecting from the type-succession at Kimmeridge, Dorset. Almost 500 feet of this succession have now been studied. One of the first results was that sexual dimorphism was evident in the ammonites from these beds, and a wider study of this problem and its relation to the taxonomy of ammonites is envisaged.

Mr. D.K. Davies: (i) The sedimentary petrology of the Upper Lias sands and associated deposits in southern England.

The complex pattern of lithological variation in the Upper Lias has been investigated to determine the provenance, dispersal, environments of deposition and diagenesis of the sediments. X-ray radiography and chemical stains have been used to study sedimentary structures in the apparently homogeneous sand-members. Mineralogical and vectorial analyses indicate the constancy of the source area and the complexity of the sediment transport system, while palaeosalinity determinations from uranium/thorium ratios support field evidence of environments of deposition. The regional picture of sediment deposition south of Cheltenham indicates the existence of two non-synchronous basins of deposition separated by the Mendip axis.

(ii) Quantification of sedimentary structural complexes.

The genetic interpretation of facies is largely dependent upon the highly subjective description and interpretation of an often unique assemblage of sedimentary structures. In this study a method has been developed which yields data more objectively than the traditional approach, and which has enabled various sedimentary structures and a sedimentary structural complex to be quantified. The nature of the data permits rigorous statistical comparisons between areas. Thus it is possible for the first time to achieve objective comparative studies between similar or dissimilar sedimentary structures, and between like or unlike facies in both recent and ancient sediments.

Mr. P.R. Hooper: (i) Regional survey of the Loppa-Øksfjord district, West Finnmark.

A regional study of this part of the Caledonian mountain chain was started in 1960 and major expeditions to the area, involving both undergraduate and postgraduate members of the Department, took place

in 1961, 1962, 1963 and 1965. Work in this area is expected to continue for at least five more years.

Mountainous, recently glaciated and dissected by fjords, the area is geologically unknown and well exposed. A highly metamorphosed succession of Eocambrian and Cambro-Silurian sediments has suffered at least two major foldings and is intruded by series of layered gabbroic and ultrabasic masses, the primary layering of which has been progressively sheared out from west to east and replaced by a strong metamorphic banding.

Many members of the Department have assisted in mapping the area. Detailed studies at present in progress include: the folded metasedimentary sequence on the Andsnes peninsula by D. Lewis; the folding and metamorphism on the islands of Silda and Marven by G.W. Gronow; the layered norite mass at Olderfjord by P.R. Hooper. In addition, Mrs. M. Williams is making a detailed study of the pyroxenes of magmatic and metamorphic basic rocks in the area.

(ii) X-ray fluorescent analyses.

The development of methods of applying this new technique to rock and mineral analysis has been continuing for some years and the method has been shown to be both rapid and accurate. Mrs. M. Williams is at present engaged in developing a technique for analysing tiny samples of pyroxene by this method.

Mr. D.M.D. James: The sedimentology of some Upper Bala formations in Central Wales.

The area under study includes the inliers south of Machynlleth, at Plynlimon and west of Llanidloes, in none of which is a base to the Upper Bala seen. However, the country north of the Dyfi, between Towyn and Dinas Mawddwy, shows a complete succession. No subdivision on the basis of fauna is possible in any part of the region, the only faunal horizon of value being the base of the Llandovery (zone of Glyptograptus persculptus). Nevertheless, lithological divisions are readily erected and enable recognition of comparable units in the various inliers.

The sequence consists of mudstones and greywacke grits with local developments of pebbly mudstone and conglomerate. Two major grit facies are recognized; each being regionally subdivisable and both almost certainly being of turbidite type. Many horizons show extensive development of ball and pillow and/or slump structures which have a regional pattern of orientation. Both longitudinal and lateral supply to the basin of deposition occurred, some lithologies being emplaced by sliding or within channels.

Palaeogeographic reconstruction of the basin with delineation of the shelf margin and other topographic features appears possible.

Dr. G. Kelling: (i) Sedimentation patterns in the Rhondda Beds (Lower Pennant Measures) of South Wales.

This work has involved integration of data on variations in interval-thickness, grosslithology, detailed microfacies, palaeocurrent measurements from cross-bedding and channels (including a

statistical hierarchical study of cross-bedding variance), detailed petrography and size-parameters. Results already published revealed a centripetal pattern of sediment-input into the South Wales basin, and the more recent work has clarified details of the sedimentary environments represented in the Rhondda Beds and has established the ultimate provenance of the detritus.

(ii) The distribution and sedimentary properties of the conglomerates and grits of Bala-Llandovery age in east-central Wales.

Elucidation of the environmental significance of these conglomerates is of particular interest since they occur in the transitional zone between "shelly" and "basin" (turbidite) facies.

(iii) Joint projects on:

(a) sedimentation of the paralic Calciferous Sandstone Series (basal Carboniferous) of East Lothian, Scotland; (b) the petrography of Lower Gondwana sandstones from the Damodar and Pachmarhi areas of India; and (c) flume-experiments (see P.F. Williams).

Mr. R. Oguike: The sedimentology of the Namurian sequence between the R. inconstans and G. subcrenatum marine bands along part of the North Crop of the South Wales Coalfield.

Detailed examination of the facies, sedimentary structures and petrography of the sand-bodies and associated sediments in the Vale of Neath area reveal distinct environmental associations and a dispersal-system of unusual type. Extension of this work to adjacent parts of the North Crop is now in progress and should lead to clearer understanding of the environment of deposition of the upper part of the Namurian and thus provide further evidence of the mode of evolution of the coal-basin.

