

GEOLOGISTS' ASSOCIATION

SOUTH WALES GROUP

**T
H
E**

**WELSH
GEOLOGICAL
QUARTERLY**

**WELSH
GEOLOGICAL
ABSTRACT**

VOL. 2 NO. 4 SUMMER 1967

ERRATA

Welsh Geological Abstracts : 1966

Page 21: Delete SQUIRRELL, H.C. See DOWNING, R.A.

Page 22: Insert SWITSUR, V.R. See GODWIN, H.

Geologists' Association - South Wales Group

WELSH GEOLOGICAL QUARTERLY

Volume 2.

No.4.

Summer 1967

CONTENTS

Page

Editorial	2
A brief review of discoveries in British palaeontology. (Based on a memorandum commissioned for the 'Dome of Discovery' at the 1951 Exhibition.)	3
News and Notes	12
Contributors to Volume 2 (W.G.Q.)	14
Conference of Geology Teachers at Keele University. September 22nd-24th, 1967.	15
The imprint of structural lineations on the physical landscape of Wales	17
Death of an Investigation	19

Welsh Geological Abstracts : 1966	(Separate pagination) 1-27
Welsh Geological Abstracts : 1965 (Supplement)	28
Locality Index	30
Subject Index	32

EDITORIAL

The main item in this, the last part of the second volume of the Quarterly, is Welsh Geological Abstracts : 1966 - a record of the 105 publications dealing wholly or in part with Wales and the Welsh Borders.

In order to increase the usefulness of this annual item, the indexes are cumulative and the subject index is a classified one, in contrast to the alphabetical arrangement of the index in Welsh Geological Abstracts : 1965.

Items inadvertently omitted from last year's abstracts are included in a supplement (pp. 28, 29).

Acknowledgements: Permission to reproduce the article, "Death of an Investigation" by Robert E. Samples, was kindly given by the Editor of the Journal of Geological Education. The photographs in the original article could not be reproduced properly by the copying process used and were, therefore, replaced by captions. The cover was designed and printed by Vivian S. James, Barry; the text was prepared and cyclostyled by Mrs. Jean Parsons.

A BRIEF REVIEW OF DISCOVERIES IN BRITISH PALAEOLOGY

(Based on a memorandum commissioned for the
'Dome of Discovery' at the 1951 Exhibition)

John Challinor

INTRODUCTION

In Britain there are stratified rocks representative of nearly all geological ages and many of these strata are very fossiliferous. There is probably no part of the world of equal size which is so rich in material for the palaeontologist.

From the time when fossils first began to attract attention there have always been scientific naturalists in Britain possessing an ability and enthusiasm worthy of this material. The history of British discoveries in palaeontology is a proud one and the work now being done worthily upholds this record.

DISCOVERIES TO THE END OF THE EIGHTEENTH CENTURY

Casual records of the occurrence of fossils in the British rocks may be found in the topographical and antiquarian descriptions by Leland and Camden in the sixteenth century, so we may say that the existence of fossils in this country had been discovered by that time. Moreover it is possible to point to the great Lias ammonite, Arictites bucklandi, as the first fossil species to have been discovered in Britain, as references by these writers to the "snake-stones" of Keynsham, Somerset, are obviously to that well-known form.

It is in the second half of the seventeenth century, when there was a great outburst of scientific activity in Britain, that we find a real interest being taken in British fossils. Discoveries were then deliberately undertaken, the specimens were carefully described and figured, and vigorous discussion began to rage about their nature. They were difficult to account for because no correct geological notions were yet current and the origin of the rocks themselves, in which the fossils were found, was not inquired into. The fact that they were considered to be so curious probably stimulated their discovery. In the regional "natural histories" of the time they took a remarkably prominent place. It was the riches of the English Jurassic rocks that supplied most of the specimens found.

The discoveries of Robert Hooke, "Curator of Experiments" to the Royal Society, stand out from the rest for his careful descriptions and drawings, particularly of ammonites, and his sound reasoning (1665, 1705). His was one of the most brilliant and versatile intellects of the period. He not only discovered the fossils themselves (mentioning his hammer, the palaeontologist's tool of discovery) but from observations of their substance and occurrence discovered their true nature at the same time.

Some seventy species were described and figured by Robert Plot, the first Keeper of the Ashmolean Museum, in his work on Oxfordshire (1677). Here we have many well-known forms (named later), such as the echinoid Clypeus plotii,

and the essential differences between brachiopods and lamellibranchs were discovered. Martin Lister (1678) brought to light further species and Edward Lhwyd (1699) wrote (in Latin) and illustrated the first work devoted entirely to British fossils. He described 1776 items and figured 267. Of these figures that of Lithostrotion basaltiforme is one of the most noteworthy. Fossils occupy most of the large plates of illustrations in John Morton's "Northamptonshire" (1712) and many are included in John Woodward's catalogue (1728-29) of a remarkably full and representative collection of "fossils" (in the old comprehensive sense as including all kinds of geological specimen), localities being carefully recorded, always a very important point.

After this there was a pause until we come to the first systematic discoveries among the richly fossiliferous Tertiary strata of southern England. These were made by Gustavus Brander and were described, with beautiful drawings, by D.C. Solander in the first fossil catalogue issued by the British Museum (1766). The scientific accuracy of this work makes it a landmark in the history of research among British fossils. It was an isolated event, as little was done, except for some records near Bath by John Walcott (1779), in making fresh discoveries of British fossils until the beginning of the next century, when truly scientific palaeontology became firmly established in Britain.

DISCOVERIES FROM ABOUT 1800 TO 1840

It was William Martin and James Parkinson who were the pioneers in the new era of discovery. The former accurately described many, now well-known, fossils from the Carboniferous Limestone (particularly) of Derbyshire (1809). Among these may be mentioned the brachiopod since named Martinia glabra. Parkinson in three large volumes of "letters" (1804-11) described fossils from many parts of the country. One of those receiving special attention was the pear-encrinite, now known as Apicrinus parkinsoni, from Bradford, near Bath, though this had been found before by Walcott. The discoveries of Martin and Parkinson were given to the world in the form of excellent descriptions and numerous fine plates of tinted engravings.

Now appeared on the scene William Smith, the "Father of English Geology". Apart from his great map of England and Wales, he published two important works (1816, 1817) in which he recorded and illustrated the details of his discovery that strata of different ages are distinguished by characteristic fossils. He thus established a principle of the first importance.

Meanwhile another principle which had been recently made apparent in France was applied to certain Tertiary strata in Britain by Thomas Webster (1814). This was that the marine or freshwater conditions of deposition of beds could be inferred from the types of fossil shells.

Knowledge of British fossils was now advancing apace and this became incorporated in the work of James Sowerby and his son (1812-29) in which specimens collected in various parts of the country and representative of some two thousand distinct species were carefully illustrated and briefly described.

