GEOLOGISTS' ASSOCIATION

SOUTH WALES GROUP

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Cardiff : January, 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 second number, like that of the first, 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 would be no more than two shillings and sixpence per copy.

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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 University College, Swansea, and University College, Cardiff, provided by Mr. T.R. Owen and Dr. D.E.T. Bidgood respectively.

# THE GEOLOGICAL CONTENTS OF GENERAL SCIENTIFIC JOURNALS : 1965

A little over two years ago Sir Eric Ashby, then president of the British Association for the Advancement of Science, suggested that university degrees should be valid for a limited period only and should expire unless evidence of further study was forthcoming.

A year ago, Professor G.J. Hills in discussing education in chemistry, while not fully agreeing with Sir Eric Ashby, seriously suggested that for posts where a degree is required - he referred particularly to teachers - attendance at suitable refresher courses should be compulsory at prescribed intervals and that provision of courses and of facilities for attendance should be planned soon.

Although occasional ad hoc refresher courses for teachers of geology have been held and will undoubtedly be held in the future, it is doubtful whether there will be sufficient of them to keep teachers up-to-date with the progress of the subject. It is believed, therefore, that the accompanying bibliography of articles published during 1965 will provide a useful key to progress in geology.

The inventory is based on a search of twelve of the best known and most widely distributed journals devoted entirely to science and designed for the non-specialist.

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Advancement of Science

COOPE, G.R. Fossil insect faunas from Late Quaternary deposits in Britain. [Darwin Lecture, 1964.] (v.21, no.94, pp.564-575)

HARRISON, J.V. The role of the field geologist. [Presidential Address, Section C, 1965.] (v.22, no.102, pp.439-454)

TERRIS, A.P. and W. BULLERWELL. Investigations into the underground structure of Southern England. (v.21, no.98, pp.232-252)

Sectional Transactions: Southampton Meeting, August 26 to September 2, 1964.

Section C (Geology). Symposia on "Geology in the Hampshire Basin"; "The Continental Shelf of N.W. Europe"; "The structure of Southern England". (v.21, no.93, pp.449-452)

Sixty-ninth (1964) Annual Report of the Committee on Seismological investigations. (v.21, no.93, pp.499-504)

## Discovery

CREER, K.M. Tracking the earth's continents. (v.26, no.2, pp.34-39)

"Geologists have argued for 50 years over the theory of drifting continents. New measurements of magnetism in ancient rocks support this theory, and lead to the suggestion that the earth is slowly expanding."

FIRSOFF, V.A. How old are the galaxies? (v.26, no.2, pp.20-25)

"Optical astronomy has shown that there are many types of galaxy. Is there a significant pattern among the galaxies which can be used to calculate their ages?"

FIRSOFF, V.A. Is the universe expanding? (v.26, no.4, pp.18-21)

"Many cosmologists believe that our universe is expanding. But the estimated age of the universe casts doubts upon current theories of expansion."

TARLO, L.J. and L.B.H. TARLO. The origin of teeth. (v.26, no.9, pp.20-26)

"Many properties of teeth, such as their sensitivity to pain, defy explanation in terms of their present day function. Only by returning to their origin in the earliest vertebrates can we begin to understand just how these abilities could have risen."

WHITAKER, J.H.Mc.D. Books for universities and technical colleges: Geology. (v.26, no.9, pp.xxii-xxiii)

## Endeavour

BLACK, M. Coccoliths. (v.24, no.93, pp.131-137)

"Very fine particles of chalk contain tiny rosettes of calcite crystals that were long thought to be inorganic in origin. They are now known to be the relics of unicellular algae called coccospheres. This article describes the life cycles of the algae, which are often abundant and important in marine algae, and the structures of the fossils - coccoliths - which are valuable to geologists for dating."

Explorer

GIBBONS, D.F. Crystals and crystal growth. (v.7, no.6, pp.8-12)

Extract: "You can grow your own crystals from solution at home if you wish. Some salts dissolve easily in water and there is an excellent book available telling you how to do it if you are interested. "Crystals and Crystal Growing" is published by Doubleday Company, in its Anchor book series, and is written by Alan Holden and Phylis Singer."

Natural History

ANDERSON, S. Confessions of a curator. (v.74, no.8, pp.60-64)

BECKER, H.F. Flowers, insects, and evolution. Specialization developed from mutual adaptations. (v.74, no.2, pp.38-45)

DESAUTELS, P.E. Interaction between light and minerals. (v.74, no.8, pp.53-57)

NACE, R.L. New age for hydrology. (v.74, no.1, pp.63-68)

Editor's note: "In this magazine just one year ago (January, 1964), Dr. Nace, in an article entitled 'Water of the World', emphasized the global aspects of water problems. He also mentioned the probability of an International Hydrological Decade, to begin in 1965. That probability has now become an accomplished fact. Here Dr. Nace discusses the philosophic and economic implications of the next ten years of study and co-operation among many of the world's nations."

SCHAEFFER, B. and M. MANGUS. Fossil lakes from the Eocene. Green River Formation discloses its 10-million-year history. (v.74, no.4, pp.10-12)

New Scientist

BATISSE, M. Launching the Hydrological Decade. (v.25, no.425)

"Almost all the countries of the world are expected to cooperate in this programme which began officially on 1 January 1965. The Decade is designed to promote the really rapid development of hydrological knowledge in the face of man's increasing demand for water."

BERKNER, L.V. and L.C. MARSHALL. Oxygen and evolution. (v.28, no.469, pp.415-419)

"When the close connection is traced between the build-up of oxygen in the Earth's atmosphere on the one hand, and the environment and physiology of living organisms on the other, a model emerges that accounts for periods of explosive evolution. It may also explain subsequent catastrophes, such as that which overtook the great reptiles."

BOYD, D. Where are new minerals? (v.27, no.460, pp.605-606)

"The world supply of minerals in 30 years' time depends on routine surveys being planned or conducted today. There are still large areas of the Earth's surface - Brazil, for example - relatively unexplored where major discoveries can be expected."

GASKELL, T. Minerals under the sea. (v.26, no.442, pp.384-386)

"Though oil and coal are at present the main materials extracted from offshore rocks - a conference called "Oil from the sea" is beginning in Monaco next week - the day will come when a wide range of minerals is mined under water. As land resources run out and techniques improve, such operations will become a necessity and, therefore, economically worth while."

GASKELL, T. The prospects for offshore oil. (v.27, no.454, pp.265-266)

GOLDRING, R. Sediments into rock. (v.26, no.449, pp.863-865)

"What we know and cannot know about the history of the Earth and life upon it depends in part on the likelihood that given conditions will be preserved in fossil form. Studies of past and present sediments show the wide variation in 'fossil potential'."

HILLABY, J. A geography of genesis. (v.25, no.436, pp.798-801)

"Although important human fossil discoveries have been made in many parts of the world, they represent only a few signposts to our ancestry. Unmistakable evidence linking man with the anthropoids still eludes us, and may be difficult to recognize when we find it."

HILLABY, J. Naming our ancestors. (v.28, no.476, p.915)

"The nomenclature of early human fossils is in a mess, which a biologist [Dr. Bernard Campbell] now tries to straighten out by a reclassification of many of the older relics under the all-embracing name of Homo erectus."

HINTON, H.E. and M.S. BLUM. Suspended animation and the origin of life. (v.28, no.467, pp.270-271)

"The way in which many present-day organisms can survive dehydration suggests a new explanation of how life originated on Earth. In the authors' view it began from organic materials collected in crevices on dry land, rather than under water."

LLIBOUTRY, L. How glaciers move. (v.28, no.473, pp.734-736)

"The flow of large masses of ice in glaciers and polar ice sheets has proved difficult to explain and analyse. Taking into account the effects of water pockets underlying glaciers, modern theories now make it possible to explain most of the phenomena observed in 'temperate' glaciers."

MERRIAM, D. . Geology and the computer. (v.26, no.444, pp.513-516)

"Geologists, habitually unaccustomed to quantitative thinking, are passing from an era characterized by data collection to one in which objective synthesis of their accumulated information is becoming possible. This gentle revolution is yet another facet of the computer age."

RAILTON, C.L. Into the dark [S. Wales caves]. (v.26, no.446, pp.665-666)

ROBINSON, R. The origin of oil. (v.27, no.460, pp.624-626)

"Is all crude oil formed by the decomposition of plant and animal life? Or does some of it originate by primary chemical reactions - the 'abiogenic' theory? These questions formed the substance of a special session held by the geology and zoology sections of the British Association on 3 September."

[Corr: (L.R. Parkes), v.27, no.462, p.783.]

STUBBS, P. The oldest rocks in the world. (v.25, no.426)

"There is reason to believe that pieces of the Earth's mantle might be carried to the surface where the overlying crust is thin. Samples from St. Paul's Rocks in the Central Atlantic indicate that they may consist of such primordial material."

STUBBS, P. Africa's ring of salt. (v.25, no.434, p.637)

"At a meeting in London last week, a collation of research in several different areas pointed to the existence of salt basins beneath the surface around the African continent. Such deposits not only provoke speculation about new oil fields but also raise interesting scientific questions."

STUBBS, P. Rocks for climbing. (v.26, no.448, pp.805-807)

STUBBS, P. Molecular fossils. (v.26, no.449, p.867)

"A new approach to the problem of how living molecules may have originated is to trace their early evolution by means of organic molecules in rocks. At the Royal Society last week Professor Melvin Calvin described some of the first fruits of this developing science."