Mr. T.R. Owen: (i) The Dibunophyllum Zone in South Wales (including Pembs.) This work, which includes the problem of the origin of pseudobreccias, has recently been extended to the Chepstow district and to areas in Gloucestershire.

(ii) The Millstone Grit and lowest Coal Measures of Gower.

The work is being carried out with a view to solving the complex structure of the belt along the Namurian-Westphalian boundary, a line which could link up with the Vale of Neath Disturbance.

(iii) The age and structural relationship of the Penlan Quartzite, near Kidwelly.

(iv) The Millstone Grit and lowest Coal Measures along the north-eastern and eastern rims of the South Wales Coalfield (in conjunction with Dr. D.G. Jones, Kings College, London).

Mr. A.T.S. Ramsay: Upper Palaeozoic ostracods.

Research to date has been concerned with the study of Carboniferous Limestone ostracod faunas from the Cleistopora and Seminula zones of the South West Province, with the view to understanding their taxonomy and distribution relative to time and ecological factors.

Studies of random samples showed that ostracods are more abundant in shales than limestones, and that shale and limestone faunas from the same zone are con-specific. Thus sections studied were chosen for their shale content.

Of eighty-two samples from four localities, thirty-nine contained rich ostracod faunas, and a collection of some thirty thousand specimens was made. The collection contains forty-two species, thirty-four of which are new. Large populations of each individual species (two hundred specimens+) were examined and detailed studies of the morphogenesis, sexual dimorphism of the adult carapace, and external and internal morphology made. The use of large populations has led to a better understanding of species, and has resulted in some revision at higher taxonomic levels.

The Seminula and Cleistopora zone populations proved to be congeneric, but at the specific level show promise as useful zonal fossils.

Professor F.H.T. Rhodes: Conodont studies, etc.

(At present in the U.S.A., he is continuing his studies on conodonts.)

Miss M.M. Rowlands: Geochemistry of some South Wales coals.

The major and minor elements in the Nine Feet and Six Feet coal seams and the minor elements from a series of coals from a shaft sunk at Cynheidre, Carmarthenshire, were investigated. The distribution of elements between the inorganic and organic phases of the coal, and the geographic distribution of the elements have been described.

Relationships were found between the following pairs of elements: Ti-Al, B-Al, Be-Al, Ga-Al, Mo-Fe, Ni-Co, V-Ti, V-Al, in the inorganic fraction, and Be-P, Ga-Al, Ni-Co, V-Ti, in the organic fraction. There is a correlation between volatile matter or coal rank; the depth of the coal below the surface and the elements B, Cu, Pb, Zn, Sn from which it is suggested that the present distribution of coal rank in the South Wales coalfield is related to the influence of mineralization during Armorican times.

The distribution of elements showed that it was not possible to correlate South Wales coal seams satisfactorily on a geochemical basis.

Dr. T.P. Scoffin: The development of the reef-bodies of the Wenlock Limestone in the Welsh Borderland.

The detailed study of reef structure, ecology and petrography, principally in the Wenlock Edge region, has revealed that the "ballstones" originated as patch-reefs, in which growth was controlled primarily by stromatoporids and coral-colonies, but with significant contributions by algae. The relative rates of growth of the reefs

may be inferred from their geometry and relationship with adjacent sediments, and suggest that the reefs formed in shallow water (a few metres) and that they were not prominent features on the Silurian sea-bed.

The equivalent non-reef sequence of alternating limestones and shales has been interpreted as due in part to primary deposition, accentuated by later, diagenetic concentration of lime.

A complex history of carbonate paragenesis has been revealed as a result of petrographic, chemical and textural studies.

Mr. G. Siddeley: Chemistry and mineralogy of the igneous rocks between Dolgelley and Arthog, Merioneth.

The igneous rocks (ranging in age from Arenig to Late Ashgillian) are extrusives and intrusives of dominantly acid or basic types; rhyolites and rhyolitic tuffs, basic lavas and ashes; intruded granophyre, gabbro and dolerites. An intermediate type present as separate sills and as margins to the granophyre contains features common to both end members and is considered to be a hybrid from acid and basic mixing. Three intrusive phases of increasing acidity are recognized, phases two and three being much closer in time than phases one and two. Resultant metasomatism is being studied. It is hoped to shed light on the origin and intrusive history of the granophyre. The separation of stilpnomelane, a constituent mineral of the granophyre and especially of its basic margins, is being undertaken to facilitate study of its properties.

Mr. B. Simpson: (i) Problems of sediment accumulation and coastal erosion at Ogmore.

(ii) Detailed study of causes and movements of landslides in the Swansea Valley.

(iii) Various other aspects of engineering geology and water supply.

Mr. J.G. Stead: The Newgale Beds (?Cambrian) in Pembrokeshire.

It is intended that after a detailed study of the facies developed in the coast-section the palaeontological, petrographical and sedimentological features of the sequence will be compared with those of adjacent and associated formations with a view both to correlation and to interpretation of the sedimentary environments.

Mr. L.P. Thomas: The sedimentation of the Sandstones, etc., between the Standard Four Feet and Gorllwyn coal seams (Middle Coal Measures) of the South Wales Coalfield.

Both surface and underground exposures are being studied throughout the area with the co-operation of the N.C.B. The aspects being studied include: stratigraphy, petrology, heavy minerals, sedimentary structures, palaeocurrents, and sedimentary facies.

Mr. M.D. Thomas: Geophysical investigations in and around the mouth of the Severn.