Geological works henceforward came to pay great attention to the fossils recorded in the several strata, as may be seen in W.D. Conybeare and William Phillips' book (1822), the first comprehensive account of British geology. In the same year Parkinson published the first British text-book of palaeontology ("oryctology") in which discoveries made up to that time were summarized.

Continued advance in our knowledge of the occurrence of British fossils is shown by S.P. Woodward's list (1830) and by the copious lists in H.T. De la Beche's general work (1831).

Etheldred Benett was perhaps the first woman to be a geologist. In 1831 she published a noteworthy catalogue of Wiltshire Mesozoic fossils, including a number of newly-discovered species.

Several outstanding works on British geology were published during the next decade and two of these are of special importance in describing new palaeontological discoveries. These are the volumes on Yorkshire by John Phillips (1829, 1836) and on the "Silurian" region by Roderick Murchison. In the former, knowledge of Mesozoic and Carboniferous fossils was greatly advanced.

Murchison's great work (1839) recorded the discovery of the rich Lower Palaeozoic fossil faunas of England and Wales, hitherto unknown except for a few casual occurrences. Here we find most of the well-known species described and illustrated, Murchison calling to his aid other palaeontologists, especially J. de C. Sowerby and W. Lonsdale. The majority of the species were new to science. Great help was given by local collectors, particularly by the Rev. T.T. Lewis of Aymestry and Dr. Lloyd of Ludlow. With the publication of "The Silurian System" we may say that British discoveries in palaeontology had brought to light all the commoner fossils from nearly all the British formations (except those of the Cambrian system).

DISCOVERIES BY THE GEOLOGICAL SURVEY

The collection and identification of fossils has always been an important part of the work of the British Geological Survey which started, under De la Beche, in 1835. In the earlier days the chief palaeontologists were John Phillips, Edward Forbes, and J.W. Salter. Until his recent retirement the Director-General was the distinguished palaeontologist, Sir James Stubblefield.

From 1849 to 1872 there were published a series of memoirs ("decades") giving detailed figures and descriptions of "British organic remains". A new series of palaeontological monographs was inaugurated in 1908 with the publication of an account of the Survey finds of the Higher Crustacea in the Scottish Carboniferous rocks, by B.N. Peach.

DISCOVERIES RECORDED BY THE PALAEONTOGRAPHICAL SOCIETY AND THE PALAEONTOLOGICAL ASSOCIATION

The Palaeontographical Society began publishing its long series of monographs in 1848 with the first part of S.V. Wood's "Crag Mollusca". In

these monographs discoveries in the field are combined with the most careful and minute examination and comparison in the laboratory and with consultation of all the relevant literature. They have always stood as the chief monuments to the advance of knowledge in the descriptive palaeontology of British fossils. The more recent works reach a very high standard in the beauty of their illustrations and in the technical skill and scholarship brought to bear throughout. Notwithstanding the wealth of material already dealt with an almost limitless amount (much already collected, vastly more still entombed in the rocks) remains to be treated in a similar manner.

The remark may be interpolated here that fossils were more readily discovered in former times in, particularly, the inland parts of southern England when numerous quarries, now filled up, provided excellent rock-exposures.

In 1957 appeared the first number of Palaeontology, published by the newly-founded Palaeontological Association. All aspects of palaeontology are treated, and with such perfection of presentation (text and picture) that one is tempted to assert (no doubt rashly) that here the ultimate has surely been attained.

SPECIAL DISCOVERIES - INDIVIDUAL, MORPHOLOGICAL, AND STRATIGRAPHICAL

As is to be expected, keen local naturalists with intimate knowledge of the rock-exposures in their own districts have often made important discoveries of fossils. Thus, as one example, Col. Colvin of Leintwardine, Herefordshire, was chiefly responsible for the discovery, about 1860, of the remarkable remains of starfish in the Lower Ludlow beds of Church Hill quarry near that place.

Possibly the most extensive and important discoveries of fossils from the British rocks ever made by one person were those bringing to light a vast number of beautifully preserved specimens, belonging to several groups, from the Ordovician rocks of the Girvan district, Ayrshire. These collections were made by Mrs. Robert Gray during the latter part of the nineteenth century and they have been described in detail by specialists, e.g. the trilobites by F.R.C. Reed (1903-06) and the cystids by F.A. Bather (1913).

The discovery of the riches of the British Lower Cambrian fauna of trilobites, brachiopods etc., the oldest fossils to be found, is almost entirely due to E.S. Cobbold, of Church Stretton, Shropshire, who collected exhaustively from the locality of Comley. He was also the describer of his own discoveries, in a series of papers of which that on the fossil shells (1920) is one. This fauna was first found to be present in this area by Charles Callaway, and Charles Lapworth, in 1885, was the first to detect recognizable fragments of the characteristic Lower Cambrian trilobite, Callavia (1888, 1891).

The Lias of the Dorset coast has long been famous for its fossils, particularly its ammonites. The chief discoverer here was W.D. Lang, of the British Museum, and one group of these ammonites has been described in great detail by L.F. Spath (1938).

Discoveries, notable for the philosophical interpretation of detailed morphology, have been made among echinoids by H.L. Hawkins (e.g. 1920) and as an example of intensive morphological studies among fossil corals, mention may be made of the work of Stanley Smith (e.g. 1915). James Wright has gradually made many discoveries among the fossil crinoids and their allies, particularly in Scotland (1939 and later papers).

The search for fossils has been greatly stimulated by their application in stratigraphy. This was particularly so in the case of the graptolites, the zonal (time) value of these fossils in the Lower Palaeozoic rocks being first made clear by Charles Lapworth, particularly in his work on the Moffat district, Dumfriesshire (1878). Notable discoveries of the value of fossils as time-markers have been made among the Carboniferous formations, and attention has thus been intensively directed to the collection and discrimination of the various forms. The chief names here are Arthur Vaughan (1905), W.S. Bisat (1924) and J.H. Davies and A.E. Trueman (1927) who respectively established the classification of the Carboniferous Limestone by means, chiefly, of the fossil corals, the Millstone Grit by the goniatites and the Coal Measures by the non-marine lamellibranchs.

DISCOVERIES IN EVOLUTIONAL PALAEOLOGY

While the discovery of specimens in the several strata, and their extraction, examination, description, and comparison must always remain the primary discoveries in palaeontology, the philosophical results that emerge from these records are themselves discoveries and are indeed the final object and justification of palaeontological exploration. The reconstruction of the life of the successive geological ages is the immediate generalization.

Fossils constitute the only evidence we have as to the course of evolution in the past. It is curious that, apart from the rise and fall of groups (some now extinct), abundantly shown in the fossil record, detailed evidence of the phylogenetic relationships of genera and species is much less common and certain than might have been expected.

