GEOLOGISTS' ASSOCIATION

SOUTH WALES GROUP

THE WELSH GEOLOGICAL QUARTERLY

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Geologists' Association - South Wales Group

WELSH GEOLOGICAL QUARTERLY

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CONTENTS

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 periodical of this kind could be useful in providing an agent for disseminating news to members of the Group. It was also felt that it might be useful in providing closer communication between the professional geologist, the teacher, the student and the amateur.

The content and format of the first number are 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 V/ales, Cardiff.

If the members feel that the periodical is worthwhile, then steps can be taken to make it a regular quarterly publication.

COVER : designed and printed by Vivian S. James, Barry.

THE NATIONAL ASSOCIATION OF GEOLOGY TEACHERS [U.S.A.]

In May, 1938, a small group of geology teachers in the Middle West of the United States founded the Association of Geology Teachers. In November, 1950, an Eastern Section of the Association was formed and the swift growth of this new group led to a joint meeting with the Mid West Section at Detroit in November, 1951. There a national constitution was drawn up, national officers elected and the title of the body changed to The National Association of Geology Teachers.

The purpose of the society, as stated in its constitution, is "to foster improvement in the teaching of the earth sciences at all levels of formal and informal instruction, to emphasise the cultural significance of the earth sciences, and to disseminate knowledge in this field to the general public".

In April, 1951, the Association issued the first number of the Journal of Geological Education. This is a quarterly series, now- in its thirteenth volume, containing original articles, brief reports, book reviews, reports on the transactions of the Association and a section entitled "Classroom ideas".

In May, 1964, the Association launched a Geology Teachers' Newsletter which is being published quarterly.

There follows a selected list of articles which have appeared in the Journal during the last five years and which may be of interest to teachers and students. The articles can be consulted at the Department of Geology, National Museum of Wales.

Classroom stream table. Walter C. Brown. (Fall, I960.)

The new mineralogy - principles and explanations of mineral properties. Dorothy J. Gore. (Spring, 1961.)

Cause and effect, a fable for geology teachers. Lucian B. Platt. (March, 1962.)

What every young geologist should know. Charles B. Campbell. (June, 1962.)

Porosity and permeability experiments for general geology. James C. Brice and Harold L. Levin. (September, 1962.)

Graphic integration of relative age, absolute age, and stratigraphic thickness. David A. Rahm. (December, 1962.)

Inexpensive models for studying helical flow in streams. William F. Tanner. (December, 1962.)

The Bahama -Banks: ' a "living" fossil environment. Louis S. Kornicker. (March, 1963.)

Stream-table development of glacial landforms, Maurice Schwartz. (March, 1963.)

Geologic terminology and the elementary student, G.T. Wickwire et al. (June, 1963.)

Mineralogy in the sixties. C.B. Slawson. (September, 1963.)

New perspectives in paleontology, James R.Beerbower. (September,1963.)

A simple rule of V's of outcrop patterns. Ruth Wehner Screven. (September, 1963.)

Field work: our scientific birthright. W.D.Keller.(December,1963.)

Atomic models of minerals for introductory geology. Daniel B. Sass. (December, 1963.)

What is a good examination. David M. Scotford. (March, 1964.)

A magnetic board as teaching aid for Historical Geology. Albert V Carozzi. (March, 1964.)

The "Student Model" approach to geology in the Secondary Schools. William F. Tanner. (June, 1964.)

Friedrich Mohs and the scale of hardness. Lloyd W. Staples. (September, 1964.)

How to repel students from the profession. John J.W. Rogers. (September, 1964.)

A plastic mount for small fossil specimens. Richard D. Hoare. (December, 1964.)

An inexpensive ice extrusion apparatus. John E. Stone (December, 1964.)

Let's abandon Elementary Physical and Historical Geology. Irving S. Fisher. (February, 1965.)

Henry Clifton Sorby (1826-1908), the Founder of Petrography. Robert L. Folk. (April, 1965.)

Weathering rates as exemplified by Cleopatra's Needle in New York City. Erhard W. Winkler. (April, 1965.)

Simple experiments to demonstrate wave-motion, flow separation J.R.L. Allen. (June, 1965.).

Geology and Astrogeology. John R. Rogers. (June, 1965.)

D.A.B.

IN SEARCH OF TRILOBITE APPENDAGES

An extract from A Natural History of Trilobites,
H.B. Whittington, Smithsonian Report for 1961,
pp. 407-408, Washington 1962.

"It is extremely rare to find parts of a trilobite preserved other than the exoskeleton. This is presumably because the exoskeleton was strengthened by secretion of mineral matter, but the covering of the antennules and other appendages was not so reinforced. From a few localities, the most important being in North America, remains of appendages are known. An early discovery, announced in 1876, was made by Charles D. Walcott (later the Secretary of the Smithsonian Institution) in a lime stone bed near Trenton Falls, N.Y. Spurred on by his memory of the enthusiasm of Louis Agassiz, Walcott obtained over 3,500 entire trilobites, in a few of which the appendages were preserved. Walcott cut thin sections of these specimens, and demonstrated clearly that trilobites possessed jointed appendages."

"A few years later, W.S. Valiant, then curator of the. museum at Rutgers College, picked up a loose piece of rock near Rome, N.Y., which contained a trilobite with appendages preserved by having been infilled with pyrite. A patient 8-year search resulted in the discovery in 1892 of the dark shale layer, less than 1 centimeter thick, from which Valiant's loose specimen had come. The formation contained hundreds of similar specimens. Delicate excavations of these fossils were made by Prof. C.E. Beecher of Yale University, but he died while still working on a drawing of one of his remarkable preparations. His student, Percy E. Raymond, took up the work and wrote an epic monograph concerned with the nature of trilobite appendages."

"Long before this monograph was completed, Walcott had made another sensational discovery, this time in the Burgess Shale - a formation of Middle Cambrian age - near Field, British Columbia. A great variety of arthropods are preserved in these shales, including trilobites with the appendages actually visible as a thin silvery film extending out beyond the margins of the exoskeleton.

"No finds of comparable richness have been made since these early days, and advances in our knowledge have come from the application of more refined techniques. An example of such an investigation is that made by Prof. Leif Størmer of the University of Oslo, who came to the United States in 1931 and worked with fragments of Walcott's original material from Trenton Palls. Størmer ground a series of sections, parallel to each other and a small distance apart, through an enrolled specimen. An enlarged drawing of each section was made, and each drawing was traced on a sheet of wax. The thickness of the wax sheets was proportional to the enlargement of the drawing and to the distance between successive sections. Each outlined wax sheet was then cut out and the sheets put together to form an enlarged model of the original specimen. The reconstruction based on these models gives an idea of the great amount of detailed information provided by Størmer's work. This new knowledge, combined with a restudy of all previously discovered material, has resulted in a major advance in our understanding of trilobites."