About twelve hundred gravity observations have been made in Glamorgan and Monmouthshire with the intention of delineating concealed Armorican structures. A number of profiles will be established across the South Wales coalfield.

Local irregularities in the gravity field are being investigated for their bearing on thicknesses of superficial deposits. Detailed gravity and magnetic surveys are planned in the Tortworth area for the purpose of outlining basement relief under the Lower Severn axis. Proton magnetometer traverses in the Bristol Channel are planned for Easter, 1966.

Mr. R.L. Thomas: Palaeontological and chemical facies in the G.subcrenatum Marine Band on the North Crop of the S. Wales Coalfield.

This investigation consists of a detailed examination of the G.subcrenatum shales in order to assess the environment in terms of redox potential, salinity and rate of sedimentation. Chemical analyses are being undertaken for the following elements: boron, uranium, thorium, fluorine, phosphorus, organic carbon, potassium, sodium, calcium, magnesium, ferric and ferrous iron, and sulpher. A quantitative study of the faunal population is being made both vertically and laterally, the interrelation of chemistry with fauna being used as the basis for environmental interpretation.

Dr. V.G. Walmsley: Ludlovian brachiopods.

A year in North America, partly spent studying Silurian and Lower Devonian sections in Nova Scotia, New Brunswick, Maine, and later visits to Silurian sections in Oslo, Gotland, Poland, and Czechoslovakia enabled a collection of comparative material to be assembled preparatory to a revision of Ludlovian brachiopods from the Welsh Borderland. At Caltech, Pasadena, a large collection of Silurian and Lr. Devonian enteletacean brachiopods was studied and joint papers are in preparation dealing with the taxonomy, phylogeny and distribution of species of Salopina, Isorthis, Resserella, Fascicostella and a new genus about to be published.

The aim is to make brachiopods more useful in correlation - especially in the Upper Silurian and Lower Devonian - in the hope that long range correlations may be improved.

Dr. B.P. Williams: (i) The stratigraphy and sedimentology of some Upper Devonian strata of Maritime Canada.

(ii) The sedimentology of some Old Red Sandstone formations of South Wales.

This work is being carried out on the petrography of the Llanishen Conglomerate of the Cardiff area, and a preliminary study of the depositional features associated with the Cosheston Group of south Pembrokeshire is also in progress.

Mr. P.F. Williams: (i) The sedimentation of the Pembrokeshire Coal Measures.

The work has involved a regional facies, dispersal, and petrological investigation. This multivariate approach was applied to determine: (a) What major environments are present and their evolution with time. Also, the minor variations within the major facies and the geomorphological character of small environments. (b) The hydrodynamic conditions suggested by the association of sedimentary structures - do they indicate high or low flow regime, increasing or decreasing regime intensity? (c) The major flow directions indicated by the palaeocurrents. Can any dispersal systems be set up on the limited lateral control present? What is the vertical variability in major and minor flow patterns, and what facies are these related to? (d) Petrographic character, variability and provenance factors in the formations studied.

The facies types range from proximal marine to fluviatile, braided river stage, and it has been possible in many cases to establish a comparison between these ancient environments and modern analogues. The current vectors, derived from large and small scale ripples and cross-stratification, micro-trough cross-lamination, primary current lineation, channel alignment, etc., show considerable variation and no aggregate dispersal direction can be given for the entire Coal Measures succession. The mineralogy shows a range of sandstone compositions from greywackes to protoquartzites, and subtle variations present in light and heavy fractions have enabled source area comparisons to be made.

Combined in a multi-variate synthesis these parameters suggest a broad sedimentation pattern which reveals considerable variability in Lower and Middle Coal Measures but greater consistency in the Pennant Measures.

(ii) Flume experiments on some aspects of shell and pebble re-orientation (in conjunction with Dr. G. Kelling).

The experiments have been undertaken to study the effect and control of flow velocity, water depth, and grain size of bed material on pebble and shell re-orientation. An attempt has also been made to relate the amount and direction of pebble re-orientation to shape, roundness, sphericity, and effective weight parameters.

The experimental work has now been completed and it is intended to publish the results in the near future.

AUTHOR INDEX

LOCALITY INDEX

Note: Figures in brackets refer to the number of references on the appropriate page.

SUBJECT INDEX

Welsh Geological Quarterly, v.1, no.3, pp.7-37.

NEWS AND NOTES

GEOLOGICAL SECTION IN U.K. WATER RESOURCES BOARD

"The increasing demand for water in the United Kingdom is estimated to be about 3 per cent per annum up to 1990. Arising from these increased demands and for other reasons a Water Resources Act was introduced in 1963 to cover England and Wales. This action was the culmination of a series of governmental committees which had considered the problem of increased water demands and the conservation and optimal use of water resources. The act became operative in April of this year [1965]. One of the principal purposes of the Water Resources Act 1963 is to secure the protection and proper use of both surface and ground waters. Twenty-seven river authorities have been set up with such responsibilities as land drainage, fisheries and prevention of pollution, as well as the conservation of water resources. Each river authority is defined areally by the catchments of one or more principal rivers. The central governmental agency is the Water Resources Board which has duties in respect of the implementation of the Act and which gives advice to Ministers and river authorities, as well as having planning and liaison responsibilities and undertaking the publication of information concerning demands and resources."