The fact that at least one group, the graptolites, revealed a connected story of gradual change was discovered by H.A. Nicholson and J.E. Marr (1895) and this story was made much more complete by Gertrude Elles (1922) and O.M.B. Bulman (1958). In 1899 A.W. Rowe published the results of his intensive collection and critical examination of some thousands of specimens of echinoids belonging to the genus Micraster from the Chalk of southern England and he was able to demonstrate a very gradual evolution in form and structural details. Other well-known discoveries in this connection are R.G. Carruthers's (the Carboniferous coral genus Zaphrentis, 1910) and Trueman's (the Liassic members of the lamellibranch family, the Ostreidae, 1922).

DISCOVERIES OF FOSSIL VERTEBRATES

In fossil vertebrates, actual discovery of specimens has largely been made by skilful, enthusiastic, and patient collectors, living in the

locality, while the description of them and the interpretation of their affinities, matters requiring special training and often of great difficulty, are necessarily the work of professional experts in the museum and laboratory.

Drawings of a few bones and teeth of vertebrates found their way onto the plates of engravings in the early works.

The most interesting British fossils belonging to the class of the fishes are the ancient, extinct and peculiar forms from the Old Red Sandstone of Scotland (and elsewhere). Some of the earliest and most famous discoveries among these were made by Hugh Miller, so picturesquely described in his well-known book (1841), and at about the same time by Robert Dick, baker, of Thurso. These specimens, as also those provided by Murchison and others, were technically described by the Swiss "ichthyologist", L. Agassiz. The monograph on the Old Red Sandstone Cephalaspid fishes by E.A. Stensiö (1932) is an outstanding example of palaeontological technique.

Discoveries of fossil fish remains, particularly from the Carboniferous formations, were catalogued and described by R.H. Traquair (1877-1914). Those from the Mesozoic were first brought prominently to notice by the discoveries and descriptions of G.A. Mantell (1822) and detailed comprehensive descriptions of the numerous later discoveries from these rocks were made by A.S. Woodward (1902-19).

Important discoveries in the Jurassic strata of the group of extinct swimming reptiles were made in the earlier part of the nineteenth century, several of the first and most notable finds being those of Mary Anning, daughter of a cabinet maker and fossil dealer at Lyme Regis. The first of these was that of the Ichthyosaurus in 1811. The fossils of this and allied genera were described by W.D. Conybeare (1821-24). Mary Anning was also the first discoverer of the Pterodactyle in England, described by William Buckland (1835). There are two famous discoveries of British dinosaurs, those of the Megalosaurus from the Stonesfield Slate, by Buckland (1824) and of the Iguanodon from the Wealden of Sussex by Mantell (1825). Richard Owen, one of the most illustrious of vertebrate palaeontologists, described all the known British fossil reptiles in a series of monographs (1851-89).

The peculiar mammalian remains occurring ⁱⁿ the Mesozoic rocks were first found in Britain by W.J. Broderip in the Stonesfield Slate and were identified by the great French palaeontologist, Cuvier, in 1818. Other specimens of Mesozoic mammals have been described by Owen (1871).

Remains of extinct mammals, of Pleistocene age, to be found in cave deposits were first brought prominently to notice by Buckland (1823), his first discoveries being made in a cave at Kirkdale, Yorkshire, in 1821. Later discoveries among these fossils, both in caves and in river-deposits, have been described by Boyd Dawkins (1866-87) and by S.H. Reynolds (1902-12).

A freakish episode in the history of British palaeontology is the discovery of the "Palaeolithic human skull" at Piltown in 1911, the elaborate description and discussion of it, its elevation to an apparently secure

place among the most important fossil specimens ever found, and its final exposure, recently, as a fraud.

DISCOVERIES OF FOSSIL PLANTS

The carbonized remains, together with the impressions and, in some cases, internal casts, of the stems and fronds of plants are conspicuous fossils in the Coal Measures. Notices and figures of some of these are to be found among the records and descriptions in the early works. They form a considerable proportion of the fossils described by Martin (1809) and, with leaves and fruits from later formations, of those described by Parkinson (1804-11). A more systematic description of discoveries of British Coal Measure plants was made by F.T. Artis (1825) and in 1837 appeared J. Lindley and W. Hutton's large work comprising descriptions of the British fossil plants known up to that time.

In 1831 a new method of investigation was established which elevated the study of fossil plants into a science dealing with copious and highly significant structural detail. This was the method of the microscopical examination of thin sections of petrified material, particularly in "coal balls". Thus palaeobotany became a science to be pursued by botanists. This important discovery was described by H. Witham and great contributions to the use of the method were made by William Nicol.

The splendid material from the Coal Measures continued to provoke more and more intensive search for specimens and this, combined with advancing technique in their study, led to more and more extensive and exact knowledge. The monograph by E.W. Binney (1867-75), a long series of monographs by W.C. Williamson (1871-91) and the unfinished monograph by R. Kidston (1923-25) are the chief monuments to this work. Discovery, in the sense of the collection of a great mass of material and its careful analysis as regards kind and stratigraphical horizon, is exemplified by D. Davies's work on the fossil plants of South Wales (1929).

Meanwhile, in 1903, the dramatic discovery was announced by F.W. Oliver and D.H. Scott that certain seeds, long known as detached fossils in the Coal Measures, were borne on fronds hitherto unhesitatingly taken to be true ferns. Thus was brought to light the existence of the surprising group of the pteridosperms, or "seed-ferns". Equally dramatic was the discovery, described in a series of papers by R. Kidston and W.H. Lang (1917-21), of fossils belonging to an extremely primitive group of land plants preserved with microscopic structure intact in a volcanically silicified peat bog in the Old Red Sandstone at Rhynie, Aberdeenshire. Many discoveries among the fossil plants in Devonian and Carboniferous rocks were made by E.A.N. Arber (e.g. 1921).

Interest in the British Mesozoic floras was greatly enhanced by Williamson's discovery (1870) of a genus of peculiar cycad-like plants, later to be named Williamsonia. A.C. Seward, one of the greatest of palaeobotanists, became the chief investigator of our Mesozoic fossil plants (1894-95, 1900-04), while Marie Stopes also made important discoveries and researches (e.g. 1918). In 1925 Hamshaw Thomas discovered a new group (the Caytoniales) of seed plants from the Jurassic rocks of Yorkshire.

Fossil plants, particularly fruits and seeds, from certain British Tertiary formations (London Clay and Bembridge Beds), have been fully described by Eleanor Reid and Marjorie Chandler (1926-33).