[Corr: (L.R. Parkes), v.26, no.451, p.105]

School Science Review

EAST, M.G. An elementary spectrometer. (v.47, no.161, pp.212-213)

GREENSMITH, J.T. Geology and the C.S.E. (v.46, no.159, pp.481-483)

HAINSWORTH, M.D. Qualitative work on observation. I. (v.46, no.160, pp.604-611)

HAINSWORTH, M.D. Qualitative work on observation. II. (v.47, no.161, pp.82-87)

HOLLAND, C.H. The troubled growth of historical geology. (v.46, no.159, pp.306-317)

PERKINS, P.J. Polishing and varnishing rock specimens for use in school. (v.46, no.160, pp.683-685)

PERKINS, P.J. Geology and the C.S.E. - further comments. (v.47, no.161, pp.247-248)

Science

ANDEL, T.H. VAN, BOWEN, V.T., SACHS, P.L. and R. SIEVER. Morphology and sediments of a portion of the Mid-Atlantic ridge. (v.148, no.3674, pp.1214-1216)

"In October 1964, a detailed geophysical and sampling survey was made of the central part of the Mid-Atlantic Ridge between 22° and 23° north latitude. The results indicate a large difference in age between the relief of the crest and that of the flanks of the Ridge and suggest that the crest portion is very young. Detailed surveys of two sediment-filled valleys on the upper western flank of the Ridge reveal different sedimentary sequences in two valleys and indicate the probable existence of a locally controlled depositional regime and a significant local supply of sediment."

BARGHOORN, E.S., MEINSCHEIN, W.G. and J.W. SCHOPF. Paleobiology of a Precambrian shale. (v.148, no.3669, pp.461-472)

"Geology, organic geochemistry, and paleontology are applied to the problem of detection of ancient life."

BARGHOORN, E.S. and J.W. SCHOPF. Microorganisms from the Late Precambrian of Central Australia. (v.150, no.3694, pp.337-339)

"An assemblage of structurally and organically well preserved micro-organisms, interpreted as both green and blue-green algae, has been found in chert facies of the Bitter Springs limestone from the upper Precambrian of central Australia. This appears to be the earliest known occurrence of green algae in the fossil record. These organisms are among the oldest known multicellular and unicellular fossils exhibiting distinct histological preservation."

BARGHOORN, E.S. and S.A. TYLER. Microorganisms from the Gunflint Chert. (v.147, no.3658, pp.563-577)

"These structurally preserved Precambrian fossils from Ontario are the most ancient organisms known."

BRAMLETTE, M.N. Massive extinctions in biota at the end of Mesozoic time. (v.148, no.3678, pp.1696-1699)

"Any proposed explanation should account for the profound effect on marine planktonic life of that time."

CHAMBERLIN, T.C. The method of multiple working hypotheses. (v.148, no.3671, pp.754-759)

"With this method the dangers of parental affection for a favosite theory can be circumvented."

[This is a reprint of a famous article in Science, 1890.]

CLARK, J.D. The Late Pleistocene Cultures of Africa. (v.150, no.3698, pp.833-847)

"It was during this time that cultures on the African continent first showed regional specialization."

CLOUD, P.E. Significance of the Gunflint (Precambrian) Microflora. (v.148, no.3666, pp.27-35)

"Photosynthetic oxygen may have had important local effects before becoming a major atmospheric gas."

EWEL, C.G., FISCHER, R.L. and A.E.J. ENGEL. Igneous rocks of the Indian Ocean Floor. (v.150, no.3696, pp.605-610)

"Four dredge hauls from near the crest and from the eastern flank of the seismically active Mid-Indian Ocean Ridge at 23°to 24°S, at depths of 3700 to 4300 meters, produced only low-potassium tholeiitic basalt similar in chemical and mineralogical composition to basalts characteristic of ridges and rises in the Atlantic and Pacific Oceans. A fifth haul, from a depth of 4000 meters on the lower flank of a seamount on the ocean side of the Indonesian Trench, recovered tholeiitic basalt with higher concentrations of K and Ti and slightly lower amounts of Si and Ca than the typical oceanic tholeiite of the ridge. The last sample is vesicular, suggesting depression of the area since the basalt was emplaced. Many of the rocks dredged are variously decomposed and hydrated, but there is no evidence of important chemical modification toward conversion of the lava flows to spilite during extrusion or solidification."

JOINT OCEANOGRAPHIC INSTITUTIONS' DEEP EARTH SAMPLING PROGRAM (JOIDES). Ocean Drilling on the Continental Margin. (v.150, no.3697, pp.709-716)

"Most of the Tertiary section has been sampled in six core holes drilled in the continental shelf, in the Florida-Hatteras Slope, and in the Blake Plateau off the coast of northern Florida."

MEINSCHEIN, W.G. Soudan Formation: Organix extracts of Early Precambrian rocks. (v.150, no.3696, pp.601-605)

"Biological-type alkanes are present in rocks of the Soudan formation that are more than 2.7 x $10^9$ years old, but evidence of life in Soudan times is marginal. The distributional patterns of the alkanes from various regions in the Soudan indicates an indigenous origin of these compounds. Isotopic analyses do not confirm the compositional analyses."

PLAFKER, G. Tectonic deformation associated with the 1964 Alaska earthquake. (v.148, no.3678, pp.1675-1687)

"The earthquake of 27 March 1964 resulted in observable crustal deformation of unprecedented areal extent."

SCHOPF, J.W., BARGHOORN, E.S. and OTHERS. Electron microscopy of fossil bacteria two billion years old. (v.149, no.3690, pp.1365-1367)

"Occurrence of well-preserved rod-shaped and coccoid bacteria in the Precambrian Gunflint chert (1.9 x $10^9$ years old) has been demonstrated by electron microscopy. This appears to be the oldest definite occurrence of bacteria in the fossil record. The organisms are morphologically comparable with certain modern iron bacteria."

TOBIAS, P.V. Early man in East Africa. (v.149, no.3679, pp.22-33)

"Recent excavations in Olduvai Gorge, Tanzania, have laid bare a new chapter in human evolution."

VALEN, L. VAN and R.E. SLOAN. The earliest primates. (v.150, no.3697)

"The known range of the Primates is extended down from the middle Paleocene to the early Paleocene and late Cretaceous by a new genus and two species from Montana .."

Science Journal

ADIE, R.J. Antarctic geology and continental drift. (v.1, no.7,)

"Studies of the geology and the ancient climates and flora of the Antarctic have clarified the evolution of land masses in the southern hemisphere. They shew that Gondwanaland - the original 'super continent' - broke up about 150 million years ago."

AGER, D.V. Report of 22nd International Geological Congress at New Delhi. (v.1, no.1, p.101)

AITKEN, M.J. Thermoluminescence. (v.1, no.4, pp.32-38)

"If subjected to natural or artificial radiation, many minerals emit energy in the form of light when stimulated by thermal agitation. This effect provides a convenient way of measuring radiation dosage and of estimating the age of archaeological specimens."

BATISSE, M. Ground water. (v.1, no.9, pp.59-65)

"Reserves below ground will not solve all water problems but their rational exploitation can be of great practical value, particularly in areas already suffering from acute water shortages."

BROTHWELL, D.R. Micro-evolution in man. (v.1, no.2, pp.79-85)

"A study of man's evolution over the last 30,000 years shows that small scale changes are still taking place. This period is critical for the study of the origins and changing patterns of disease in man."

DOLLAR, A.T.J. Geothermal energy. (v.1, no.7, pp.59-64)

"The release of geothermal energy occurs most spectacularly - but most wastefully - in volcanic eruptions. But in active zones where the heat of the Earth's outer layers is expended partly in heating water it can provide a significant source of power."

GASKELL, T.F. The earth's upper mantle. (vol.1, no.4, pp.72-79)

"Convection currents in the plastic layer of the Earth's mantle provide the most satisfactory explanation of continental drift. Produced by radioactive heating, they could account for nearly all the horizontal and vertical movements in the Earth's crust."

KERMACK, K.A. The origin of mammals. (v.1, no.7, pp.66-72)

"Fragmentary remains of jaw bones, about 200 million years old, which possess both reptilian and mammalian features are clarifying the evolutionary pathways by which mammals arose."

RECHNITZER, A.B. Underwater exploration. (v.1, no.8, pp.74-80)

"Current underwater research is centred on means of extending the range of 'free' dives and the development of a new fleet of highly mobile submersible craft. The ultimate aim is to exploit the ocean's vast resources of protein and minerals."

STEERS, J.A. The changing coastline. (v.1, no.2, pp.66-73)

"No beach is static; along the coast of England and Wales - from Northumberland to Essex, from Kent to Cornwall - change is constantly taking place as a result of erosion and accretion."

Science Progress

KING, B.C. The nature of basic igneous rocks and their relations with associated acid rocks. Part V. (v.53, no.209, pp.117-125)

"The occurrence of fine-grained margins in basic rocks at their contacts with acid rocks in composite intrusions has been variously interpreted, but an origin by chilling of basic magma by cooler acid magma appears to be generally substantiated. The various forms shown by the basic and acid components also provide critical evidence by which the manner and sequence of emplacement of the two may be established. Among plutonic associations, in particular, processes of metasomatism, 'hybridization' and contamination predominate in determining the mutual relations between basic and acid rocks."