A LIST 0F PROVISIONAL TITLES OF THESES WHICH ARE AT PRESENT BEING PREPARED ON ASPECTS OP THE GEOLOGY, GEOMORPHOLCGY, ETC., OF WALES AND THE WELSH BORDERS.

Work started in 1964

BASSETT, M.G. The Wenlockian brachiopod fauna of Wales and the Welsh Borderland. (Wales : Swansea.)

BROWN, M.J.F. Glaciation of South-west Shropshire. (London : University College.)For M.Sc.

CASTON, V.N.D. A study of the Recent sediments and sedimentation in Tremadoc Bay, Nprth Wales. (Wales : Aberystwyth.)

ELLIS-GRUFFYDD, I.D. Glaciation of the Usk valley. (London : University College.) For M.Sc.

FOSTER, H. Glaciation of the Harlech Dome. (London : University College.) For M.Sc.

HUGHES, C.P. [The Ordovician (bifidus to gracilis) trilobites of the Llandrindod-Bui1th area including comparisons with the faunas of the Llandeilo area.] (Belfast.) For Ph.D.

JAMES, D. Sedimentary studies in the Upper Bala of Central Wales. (Wales : Swansea.)

JONES, A.S.G. The study of Recent sedimentation in a portion of Cardigan Bay. (Wales : Aberystwyth.)

LISTER, T.R. A study of the stratigraphic distribution of certain groups of microfossils from the Silurian rocks of Wales, Welsh Borderland and the Lake District, (Sheffield.) For Ph.D.

SIDDELEY, G. The igneous rocks of the Dolgellau-Arthog district. (Wales : Swansea.)

THOMAS, L.P. A sedimentary study of the sandstones between the horizons of the 2' 9" coal and the Gorllwyn coal of the Middle Coal Measures of the South Wales Coalfield. (Wales : Swansea.)

THOMAS, M.D. Geophysical investigations around the mouth of the Severn. (Wales : Swansea

THOMAS, R.L. Stratigraphy and sedimentation of the Brownstones and Upper Old Red Sandstone of Carmarthenshire. (Wales : Swansea.)

WOOLLANDS, M.A. Geology of the Llandovery Series between Llandovery and Rhayader. (London : University College.)

WRIGHT, L.J. The upland surfaces of the Radnor Forest district. (Birmingham.)

Work started in 1963.

AUSTIN, R.L. Carboniferous conodont faunas. (Wales : Swansea.) For Ph.D.

CHAPELHOW, R. Deglaciation in the central Shropshire Hills. (Liverpool.)

CHAPLIN, E.W. Geochemistry and micropalaeontology of marine bands from the Coal Measures of South Wales. (Wales : Swansea.) For Ph.D.

CRIMES, T.P. A comparison of structural and sedimentary features between north Wales and south-east Ireland.(Liverpool.)

EDWARDS, E.M. Periglacial landforms of the Berwyn Mountains. (Wales: Aberystwyth.)

HARDING, D.M. Floods and droughts in Wales. (Wales : Aberystwyth.)

KELLY, P.A. Geomorphology of Wirral. (London: Birkbeck College.)

LEWIS, C.A. Periglacial landforms in the Brecon Beacons. (Wales; Aberystwyth.) For Ph.D.

LUCKMAN, B.H. Aspects of the geomorphology of the Lugg and Upper Teme Valleys. (Manchester.)

RAMSAY, A.T.S. Palaeontological studies of Upper Devonian and Lower Carboniferous Ostracods. (Wales : Swansea.)

ROWLANDS, M.M. Geochemistry of coal from the South Wales coalfield. (Wales : Swansea.) For Ph.D.

ROWLANDS, P.J. The Pleistocene history and palynological investigations of some west Shropshire valleys. (Birmingham.) For Ph.D.

SCOFFIN, T.P. The sedimentology of the Wenlock Limestone. (Wales : Swansea.) For Ph.D.

WILLIAMS, P.F. The sedimentation of the Pembrokeshire Coal Measures. (Wales : Swansea.)

D.A.B.

GEOLOGY IN THE C.S.E. EXAMINATION

George Askey.

It was assumed by the Beloe Committee "that up to 20% of the total 16 year-old age group may be expected to attempt, though not necessarily to pass G.C.E. '0' level examinations in a fair range of subjects, say four or more". The new Certificate of Secondary Education aims to cater for the next 40 per cent, that is, "the band of candidates spanning roughly the 80th to the 40th percentile of general ability", irrespective of the type of secondary school attended.

The diagram (page 21) shows the curve of distribution of ability referred to in the Beloe Report. The overlap of the two bands at or about the 80th percentile is noteworthy, and shows that there is a narrow band of candidates within the C.S.E. range who, in terms of their general ability, might well succeed in obtaining a pass at the '0' level examination. Let it be emphasised, however, that the total number of such candidates is small in comparison with those who lie further down the scale of general ability, and that by its very definition, the C.S.E. examination should be largely concerned with the difficult-to-define 'average' pupils of 16 years of age; and the majority of these lie closer to the 40th and 50th percentile in the scale than to the 80th.

The results of the examination are published in five grades 1-5 in descending order of merit, without any pass or fail element, and thereby it is intended to cover the performances of a wide range of candidates. A pupil of average ability who has applied himself to a course of study regarded by his teachers as appropriate to his age, ability and aptitude, may reasonably expect to secure a Grade 4 pass in that subject. A Grade 5 pass would be accorded to the candidate who, though not quite up to the standard of a Grade 4 pass, was nevertheless considered properly entered for the examination. A pupil whose ability is such that he might reasonably have secured a pass in the G.C.E.Ordinary level examination, had he applied himself to a course of study leading to that examination, may reasonably expect to secure Grade 1.

It was felt strongly that much of the control of the new examination should be in the hands of teachers, and that the examination should have no limiting control upon school curricula or on methods of teaching. As far as possible, the aim should be to create a national examinations system which should be the servant of the schools and not their master. Thus panels of practising teachers were set up whose difficult task it was to produce syllabuses and specimen question papers suited to the whole range of pupils who might take the examination. It is also worth recording that panels working in Wales had in mind the special character of the catchment areas of many Welsh secondary schools, and especially

those grammar and bilateral schools who number among their pupils many who fall within the band of general ability covered by the C.S.E. Where these schools are small, it is likely that such pupils share a common timetable, common syllabuses and teachers, with those who would normally be considered above the limit of C.S.E. and who would be entered for the Ordinary level examination. At the same time the syllabuses drawn up had to allow for many pupils who were in secondary modern schools, having failed to obtain places at the local small grammar or bilateral school, despite the high percentage of intake to such schools, and who might thus be considered to be of limited general ability.