REFERENCES

- ARBER, E.A.N. 1921. Devonian floras.
- ARTIS, F.T. 1825. Antediluvian phytology.
- BATHER, F.A. 1913. Caradocian Cystidea from Girvan. Trans.R.Soc.Edinb., 49.
- BENNETT, E. 1831. Organic remains of the county of Wiltshire.
- BINNEY, E.W. 1867-75. Fossil plants in Carboniferous strata. Palaeontogr. Soc.
- BISAT, W.S. 1924. Carboniferous goniatites of the north of England. Proc.Yorks.geol.Soc., 20.
- BRANDER, G. 1766. Fossillia Hantoniensia.
- BUCKLAND, W. 1823. Reliquiae Diluvianae.
- _____ 1824. Megalosaurus. Trans.geol.Soc.Lond., series 2, 1.
- _____ 1835. A pterodactyle in the Lias at Lyme Regis. Trans. geol.Soc.Lond., series 2, 3.
- BULMAN, O.M.B. 1958. Sequence of graptolite faunas. Palaeontology, 1.
- CARRUTHERS, R.G. 1910. Evolution of Zaphrentis delanouei. Quart.J. geol.Soc.Lond., 66.
- COBBOLD, E.S. 1920. Cambrian horizons of Comley. Quart.J.geol.Soc.Lond., 76.
- CONYBEARE, W.D. 1821-1824. Ichthyosaurus and Plesiosaurus. Trans.geol. Soc.Lond., 5, series 2, 1.
- _____ and W. PHILLIPS. 1822. Geology of England and Wales.
- DAVIES, D. 1929. Palaeontology of the Coal Measures of east Glamorgan-shire. Philos.Trans., B, 217.
- DAVIES, J.H. and A.E. TRUEMAN. 1927. Non-marine lamellibranchs of the Coal Measures. Quart.J.geol.Soc.Lond., 83.
- DAWKINS, W.B. 1866-87. British Pleistocene Mammalia. Palaeontogr.Soc.
- DE LA BECHE, H.T. 1831. Geological Manual.
- ELLES, G.L. 1922. Graptolite faunas of the British Isles. Proc.Geol.Ass., Lond., 33.
- HAWKINS, H.L. 1920. Ambulacrum in the Echinoidea Holactypoida. Philos. Trans., B, 209.
- HOOKE, R. 1665. Micrographia.
- _____ 1705. Discourse of Earthquakes.
- KIDSTON, R. 1923-25. Fossil plants of the Carboniferous rocks of Great Britain. Mem.geol.Surv.U.K.
- _____ and W.H. LANG. 1917-21. Old Red Sandstone plants showing structure. Trans.R.Soc.Edinb., 51-52.
- LAPWORTH, C. 1878. Moffat series. Quart.J.geol.Soc.Lond., 34.
- _____ 1888, 1891. Olenellus [Callavia]. Geol.Mag., 24, 27.
- LHWYD, E. 1699. Lithophylacii Britannici ichnographia.
- LINDLEY, J. and W. HUTTON. 1837. Fossil Flora of Great Britain.

- LISTER, M. 1678. *Historia animalium Angliae: de lapidibus.*
MANTELL, G.A. 1822. *Fossils of the South Downs.*
1825. *Iguanodon.* Philos.Trans.
MARTIN, W. 1809. *Petrificata Derbiensia.*
MILLER, H. 1841. *Old Red Sandstone.*
MORTON, J. 1712. *Natural history of Northamptonshire.*
MURCHISON, R.I. 1839. *Silurian System.*
NICHOLSON, H.A. and J.E. MARR. 1895. *Phylogeny of the graptolites.*
Geol.Mag., 32.
OLIVER F.W. and D.H. SCOTT. 1903. *Lagenostoma*, the seed of *Lyginoden-*
dron. Proc.R.Soc., 71.
OWEN, R. 1851-89. *Fossil Reptilia.* Palaeontogr.Soc.
1871. *Fossil Mammalia from the Mesozoic formations.* Palaeontogr.
Soc.
PARKINSON, J. 1804-11. *Organic remains of a former world.*
1822. *Fossil organic remains.*
PEACH, B.N. 1908. *Higher Crustacea of the Carboniferous rocks of Scotland.*
Mem.geol.Surv.U.K.
PHILLIPS, J. 1829, 1836. *Geology of Yorkshire.*
PLOT, R. 1677. *Natural history of Oxfordshire.*
REED, F.R.C. 1903-06. *Trilobites of Girvan.* Palaeontogr.Soc.
REID, E.M. and M.E.J. CHANDLER. 1926-33. *Tertiary floras.* Br.Mus.nat.
Hist.
REYNOLDS, S.H. 1902-12. *British Pleistocene Mammalia.* Palaeontogr.Soc.
ROWE, A.W. 1899. *Micraster.* Quart.J.geol.Soc.Lond., 55.
SEWARD, A.C. 1894-95. *Wealden Flora.* Br.Mus.nat.Hist.
1900-04. *Jurassic Flora.* Br.Mus.nat.Hist.
SMITH, S. 1915. *Lonsdaleia.* Quart.J.geol.Soc.Lond., 71.
SMITH, W. 1816. *Strata identified by organized fossils.*
1817. *Stratigraphical system of organized fossils.*
SOWERBY, J. and J.D.C. 1812-29. *Mineral conchology of Great Britain.*
SPATH, L.F. 1938. *Liparoceratidae.* Br.Mus.nat.Hist.
STENSIO, E.A. 1932. *Cephalaspids of Great Britain.* Br.Mus.nat.Hist.
STOPES, M.C. 1918. *New Bennettitean cones from the British Cretaceous.*
Philos.Trans., B, 208.
THOMAS, H. 1925. *Caytoniales.* Philos.Trans., B, 213.
TRAQUAIR, R.H. 1877-1914. *British Carboniferous fishes.* Palaeontogr.Soc.
TRUEMAN, A.E. 1922. *Gryphaea in the Lower Lias.* Geol.Mag., 59.
VAUGHAN, A. 1905. *Palaeontological sequence in the Carboniferous Lime-*
stone of the Bristol area. Quart.J.geol.Soc.Lond., 61.
WALCOTT, J. 1779. *Petrifactions found in the quarries near Bath.*
WEBSTER, T. 1814. *Freshwater formations in the Isle of Wight.* Trans.
geol.Soc.Lond., 2.
WILLIAMSON, W.C. 1870. *Zamia gigas.* Trans.Linn.Soc.Lond., 26.
1871-91. *Organization of the fossil plants of the Coal*
Measures. Philos.Trans., 161-181.
WITHAM, H. 1831. *Fossil vegetables.*
WOOD, S.V. 1848. *Crag Mollusca.* Palaeontogr.Soc.
WOODWARD, J. 1728-29. *Natural history of the fossils of England.*
WOODWARD, S.P. 1830. *Table of British organic remains.*
WRIGHT, J. 1939. *Scottish Carboniferous Crinoidea.* Trans.R.Soc.Edinb., 60.