"A Geological Section has been established within the Water Resources Board to deal with hydrogeological and ground-water problems and to offer geological advice and guidance on the development and management of ground-water resources. The nucleus of this section comprises geological staff transferred from the Water Department of the Geological Survey of Great Britain. Because of the importance of hydrogeological investigations in certain fields of water resources, it was considered desirable that such a section should be formed as an integral part of the newly created Water Resources Board. Thus, hydrogeologists will work in close co-operation with other professional staff, particularly engineers, in the field of water resources. Dr. J. Ineson is in charge of the new Section."

Commonwealth Geological Liaison Office
Newsletter, June, 1965.

TYRANNOSAURUS IS ON VIEW

"The mounted skeleton of the dinosaur Tyrannosaurus rex makes an impressive addition to the gallery of extinct giants in the Natural History Museum, South Kensington. In life - some 70 million years ago - it was the largest of flesh-eating animals that ever walked on land, a nightmare seven tons, with a 4ft. skull, 6in. fangs, and a length of 40ft. In overall dimensions it was less than Diplodocus Carnegii, its museum neighbour, but the latter was a vegetarian, presumably as mild as it was vast."

"The remains of the ferocious Tyrannosaurus, bought for the museum in 1959 and one of the skeletons discovered in America, make up the only specimen of the kind in western Europe. Skeletons of a related

Mongolian species found since 1946 are in Moscow and Warsaw. More complete examples of the American reptile are in New York and Pittsburgh."

"The construction of the exhibit, the largest to be completed in the Natural History Museum since the Second World War, has taken more than a year to finish ....."

Part of an item in The Times,
February 12th, 1966.

SHORE-HUNTING WITH A HAMMER

" In Moscow the Soviet scientist refused to commit himself about those moon "stones" disclosed by Luna 9, and simply said: 'Let me get there with my hammer.' He little knew what a chord he touched in one English household. Don't forget the hammer - this has long been our parting thought when the car is packed and ready for the run to Lyme Regis."

"It had better be a hefty coal hammer, if such things are around in this smokeless-zone age: one sharp whack on the right spot should be enough to lay open the biggest pebbles on the shore at Lyme and reveal the beautiful fossils, like kernels of nuts."

"Mary Anning, that astonishing figure in geological history, never forgot her hammer when she went along the shore of her home town of Lyme Regis, and one result of her alert industry is the historic skeleton of Plesiosaurus at the South Kensington Natural History Museum. She was only about 10 when she found - and extracted - the fossil of an Ichthyosaurus. "

"In her smaller way she too tapped out an indelible message in the world's story, though not so easily deciphered as Luna 9's. Our holiday fun rapping out the ammonites and belemnites is but a trivial by-product, but a pleasant one that visitors to Lyme might make more of."

Part of an item in The Times
February 14th, 1966.

METEORITE STARTS A 'GOLD RUSH'

"Children, pensioners, farmers, and city workers took part today in a miniature 'gold rush' at the village of Barwell, Leicestershire. They were hunting for pieces of a meteorite for which the British Museum is offering a reward of up to 10s. an ounce."

"One man, Mr. George Potterton, aged 50, of Barwell, has earned £139 for a piece weighing 17 lb. 6oz. and a neighbour, Mr. Harold Platt, receives £39 for a piece weighing 5lb."

"Pieces of the meteorite weighing a total of 86lb. have been found. Leicester Museum said today: 'There is probably as much again which has not been found.'"

The Times, March 7th, 1966.

MODEL-MAKING COURSE

A 3-day course on relief model-making mainly for C.S.E. geology teachers submitting pupils for the W.J.E.C. Examination was organized by the National Museum of Wales Geology Department on 19th-21st February, 1966. Eight of the 51 local schools circulated were represented and, with the addition of Dr. R.K. Grant of the Glamorgan Inspectorate, there was a total of 9 members. By extending the course for one further day on 25th March, most members were able to complete a selected portion of the model of their school region. All members agreed that it had been a profitable and successful meeting, and were prepared to attend an identical course which the Department plans to hold later in the year for teachers from more distant schools.

GEOLOGY GRADUATES 1938-1954

The following figures are taken from a table entitled "First degrees and diplomas in Pure Science" in the book South Kensington to Robbins by Michael Argles, Longmans 1964, p.102.

Honours degrees:	1938-39	1947-48	1951-52	1952-53	1953-54
Geology and related sciences.	21	89	144	129	129

[More recent figures are given on page 3 of this number.]

HELICOPTERS AND GEOLOGY

"In any event, the impact of the helicopter on the rate of reconnaissance geological mapping in Canada has been truly spectacular. In the period 1842 to 1951 the Geological Survey mapped somewhat more than a million square miles. From 1952 to 1958 field work was completed within nearly half a million square miles by seven major helicopter Operations - in addition to much other field work accomplished by some 530 party-years' effort. Thus, since 1952, the Survey's staff mapped about half as much of Canada as in the previous 110 years - due, in large measure, to the helicopter. Clearly, this achievement represents the first major break-through in the Survey's century of effort to complete the initial or reconnaissance phase of the geological mapping of Canada. Less than a decade ago it looked as though a century or two would be required to complete this phase. Now there is reason to expect that it will be nearly completed in a decade or two."

Geological Survey of Canada,
Bulletin 54, 1959, p.6.

A GEOLOGICAL TIME-SCALE

D. Emlyn Evans

Few people have the ready ability to appreciate fully the immensity of geological time. Most of us need some assistance perhaps, and for this reason the accompanying time-scale might be of interest because it incorporates the simple device of representing the age of the earth by one calendar year, an idea already proposed by many authors.