It is the responsibility of the schools themselves to decide whether or not they should enter their pupils for the examination. Considerable responsibility lay upon the teachers' panels, who were chosen to produce syllabuses because they knew best what to expect from their pupils. Teachers were also considered best qualified to decide the standard appropriate to each grade, and it is they who form the moderating and awarding committees who ultimately decide the techniques of the examination and its standards.

In the majority of secondary schools in the Principality, geology retains only a small role in the curriculum at the present time. The National Museum of Wales has made available to schools an increasing amount of geological material, and the constantly growing demand for this suggests a great interest. Many teachers enrich their pupils' experience by using geological loan material in the course of their lessons, often in lessons in geography, general science or environmental studies. In response to such general indications and to requests from schools, it was felt that a C.S.E. syllabus in geology, produced by practising teachers of the subject, might serve to intensify interest, and guide but 'not circumscribe' geology teaching in schools.

The geology panel produced a version of the syllabus and a specimen question paper, which were sent in draft to secondary schools for comment, and many of the observations that were received were incorporated before a second version of the syllabus was finally published. In this way, teachers in all the secondary schools in Wales had the opportunity to influence the work in which their pupils might ultimately be examined.

It would appear that the main principles observed in drawing up the geology syllabus were four-fold: that geology should be considered as a practical or 'doing' subject, based upon observation of the present as the key to the past; that such practical work should have local relevance, and should encourage awareness of the social importance of what is taught and learned; that teachers should be free to teach and to examine what they considered to be relevant to their pupils' needs; and that geology should be seen in relation to other sciences, but, at the same time should be regarded as a unity within itself.

Emphasis on the first two of these becomes apparent when we consider that 40% of marks are given for a practical test, to be assessed by the teacher himself; a sample cross-section of candidates from each school will then be moderated externally. An oral examination in the practical test, invites the teacher, if he so wishes, to examine what may actually be seen in the field; at the same time, candidates are encouraged, free from the inhibition of expressing themselves on paper.

The third principle is shown by the freedom of choice of teacher and pupil to explore the 'home area' and to deal only with those features that can be examined at first hand. In relating this to more general information about the main elements of geology, the fourth principle of subject unity is readily maintained.

The theory examination which carries 60% of the marks aims at helping the pupil to place his local knowledge into a general setting, and to use his observation of present-day phenomena as a key to the past. Thus the study of rocks will be related to many aspects of the section dealing with earth sculpture. The links may be observed in the local stream or sand dune or in a photographed volcano; such study should lead to a realisation of the many agents operating together to make a given landscape. Likewise emphasis is laid upon the use of fossils to the geologist, and the ways in which the process of fossilisation may be taking place, and did take place in geological time. Practical tests leading to an understanding of exact differences between mineral and mineral, perhaps an awareness of their chemical nature and crystalline form, should be a sound basis for appreciating that rocks in their turn are, in bulk, composed of mineral detritus as well as fossil remains. It would be hoped that the application of geology to everyday life would follow as a logical conclusion to the scheme of work outlined. At all times the teacher will have freedom to use those elements of his immediate landscape, that best serve to illustrate the unity of the subject.

The aims of the specimen question paper (pages 16-20) would appear to be two-fold: first to encourage candidates to observe accurately, and to use source material properly; and secondly, to supply a range of questions to cater for the wide spread of ability of the candidates presented for the examination. It may be argued that it is a bad thing that a past paper should suggest what may be subsequently taught. However, when bearing in mind the kinds of candidates who may be presented for the examination it should be remembered that their main need is knowledge and an awareness of geology. This examination should, as far as possible, make it easier for them to acquire the skill to use their knowledge.

In compiling the question paper due regard was paid to the relative inability of many candidates to express themselves in continuous prose. Objective test questions of the choice/response type (Q.4), and one word answers (Q.1) and (Q.2), are as relevant as are questions that offer a guide to answers (Q.11) or questions that ask for precise information observed in photograph or diagram (Q.15). More able and perhaps more literate candidates are catered for by the inclusion of questions requiring longer written answers, where they are required to assemble information or develop an argument for themselves. And those who have knowledge of maps, sections or models of their 'home area' are likewise enabled to exhibit their skill (Q.20). In the words of Examination Bulletin No.1, pupils should be prepared "through aroused interest, to give expression to their experiences, impressions and opinions both orally and on paper".

It is hoped that teachers will find sufficient scope in such a syllabus as has been drawn up, and that they will concur with the techniques of examining that are employed. But no school is bound to adopt in any subject the syllabus or method of examining prepared by the Welsh Joint Education Committee through its teachers' panels. Any school (or group of schools) may submit its own syllabus to the Committee for approval, and ask the Committee to provide an examination based on such a syllabus (if it is approved) - or it may set and mark its own internal examination. In the latter case the Committee will supervise the examination arrangements and moderate the results. These two options are known, respectively, as Mode 2 and Mode 3 examinations.

The readiness with which the Geology Department of the National Museum of Wales has undertaken to prepare schools to deal with problems relating to their 'own' local geology, underlines, the various ways in which interest in geology is being supported. The new C.S.E. Examination has been rightly ascribed the qualities of a new challenge and opportunity, with the immediate prospect that for the first time ever in many cases, pupils in the lower ability groups in secondary schools may take an examination designed to meet their own particular needs. It is to be hoped that geology teachers, or those teachers who have an interest in the subject, will accept this challenge and use the opportunity.

WELSH JOINT EDUCATION COMMITTEE

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CERTIFICATE OF SECONDARY EDUCATION

Draft Syllabus in GEOLOGY

The examination will consist of a practical test and a theory paper of 2 hours' duration.

The syllabus is intended as a guide to teachers, and should not circumscribe the teaching of geology in schools. It is hoped that the syllabus will encourage accurate observation and lead to the acquisition of useful knowledge in the field, and more especially in the candidate's 'home area'; the 'home area' should coincide with the area reasonably accessible for field study from the school. Such knowledge as is gained in this way should be the basis for further study, so that the general principles of the subject are illustrated by observed examples obtained by study at first hand.

Practical Test

The practical test will be conducted by the class teachers with their own pupils, and will take the form of an oral examination. A sample cross section of candidates from each school will be selected for moderation by an external Examiner.