NEWS AND NOTES

ROCKS SHED FRESH LIGHT ON CHEMICAL ORIGINS OF LIFE

Life on earth today depends on the same chemical processes as it did more than 3,000m. years ago, according to evidence found in an African rock formation by Dr. William Schopf, a Harvard palaeobotanist working at the Ames Research Centre in California.

After standard laboratory tests, Dr. Schopf found traces of 22 amino acids in crystalline quartz which has been dated as at least 3,100m. years old - probably less than 2,000m. years after the genesis of the earth.

There were also fossils of algae and bacteria. Without the presence of amino acids, the essential components of proteins which make up all known living cells, it was theoretically possible that these could have represented some different chemical composition of life.

But Dr. Keith Kvenvolden, who supervised Dr. Schopf's work at Ames, said he was certain that the substances detected in the rock were amino acids, and virtually certain that they had been part of a primitive life process. The finding provided additional important evidence to support prevailing theories of the chemical evolution of life on earth.

Part of an item in The Times, 6th September, 1967.

SERMONS IN STONES

There is limited storage space for decent-sized rocks in the average classroom, so students of geology normally have to make do with small specimens or rely on visits to museums for first-hand experience.

Either course has disadvantages - on the one hand it is hard to recognize a rock as a prominent scarp-former when it is represented by something the size of a hen's egg; on the other, museum collections generally show rocks as they occur in their fresh state, while some rocks undergo a marked change in appearance as a result of weathering. At St. Paul's, Cheltenham, the difficulty has been overcome by building a geological garden in the school grounds where large pieces of rock are set on a base of stone chips. This not only solves the storage problem but gives real insight into the respective rates at which different rock types break down through weathering.

Part of an item in The Times
Educational Supplement, 17th November, 1967.

URANIUM ON STROMA ISLAND

Appreciable amounts of uranium have been found on the Isle of Stroma in the Pentland Firth, Scotland. The deposit, in the form of a bituminous shale is estimated to be 350m. yrs. old, was discovered by Mr. J. Saxon of Thurso. Further investigations are needed to determine if the deposit is of any commercial value.

Financial Times, 1967.

A COUNTRY DIARY

Machynlleth: Lately I have been fossil hunting, a pursuit that can be most rewarding, but not near here. You can hammer for hours at some of our local rocks and if you find a few fragmentary graptolites you have had a good day. In fact there are thousands of feet of mudstones hereabouts that have yielded scarcely a fossil. So it was a pleasant change last week to find myself on the Glamorgan coast just west of Cardiff where the rocks are millions of years younger than those around Machynlleth and where in cliffs and quarries there are reasonable hopes of finding fragments of fossil fish or reptiles or ammonites. A really perfect ammonite was something I particularly wanted to find, not for any scientific purpose but simply because I admire the beautiful spiral structure of these fossils. But I did not have much success. I found various broken bits and some more complete; but the perfect specimen eluded me. Yet life has some funny quirks. Next day, passing through Bridgend on my way home and thinking of anything but most famous ancient monuments, Ewenny priory church. And what do I find on show there, among the memorial sculptures and slabs; but a very fine large specimen of an ammonite! No doubt someone had put it in the church many centuries ago believing it to be a holy though mysterious relic. William Condry.

The Guardian, 7th October, 1967.

MACHYNLLETH MYSTERY

Sir, — It is normal in public rural places to see notices asking us not to pick the wild flowers or to uproot plants. Fortunately for the survival of wild plants, this injunction is fairly well obeyed.

Wild plants can reproduce themselves. Rocks, and the fossils they contain, cannot - at least, not in the same time scale. How is it, then, that William Condry at Machynlleth can permit himself to "hammer away for hours" at rocks in the hope of finding "a really perfect ammonite ... not for any scientific purpose but simply because I admire the beautiful spiral structure of these fossils"?

Must yet another public notice be added to protect a form of "wild life" which can be destroyed as easily as vegetable and animal rarities? — Yours faithfully, T.C. Hart.

A letter to the Editor of The Guardian,
11th October, 1967.

SEA BED EXPLORATION BY BRITAIN

In the British Parliament Mr. Anthony Crosland, Minister of Education and Science recently stated in answer to a question that the Government had initiated a review of work on the resources of the sea and sea bed. The Natural Environment Research Council (N.E.R.C.) was also examining the extent to which it would be justifiable to expand its exploration of the continental shelf with particular reference to economic returns and the needs of the extractive industries.

Nature, Lond., 15th July, 1967.

NEW ESTIMATE OF EARTH'S AGE

The earth first became a recognizable planet approximately 4,350 million years ago, according to a new estimate published in an article in the journal Science.

The estimate was made by Dr. T.J. Ulrych, of the University of British Columbia, who based his figures on studies of basalt rock outcrops found in the Atlantic and Pacific Oceans and in Llano, Texas. His calculations were based on the relative quantities of three different forms of lead and two of uranium found in the basalt samples.

Earlier estimates of the earth's age ranged up to some 4,750 million years.

The Times, 31st October, 1967.

CONTRIBUTORS TO VOLUME 2 (W.G.Q.)

- Bassett, D.A. Keeper, Department of Geology, National Museum of Wales, Cardiff.
- Bates, D.E.B. Lecturer, Department of Geology, University College of Wales, Aberystwyth.
- Campbell, I. Chief, Division of Mines and Geology, Mineral Information Service, San Francisco.
- Challinor, J. Senior Lecturer (retired), Department of Geology, University College of Wales, Aberystwyth.
- Cowie, J.W. Lecturer, Department of Geology, University of Bristol.
- Evans, D.E. Assistant Keeper, Department of Geology, National Museum of Wales, Cardiff.
- Kelling, G. Lecturer, Department of Geology, University College, Swansea.
- Lubbock, A.P. Commonwealth Geological Liaison Office, London.
- North, F.J. Keeper (retired), Department of Geology, National Museum of Wales, Cardiff.
- Owen, T.R. Senior Lecturer, Department of Geology, University College, Swansea.
- Phillips, W.J. Lecturer, Department of Geology, University College of Wales Aberystwyth.
- Rao, G.H.S.V.P. Commonwealth Geological Liaison Office, London.
- Robinson, J.E. Lecturer, Department of Geology, University College, London.
- Samples, R.E. Director, E.S.C.P. Laboratory Development Program, Boulder, Colorado.
- Stubblefield, C.J. (Sir) Director (retired), Geological Survey of Great Britain and Museum of Practical Geology, London.
- Thomas, T.M. Research Officer, M.H.L.G., Welsh Office, Cardiff.
- Wood, A. Professor of Geology, University College of Wales, Aberystwyth.

CONFERENCE OF GEOLOGY TEACHERS AT KEELE UNIVERSITY

September 22nd-24th, 1967.