KING, B.C. The nature of basic igneous rocks and their relations with associated acid rocks. Part VI. (v.53, no.211)

"The concluding article in this series deals with certain aspects of the relations between basic and acid volcanic rocks. While the ready availability of magmas of contrasting composition from the same source has long been recognized in certain types of vulcanism, important advances have been made in recent years in the recognition of instances of the simultaneous emission of such magmas. These phenomena raise important problems of petrogenesis and of the physical behaviour of basic and acid magmas in mutual contact."

Times Science Review

FLEMING, M.G. A revolution in mineral processing. (Summer 1965, pp.10-12)

"The mineral industry has changed more within the lifetime of most of us than in all previous history. Between 1936 and 1962, world output of aluminium minerals increased 14-fold, of titanium minerals nearly 10-fold, asbestos more than 5-fold, and others including diamonds, iron ore and copper by around 3-fold. Output of coal, still quantitatively the biggest, more than doubled. The earth's crust contains all the minerals that man could ever need, but rich concentrations of particular types of minerals become progressively more scarce. Already many metallic and other valuable minerals come from deposits so low-grade that they were considered valueless in the past and so complex that they were untreatable by traditional techniques. Thus, much of the responsibility for supplying our mineral needs falls on the mineral technologist, whose job it is to take these lean, complicated ores and to separate from the matrix of worthless rock the small proportions of valuable minerals they contain. The requirements of nuclear energy, not only for uranium but for special metals, and later of rocket fuels, have led to the application of new concepts and techniques which constitute the first stage of a scientific revolution in mineral processing."

STRIDE, A.H. Marine geology at the National Institute of Oceanography. (Winter 1965, pp.10-11)

"The geological history of the Earth, from its beginning to the present day, has been derived almost entirely from the rocks found on land, where much is obscure, imperfectly preserved or not preserved at all. The study of these rocks is by no means complete, yet their unravelling has taken as much as 150 years and represents one of the most intricate problems in the history of science. Only during the past 30 years has the remaining two-thirds of the earth's surface, the sea floor, received a little of the attention it deserves. Already, the new results have had considerable impact on geological thinking."

WESTOLL, T.S. New techniques and thinking in geology. (Autumn 1965, pp.14-15,18)

"Geology, like all the other natural sciences, has undergone an astonishingly rapid acceleration of the rate of development of new techniques and methods, and of new orientations of investigation, during the last few decades. There is every indication that this process will continue."

Welsh Geological Quarterly, v.1, no.2, pp.3-14. D.A.B.

# THE SEARCH FOR OIL AND GAS IN THE IRISH SEA

Trevor M. Thomas.

In contrast to the great surge of interest shown in the North Sea as a possible major petroleum province, following the proving of the stupendous Groningen gasfield in the north-east Netherlands in 1959, no serious thought seems to have been given, prior to 1965, to the petroliferous potentialities of the sedimentary basins in the eastern half of the Irish Sea. These show a close analogy in shape to the Cheshire basin. Recent gravity surveys* suggest that they have "fills" of 7,000 to 8,000 feet of Permo-Trias and Carboniferous rocks. In this sedimentary sequence the likeliest reservoir rock is the Collyhurst Sandstone, the lower member of the Permian and the equivalent of the Rothliegende sands, the host rocks of the Groningen gas.

Originally deposited on a deeply-eroded, pre-Permian topography the Collyhurst Sandstone shows sharp variations in vertical thickness. In a deep borehole at Formby** in west Lancashire no less than 2,345 feet of this formation was penetrated, but elsewhere in north-west England it is liable, at the extreme conditions of former erosion, to be completely absent. Where buried on the floor of the Irish Sea, the Collyhurst Sandstone is overlain by the Manchester Marls which could provide an impermeable seal.

Favourable indications for the eventual discovery of exploitable resources in the Irish Sea are the occurrence of oil in the Formby seepage area and the existence of thick sandstones in the Permo-Trias with satisfactory cover rocks. In the Formby area the extensive seepage of oil in a peat bog, lying on Triassic beds, suggests the likely occurrence of a sizeable reservoir in the deeper-lying Carboniferous. Shallow wells formerly provided a small yield,** but several deep bores have failed to locate any commercial quantities of oil.

Factors which raise doubts concerning the prospects for success of any future drilling venture in the eastern Irish Sea are the probable sharp variations in the vertical thickness of the potential reservoir rocks, and the great period of time during which the likely source rocks in the underlying Carboniferous were exposed to sub-aerial erosion before the reservoir rocks were deposited.

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* BOTT, M.H.P. 1964. Gravity measurements in the north-eastern part of the Irish Sea. Quart.J.geol.Soc.Lond., 120, 369-396.

** The British Petroleum Co. Ltd. 1962. The oilfields of Britain.

One might then be tempted to elevate the prospects of the eastern half of the Irish Sea, particularly the shallow Liverpool Bay area, to the position of being on par with those of large areas of the North Sea. The United Kingdom portion of the Irish Sea, lying east of the 5°W line of longitude, was designated, under the provisions of the Continental Shelf Act 1964, in August 1965 when applications for production licences to search for oil or gas, on the same basis as those issued for the North Sea, were invited by the Ministry of Power.

On November 24th 1965, the Minister of Power announced that his Department had granted a new series of production licences embracing a further 10,000 square miles of the North Sea as well as licences for about 500 square miles of the Irish Sea covering the Liverpool Bay area lying north of the Flintshire coast and west of the Lancashire coast as far north as Fleetwood. These five Irish Sea "blocks", each approximately 100 square miles or 250 square kilometres in extent, will be explored by Gulf Oil, the American Company largely responsible for the recent major oil discoveries in the Niger delta and adjoining offshore areas.

Preliminary seismic work, backed by an Anglo-American seven-company consortium and covering about 1,000 square miles between north-west Cumberland, the Isle of Man and north-east Wales, was commenced in the middle of 1965. It seems likely that no drilling will start for at least two or three years. All the available rigs are fully committed in the intensive North Sea programme where drilling schedules are already three to six months behind because of bad weather conditions, strikes at shipyards, shortages of materials and the general teething troubles encountered in the operation of expensive and complex drilling equipment.

Offshore areas now produce about 16 per cent of the non-Communist world's oil needs. By 1990 this proportion could well increase to more than 25 per cent. With better prospects overseas and taking full regard of the world-wide shortage of offshore drilling equipment, it seems that activity in the Irish Sea will remain in a minor key unless exceptionally promising discoveries are made at an early stage.

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Welsh Geological Quarterly, v.1, no.2, pp. 15-16.

## DEFINITIONS OF GEOLOGY (2)

"The task of geology - the science of the earth - is to achieve as complete an understanding of the phenomena of the earth as possible. Since it is evident that the phenomena of geology are a composite of the phenomena of all the other natural sciences, it is equally evident that a usable knowledge of the fundamental principles established in these other sciences is essential if geologists are to reduce the chaos with which they must deal to readily comprehensible terms."

"In view of the complexity of these phenomena it is not surprising that geologists too have tended to become confused and to adopt the specialistic view of how they must proceed. Thus, instead of being students of the earth, geologists have tended to become students of minerals, of rocks, of ore deposits, of coal, of petroleum, of strata, of fossils, of deformational structures, of volcanoes, of erosion and landforms, and of the physics and the chemistry of the earth."

"There is additional confusion between geology as a science and geology as a gainful occupation. This is particularly evident in the field of petroleum geology, which constitutes, scientifically, but a limited fraction of the total field of geology, yet represents by a wide margin the largest single source of geological employment. It has been known from the beginning that the world's resources of petroleum are finite, and hence that this field as a major source of gainful employment can only be ephemeral. Yet despite this knowledge it is not surprising, as a sociological phenomenon, to see defensive movements of a trade-union nature originate spontaneously as employment of geologists in the petroleum industry of the United States approaches its culmination and eventual decline."

"Whether such movements may be detrimental to the progress of geology as a science merits serious consideration."

"Offsetting these negative aspects of geological science is the fact that during recent decades the view that geology is an integral science and that an adequate geological education must embrace the fundamentals of the other sciences has gained wide acceptance, and very good educational programs based on this view are already in successful operation in a number of universities."

M. King Hubbert - Are we retrogressing in science?. Bulletin of the Geological Society of America, 74, 1963, p.377.

"Like the late Professor W.W. Watts, .... I prefer to think of geology as the geography of the past, and of geography as the geology of the present."

Leonard J. Wills - The Palaeogeography of the Midlands. 1948, p.iii.

"Geology is probably the most diverse of all the sciences, and its status as in part a historical science is correspondingly complex. For one thing, it deals with the immanent properties and processes of the physical earth and its constituents. This aspect of geology is basically nonhistorical. It can be viewed simply as a branch of physics (including mechanics) and chemistry, applying those sciences to a single (but how complex!) object: the earth. Geology also deals with the present configuration of the earth and all its parts, from core to atmosphere. This aspect of geology might be considered nonhistorical insofar as it is purely descriptive, but then it also fails to fulfill the whole definition of a science. As soon as theoretical, explanatory relationships are brought in, so necessarily are changes and sequences of configurations, which are historical. The fully scientific study of geological configurations is thus historical science. This is the only aspect of geology that is peculiar to this science, that is simply geology and not also something else. (Of course I do not mean that it can be studied without reference to other aspects of geology and to other sciences, both historical and nonhistorical.)"