The work for the practical test should be based on a study of the candidate's home area, especially in the field. Candidates should present their own collections of labelled specimens, together with suitable photo graphs, drawings and maps of interesting local features of geological significance. These should be accompanied by a loose-leaf folder or note book of observations related to the work done in the field. A knowledge of the main symbols used on simple geological maps is assumed.

(In order to assist in this matter of local field study the Geology Department of the National Museum of Wales is prepared to run courses so as to help teachers to prepare models and sections of the areas chosen for study by schools.)

The examination will contain questions that deal with the following essential points:

(a) The origin and age of the local rocks in relation to the stratigraphical column; the recognition and use of local rocks and fossils.
(b) A simple study of the economic use of local rocks and minerals.
(c) The relation between structure and relief in the home area.
(d) Field evidence of the effect of agents of erosion and deposition in the home area.
(e) The candidates' own collections of specimens.

The practical test will carry 40% of the total marks for this subject.

Theory Paper

This examination will be aimed at helping the pupil to place his local knowledge into a general setting, and to encourage observation of present-day phenomena as a key to the story of the past.

(It is suggested that the collection of geological specimens in the loan scheme of the National Museum of Wales Schools Service might form an important source for first hand study.)

The paper will consist of the following sections.

ROCKS - a simple classification of rocks according to mode of origin and composition.

Sedimentary rocks. Special attention should be paid to limestone, marl, sandstone, shale, coal, conglomerate and breccia. These rocks should be studied with special reference to the ways in which such rocks may be forming at the present time.

Igneous Rocks. Pupils should study granite, dolerite, a porphyry, and basalt to represent coarse, medium and fine-grained igneous rocks found in intrusions and flows, and illustrative of acid, intermediate and basic rocks.

Metamorphic rocks. Marble and slate as examples of the effect of heat and pressure in altering rocks.

MINERALS - The meaning of the term. The difference between minerals and rocks.

The main properties of quartz, orthoclase felspar, mica, magnetite, haematite, galena, calcite, fluorspar, rock salt, gypsum,, graphite, flint, chert, corundum, clay ironstone, barytes.

Emphasis should be placed on the study of these minerals in relation to the following tests that help to distinguish between common minerals in the hand specimens: hardness, streak, cleavage, fracture, lustre and specific gravity.

FOSSILS - The term explained. Ways in which fossils are preserved. The use of fossils.

Recognition of representative examples of each of the following groups: graptolites, corals, crinoid stems, brachiopods,lamellibranchs, ammonites, nautiloids, goniatites, trilobites, and Coal Measures plants. (Candidates will not be expected to label the parts of fossils.)

THE CHANGING SURFACE OF THE EARTH

Earth movements, relative movements of land and sea, vulcanicity, earthquakes.

Simple structures, horizontal and dipping strata, dip and strike, anticline, syncline, and faulting.

Earth sculpture. A simple study of the main elements of the modelling of scenery through erosion and deposition:

(i) by weathering - frost action, decomposition of rocks, solution, mass movements;

(ii) by rivers - the three main stages in the development of river valleys and their associated features, underground waters, lakes, deltas, rias;

(iii) by wind - sand dunes, etched landscapes and buildings, soil erosion;

(iv) by ice - corries, U-shaped valleys, hanging valleys, arêtes, moraines, ribbon-lakes, fiords, drumlins, drift;

(v) by sea - coastal erosion, transportation and deposition, cliffs, arch, stack, caves, beaches, sand spits.

As far as possible examples should be taken locally and from the British Isles.

SOME USES OF GEOLOGY

The application of geological knowledge to every day life.

(i) Water supply.

(ii) The search for oil and natural gas.

(iii) Limestones and their uses.

The theory paper will carry 60% of the total marks for this subject.

WELSH JOINT EDUCATION COMMITTEE

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CERTIFICATE OF SECONDARY EDUCATION

Specimen Paper in GEOLOGY

(2 hours)

Answer ALL questions in Section A and FIVE questions in Section B.

Credit will be given for sketch maps and diagrams.

All questions for which spaces are not provided beneath the questions should be answered at the back of the book, and care should be taken to number them accurately.

SECTION A

1. Complete the following sentences:

   (a) _____ is a mineral that cannot be scratched with a knife.
   (b) Haematite shows a _____ streak on the streak plate.
   (c) _____ is a mineral that is distinguished by having one good cleavage allowing it to split into thin sheets.

2. Name one rock that may have been formed in each of the following ways:

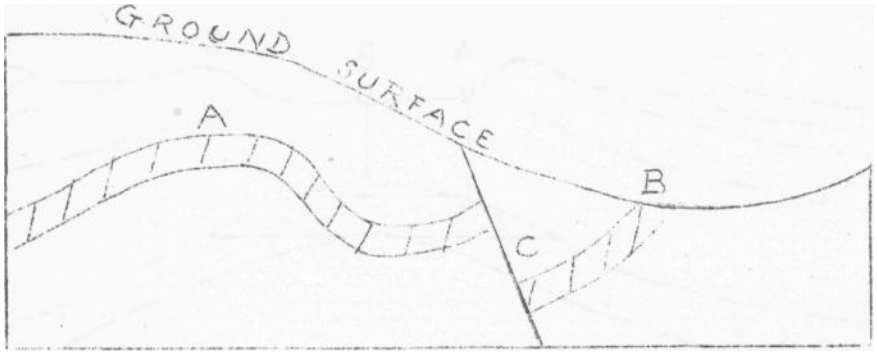
   (a) on the slopes of a mountain_____,
   (b) by the alteration of limestone due to heat_____,
   (c) on the floor of a desert lake_____.

3. In the space below, draw a simple labelled diagram to the difference between dip and strike.

4. Underline the correct word shown in brackets in the following sentences.

   (a) A landform due to marine erosion is a (stack, delta).
   (b) A drowned glaciated valley is known as a (fiord, ria).
   (c) A landform due to deposition by ice is a (truncated spur, drumlin).

5. Examine the diagram below



Write sentences to explain what has happened to the bed of rock at A, B and C respectively.