A Conference of Geology Teachers was organized at the University of Keele on September 22nd-24th last by the British Association Section C Sub-Committee on the Teaching of Geology in Schools. Most of the 140 people who attended teach the subject at secondary level and many of the remainder at junior level. Included, also, were lecturers at Colleges of Education and at Universities.

The conference opened with an address of welcome by Professor F.W. Cope of Keele University. This was followed by an address given by Professor T.N. George of Glasgow University, the Chairman of the organizing committee. During the first session on Saturday morning short introductions were presented to discussions on the following topics:- teaching method (Miss C. Evans, Crewe College of Education), fieldwork (Mr. Iain Williamson, Wigan and District Mining and Technical College), and specimens, models and equipment (Mr. D.E. Evans, National Museum of Wales). During the remainder of the morning two concurrent sessions were held: one concerned with Advanced and Ordinary level geology; the other with the Certificate of Secondary Education and Primary School geology. In the former short introductions were presented to discussions under the following titles:- "A teaching syllabus for A Level Geology" (Mr. D. Ferguson, Leighton High School for Boys, London), "An Examiner's comments" (Mr. B. Simpson, University College, Swansea), "Careers followed by graduates in geology" (Mr. D. Elsom, University of Keele); and in the latter:- "Geology in the Certificate of Secondary Education" (Mr. I.D. Sheen, Llantarnam Secondary Modern School, Mon.), "Geology as an integral part of science and of environmental studies" (Mr. A. Bray, retired from H.M. Inspectorate of Schools), and "Geology in Colleges of Education" (Mr. A.J. Dunk, College of St. Mark and St. John, Chelsea).

During the afternoon field excursions to places of geological interest were led by Professor F.W. Cope, Dr. R. Roach and Mr. J. Myers, Keele University, and Dr. F. Moseley, Birmingham University.

Those who did not join the field excursions were able to visit either the various displays arranged by Professor Cope at the Keele Department of Geology, or the exhibitions of geological material which were on display in the Chancellor's Building. Exhibitors here included School Services from: the Buckinghamshire County Museum, Aylesbury; Derbyshire Museum Service, Derby; the Institute of Geological Sciences, South Kensington; the Liverpool City Museums; the National Museum of Wales, Cardiff; the City Museum and Art Gallery, Plymouth; Portsmouth City Museums; and the Sheffield City Museum. Displays were arranged, also, by: the Field Studies Council; the Geologists' Association; the Nature Conservancy; the Great Bar Comprehensive School, Birmingham; Kingston College of Technology; Queen Mary College, London; and Slough Technical High School. The following firms

displayed specimens and equipment: Ammonite Ltd., Cowbridge; Hilary Corke (Minerals), Abinger Hammer; Cutrock Engineering Co. Ltd., London; Gregory, Bottley and Co., Chelsea; R.F.D. Parkinson and Co. Ltd., Shepton Mallet. Here, too, specimens and field excursion notes were exchanged by teachers and representatives from various institutions.

The second part of the conference, which was concerned with the formation of an association of geology teachers, started with an address by Dr. D.A. Bassett (National Museum of Wales) on "How the proposed association might help the teacher". This was followed on Sunday morning by a general discussion on a document of proposed Rules and Regulations which had been prepared by Dr. J. Harpum of Queen Elizabeth Grammar School, Penrith, and which had been circulated previously to all those attending the conference. At a second meeting it was decided unanimously that an association be formed and that subscriptions for membership should be £1 for ordinary membership and 10/- for student membership. A Steering Committee was elected to draw up proposals for a Constitution, Rules and Regulations, etc. The members of this committee are as follows: Dr. D.A. Bassett (Chairman), Mr. J. Myers (Treasurer), Mr. A. Bray, Mr. A.J. Dunk, Dr. J. Harpum, Professor L.R. Moore. Immediately after the meeting 96 people paid their subscriptions to the Treasurer.

The proposed traverse across the North Staffordshire Coalfield on Sunday afternoon, to be led by Mr. J. Myers, was cancelled owing to inclement weather.

In addition to the people who attended the conference, there are over 500 people who responded to a circular sent out by the British Association Sub-Committee and who expressed an interest in the formation of the proposed association. These and any further people who might be interested will soon receive a fuller report of the conference which will include abstracts of the various contributions together with up-to-date information and details of the progress made by the Steering Committee.

D. Emlyn Evans.

THE IMPRINT OF STRUCTURAL LINEATIONS ON THE PHYSICAL LANDSCAPE OF WALES

Trevor M. Thomas

Much of the land surface of Wales is typified by structurally-produced linear breaks of slope. From a close study of more than 25,000 vertical aerial photographs, on an approximate scale of 6 inches to the mile, and supplemented by detailed observations made on numerous field traverses, particularly of the Welsh uplands, a series of "structural grain" maps has been constructed, based on the strike or trend lines of these breaks of slope. In order to retain as much detail as possible the working sheets were on a scale of 1/25,000. These were later compounded and reduced to a 1 inch scale so as to provide a wider picture of the broad regional patterns. Segments of two One-inch Ordnance Survey sheets on which these lineations have been plotted are included with this note as illustrations of the survey which has been completed for the whole of Wales.

As a starting point a choromorphological map of Wales was compiled showing a whole range of what may be described as "terrain types". Within this classification, those sectors where the imprint of structural grain is strong have been categorized as follows:-

Type I. Areas where structural ribbing in the form of minor strike ridges or benches is discernible but with few actual rock exposures.

Type II. Areas showing pronounced structural ribbing with strike ridges or benches averaging 10 to 50 feet high and in which the rock is often exposed.

Type III. Areas with low rises or "whalebacks" of smooth long profile whose axes show a large measure of conformity or are only slightly "plagioclinal" to the strike of the underlying beds.

Type IV. Areas characterised by elongated, and frequently rocky, hillocks or spurs, typically 80 to 250 feet high, with intervening troughs and aligned parallel to the regional strike of the rocks.

Type V. Rocky escarpments or "edges" displaying strike sections or gently dipping beds.

Fault line depressions were also mapped. In some areas master joints or powerful cross joints directly opposed to the general strike of the beds have facilitated the production of benches, elongated hollows or distinctive notches. If strike ribbing is also present the net result is a chequerboard effect displaying generally a parallelogram grid rather than a rectangular one since the major joints in the more massive beds rarely trend perfectly at right angles to the strike.