G. Gaylord Simpson - Historical Science? The fabric of geology. 1963, p.25.

"Geology is primarily an observational science. Only to a limited extent at present are its data amenable to mathematical treatment. None the less, its 'laws' are based on foundations which, established firmly as many of them were nearly a hundred years ago, have survived the searching tests of a century's observations, and have been strengthened in no small measure by the fulfilment of diverse predictions. Discoveries that revolutionise the very basis of thought must, from the nature of our subject, be few and far between, and it is therefore unnecessary to discuss the fact that geologists have not for many decades aroused the scientific world by sensational announcements. The development of our science from close observations of innumerable field-phenomena and from cautiously drawn inferences, has been guided by the principle that 'the present is the key to the past'. But this is not to say that startling and fascinating hypotheses have been lacking. I need only cite those of Continental Drift and the Nappe Theory of Mountain-building. It has rather made for strength in our science that these flights of imagination have been looked at askance, after the traditional manner of British geologists; and some attractive hypotheses have not emerged unscathed after careful study in the cold light of accumulated facts."

P.G.H. Boswell - The contacts of geology: the Ice Age and early man in Britain. Report of the British Association for the Advancement of Science, 1932, p.57.

"From the beginning of its career, geology has owed its foundation and its advance to no select and privileged class. It has been open to all who cared to undergo the trials which its successful prosecution demands. And what it has been in the past, it remains to-day. No branch of natural knowledge lies more invitingly open to every student who, loving the fresh face of Nature, is willing to train his faculty of observation in the field, and to discipline his mind by the patient correlation of facts and the fearless dissection of theories. To such an inquirer no limit can be set. He may be enabled to rebuild parts of the temple of science, or to add new towers and pinnacles to its superstructure. But even if he should never venture into such ambitious undertakings, he will gain, in the cultivation of geological pursuits, a solace and enjoyment amid the cares of life, which will become to him a source of the purest joy."

Archibald Geikie - The Founders of Geology. 1905, p.469.

".... geography and geology are one science, treating of the earth, and it is needless for us to embarrass our work by attempting unnecessary subdivision and limitation of the fields that the two branches shall occupy. Let each one take whatever will aid its attainment of the desired end. If we can understand geographical morphology better by some consideration of geological structure, let it be introduced, just as chemistry is introduced into physiology, or physics into meteorology. Surely geologists have employed geographical methods freely enough to warrant our reversing the relation. If some consideration of geological processes will serve our purpose and give better appreciation of the sequence of forms that geographical individuals pass through, then call freely on geology for such consideration, and use it to the best advantage. Do not hamper our endeavor to understand the form of the earth's surface by an arbitrary limitation of the means that we shall employ to the end. It is plainly apparent that geology and geography are parts of one great subject, as ancient and modern histories are, and they must not be considered independently. Indeed, it is only in this close relation that a satisfactory definition of the two terrestrial sciences is obtained. Mackinder has concisely said that geology is the study of the past, considered in the light of the present, and geography is the study of the present, considered in the light of the past. I can quote no better indication of the close connection of the two divisions of the world's history."

W.M. Davis - Methods and models in geographical teaching. Geographical essays. 1909, pp.196-197.

"You asked for a book on rocks. You wanted to penetrate the innermost secrets of the mountains with the help of dry printed words and symbols. Did you not realize that you were asking the impossible?"

"Geology, the study of the nature and evolution of our own much too slowly changing earth, is the one subject which can absolutely never be learned from books and pictures alone."

"To piece together the shape of a single large fold from a hundred small outcrops, or of an old volcanic hearth as big as a province, and, moreover, to set such features in motion, so that they appear to move as they once did, requires both the natural example and lively personal communication between man and man."

"And therefore the relationship between teacher and pupil in our noble earth-science, as they eagerly work together in the presence of nature, is more meaningful and fruitful than in any other scientific discipline."

Hans Cloos - Conversation with the Earth. 1954, pp.248-249.

"The intellectual activity known as science is man's continuing attempt to understand the universe in which he lives. To obtain a factual basis for contemplation, science must first make observations of natural phenomena. This part of science - the empirical part - is basic, for we can hardly speculate usefully about nothing."

"Geology and geography, like other branches of natural science, thus depend heavily on detailed and accurate observations of phenomena: What is the exact distribution of land and sea? What kind of rocks make up the continents and the ocean basins? How old is the oldest known fossil and what kind is it? Where do we find fossil animals and plants? Are they related to living animals? The answers to these questions, and countless others, form the factual, or empirical, side of geology and geography."

"All sciences must have a theoretical or conceptual side to complement the empirical; this follows from the basic objective of science, which is to understand the universe. Thus the factual part of geology asks, "What is the world like?" while the theoretical side asks, "Why is it like this?" Why are land and sea distributed the way they are? Why did mountain ranges like the Alps develop during a particular part of the earth's history? Why did dinosaurs evolve? Why did they become extinct? Why do deserts develop in some places and not in others?"

John Imbrie - Natural History, 74, 1965, pp.10-11.

# NORTH-EAST MONTGOMERYSHIRE: A CORNER OF GEOLOGISTS

P. Carter and D.A. Bassett.

The north-east corner of Montgomeryshire and the immediately adjacent parts of Shropshire have provided geology with six of its enthusiastic disciples - the compiler of the first catalogue of British fossils, a leader in the study of ancient man, a promising young geologist who unfortunately died at the age of thirty-five, a professor of geology at Edinburgh, another at Pietermaritzburg, and a Director of the Geological Survey of Great Britain.

As a group, they are interesting because although they have come from a small area, they show considerable variety in their specialities due partly, at least, to the age in which they lived and partly to the place where they received their formal education.

## Edward Lhuyd (1660-1709)

In chronological order, the first is Edward Lhuyd (also spelt Lhwyd), who by any form of accounting was an eminent and also an ardent Welshman. Sir Hans Sloane, a famous contemporary figure, called him "the best naturalist in Europe"; a number of distinguished Welshmen subscribed for a mural brass tablet to be placed in his memory in the Chapel of Jesus College, Oxford, in 1905; and R.T. Gunther, author of the Life and Letters of Edward Lhwyd, which forms the fourteenth volume of the series of volumes on Early science in Oxford, regarded him as the father of British palaeontology and of comparative Celtic etymology.

Born at Llanforda, one and a half miles west-south-west of Oswestry,* he was educated at Oswestry Grammar School and then at Jesus College, Oxford. His first appointment was as assistant to Dr. Robert Plot, at the Ashmolean Museum in Oxford, and in 1691 he succeeded Dr. Plot as Keeper, a position he retained until his death in 1709.

One of Lhuyd's most valuable contributions was the illustrated catalogue of the fossils and minerals at the Ashmolean, the first catalogue of its kind in Britain. It was called Lithophylacii Britannici Ichnographia, and was published in 1699** with the financial assistance of some of the author's friends, among whom were Isaac Newton and Hans Sloane.

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* "Cardiganshire has always claimed the honour of being the birth-place of Edward Lhuyd. A MS. in the Llanstephan collection robs the county of this distinction." R.T. Gunther.

** The original edition is very rare, for only 120 copies were printed. A reprint with alterations and corrections was issued in 1760. There is a copy of the first edition in the Central Library at Cardiff and of the reprinted edition at the National Museum of Wales.

The book contains a preface, written at Montgomery in November 1698, followed by details of nearly eighteen hundred minerals and fossils arranged according to the thirteen classes of "figured stones" recognized by Lhuyd, and concludes with six letters written in elegant Latin, on the nature and origin of these odd substances; with twenty-one copper-plates representing two hundred and fifty of the choicest rarities described.

The catalogue contains descriptions and illustrations of corals (Lapides corallini), plants (Lithophyta), gastropods and cephalopods (Fossilia turbinata), lamellibranchs (Bivalvia), sea-urchins (Crustacea punctulata), fossil teeth (Ichthyodontes cuspidati), single vertebrae or joints in the back-bones of fishes (Ichthyospondyli), etc. Many of the specimens are from Welsh localities and three of the most interesting varieties are:

(i) "a stone ... of a compressed cylinder form; and as it were cut off even at each end: about 8 inches long, and 3 in breadth: its superfices adorned with equidistant dimples, and in each dimple a small circle: and the centre of each circle a little stud like a pin's head." This was evidently a piece of the root-like Stigmaria.

(ii) "Fairy Causeways, which I call so in imitation of the Giant's Causeway in Ireland; for whereas their's may be half a mile long, ours seldom exceed a yard. Our lime quarries yield two or three bodies congerous with it, .... and perhaps all may be referrible to the coralline class, the second in my catalogue."

He described the fossil as Lithostrotion sive Basaltes minimus striatus et Stellatus and gave an excellent illustration of it. The species to which these specimens belong have since been given a variety of names including Lithostrotion striatum, Madrepora verticalis and Astraea basaltiforme. On the basis of priority in nomenclature, however, the species is now referred to as Lithostrotion vorticale (Parkinson).*

Lhuyd's coral was from Wales, but from his text one cannot say precisely from what locality. The probability is that it came from limestone of $S_2$ age at Giltar Point, Tenby.

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* A detailed history of nomenclature is given in Dorothy Hill's Monograph on the Carboniferous Rugose corals of Scotland (Palaeontographical Society, 1938-1941).

(iii) "several new sorts of figured fossils; amongst which ye enclosed figure of some flat fish represents one of the greatest rarities hitherto observ'd by ye curious in such enquiries."