6. Name any fossil. In the space below make a simple drawing of the fossil that you choose.

7. Write three sentences to show the differing economic uses that may be made of limestones.

8. Granite consists of three main minerals. Name these.

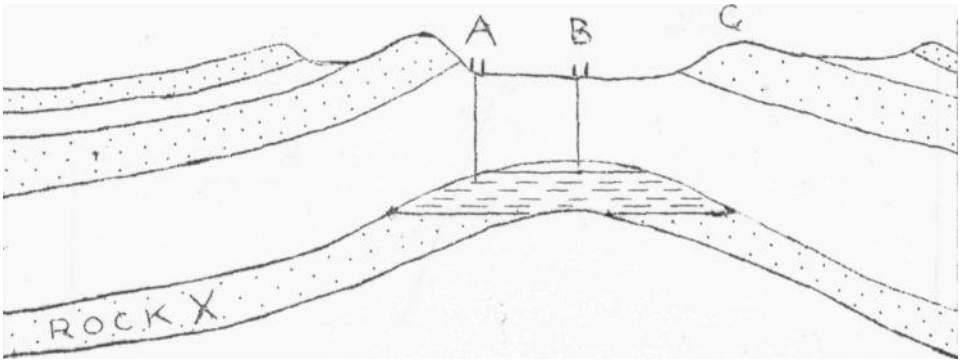
9. The diagram below shows a simple representation of part of the geological column. Fill in the names of the missing geological systems (or periods).

CRETACEOUS
TRIASSIC
PERMIAN
DEVONIAN
SILURIAN
CAMBRIAN
PRE CAMBRIAN

10. Write one sentence to explain the use that you would make of each of the following in geological work: a clinometer, a hand lens, dilute hydrochloric acid.

SECTION B (Answer FIVE questions from this section)

11. Study the diagrams given below, then answer the questions beneath.

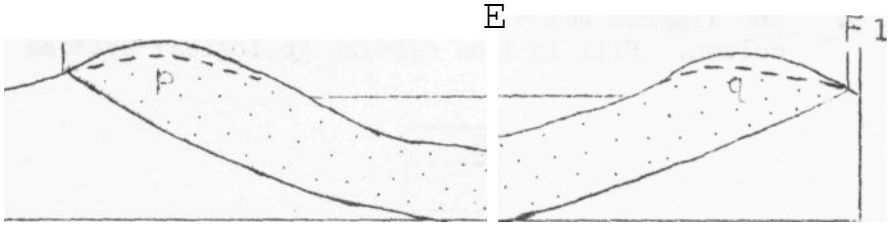


(a) What economic product might be obtained, from Well A?

(b) What economic product might be obtained from Well B?

(c) Give the name of the landform marked C.

(d) What are the differences between rock X and those rocks that occur immediately above it and below it?



(e) If water is obtained from the Well E

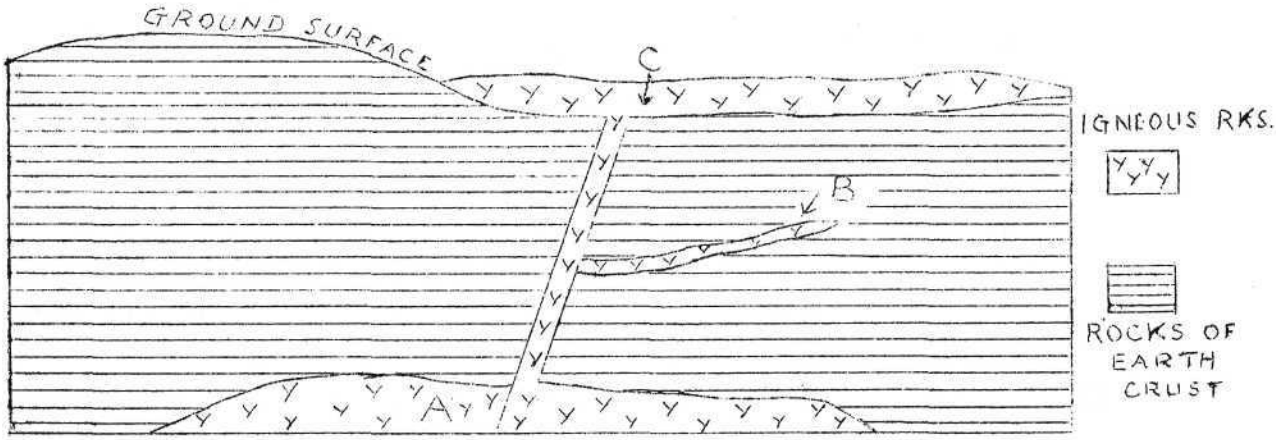
(i) What geological feature does the diagram represent?

(ii) What would you expect to find at points F and Fl?

(f) What is represented- by the dotted lines at p and q?

12. Explain what is meant by the term 'fossil', and describe the various ways in which fossils may be preserved.

13. Study the diagram below, then answer the questions that follow.



(a) Give a name to each of the shaded areas of igneous rocks marked A, B and C, and name a rock you would expect to find in each.

(b) How does the rock you name for A differ from the one you name for C? Account for the differences that you mention.

14. Fossil sea shells have been found near the summit of Snowdon at over 3,500 feet above sea level and near to bedded volcanic rocks.

Write an essay to explain how this may have come about.

15.

Photograph I

Photograph of a pot-hole forming in an active river bed.

(A. Holmes. "Physical. Geology." Plate 35a. facing p.149)

Photograph II

Photograph of bold meanders in a mature river valley.

Points A on the photograph mark the inside bend of the meander, and point B the neck of a meander.

(Young and Lowry "A Course in World Geog." Book 1V. page 24.)

Examine the two photographs I and II, then answer the following questions:

(a) What is the river doing in Photograph I?

(b) In which part of the river's course was Photograph I taken?

(c) Describe briefly the scene shown in Photograph II.

(d) What is the river doing at the points A in Photograph II?

(e) What may eventually happen at Point B and what feature may result from this?

16. Describe, briefly, how coal is formed. Suggest areas and conditions in which coal may be forming at the present time.

17. What tests would you use to identify a mineral in the hand specimen? Illustrate your answer by mentioning minerals that you have studied.

18.

Photograph A	Photograph B	Photograph C
Photograph of gently dipping beds of alternating hard and soft rocks. (A. Holmes. "Physical Geology." Fig. 24. page 72.)	Photograph of a quarry face showing normal faulting. ("Geology for Geographers." Cresswell. Fig.54. page 70.)	Photograph of an anticlinal structure, showing erosion by the sea. (A. Holmes. "Physic Geology." Plate 12 facing page 68.)

Study the three photographs A, B and C. Describe, as fully as possible, what you can see in each photograph.

19. Select any <u>three</u> of the following features: corrie (cwm), hanging valley, sand dune, spit, waterfall, stalagmite.

Explain how each of the three features that you select has been formed, and name a region where such a feature can be found.