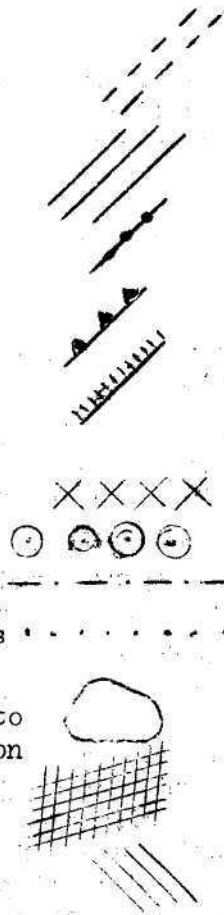
The accompanying maps are photographic reductions of parts of the Ordnance Survey map, sheets 116 and 127. The one shows the lineations

with the Harlech Dome and the Cader Idris range; the other the ground north and south of the Dyfi estuary. The maps should be compared with the following geological maps published in the Quarterly Journal of the Geological Society of London: the former with the map of the Harlech Dome by C.A. Matley and T.S. Wilson (1946), of the Arthog district by A.H. Cox and A.K. Wells (1921) and of Cader Idris by R.G. Davies (1959); the latter with maps of the Towyn-Abergynolwyn area by R.M. Jehu (1926), the Machynlleth-Llyfnant Valley area by O.T. Jones and W.J. Pugh (1916) and the Plynlimon-Pont Erwyd area by O.T. Jones (1909).

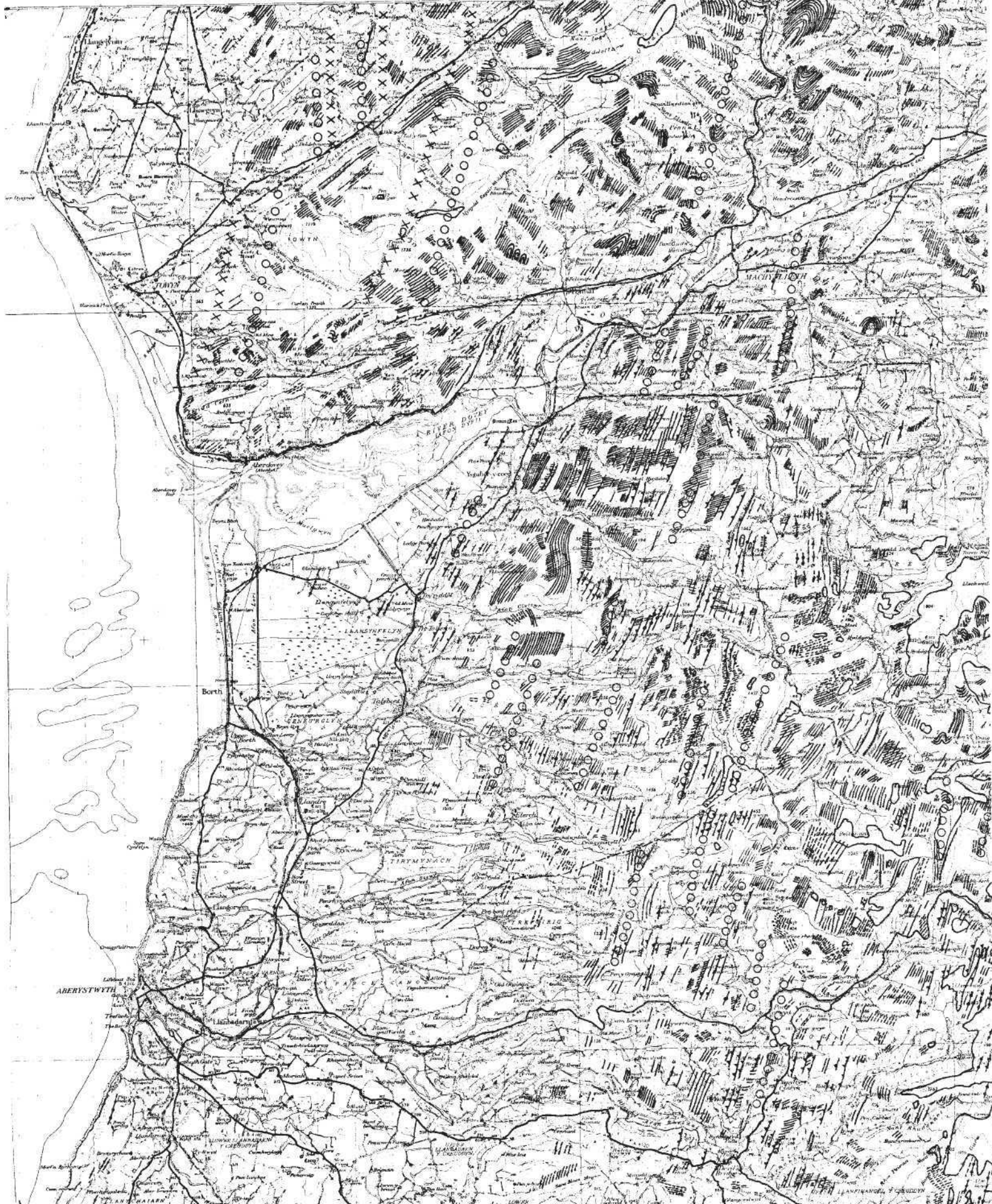
A paper entitled "The Imprint of Structural Grain on the Micro-Relief of the Welsh Uplands" was read at the Annual Conference of the Institute of British Geographers held at Sheffield University in January 1967. It is hoped to publish a paper shortly.

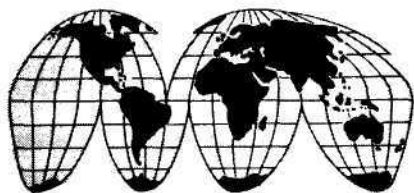
KEY

1. Minor strike ridges or benches showing few rock exposures
2. Pronounced strike ridges or benches with the rock freely exposed
3. Elongated "whalebacks" with smooth long profile
4. Rocky hillocks with long axes parallel to the strike of the beds
5. Rocky scarps or "edges" displaying strike sections or gently-dipping beds
6. Main synclinal axes
7. Main anticlinal axes
8. Major faults
9. Linear minor depressions defining the courses of minor faults or master joints
10. Areas with thick hill peat cover (usually 3 to 10 feet) and normally showing signs of erosion
11. Notching or benching deriving from strong cross jointing
12. General strike of cleavage









a project of the American Geological Institute

Death of an Investigation

Robert E. Samples, Boulder, Colorado¹

This article illustrates the differences between two approaches to the problem of involving students in laboratory activities in the science classroom. The first approach is what may be called "authoritarian", whereas the second is often referred to as "investigative."

The setting is a ninth-grade classroom where students are supposedly determining the density of ice (ESCP Investigation P-2). The basic ideas, however, are applicable at all grade levels, from elementary to college.

As the class period opens the teacher instructs the students.

"The alcohol costs money, so don't waste it. The proper way to use it is to pour 25 ml. of alcohol into the beaker and place the ice cube in the alcohol. As you notice, the ice cube will sink. Add water slowly, mixing it until the ice cube just floats. Remove the ice cube, weigh the solution, and measure its volume. This will give you the information necessary to determine the density of the ice cube. All right, get your materials and get to work. Let's not have a mess; you're not third graders."