The "flat-fish" were the first trilobites to be discovered in Wales. He illustrated one specimen, calling it Trinucleum (now identified as Cryptolithus cf. concentricus) and illustrated another from 'Llan Deilo' which is readily identified as Ogygiacarella debuchi.

In contrast to his good factual descriptions and fine illustrations, Lhuyd's ideas concerning the origin of fossils were very much the product of the time. He suggested, as an explanation of the presence of figured stones in the rocks, that mists drifting from the sea over the land carried with them the "seed" of sea animals. These were washed down by the rain into the crevices of the rocks and caused the growth of stones resembling the shellfish, sea-urchins and the like from which they had come. Nevertheless, there was probably more sense in this line of thought than in the teaching of a learned Oxford Divine as late as the nineteenth century who, according to a story told by Sir Archibald Geikie, was of the "opinion that fossils in the rocks had been purposely placed there by the devil to deceive, mislead and perplex mankind".*

For nearly two hundred years it was supposed that Lhuyd's collection was lost, but during the thirties R.T. Gunther discovered part of it, in the original wrappings, in a cabinet associated with the Lewis Evans' Collection of Scientific Instruments in the Ashmolean Museum.

## Sir William Boyd Dawkins (1837-1929)

The second in the list is William Boyd Dawkins who if he "had not been famous in the realm of Geology, he would still have been a prominent figure among anthropologists and archaeologists; and if he had not established for himself a name among those whose researches have enriched the data and philosophy of science, he would still have been prominent as a teacher, an organizer, and a public-spirited citizen".** To be elected to the Fellowship of the Royal Society for his work on Pleistocene mammalia at the age of twenty-seven years, to be honoured with the Lyell and Prestwich medals of the Geological Society of London, is sufficient proof that he was, however, an eminent geologist.

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* Quoted in H.H. Swinnerton's Fossils (1960, p.5).

** From: Eminent Living Geologists. William Boyd Dawkins, M.A., D.Sc., F.R.S., F.S.A., F.G.S. in Geol.Mag.,Lond., dec.5, vol.6, 1909, p.529.

Born at Buttington, three miles north-east of Welshpool, he was educated at Rossal school and then at Jesus College, Oxford, where he distinguished himself in classics, but later became diverted to geological interests by the inspiring personality of the professor of geology, John Phillips. His first appointment was with the Geological Survey of Great Britain, when he mapped the Wealden and associated formations in Kent and the Thames Valley. In 1869, Professor T.H. Huxley nominated him for the formidable job of building up the Manchester Museum, and from 1872 until his retirement in 1908, he was, in addition, Professor of Geology at Owen's College and later at the University of Manchester.

Whilst mapping, Boyd Dawkins became interested in the rich mammalian remains in the cave-earths and gravels of the Thames Valley at the time when there was widespread interest in the subject of the antiquity of man and in the possible occurrence of human implements associated with the remains of extinct animals in Western Europe. He was thus led to study these problems, and he soon became a pioneer in the modern methods of dealing with them. In 1859 and in the two succeeding years he examined the deposits on the floor of Wookey Hole Cave, near Wells in Somerset; he showed that the cave had been occupied during the Pleistocene at times by hyaenas, at other times by man. The stone and bone implements of primitive (Palaeolithic) man were clearly associated with remains of the mammoth and other Pleistocene mammals. In the years 1875 to 1878 he joined the Rev. J.M. Mellow, Rector of St. Thomas, Brampton, Derbyshire, in making similar excavations in caves in the Cresswell Crags, near Worksop, on the border of Derbyshire. Here the evidence for the contemporaneity of man with extinct mammals proved to be still more abundant, and Boyd Dawkins was able to recognize a definite succession of faunas and clear progression in the handiwork of successive human races. In the latest Pleistocene deposits he discovered a piece of bone bearing an incised figure of the head of a horse - the first example of cave-man's art met with in Britain.

In 1874 he summarized his results (including those on the caves at Cefn, near St. Asaph) and those of his fellow workers in a volume entitled Cave Hunting: researches on the evidence of caves respecting the early inhabitants of Europe. It was the first synthesis of the knowledge gained from the study of caves since the famous Reliquiae Diluvianae published in 1823 by the Rev. William Buckland, Professor of Geology at Oxford and Dean of Westminster - the book which in Boyd Dawkin's own words "led me in 1859 into the path of comparative osteology, and the exploration of Wookey Hole .."*

In the years intervening between the publication of the two books, the momentous discoveries of human relics along with the extinct animals in caves and in river deposits had revolutionized the current ideas as to the antiquity and conditions of man, with the result that the sub-title of Buckland's book read strangely in 1874 - Observations on the Organic Remains contained in Caves, Fissures, and Diluvial Gravel, and on other Phenomena attesting the action of a Universal Deluge.

*The quotation is from Boyd Dawkins' Preface to Mrs. Gordon's "The life and correspondence of William Buckland, D.D., F.R.S." (1894).

The book on Cave Hunting was designed to clear the way for a "major enquiry into primaeval man, his growth in culture, his conditions of life and his relation to history." This second book which appeared in 1880 under the title of Early man in Britain and his place in the Tertiary Period became "the foundation stone of researches which have since developed along many lines of thought, and this remarkable work has consequently become, not merely a popular presentation of a wide group of related subjects of human interest, but a classic to the archaeologists and the anthropologist .."

In his later years Dawkins was much occupied with economic geology, and was often consulted about water-supply and engineering projects. While engaged on plans for the Channel tunnel in 1882 onwards, he suggested that the shaft which had been sunk at the Dover end would be a suitable spot for boring to find the buried coalfield which must underlie South-east England. This boring, which was made in 1890, reached productive coal measures at a depth of 1,100, and inaugurated the exploitation of the Kent coalfield.

## Joseph Bickerton Morgan (1859-1894)

The third on the list, J.B. Morgan, was yet another Museum Curator. Born at Welshpool, he showed an interest in geology at an early age, taking first prize for a collection of fossils at the National Eisteddfod at Cardiff in 1885 and again at Caernarvon in 1886. In 1887 he was appointed Assistant Curator of the Powysland Museum at Welshpool where he classified and arranged the large collection of recent shells given to the Museum by the Rev. J. Vize, rearranged the fossil collections, and donated large numbers of specimens from his own cabinets. In 1892, having obtained a free scholarship at the Royal College of Science, he went to London and in one year succeeded so well that he obtained the first prize at the College, together with the Murchison Medal and gift of instruments and books, and was appointed demonstrator in geology. Unfortunately his health failed and on 8th March, 1894, he died at the early age of thirty-five.

The bestowing of the Murchison Medal was most appropriate because not only was Bickerton Morgan born in Siluria, but his main interests lay in the fossils of the Ordovician and Silurian, especially those of the Welshpool area. He obtained a large series of fossils from localities such as Fforddy Gastell near Llanfyllin and Gaerfawr, Bellan and Cwm-y-sul, near Welshpool, and in 1884 sent them to Professor Charles Lapworth (who had recently come to Birmingham) for identification.

Professor Lapworth advised the young collector to map the rocks of his area in order to define the limits of the Silurian in the district. He duly started the work, established the Silurian age of the Powis Castle conglomerate and thus demonstrated the presence of an unconformity between the Ordovician and Silurian rocks. He read a paper on the subject at the Leeds meeting of the British Association for the Advancement of Science, but unfortunately, however, he did not complete the project. It was not until 1911, therefore, that a reasonably comprehensive description of the Welshpool district became available when Arthur Wade (making numerous references in his fossil lists to the J.B. Morgan collection) published the results of his survey.

Amongst the collection sent to Lapworth were some specimens of Polyzoa which were passed on to G.R. Vine for identification. They proved to be hitherto undescribed forms, and two new species - Phyllopora tumida from Wern-y-scadog, Llanfyllin and Thamniscus antiquus, Middleton Hill - were erected in a paper by Vine to the Geological Society in 1885. It is interesting to note that in the title to this paper the old term Lower Silurian is still used for what we now know as Ordovician. The term Ordovician was proposed by Lapworth in 1879, but it was some time before it was generally adopted by geologists. On the maps of the Geological Survey, for example, the term did not appear until 1906.

To return to the fossils of the Welshpool district, all the material in the Powysland Collection was transferred to the National Museum of Wales at Cardiff in 1962 due to lack of space at Welshpool.

## Sir William John Pugh

In the year that Bickerton Morgan received his Murchison Medal at Imperial College, another Murchison medallist was born at Westbury, Salop. Although this village is three miles over the border, it is appropriate to include William John Pugh in this paper because he not only attended Welshpool County Intermediate School, but was later chosen to be President of the Montgomeryshire Society.

Pugh graduated at the University College of Wales, Aberystwyth, in 1914, became Professor of Geology at the College in 1919 when he succeeded Professor O.T. Jones, and in 1933 followed the same person to the Chair of Geology at the University of Manchester where, at various times he also acted at Pro Vice Chancellor and Deputy Vice Chancellor. In 1950 he was appointed Director of the Geological Survey of Great Britain, a post which he held until his retirement in 1960.

The award of the Murchison Medal of the Geological Society of London to Pugh in 1952 was particularly appropriate and for the reasons outlined in the following quotation from the citation:

"During the course of your university life you applied yourself continuously to a programme of stratigraphical studies in central Wales, and you have demonstrated the degree to which detailed mapping and careful stratigraphical studies can elucidate difficult and important problems."