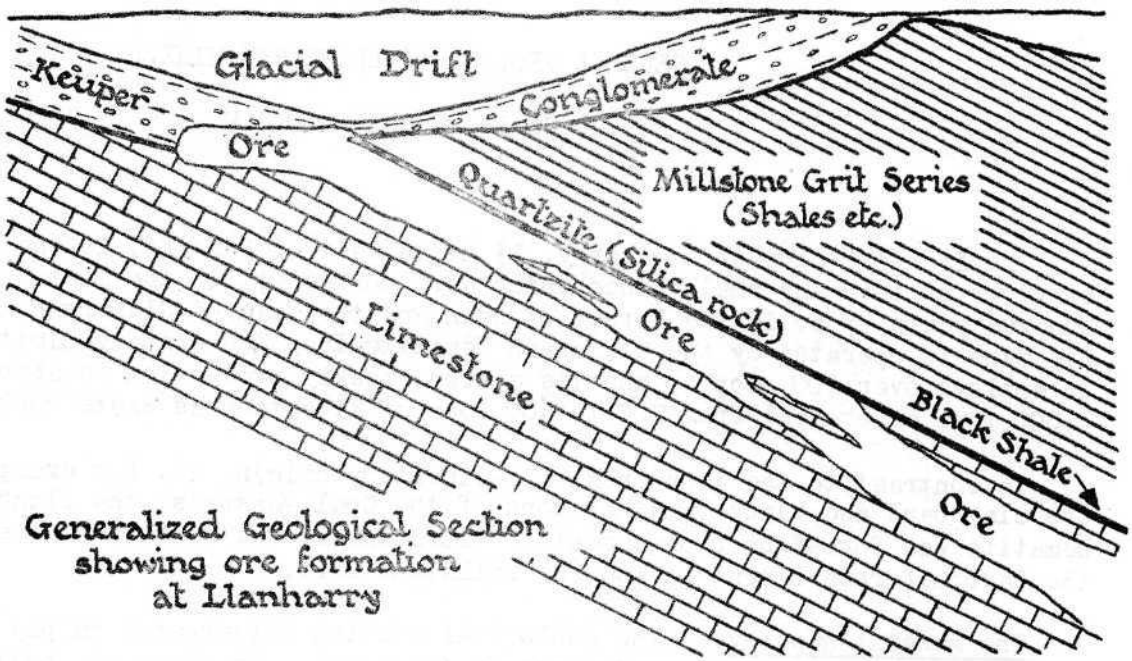
20. Draw (a) a simple geological map, and (b) a diagrammatic cross section, of any area that you have studied. Use the proper map symbols to indicate the structure, and add a suitable key to the rocks.

In the actual examination paper sufficient blank sheets would be included to allow candidates to answer any questions they may choose for which spaces are not provided beneath the questions themselves.

CARBONIFEROUS LIMESTONE EXTENDS TO THE COAST SOUTH

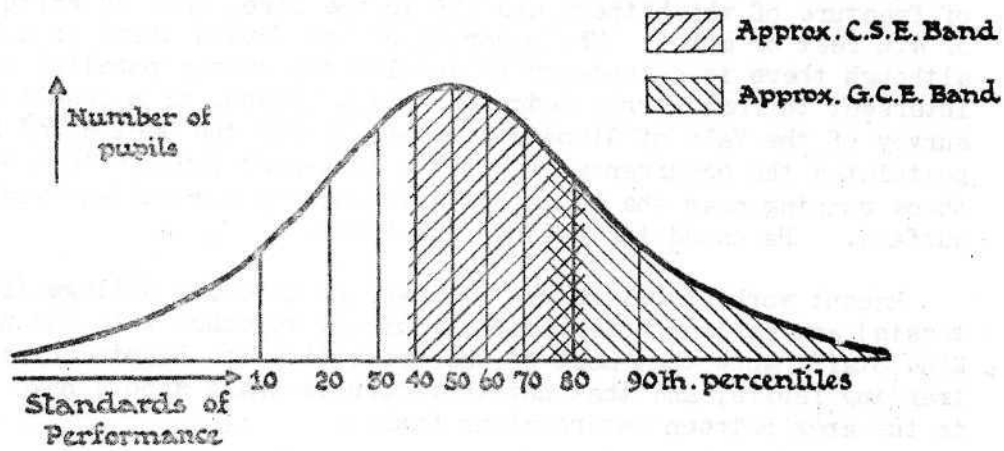
MILLSTONE GRIT SERIES ± 1500 FEET

COAL MEASURES TO THE NORTH



Generalized Geological Section showing ore formation at Llanharry

DIAGRAM OF THE NORMAL CURVE OF DISTRIBUTION OF ABILITY



Taken from Scope and Standards of the Certificate of Secondary Education. Seventh Report of Secondary School Examinations Council. 1963. p. 4. (H.M.S.O.)

GENERAL GEOLOGY OF LLANHARRY MINE.

E.L.J. Smail, B.Sc., A.O.S.M.

The iron-ore mine at Llanharry, 13 miles west of Cardiff, is the sole survivor of the many small mines which were worked within the last hundred years or so in the Forest of Dean and the Vale of Glamorgan. The mine is operated by the Glamorgan Hematite Iron Ore Company Limited. It employs over 400 people, and its current weekly production is about 3,000 tons of ore and from 200 to 400 tons of limestone as waste rock.

In contrast to the iron ores of sedimentary origin, as, for example, the clay band and black band horizons of the Coal Measures, the Llanharry hematite was formed by replacement of limestone at the contact between the Carboniferous Limestone and the Millstone Grit.

The general geology. The geological section illustrated on page 21 represents the geological conditions at the mine. It shows the position of the ore shoot, the northerly dip of the limestone and shales - part of the southern limb of the coal basin - the minor unconformity at the base of the Millstone Grit, the major unconformity below the Trias, and the uneven pre-glacial topography.

The section does not, however, illustrate the faults and other planes of fracture of which there are 170 in the mine, some of which have throws of 400 feet or more. The majority of the faults trend in a N.W. direction although there is a tendency to develop two nearly parallel sets which intersect to form narrow wedges. E.E.L. Dixon, as a result of a pre-war survey of the Vale of Glamorgan ore-field for the Geological Survey, postulated the occurrence of a major east-west fault with a southerly down-throw running near the Millstone Grit outcrop but not exposed on the surface. He named it the Angelton Fault.

Recent work by Dr. Mervyn Williams of Imperial College (for a doctoral thesis) and earlier observation by Dixon, together with the work of the Mine Staff, show that most of the ore bodies are bounded by the N.W. trending faults, and that not infrequently small shoots have been formed in the apex between intersecting faults.

The ore body.

In the upper levels the deposition was generally against the Black Shale up dip to the conglomerate capping and in many cases up into the Keuper conglomerate itself which has been mineralized to a height of up to 50 feet above the top of the limestone.

The deposition also spread southwards somewhat away from the Millstone Grit contact forming huge shoots of ore.