If we do adopt this scheme and accept the figure of 4,600 million years as the probable age of the earth, and if we scale down this span of time into a calendar starting on 1st January and ending on 31st December, then 12.6 million years are represented by one 24-hour day, 1066 A.D. by a time 6.172 seconds ago, the birth of Christ by a time 13.474 seconds ago, and the emergence of the "British area" out of the Chalk Sea by some time after 8.00 p.m. on Boxing Day.

A particularly interesting item is the occurrence in Western Europe of the oldest example of the earliest men of completely modern type at a time which can be expressed on our calendar as a time some 4.571 minutes ago. This and the other times in the scale which relate to the emergence of man are based on the work of Dr. K.P. Oakley[1]. It has been considered advisable also to include for geomorphological interest the suggested times of origin of the planation surfaces in Wales which have been described and named by Dr. E.H. Brown as the "High Plateau", the "Middle" and "Low Peneplains" and the "600-foot marine platform".[2]

With one exception, the next part of the column, from the Pliocene to the Cambrian inclusively, has been based upon the dates accepted by the Geological Society Symposium held in Glasgow in February, 1964,[3] and dedicated to Professor Arthur Holmes who was one of the leading British geologists working in the field of geochronology. It was suggested at this meeting that the Pliocene-Pleistocene boundary may ultimately be found to lie between 1.5 and 3.5 million years ago. In view of a more recent publication by D.B. Ericson and others,[4] this range has been modified to lie between 1.5 and 2 million years ago.

Proceeding to the so-called Pre-Cambrian section, the first item in descending order refers to the recovery of Pre-Cambrian brachiopods from Victoria Island in the Canadian Arctic by Professor A.H. McNair and dated as being 720 million years old. In his address to the Geological Society of America in November, 1965, the discoverer claimed that the usually held theory that it was an "evolution explosion" that gave sudden rise to such creatures as brachiopods about 600 million years ago is now in serious doubt.[5]

Proceeding down the column, some other results are listed of the two spectacular developments of the last decade or so. Radiometric dates of older and older rocks are being announced regularly. In addition more and more primitive fossil organisms are being recovered by new laboratory techniques at increasingly lower geological horizons from various localities. Some of the more important finds come from Norway,[6] Leicestershire[7], Ontario[8,9] Southern Rhodesia[10] and South Africa.[11,12]

The Barberton district of South Africa has yielded chemical remnants of bacterial systems from a series of rocks for which a number of radiometric dates are available.[11] Professor E.S. Barghoorn of Harvard University, who has discovered these ancient fossils, has stated in a personal communication to Dr. Bassett that these dates "range from 2,900 million years to 3,400 million, and average 3,200 million".

According to a recent Carnegie Institution report,[12] the most amazing ages are claimed for rocks found in St. Paul's Rock, a small island in the mid-Atlantic. It is claimed that they are 4,500 million years old. The same report includes reference to work done at the Institution which points to the age of the earth being 4,600 million years. Despite the claim made in a recent publication by the Geological Society of America[13] that the earth is some 400 million years older than this, preference on this occasion has been given to the lower estimate.

---

1 OAKLEY,K.P. Dating the emergence of man. Advanc.Sci., 18, no.75, January 1962, pp.415-426.

2 BROWN,E.H. The relief and drainage of Wales. Cardiff: University of Wales Press, 1960.

3 Symposium: The Phanerozoic Time-scale (edited by W.B. Harland). Geological Society of London, 1964.

4 ERICSON,D.B., EWING, M. and G.WOLLIN. The Pleistocene Epoch in deep-sea sediments. Science, 146, no.3645, 6th November 1964, pp.723-732.

5 New Scientist, 28, no.470, 18th November 1965, p.491.

6 SPJELDNAES, N. A new fossil (Papillomembrana sp.) from the Upper Pre-Cambrian of Norway. Nature,Lond., 200, no.4901, 5th October 1963, pp.63-64, 3 figs.

7 FORD, T.D. The Pre-Cambrian fossils of Charnwood Forest. Leics. Lit. & Philos.Soc., 57, 1963, pp.57-62, 4 figs.

8 FRAREY,M.J. and D.J. McLAREN. Possible Metazoans from the early Proterozoic of the Canadian Shield. Nature,Lond., 200, no.4905, 2nd November 1963, pp.461-462.

9 New Scientist, 16, no.313, 15th November 1962, p.397.

10 MACGREGOR, A.M. The geology and geochronology of Southern Rhodesia [abs. with discussion]. Proc.Geol.Soc.,Lond., no.1541, 1956, pp.117-121.

11 New Scientist, 28, no.470, 18th November 1965, p.491.

12 The Report of the President in the Carnegie Institute of Washington Year Book 63 for the year 1963-64. Washington D.C., 1964.

13 Science Journal, 1, no.4, June 1965, p.11.

THE GEOLOGICAL TIME SCALE

The estimated age of the earth is 4,600 million years. In the Calendar Time-Scale column this is represented by one calendar year extending from January 1st to the end of the 31st December so that 1 day will be represented by 12.6 million years. On this scale the year 1066 would be represented by a time 6 seconds ago and the birth of Christ by a time 13¼ seconds ago.