"In your early work you mapped the Upper Ordovician and Lower Silurian of central Wales along the north-west edge of the central Wales syncline from Aberdovey to Lake Bala, and you performed a valuable service in producing detailed maps where none previously existed and in solving many problems of correlation between the two opposed facies, shelly and graptolitic."

This aspect of Pugh's work is outlined in a little more detail by Professor O.T. Jones in a paper entitled: "The use of graptolites in geological mapping" (1953): "Professor W.J. Pugh,* together with R.M. Jehu,** succeeded in tracing a thin band of graptolitic shales, called the Nod Glas, from near Towyn on the west coast to the neighbourhood of the Bala district. In spite of its insignificant thickness this band was mapped with great precision for a distance as the crow flies of over 30 miles although actual exposures are relatively infrequent. The band overlies for most of the distance a monotonous group of dark grey shales but is overlain by a highly distinctive group of greenish-grey mottled mudstones. It was in fact the clear difference between the lithologies of the overlying and underlying groups that enabled this band to be traced so successfully. Its upper and lower limits could be determined precisely in those places where the band was well exposed. By means of it the structure of a large area of the Bala rocks of Wales was defined; it also allowed of a correlation of the rocks in the south west in terms of the subdivisions which had been established by Dr. Elles in the Bala district."

To return to the words of the citation: "In much of this research you were in collaboration with Professor O.T. Jones, and when the name of Builth is mentioned British geologists inevitably think of Jones and Pugh as one always associates Peach with Horne when thinking of the Highlands."

"In the Radnorshire area, the elucidation of a remarkable series of multi-layered dolerite intrusions within the Ordovician and the demonstration of the buried rugged shoreline of cliffs and stacks within the zone of Didymograptus murchisoni were outstanding achievements."

Professor Thomas John Jehu (1871-1943).

The next two on the list both bear the relatively unusual name of Jehu. Thomas John Jehu was born in Llanfair Caereinion, eight

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* In papers to the Geological Society of London in 1923, 1928 and 1929.

** In a paper to the Geological Society of London in 1926.

miles west of Welshpool, and educated first at Oswestry High School then at Edinburgh University where he qualified with a medical degree in 1893 and a science degree in 1894. He continued his studies in Cambridge University and there had a distinguished record, gaining a first class in both parts of the natural science tripos in 1897-98. He was Newcombe Prizeman in natural science and philosophy of St. John's College 1898, and an Arnold-Gernsternberg scholar in 1900. He was awarded the Heriot Fellowship in Edinburgh University in 1901, and during his tenure of the Fellowship undertook his first research work - a bathymetrical and geological study of the lakes of Snowdonia and eastern Caernarvonshire - the results of which appeared in a paper published by the Royal Society of Edinburgh in 1902.

In 1903 Jehu was appointed to the newly instituted lectureship in geology at St. Andrews University and continued his work on Welsh glacial deposits, and published two further papers in The Transactions of the Royal Society of Edinburgh dealing respectively with "The glacial deposits of northern Pembrokeshire" (1904) and "The glacial deposits of western Caernarvonshire" (1909). Later he began an investigation of the southern margin of the Scottish Highlands at Aberfoyle and in 1912 he announced his discovery of fossils in the rocks of the Highland Border Series in that district.

In 1914 Jehu returned to Edinburgh to succeed his old teacher, James Geikie, as Regius Professor of Geology and Mineralogy. His interest was now centred chiefly on Scottish geology and several of the resulting papers were contributed jointly with Dr. R. Campbell and Dr. R.M. Craig.

Apart from his research activities Professor Jehu did a great service to geology in Edinburgh by his efforts to raise money for the building of the present department which, opened in 1932, is still considered one of the finest in the country.

Professor Ralph Morris Jehu.

Ralph Morris Jehu of Welshpool was a distant cousin of Professor Thomas John Jehu. He was educated at Welshpool Intermediate School and graduated at the University College of Wales, Aberystwyth, under O.T. Jones and W.J. Pugh and under the geographer H.J. Fleure. His academic career was interrupted by service in France in World War 1. In the twenties after geological fieldwork between Towyn, Pennal and Abergynolwyn, which has already been mentioned, he succeeded another Welshpool product, R.U. Sayce, as Professor of Geography and Geology at Pietermaritzburg in the University of Natal, a post he held until his recent retirement.

Thus we have noted six men from within a radius of a dozen miles of Welshpool whose primary interest has been geology. They constitute an unusually large cluster for such a sparsely populated area, and it would be interesting to know whether similar concentrations have occurred elsewhere in Wales and the border counties.

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Welsh Geological Quarterly, v.1, no.2, 21-28.

## BOOKS: NOTICES AND REVIEWS

Submarine geology and geophysics. Colston Papers No.17. Edited by W.F. Whittard and R. Bradshaw. Butterworth & Co. (Publishers) Ltd., London. 1965. Pp.1-515, illustrated. £5. 5. 0.

There are twenty-three items, including:

Experiments in connection with turbidity currents and clay-suspensions.

Sedimentary basins of the Mediterranean Sea.

Bathymetry of the North-eastern Atlantic Ocean and recent geophysical studies.

The deep structure of the Northern Irish Sea - a problem of crustal dynamics.

The geology of the Western Approaches of the English Channel III. The Globigerina Silts and associated rocks.

The Rhône deep-sea fan.

The geology of the Western Approaches of the English Channel IV. A recently discovered Variscan granite west-north-west of the Scilly Isles. With appendix "The petrology of specimens from Haig Fras" by P.A. Sabine.

Submarine canyons explored by Cousteau's Diving Saucer.

Mid-oceanic ridges and tectonics of the sea-floor.

Geochemical and geophysical mineral exploration experiments in Mounts Bay, Cornwall.

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Frontiers in geographical teaching. The Madingley Lectures for 1963. Edited by Richard J. Chorley and Peter Haggett. Methuen & Co. Ltd., London. 1965. Pp.i-xii, 1-380, illustrated. £2. 2. 0.

The eighteen essays which make up the book include:

Changes in the philosophy of geography (E.A. Wrigley)

A re-evaluation of the geomorphic system of W.M. Davies (R.J. Chorley)

The application of quantitative methods to geomorphology (R.J. Chorley)

and essays on the teaching of geography in universities, colleges and schools.

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Sir Charles Lyell. Interpreter of the principles of geology. By F.J. North. (Creators of the modern world series. General Editor: E. Royston Pike.) Arthur Barker Limited, London. 1965. Pp.1-128, illustrated. 12s. 6d.

CONTENTS



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Naming the living world. An introduction to the principles of biological nomenclature. By Theodore Savory. The English Universities Press Ltd., London. 1962. Pp.i-xiv, 1-128. 12s. 6d.

CONTENTS



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The anatomy of judgement. An investigation into the processes of perception and reasoning. By M.L. Johnson Abercrombie. Hutchinson, London. 1965. Pp.1-150, illustrated. £1. 5. 0. [3rd impression.]

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# NOTES AND NEWS

## NEW AND FORTHCOMING BOOKS

A new "Guide to Gower" has just been published by the Gower Society. The book will soon be obtainable at most South Wales bookshops at a cost of 7/6d per copy. It contains brief articles on animal and plant life, geology, archaeology, history, and a useful glossary of place names.

Mr. Brian Simpson has completed a textbook entitled "Rocks and Minerals" which will be published by Pergamon Press in 1966. It covers the essentials of crystallography, mineralogy and the igneous, sedimentary and metamorphic rocks for use in Advanced Level G.C.E. examinations in geology. It will also be useful to first year university students.

Papers presented at the joint symposium meeting of the Geological Society of London and the Palaeontological Association, held on December 20th and 21st at the Department of Geology, University College, Swansea, will be published this year in a volume entitled A review of the fossil record - a summary of current knowledge of the ranges of fossil organisms through geological time.

A brief review of some of the points discussed at the meeting is given by Dr. W.S. McKerrow in the New Scientist for 6th January, 1966.

## BOOK AWARD

Kirtley F. Mather's The Earth Beneath Us (Random House, New York, 1964) has been awarded the Thomas Alva Edison Foundation's tenth Edison award for the best science book for young people.

## SURVEYING COLLECTION AT SCIENCE MUSEUM

The collection of surveying instruments at the Science Museum, Kensington, is open to the public in the Museum's new centre block gallery. Illustrating their development from ancient Egyptian times to the beginning of the present decade, the collection is presented in a revised and improved display, like the other sections in the completed new galleries.

## SURVEY OF SAND AND GRAVEL DEPOSITS

The Department of Geology, University College, Cardiff, has been invited to co-operate with the Ministry of Land and Natural Resources in preparing a new survey of sand and gravel deposits in England and Wales.

## THE SOIL SURVEYOR AND GLACIAL DRIFT

The nature of glacial drift can profoundly affect soil development in it, and so a soil surveyor is very sensitive to small changes in drift character and thin drift sola, possibly more so than many geological surveyors. An extensive soil survey in South Wales has revealed certain movements of materials which correlate with directions of ice movement ascertained on the basis of transported boulders and grooving. Thus, between St. Bride's Major and Colwinston sufficient material has been carried off the outcrop of the Carboniferous Limestone and eastwards over the Lower Lias outcrop to give rise to shallow, reddish, silty soils, completely different to the soil profiles developed elsewhere on Lias rocks, but similar to shallow soils typically occurring on the Carboniferous Limestone. The direction of transportation of surface material is consistent with the passage of ice from the Irish Sea, presumably during the penultimate Riss Glaciation as ice failed to reach the Vale during the last (Würm) glaciation.