With increasing depth, ore has tended to fall away from the black shale in some cases and to form shoots generally following the dip of the strata which is about 30° to the north, but in one case the ore shoot plunges vertically through the limestone passing into a deeper zone than any other. Even within the confines of an orebody the limestone has not all been dissolved and "horses" of unaltered limestone are found in the midst of the ore deposit in some places.

The uppermost limestone beds at Llanharry, about 200 feet in thickness, consist of the Dibunophyllum zone limestones known as pseudobreccias, originally undolomitized but now often found to be dolomitized near the ore. Dolomitization involves the partial replacement of some calcium carbonate by magnesium carbonate until a 55/45 ratio of the two carbonates approximately is present.

Some 200 feet of interbedded white, grey and dark coloured calcite mudstones underlie the Dibunophyllum zone and form the Modiola phase of the Seminula Oolite which underlies them and makes a total thickness of about 600 feet. Characteristic fossils are the corals Dibunophyllum, Lithostrotian and Palaeosmilia with some Koninckophyllum, while large Productus bivalves characterize the upper limestone with some Mytilus, Seminula, and small Productus corrugato - hemisphericus in the lower beds. Fossils are not readily found however.

Origin of the ore.

There are two basically different theories advanced for the source of the hematite ores of South Wales, one suggests surface waters where iron has been dissolved from later Triassic sediments and on finding its way into the underlying limestone has dissolved some and filled some of the previously dissolved natural cavities or vughs usually present in limestone country to form the orebodies. The

general shallow nature of most of the deposits lent support to this theory, plus the presence of stalactitic "pencils" of specular hematite, common at Llanharry which were felt to indicate descending water.

Dixon, in 1939, when the depth limit of Llanharry was thought to be much less than subsequent events have proved, nevertheless favoured the magmatic or ascending solution theory and suggests that igneous activity of Miocene age has been discovered in the nearby Lundy Island in the Bristol Channel by T.C.F. Hall and Dr. A.T.J. Dollar, thus demonstrating that the greatest previous objection of the magmatic theory, the lack of any evidence of igneous rocks in the area, has been overcome.
He also finds the argument that specular stalactitic crystals could only have been deposited by descending water unconvincing as local convection currents, formed by hot water being cooled against some impervious barrier, could reasonably be expected to take a local downward course to form stalactitic crystals. It also seems easier to understand the ascending waters welling up against the Black Shale and then successively the conglomerate, even penetrating up into the conglomerate and forming the present orebodies than the reverse water flow direction.

The presence just to the north of small deposits of galena is felt by Dixon to support the magmatic theory.

The author draws no conclusions but has presented the facts and opinions culled from the sources listed and trusts that the information will interest the student and amateur and may provoke the expert to re-examine the evidence.

Acknowledgements: The author gratefully acknowledges permission to publish this article by the Chairman and Directors of the Glamorgan Hematite Iron Ore Company.

References: The Iron Ore Industry of Great Britain, published by The National Council of Iron Ore Producers; also unpublished Reports - Geological Survey - Vale of Glamorgan Hematite Iron Ore Resources by Ernest Dixon and Geological Reports by Dr. Mervyn Williams.

DEFINITIONS OF GEOLOGY

"Of what materials is the earth composed, and in what manner are these materials arranged? These are the inquiries with which Geology is occupied, a science which derives its name from the Greek ge, the earth, and logos, a discourse. Such investigations appear, at first sight, to relate exclusively to the mineral kingdom, and to the various rocks, soils, and metals, which occur upon the surface of the earth, or at various depths beneath it. But, in pursuing these researches, we soon find outselves led on to consider the successive changes which have taken place in the former state of the earth's surface and interior, and the causes which have given rise to these changes; and, what is still more singular and unexpected, we soon become engaged in researches into the history of the animate creation, and of the various tribes of animals and plants which have, at different periods of the past, inhabited the globe."

Charles Lyell - Elements of Geology. 1838.

"Astronomy made the universe immense; physics and related sciences made it lawful. 'To all these discoveries and principles, which so greatly modified concepts of the cosmos, geology added two more of fundamental, world-changing importance: vast extension of the universe in time, and the idea of constantly lawful progression in time.'"

G. Gaylord Simpson - The world into which Darwin led us. Science, 131, 1960, 966-974.

"Geology is usually defined as an application of the sciences to the earth. There is an element of truth in this, for geology certainly endeavours to explain earth phenomena with the aid of natural laws. It is thus a derivative science in not erecting new fundamental cosmic laws but being founded on those of other sciences, particularly chemistry and physics. Nevertheless the author disagrees with this definition, for by no means are all the methods and the particular assertions of physics and chemistry rigorously applicable to geology. Geology has not only to explain the present state by present phenomena, it must also investigate an evolutionary time-process that cannot be observed directly. It must indeed accord with the fundamental laws of science (gravitation, thermodynamics, etc.) in order to keep on firm ground, but individual experiments are not necessarily binding for it. There is always a possibility that experimental results correct under present conditions may not be valid for other time-space relationships. Experiments accordingly plays a less important role in geology."

Serge von Bubnoff - Fundamentals of Geology. 1963, p.3.

"Geology is merely physics, chemistry, and mathematics in which the problems solved are Earth problems. It is a dependent science and geological phenomena and processes can be broken down into their physical and chemical aspects. Field data are vehicles for chemical and physical experiments. Field work itself is an escape mechanism used by geologists to avoid serious scholarship.

Geotimes, 8, no.4, pt.2, Nov.-Dec. 1963, p.13. From the summarized answers to the GEO-Study questionnaire.

"I have said that the widest definition of Geology is that it is that science which, leaving to Astronomy the study of the heavenly bodies as a society, devotes itself to the study of the earth as an individual; in other words, that it is a 'Geonomy' as contrasted with an 'Astronomy'. But while this description is justifiable in principle, it is open to the natural objection that it shares this earth-knowledge with many other sciences, especially with the science of Geography. Perhaps the shortest definition that has been made of our science, and one equally acceptable to its students and to those who view it from the outside, is that Geology is the 'science of the structure of the earth'. It is in and around that earth-structure that all geological ideas centre."

Charles Lapworth - Quarterly Journal of the Geological Society of London, 59, 1903, pp. lxxii-lxxiii.

"Ranked according to degree of dependence on other sciences for fundamental concepts, geology is a third order discipline subordinate to physics, chemistry, and astronomy. Geophysics and geochemistry are not sciences, properly speaking, but are rather the vehicles by which a more dependent science incorporates data and techniques of a less dependent science."

M. King Hubbert - The place of geophysics in a department of geology. American Institute of Mining and Metalliferous Engineers, Technical Publication 945, 1938.