ERA	PERIOD (of time) or SYSTEM (of rocks)	MILLIONS OF YEARS: Ages of bases of periods or other horizons	MILLIONS OF YEARS: Duration of Period	CALENDAR TIME-SCALE *For dates below the asterisk, the time in minutes has been corrected to the first place of decimal	IMPORTANT EVENTS IN THE EVOLUTION OF LIVING THINGS	MAJOR GEOLOGICAL EVENTS ETC.
QUATERNARY	Recent or Holocene	1/100	1/100	1.143 mins ago	Rise of modern man.	
	Pleistocene	1/25		4.571 mins. ago	Oldest example of modern man, *Homo sapiens*.	Main incursions and retreats of the ice during The Ice Age.
		½	1½–2	57.143 mins. ago	Oldest hominines.	
		1		22 hrs. 5.714 mins on 31 Dec.	Oldest tool-making hominidae.	Retreat of the sea around the coasts. Six hundred foot Marine Platform.
		1½–2		21.08.571-20.11.429 on 31Dec.		
CAINOZOIC OR TERTIARY	Pliocene	7	5-5½	13.20 on 31 Dec.	Waning of larger mammals.	The erosion of the Low Plateau. The erosion of the Middle Plateau.
	Miocene	26	19	23.25.714 on 29 Dec.	Incipient hominidae.	Erosion of the High Plateau. Alpine Mountain Building earth movements.
	Oligocene	37–38	11–12	★ 01.31.4-23.37.1 29-28 Dec.	Earliest anthropoids. Rise of mammals.	Slight elevation in the British area.
	Eocene	53–54	15–17	19.02.9-17.08.6 on 27 Dec.	Archaic mammals.	Volcanic activity in the Scottish area.
	Palaeocene	65	11–12	20.11.4 on 26 Dec.	Earliest primates.	Elevation of land. Initiation of present drainage system.
MESOZOIC OR SECONDARY	Cretaceous	136	71	04.57.1 on 21 Dec.	Extinction of the great reptiles, ammonites and belemnites. First true birds.	Chalk Sea transgression.
	Jurassic	190–195	54-59	22.05.7- 12.34.3 on 16 Dec.	Spread of the reptiles to land, sea and air Ammonites and belemnites abundant.	Minor earth movements. Jurassic Sea transgression.
	Triassic	225	30–35	03.25.7 on 14 Dec.	First mammals. First dinosaurs and large marine reptiles.	Rhaetic Sea invasion. Desert land with salt lakes
PALAEOZOIC OR PRIMARY	Permian	280	55·	18.40 on 9 Dec.	Life in shallow seas reduced. Last trilobites.	Desert climate and extensive erosion. Armorican Mountain Building movement.
	Carboniferous: Coal M.	310–315	15–25	09.31.4-24.00 on 7-6 Dec.	Very rich Coal Measure Forest flora.	Succession of forests destroyed by continued subsidence.
	Carboniferous: Mill.Grit		10–15		Goniatites and brachiopods in marine conditions. Non-marine lamellibranchs in "deltaic" conditions.	The Welsh area occupied by largely estuarine lagoons.
	Carboniferous: Carb.Lst	325		04.57.1 on 6 Dec.	Corals, brachiopods, crinoids and goniatites abundant.	The Welsh area mainly under the sea.
		345	20	14.51.4 on 4 Dec.		
	Devonian	395	50	15.37.1 on 30 Nov.	Amphibians evolve from air-breathing fishes. First known insects and spiders.	Caledonian Mountain Building movement. The Welsh area mainly land enclosing large lagoons.
	Silurian	430–440	35–45	20.57.1-01.54.3 on 27 Nov.	Armoured jawless fishes abundant. Rich coral reef faunas. Last true graptolites.	Final silting up of the sea basin (or lower Palaeozoic Geosyncline).
	Ordovician	500	60–70	07.37.1 on 22 Nov.	Acme of graptolites. First armoured jawless fishes. Brachiopods and crinoids abundant.	Uplift of land. Slowly sinking sea floor. Extensive submarine and subaerial volcanic activity.
	Cambrian	570	70	18.17.1 on 16 Nov.	First graptolites. Dominance of trilobites.	Uplift of land. Slowly sinking sea floor. Marine transgression over the British area.
EOZOIC OR PRE-CAMBRIAN	Pre-Cambrian	720	over 4000	20.34.3 on 4 Nov.	Sudden appearance of representatives of nearly all the invertebrate phyla.	
		800–900		12.11.4 on 29 Oct. to 13.42.9. on 21 Oct.	Earliest recorded fossil brachiopods from Victoria Island, Canada.	
		1000		15.14.3 on 13 Oct.	Possible fossils of primitive seaweeds or algae from Norway.	
		1600		00.22.9 on 27 Aug.	Fossils of primitive marine creatures from Charnwood Forest, Leicestershire.	
		1700-2100		04.57.1 on 22 Aug. to 08.00 on 18 July	Fossils of primitive marine creatures from Algoma, Ontario.	
		2600		15.37.1 on 8 June	Fossils of seaweed cells and possibly bacteria from Southern Ontario.	
		3200		00.45.7 on 22 April	Fossil seaweeds from Southern Rhodesia.	
		3400		03.48.6 on 6 April	Chemical remnants of fossil bacterial systems from Barberton district, South Africa.	
		4500		22.28.6 on 8 Jan.		—A metamorphic rock from Swaziland.
		4600		00.00 on 1 Jan.		—The oldest rock, yet reported, from St. Paul's Rock.

THE EARTH SCIENCE CURRICULUM PROJECT

D.A. Bassett

For some time now there has been talk of and publications about the 'new' mathematics. Considerable effort has also been devoted to the preparation of revised curricula for children in the age range 11-16 in physics, chemistry and biology; as for example, the Nuffield Foundation Science Teaching Project.* But little has been heard of the 'new' geology.