In South Breconshire identifiable surface débris derived from the Old Red Sandstone outcrop has been carried southwards on to the outcrop of the Carboniferous Limestone (where it is low-lying relative to the surrounding terrain), consistent with the movement of ice south from the heights of the Brecon Beacons range during the ultimate Würm Glaciation. In the shallow, stony solum highly acid soils, peaty gleyed podzoles, have developed over calcareous rocks, to yield an apparently anomalous sequence. North of Craig-y-Llyn the Würm ice flow split into two streams, one passing each side of the prominence. Ice piled up in front of Craig-y-Llyn, locally pressing back and carrying identifiable sandy material derived from the Millstone Grit outcrop on to the Carboniferous Limestone, in which shallow and highly acid/podzolized soils have since developed."

solum

C.B. Crampton,
Soil Survey of England & Wales.

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Solum - that part of the soil profile in which the processes of soil formation occur; i.e. the soil proper.

## TRILOBITE APPENDAGES

The following quotation is taken from Henry Woodward's Anniversary Address as President of the Geological Society of London in 1895 and should be read in conjunction with the longer quotation from Professor H.B. Whittington's Natural History of Trilobites quoted in the first number of the Quarterly:

"One cannot help ... imagining the joy with which so enthusiastic and earnest a worker as Salter would have welcomed and revelled in the recent discoveries of the long-sought appendages of the trilobites, which, alas! he did not live to see."

"In 1864 he observed:- 'Every author who has written on trilobites has more or less perceived their analogy with the Limulus or King-crab, to which tribe there is, indeed, a good deal of external resemblance. But this resemblance totally fails when we examine the under side of the animal; for all the researches hitherto made (and they are many) fail to detect the slightest traces of limbs in the trilobite.' .... 'It is impossible, seeing the state of preservation in which they occur, to suppose that in every case - in fine shale, in limestone, in arenaceous mud - all traces of these organs should have been lost, had they ever existed. We are compelled to conclude that trilobites had not even membranaceous feet, and that the ventral surface was destitute of appendages.'

" Fortunately, these long-sought organs have now been discovered."

## UNDERGROUND STORAGE OF GAS

Part 11 of the Gas Act 1965, which is now in force, provides for the development and control of underground gas storage in Great Britain. Under this legislation the Gas Council and the Area Gas Boards are enabled, under Government supervision, to use natural porous strata underground for the storage of gas where this is safe and advantageous. A recent pamphlet issued by the Ministry of Power answers some of the questions which may be asked about underground gas storage. For example: What is underground storage? How is the gas put into the porous layer and what keeps it there? What happens when gas is taken out of storage? Is underground storage in porous strata something new? Can suitable conditions be found in this country? Is underground gas storage safe? What safety control will be exercised over an underground storage? And so on.

## NEW WALL CHART

"A new wall chart, 'Stone and Concrete', the second in a series of five entitled, Diamonds at Work, is now available free of charge from the Industrial Diamond Information Bureau, Arundel House, 36-43 Kirby Street, London, E.C.1. Measuring 3¼ ft X 2 ft, and printed in four colours, the chart illustrates major applications for diamond tooling in the stone, rock-drilling, concrete and construction industries."

"In rock-drilling, which covers exploratory work for oil, coal, gold and other mineral deposits as well as geological investigations for purely scientific purposes or to test the earth's structure before the start of major engineering projects, diamond-studded drill crowns have been established for many years, both for coring and non-coring use."

" A more recent development has been the widespread adoption of diamond-tooling by the stone industry. Fast, accurate diamond-blade circular, frame and band saws have saved the industry from virtual economic extinction in many countries."

An extract from a note in The School Science Review, July 1965.

## PERSONAL

George Askey has been appointed an Inspector of Schools for the City of Cardiff; D.A. Bassett has accepted an invitation to represent Wales on the Water Resources Board and to serve on the Welsh Committee of the Board; D.E.T. Bidgood has accepted an invitation to become an Associate Scientist with the Nova Scotia Research Foundation, Halifax, Nova Scotia; D.E. Morgan has been elected Chairman of the Corresponding Societies Committee of the British Association for the Advancement of Science; F.H.T. Rhodes is spending a year at Ohio State University as a Senior Research Fellow of the National Science Foundation; R.A. Stevens has been awarded a Travelling Fellowship of the Worshipful Company of Goldsmiths to visit France, Switzerland and Austria for three months in order to study methods of education in engineering.

## NEW WOODWARDIAN PROFESSOR

Professor H.B. Whittington of Harvard University has been appointed Woodwardian Professor of Geology at Cambridge University to succeed Professor O.M.B. Bulman.

GEOCHEMICAL SURVEY

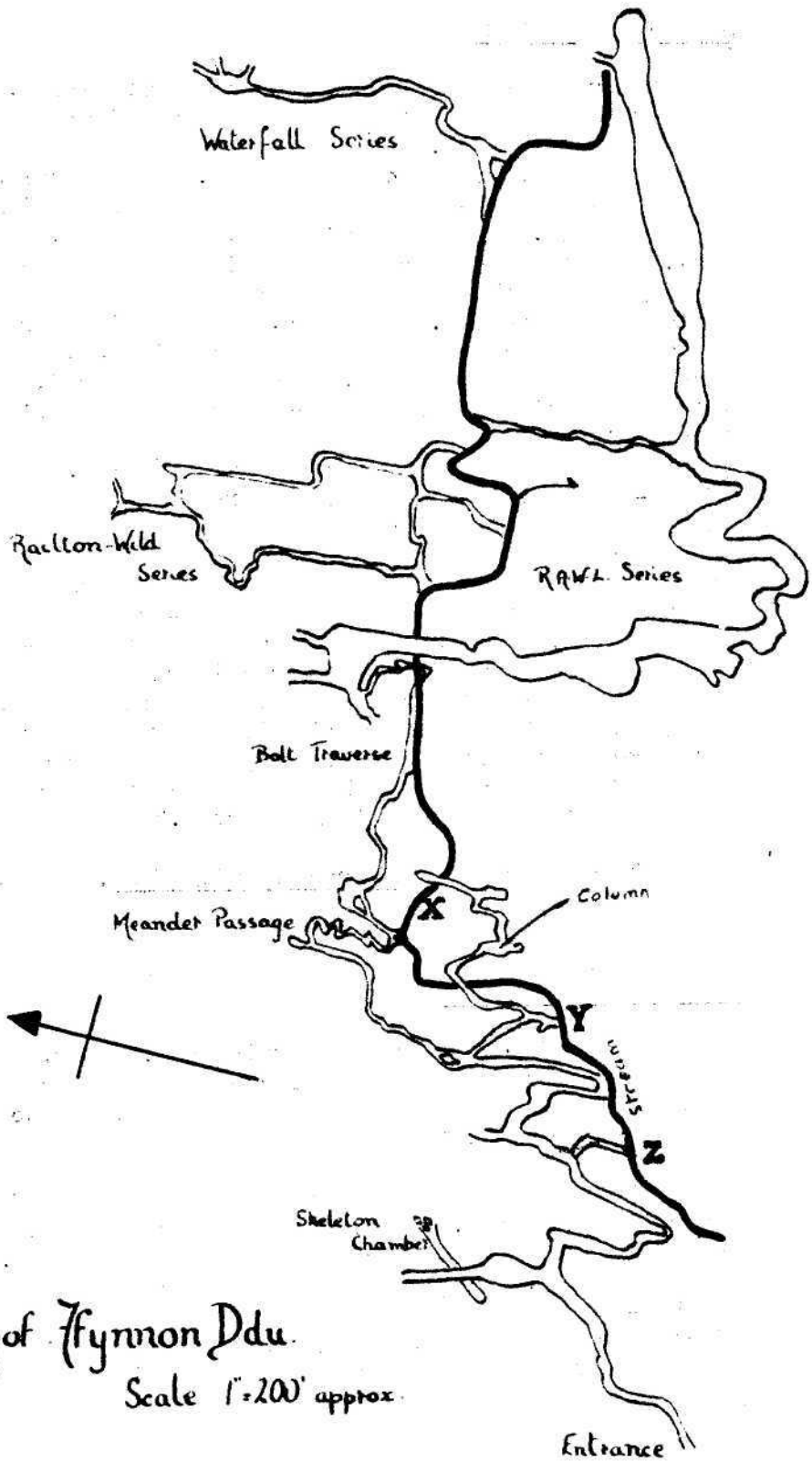
"Surveys are being carried out in Derbyshire, North Wales and Devon in an attempt to find out what mineral sources lie in and beneath the soil. In particular geologists are looking for traces of lead, zinc, copper and tin, it is disclosed in the latest report giving the summary of progress of the Geological Survey of Great Britain, and Museum of Practical Geology. The report, for 1964, says that the surveys are being concentrated around Denbigh and Rhyl in North Wales; Holsworthy and Okehampton in Devon, and Buxton in Derbyshire. The surveys are being carried out under a research contract placed with the Imperial College of Science and Technology under the supervision of Professor J.S. Webb. 'We are not just looking for lead, copper, zinc and tin,' said Professor Webb. 'They are only four of the fifteen or twenty elements we are investigating in a general research study. This is a method of geo-chemical reconnaissance whereby we hope to produce maps showing the distribution of these elements on a regional scale.' Within the next few years, groups of scientists will be touring Britain taking samples of water and sludge from the bottom of hundreds of streams to produce the geo-chemical map of the soil of this country. Professor Webb said that the geo-chemical survey will have mineral mining and agricultural aspects with the accent on the latter for the results will be mainly concerned with constitution of the top layer of soil and rock in Britain. Initially his department will be taking samples from North Wales and Derbyshire but this was purely in the nature of a reconnaissance to be followed later by a much fuller survey."