POLISHING AND VARNISHING ROCK SPECIMENS

In a recent article in The School Science Review (vol.46, no.160, June 1965, pp.683-685), P.J. Perkins of Great Bar Comprehensive School, Birmingham, describes and illustrates the equipment necessary for polishing and varnishing hand-specimens of rocks and outlines the method. Very briefly the details are:-

Equipment: A piece of sheet glass in an open-ended wooden tray (about 12" x 18"): silicon carbide abrasive (Carborundum Company numbers 80 and 220 for grinding; number 600 for polishing) available from most ironmongers.

Grinding and polishing: Trim one face of specimen to as near flat surface as possible; place one-quarter of a teaspoonful of the number 80 grain abrasive powder on the glass and add a little water; move specimen in a circular motion through the slurry of powder, add a little water if the specimen sticks; wash the specimen and the glass thoroughly to remove all the coarse grit; repeat the process with 220 grain grit; wash the specimen etc.; repeat again with the 600 grain grit. It is vitally important to remove all traces of the coarser grit before using the finer one. It may be worthwhile using three separate trays, one for each grain of powder.

Varnishing: Cover the surface with a thin, dust-free coat of clear varnish to provide a permanent coating.

NATIONAL MUSEUM OF WALES: DEPARTMENT OF GEOLOGY

During the period covered by the Annual Report for 1964-65, there were two important acquisitions of specimens from Welsh localities. The first was a collection of 128 graptolites from black shales representing the Dicranograptus clingani and Pleurograptus linearis zones of the Ordovician and exposed near an old coal trial on the east bank of the Dwyfach river near Plas hên, north of Llanystwmdwy, Caernarvonshire. The material was presented by Dr. John Harper of Liverpool University, and the fauna is listed in his paper describing the Ordovician succession in the Dwyfach section (Liverpool and Manchester Geological Journal, vol.1,

pt.4, 1956). The second one was a collection of 1,100 fossils mainly from the Wenlock Series of Penylan Quarry, Cardiff. This is of considerable interest not only because it represents a major addition to the Museum collection of the material from this historically important locality, but also because it has been presented by Mr. Robin Old, a young collector who has been closely associated with the Museum throughout his geological career.

Purchases included: a collection of 425 fossils from the marine bands in the sections of Millstone Grit rocks at Pontneddfechan, Upper Clungwyn Falls near Ystradfellte, Rhymney Bridge district and the Upper Morlais Valley on the North Crop of the South Wales Coalfield, from Mr. Robin Old; the tectonic map of Europe on a scale of 1:2,500,00, published by the Twenty-first International Geological Congress, Moscow, 1960; and photostat copies of 182 unpublished six-inch geological maps of the areas bordering the coalfield in Brecknockshire, Carmarthenshire and Monmouthshire, from the Geological Survey.

Outward loans for research purposes included: specimens of the brachiopod Syringothyris from the F.J. North collection to Professor D.B. Sass, Alfred University, New York, for investigation with the aid of an electron microscope; specimens of Upper Ordovician Cystoidea from Clôgyfrân, Carmarthenshire, and Sholeshook Cutting, Haverfordwest, to Mr. Christopher Paul of Cambridge University; and Silurian corals, mainly from the Rumney Quarry, Cardiff, to Dr. I.D. Sutton of Nottingham University.

Work on the compilation of adequate bibliographies and source-books of Welsh geology was started five years ago and has been extended to include the preparation of a comprehensive index of collections of geological specimens from Welsh and Welsh Border localities, of maps representing the whole or part of Wales, and of the personalia of geologists who have made major contributions to Welsh geology.

The co-operation of the reader is invited in tracing the whereabouts of private collections of Welsh material. Information should be sent to The Keeper, Department of Geology.

BOOKS: NOTICES AND REVIEWS

Handbook of paleontological techniques. Prepared under the auspices of the Paleontological Society. Edited by Bernhard Kummel, Harvard University, and David Raup, The John Hopkins University. W.H. Freeman and Company, San Francisco and London. 1965. Pp.i-xiv, 1-852, illustrated. £6. 10. 0.

CONTENTS

The history of the study of landforms or the development of geomorphology. Volume 1: Geomorphology before Davis. By Richard J. Chorley, Antony J. Dunn and Robert P. Beckinsale. Methuen & Co. Ltd., John Wiley & Sons Inc. 1964. Pp. i-xvi, 1-678, illustrated. £4. 4. 0.

CONTENTS

The Fabric of Geology. Prepared under the direction of a Committee of the Geological Society of America, in commemoration of the Society's 75th Anniversary. Edited by C.C. Albritton, Jr. Freeman, Cooper and Company, California. 1963. Pp. i-x, 1-372, illustrated. £2. 17. 0.

CONTENTS

Science in its context. A symposium with special reference to sixth-form studies. Edited and introduced by John Brierley. Heinemann, London. 1964. Pp. i-viii, 1-372, illustrated. £1. 10. 0.

It contains an article on: "The development of geological thought and the scientific study of scenery" by R.W. Clayton.

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1965-1966

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ANNUAL REPORT

Session 1964-1965

During the session, six Ordinary Meetings and four Field Meetings were held. The Ordinary Meetings were held alternatively at Swansea and Cardiff at the University Colleges.

17th October, 1964.	"Finding fossil mammals" - Dr. R.J.G. Savage.
14th November, 1964,	"Australia - an isolated continent" - Professor F.H.T. Rhodes.
12th December, 1964.	"The Silurian of South Wales" - Dr. V.G. Walmsley.
16th January, 1965.	"Gemstones" - Mr. B. Simpson.
13th February, 1965.	"The O.R.S. of South Wales and the Welsh Borderland" - Mr. J.W. Baker.
13th March, 1965.	The Seventh Annual General Meeting. "Geology in industry" - a neglected tool?" - Dr. R.H. Cummings.
3rd April, 1965.	Field visit - "The coastal sections in the Ogmore by Sea and Southerndown area of the Vale of Glamorgan" - Mr. T.M. Thomas.
1st May, 1965.	Field visit - "The geomorphology of the country between Swansea and Carmarthen" - Dr. David Q. Bowen.
22nd May, 1965.	Field visits - (i) "The hydrology and morphology of the Ogof Ffynnon Ddu cave system in the Upper Tawe Valley" - Mr. R.A. Stevens. (ii) "Structure and stratigraphy of the Cribarth Ridge and Upper Tawe Valley" - Mr. T.R. Owen.
2nd-3rd October, 1965,	Week-end excursion to the North Pembrokeshire area. Dr. G. Kelling and Dr. T.W. Bloxham.