In the U.S.A., on the other hand, the massive "course-content improvement programs" in chemistry, physics, biology and mathematics, undertaken by groups of academic and research scientists from institutions such as Yale, M.I.T. and California, have, as a result of the Earth Science Curriculum Project, been followed by a 'new' earth science, which includes a 'new' geology.

Efforts are being made in this country to modernize the curriculum, but, as yet, there is little in published form. In the meantime, an outline of the history of the American Project and a brief reference to some of its results is appropriate.

History. The almost explosive development in the number of students taking earth science in the schools of the U.S.A. in the fifties inspired the American Geological Institute, with the support of the National Science Foundation, to make a serious effort to provide up-to-date textbooks and teaching materials for teachers and pupils.

In the autumn of 1958, a committee was appointed to organize and plan a six-week conference on the development of resources for teaching. At the conference, held in Duluth in 1959, a preliminary draft of a sourcebook for students was produced; and in 1962, after considerable revision, The geology and earth sciences sourcebook for elementary and secondary schools was published (Holt, Rinehart and Winston, Inc.). A reprint was issued in 1963. The first two paragraphs of the Preface to the Sourcebook will have a familiar ring for teachers who have followed the history of the teaching of geology in the schools of this country.

> "Geology has far-reaching effects on individuals, on groups, and on the destiny of nations, yet it is generally little understood even by many well-educated people. Geologic processes control the earth on which we live; mineral resources provide the basis for our expanding industrialized civilization and are a dominant factor in world politics; and a knowledge of geology and the earth sciences provides rich cultural rewards in appreciation of the development of the world's natural scenic wonders."
>
> "In spite of the enthusiasm and interest of people, especially boys and girls, the teaching of earth science has been inadequate

---

* The Nuffield Foundation Science Teaching Project. Progress Report, October 1964. (Longmans/Penguin Books.)

or entirely lacking in many elementary and secondary schools throughout the country. Recognizing this fact, the Education Committee of the American Geological Institute gave careful consideration to the type of program that would be most effective in improving the quality of current teaching. They decided that the availability of better geology and earth science resource materials for teachers would encourage them to incorporate more of the earth sciences into their other science courses, and that with improved teaching materials at hand there would be a greater incentive for colleges and universities to include geology courses in the training of future science teachers."

Almost at the same time that the Sourcebook was published, plans for developing additional resource materials for use by both students and teachers were formulated by the Education Committee of the American Geological Institute. Discussions were conducted with the Earth Science Division of the National Research Council of the National Academy of Sciences, with the Council of Geography Teachers and similar groups and with individuals representing all of the earth sciences. There was complete agreement on the need for corporate action and that the A.G.I. should assume administrative responsibility for the project. A proposal to initiate a major interdisciplinary programme to improve the content of the school curriculum was approved by the A.G.I. in the spring of 1962, submitted to the National Science Foundation in June of that year, and a grant of 147,182 dollars granted early in 1963 to support the initial stage of what is now known as the Earth Science Curriculum Project.

A Steering Committee and an Advisory Committee were quickly formed, headquarters established in Boulder, Colorado, and a Director, Associate Director, Director of Publications and an Administrative Assistant appointed.

The first of a series of planning-writing conferences was held at Colorado in August 1963, when 20 scientists, secondary school teachers, and other educators prepared detailed outlines for an earth science text, laboratory manual and teacher's guide. In the summer of 1964 a similar group of people - 41 in number - spent 8 weeks at a writing conference and produced a 450-page text, a 250-page laboratory manual and a 650-page teacher's guide - under the general title Investigating the Earth.

The contents page of the Text read as follows:-

UNIT II EARTH CYCLES

Chapter 7 Circulation of Moisture
8 The Atmosphere
9 The Hydrosphere
10 Moisture in the Atmosphere
11 Dispersal of Precipitation
12 Gradation: The Leveling of the Land
13 Ocean Basins and Their Sediments
14 Volcanoes and Volcanism
15 Earth Movements
16 Mountain Building
17 The Interior of the Earth

UNIT III THE EARTH'S PAST

Chapter 18 The Record in the Rocks
19 The Biologic Realm
20 Geologic Time
21 Dating Geologic Events
22 Anatomy of a Continent
23 Ancient Climates and Ice Ages
24 Evolution of Landscapes
25 Geologic History of a Continent: North America

UNIT IV EARTH AND THE UNIVERSE

Chapter 26 The Moon
27 Our Solar System
28 Stars and Galaxies
29 Origin of the Solar System
30 The Universe and Its Origin

APPENDIX A POWERS OF TEN
" B THE METRIC SYSTEM
" C TEMPERATURE SCALES
" D THE ELEMENTS
" E PHYSICAL PROPERTIES OF SOME COMMON MINERALS
" F RADIOACTIVE DATING METHODS
" GG GEOLOGIC TIME CHART
" H THE PLANETS
" I GREEK ALPHABET
" J PHYSICAL LAWS AND GENERALIZATIONS

Investigating the Earth was tested formally at 75 junior and senior high schools in 15 towns. The comments were then relayed back to Colorado where, in the summer of 1965, another 8-week conference was held at which fully revised versions of the 3 printed volumes were prepared. This revised edition is now being tested formally in 75 schools by 10,000 students, and informally in an additional 300 schools by 21,000 students. The results of this year's testing will be used as the basis for final revisions and publication in early 1967 of the hard cover version by the Houghton Mifflin Company.