Extract from the Liverpool Daily Post, 30.12.65.

ALFRED SHERWOOD ROMER

The following story concerning A.S. Romer, the vertebrate palaeontologist and recently elected President of the American Association for the Advancement of Science, is quoted in Science (February, 1965, p.890):

"His associates have hung two photographs of Alfred Sherwood Romer in his office. One, labeled Alfredum shows a scholarly individual in the academic regalia of a Harvard Sc.D.; the other, labeled Roamer, is of an unshaven character in battered hat and weather-stained clothes who looks as though he had just been ejected from a box car. They vividly express two facets of Romer the scientist - the field as well as the laboratory worker."




# Ogof Ffynnon Ddu

Scale 1"=20' approx

# OGOF FFYNNON DDU

R.A. Stevens.

Ogof Ffynnon Ddu is one of the best known caves in South Wales. C.H.D. Cullingford, in his book British Caving, states that in addition to being the best surveyed cave in the country, it is the one in which the applicability of the various theories of cave formation has been most carefully examined.

The present note briefly summarizes the literature on the cave and provides supplementary information for the members of the South Wales Group of the Geologists' Association who visited the cave last summer.

On May 22nd, 1965, members of the Group visited Ogof Ffynnon Ddu near Craig-y-Nos in the Tawe valley. In such a brief visit it was only possible to cover about three-quarters of a mile of the three-and-a-half miles of the cave system so far surveyed; that is to say the "Entrance Series" and part of "Stream Passage". These portions form a main route through the cave and other series of passages such as the "Rawl Series", "Waterfall Series", etc. communicate with the main route to produce a most intricate system.

The cave takes its name from Ffynnon Ddu - the black spring - a powerful rising in what appears to be a cave entrance on the east side of the valley (Grid ref:- SN.847151). Numerous attempts were made to force an entrance, but the stream emerges through a mass of boulders (boulder-choke) which could not be passed. In 1946, however, Harvey and Nixon of the South Wales Caving Club eventually entered the cave system through an excavation in a dry valley nearby. The present entrance was made a short time later and at a short distance away (Grid ref:- SN.848153). The entrance to the cave is marked on both 1-inch and 2½-inch Ordnance Survey sheets.

In a pioneer study of Ogof Ffynnon Ddu, E.A. Glennie* showed, by tracing individual beds of limestone, that much of the complex cave system encountered on entering the cave is developed within a very small range of strata in the $D_2$ sub-zone of the Carboniferous Limestone which at this point dips almost due south at 16°.

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* GLENNIE, E.A. 1. Some points relating to Ogof Ffynnon Ddu. Trans. Cave Res.Grp.,Gt.Brit., 1, no.1, December 1948.

2. Further notes on Ogof Ffynnon Ddu. Trans.Cave Res.Grp., Gt.Brit., 1, no.3, March 1950.

A large portion of the cave was surveyed by C.L. Railton* and other members of the South Wales Caving Club in the early fifties, and there is available a reliable plan accompanied by sections and a descriptive memoir. Because the plan gives a two-dimensional view only of what is a complicated three-dimensional system, the longitudinal sections of passages are essential to give their vertical position, and the transverse sections to give the shape of the cross-section which can vary very much over short distances.

The stream that now runs through the cave is the Byfre Fechan, but this is certainly not the agent that formed the cave originally. It rises on Fan Girhirych, flows due south for about a mile and a half and then turns towards the west. After a short distance it turns south west and sinks at Pwll Byfre (SN.875167). If the original westerly course is followed it leads to Nant Byfre which is the course of the stream before it was diverted by a Late Glacial moraine; a feature clearly seen on the 2½-inch map. The resurgence is at Ffynnon Ddu (847151) which is about 500 feet from the cave entrance and which was visited before the party entered the cave.

The resurgence is nearly two miles from Pwll Byfre, the connection has been proved by means of dye in the water, but the furthest accessible point in the cave is less than a mile from the entrance. This suggests that there is a further cave system that has not yet been entered, although an extensive system has been discovered which can be entered from Cwm Dwr quarry at Penwyllt and lies almost on a line joining the sink resurgence and may be related.

Glennie's studies on the system, which appear to be unique, provide a possible mode of formation for the cave suggesting that the origins go back well before the Ice Age. It must be borne in mind, however, that at the time of publication in 1950 much less of the system was known, and to the writer's knowledge no further work has been carried out on the geology and hydrology of the cave. It is felt that the study of Ogof Ffynnon Ddu in particular and of caves in general has been very much neglected, particularly by professional geologists and by the university departments and would well repay more attention.

Acknowledgements. Sincere thanks are due to Mrs. A.M. Williams, Mr. D.W. Jenkins and Mr. E.G. Inson of the South Wales Caving Club for their help in leading the party, and to Mrs. J. Barrows of The Grithig for permission to visit the cave.

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* RAILTON, C.L. The Ogof Ffynnon Ddu System. Cave Res.Grp.Pubn. no.6, 1953.

# IN SEARCH OF A CAVE

Clive Jones.

Members of the South Wales Caving Club have, during the twenty years of the Club's existence, discovered a number of important caves and potholes, including the spectacular Ogof Ffynnon Ddu, Pant Mawr Pothole and Tunnel Cave. Nevertheless, some of the first problems that the Club members set out to solve just after World War II remain unsolved. One such problem - Waen Fignen Felin - is summarized briefly by Clive Jones, sometime Secretary of the Club.

The mystery attached to the peat bog known as Waen Fignen Felin in Cwm Haffes in the Tawe valley, was known long before the formation of the South Wales Caving Club, because it is one of the main sinks for the well-known Dan-yr-Ogof cave system near Craig-y-nos Castle. This cave was discovered in 1912 and soon attracted cavers from all over the country. It was readily apparent that part of the water at Dan-yr-Ogof came from a peat bog which drained into a swallow hole and that there should, therefore, be a large cave system between this sink and the known cave. It was, however, far from apparent how to gain entrance into it.

It proved impossible to proceed far in the cave as a mass of boulders (boulder-choke) and a number of water-traps (sumps) blocked the way. Attention had therefore to be turned to the sinks. At first the peat bog was not considered a possible route into the inferred part of the cave because most cavers thought it was a recent invasion of water into a well established cave system and the new part of the cave would be nothing but enlarged joint-planes and bedding-planes, probably too narrow for cavers to negotiate.

In 1936, however, four members of the Dragon Group (an offshoot of the Wessex Caving Club) started excavating near the western edge of the bog. By 1947, despite very many disasters, they had sunk a shaft forty-five feet deep and they could see a large black space at the bottom of the shaft. All looked well for a big discovery, but when they returned to the excavation the week-end after the first sighting of the space, they found the entire shaft had collapsed. In consequence, after eleven years of work with nothing to show for their efforts, they abandoned the project and chiselled "Dig to let" on the cliff wall.

In the years following a number of less spectacular attempts were made, but to no avail.

In 1963 another big effort was mounted, this time by twenty members of the South Wales Caving Club. On August Bank Holiday 1963, two-and-a-half tons of timber, a winch, a generator and other equipment, including an electric power (Kango) hammer, were taken up to the site. A week later the timber was lining a shaft thirty-five feet deep in the same place as the original shaft, but this time the shuttering was secure, the spoil from the shaft was being used to build a dam across the stream in order to prevent flooding, a cable railway with tipping buckets and the winch were speeding up the work, and the generator and Kango hammer were helping to make the most efficient use of the explosives. In a few weeks the forty-five feet mark was reached, the black space seen by the Dragon Club was entered, but it turned out to be a bedding plane with no way on other than through loose boulders on the floor. It was decided, therefore, to dip deeper. Despite many problems and difficulties, the shaft is now nearly ninety feet deep, and although there has been heavy flooding in recent years, the shuttering has remained secure.

In spite of the slow progress, particularly during the bad weather this year, a number of Club members still have a great deal of enthusiasm for Waen Fignen Felin. The work will, therefore, continue until the shaft reaches either rock bottom or a cave system. The facts collected during the investigation indicate that the sink is not a new invasion of an established system, but a collapse of part of a very large cave. And one fact is particularly encouraging: there is a strong draught in the excavation. As the majority of the bigger finds made by members of the Club have followed this "wind of chance", there is hope that the air current at Waen Fignen Felin will be true to form and lead to the missing miles of Dan-yr-Ogof.

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Welsh Geological Quarterly, v.1, no.2, pp. 39-40.

## Advertisements

The first number of the Welsh Geological Quarterly contained the following items:-

Editorial

The National Association of Geology Teachers

In search of trilobite appendages

A list of Welsh geological theses at present in preparation

Geology in the C.S.E. Examination

C.S.E.: Draft syllabus in geology

C.S.E.: Specimen paper in geology

General geology of Llanharry mine

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