As in the various programmes of curriculum reform carried out in other subjects, the emphasis in Investigating the Earth is on inquiry and investigation rather than memorizing and tabulating. An attempt is made to present the fundamental ideas of the various disciplines and, in so doing, to develop favourable attitudes towards learning and inquiry. Considerable emphasis is given to the method of learning, as stated by F.S. Chase in an article in School Review in 1962: "..... a central theme in the curriculum studies is the learning of modes of inquiry through which one's knowledge may be extended, not merely to the limits of existing knowledge, but beyond. The emphasis on the laboratory, on investigatory procedures, on the formulation and testing of hypothesis - in short, on the participation by students in a genuine process of scientific enquiry - is probably the most notable feature of the curriculum studies."

The compilers of this new text obviously share the opinion that J.S. Bruner expressed so well in The Process of Education (1963): "That the school boy learning physics is a physicist and it is easier for him to learn physics behaving like a physicist than doing something else." The something else in this instance refers to discussing the conclusion in physics rather than centering upon the inquiry itself.

The organizers also recognize that adequate preparation for the teacher is as important as suitable preparation for the student. Preliminary studies have shown that a great many persons now teaching earth science in American schools lack adequate preparation. The publication of a Teacher's Guide is one way to improve the situation.

Copies of the Sourcebook and of both editions of Investigating the Earth are available for consultation at the National Museum of Wales. All teachers of geology and its allied sciences will be well advised to make an effort to consult these publications.

E.S.C.P. Pamphlet Series

Much of the uniqueness of Investigating the Earth lies in the necessity, sooner or later, to make direct observations out-of-doors. Consequently, E.S.C.P. is preparing a series of pamphlets on topics that can be treated by field study. Layered Rocks, Rock Weathering, and Soils are the first pamphlets of the series. They are scheduled for distribution by mid-1966, will be approximately 32 pages in length and under 1 dollar in price.

The present note is based on items in the E.S.C.P. Newsletter; and R.L. Heller, 1964. The Earth Science Curriculum Project. J.Geol.Educ., v.12, no.2, pp.64-68.

BOOKS : NOTICES AND REVIEWS

Atlas of evolution. By Sir Gavin de Beer. Thomas Nelson & Sons Ltd., London. 1964. Pp. 1-202.

"A book that opens with cross-pollination of cauliflowers with cabbage pollen, and then in 202 king-size pages of text and figures runs steadily through the development of living things to end with Van Gogh, is obviously broad in scope. Add to this the coffee table-type format and the lavish quality of production (500 illustrations, many in colour, 32 maps and 16 colour plates) and a writer of the distinction of Sir Gavin de Beer, and the recipe for success is almost assured."

"And so it proves to be. This is a splendid book, comprehensive in scope, accurate and authoritative in treatment, literate and fluent in style. De Beer sets out to survey the whole subject of evolution for the general reader. After a brief historical section, he gives a short discussion of adaptation and natural selection, and then reviews the spectrum of evidence for regarding evolution as a fact. He covers the standard range of "proofs", including morphological, embryological, biochemical, serological and behavioural similarities, parasitism, classification, geographical distribution and palaeontology. This last section is pitched at an introductory level, but there are still many surprising errors. Geology students will (I hope) raise their eyebrows to discover that the time chart after page 49 shows that ammonites first appeared in the Carboniferous, and that trilobites became extinct in the Carboniferous. These ranges are plotted on a grid where thicknesses of strata are said in the caption to be plotted to scale (whatever thicknesses that may mean)."

"It is also a pity to see Primary and Secondary, eras resurrected from oblivion and the Cretaceous promoted to the status of an era. Some of the other rather speculative ranges on the chart do not correspond with those given in the text; for example, on page 55 the first appearances of angiosperms, eurypterids, ammonites (Triassic this time), king crabs, trilobites and so on. Some of the extinction times also differ (for example, eurypterids again). These are not mistakes of any great significance, but they are regrettable in a work of this quality."

"It is unfortunate that the vast majority of illustrations lack any scale. This does not matter in the case of familiar animals, but it sometimes produces misleading effects in palaeontology as, for example on page 68, where a series of transitional forms are shown as apparently all the same size although in fact, they are of very different dimensions."

"The largest and best chapter of the book is devoted to the mechanism of evolution, with excellent and critical reviews of the genetic basis of natural selection and geographic isolation. The illustrations of this section are the finest and most comprehensive yet published, and do much to give dynamic understanding to a topic which is so often presented in other works in static form. The colour plates in this section are used with great effect to illustrate colour-gene selection in moths, mimicry in cuckoos' eggs and the now classic example of geographic subspeciation."

"Chapter 4, the major steps of evolution, is devoted to a review of the origin of life, the nature and development of sex and a limited review of the history of animals and plants, in which anagenesis, cladogenesis, stasigenesis and paedomorphosis are illustrated as the main components of the essential evolutionary pattern."

"The final chapter on the evolution of man is presented with admirable balance. It is a pity that it was written just too early to take in Leaky's most recent discovery at Olduvai, which implies that early members of the genus Homo were contemporaries with Zinjanthropus."

"Some books are bought for their authorative information, others for the beauty of their illustrations, and still others as display pieces. This book can be commended on all three counts. It has already become a standard work."

F.H.T. Rhodes.

The process of education. [A searching discussion of school education opening new paths to learning and teaching.] By Jerome S. Bruner. Harvard University Press, Cambridge, Massachusetts. 1965. Pp.i-xx, 1-97. £1. 2. 0.

CONTENTS

WELSH GEOLOGICAL QUARTERLY

Volume 1, no.1, Autumn 1965

Volume 1, no.2, Winter 1965