As the students silently proceed through the lab, one drops a beaker as it is being filled.

"All right, butterfingers, let's see you finish the lab without one of your beakers. Can't you people do this kind of thing without somebody holding your hand? You don't think science got this far without some discipline, do you?"

The rest of the "investigation" is explosively pun-

uated by outbursts from the teacher that follow the same pattern.

"I thought I told you to pour water into the alcohol. Can't you people listen?"

"I said, take the ice cube out of the solution after it starts to float. You know why?"

The students shake their heads.

"What's the temperature of the room?"

A chorus of "I dunno's" is interrupted by a scattering of "70 degrees."

"Right, it's 70. What is the temperature of the ice cube?"

"Thirty-two." It rings clear this time.

"Okay, so you don't want the ice to melt into the solution or it will change your results and the accuracy of the answer will be out the window. Hurry up, I want this place spotless before the bell rings. Watch your math and *follow the instructions* or you will never get the right answer which is .974 grams per milliliter."

The writer never actually heard this particular monologue, but it is typical of the sort of teaching in too many classrooms. At the end of a session like this, the teachers' lounge probably echos with complaints about the lack of quality to be found in junior high students, beakers, and curriculum writers. In all but the first instance, the teacher may be right. The junior high student is intrinsically a dynamic, highly interested human being. In a learning environment such as the one described, he is almost superfluous.

First, the ritualistic recitation of the instructions had nothing to do with the investigation and little to

¹ Director, ESCP Laboratory Development Program.

Figure 1. Ninth grade ESCP students determine the weight of an alcohol-water mixture.

do with the students, except, of course, the management of their actions. In a sense they form the chess board upon which the game is to be played. The students cannot leave the confines of the pattern without being ridiculed any more than a rook can move 25 spaces to the left without leaving the board. The teacher is the mover and by innuendo guides the course of action.

And the students? They are the mute pieces that mechanically shuffle through the constricting corridors created by the instructions. Like the chessmen, the students are different, but their motions are still governed by external rules.

Is this analogy preposterous? Unfortunately, it isn't. Things like this happen in classrooms and often the teacher feels that the orderliness of the action is a criterion for judging the quality of the "science." It would seem, by this view, that science is good if the students report their psychomotor obedience with an equally obedient communication effort. If you examined the total situation you would find that the "write-up" is an end in itself, and, being an end, the means to it should be subject to rigor.

However, any teacher, even the mythical one who provided the monologue, would cry heresy if it were suggested that there wasn't room for the students to think during an investigation. In reality the thoughts of the students were probably of a Darwinian survival type. They recognized the teacher's stimulus and responded accordingly. The peripheral concepts that could have been achieved, the process of investigation, and the basic idea of intellectual honesty, are never made available to the student.

Let's be specific. The detailed instructions remove the "investigation" from the activity and make it a demonstration problem. The only difference between this and more traditional approaches is that the *student* baits the hook before fishing for the answer.

By being so specific in the instructions, "place the ice cube in the alcohol. As you notice, the ice cube will

sink. Add water slowly, mixing it until the ice cube just floats," the teacher removes the exercise from the realm of science. The students should have been permitted to discover the need for controls such as "slowly mixing until the ice cube just floats." Such precisely phrased instructions may make the student wonder why it is necessary to mix the water with the alcohol. The teacher might answer that the densities of alcohol and water are different, so it is necessary to mix them. Since this is true, why not allow the students to establish the truth themselves?

The reason for the second instruction, "Remove the ice cube, weigh the solution and measure its volume," is provided when our mythical teacher says "... you don't want the ice to melt into the solution or it will change your results and the accuracy of the answer will go out the window."

Because equilibrium is a scientific concept of such stature, why not let the students discover it for themselves if at all possible? In the discourse, the teacher stresses the sanctity of the answer several times, even suggesting a value of .974 g/ml. It is highly probable that most of the students will manipulate their data until the lie .974 g/ml. appears on their papers. After all, the handwriting is on the wall. The bubbles that were in their ice cubes, and which *really* gave them a value of .914, will be ignored, as will the other variables that should have affected their results. The accuracy of their measurement of mass and volume of the solution may also be ignored if they interfere with getting the "right" answer.

In short, all the science involved in the investigation will have been sacrificed for adherence to the recipe. No one will have realized that more science went into writing the recipe than in following it.

This point of view might rightly be termed idealistic and dismissed with the comment, "that approach looks good on paper, but it's impossible in a real classroom." After all, the critics might add, junior high students are too immature to perform without rigorous guidance. And more certainly, they *must* be guided through the material to be covered.

There is little that can be said to a teacher whose attitude demands rigid adherence to the rules. The very foundations of such an attitude are rooted in two disputed notions. The first notion conceives of science as a veritable mountain of information over which novices must be guided by rigorous routes. The second conceives of scientific inquiry as a rigid methodological pattern of behavior. The precision of performance and adherence to "the routine" would be the criteria for evaluation under these concepts.

These notions project an image of science and inquiry that modern science curricula are attempting to erase. By modern educational standards, science must be presented as both inquiry and the knowledge gained by inquiry. The knowledge is never an end in itself,

but a stepping stone to further inquiry.

How can a teacher participate in the investigation described earlier and sponsor inquiry in a more effective manner?

"What do you people see here on the table?"

"Two beakers of water." The class members at their places view these beakers at the teacher's demonstration table.

"What would happen if I put ice cubes in the beakers?"

"They would float."

The teacher then places an ice cube in each beaker. In one beaker it floats, and in the other it sinks. The excitement generated by this "anti-intuitive" event is at once apparent by the excited murmur throughout the room.

"What's wrong?" the teacher asks.

"One of those beakers contains some pretty silly water."

"One ice cube is heavier than the other."

"The cube that sank is not ice."

The responses of all the students are directly related to the nature of the materials that are viewed. They are mildly frustrated by being unable to touch and handle the materials. This kind of reaction is generally true of student response to demonstrations of any kind.

"What can I do that will allow you to check some of your ideas?" The teacher asks the question only after he is sure that the students have exhausted a good supply of possible explanations.

"Switch the cubes," one student challenges to a chorus of approval from his peers.

The teacher switches the cubes and the results are the same. The cube sinks in the same liquid in which it had sunk previously and floats in the same liquid in which it had floated before.

"The ice cubes are the same," a student offered, "so the liquids have to be different."

"I told you it was silly water," said the student who originally proposed this notion.

"Well, we *proved* it couldn't be the cubes," said others.

"Since you people have worked with calculating the densities of different materials, can we make some kind of a statement about the densities of these things we are viewing?"

After a bit of further discussion, the students decide that they can rank the density order of liquids on the basis of ice. The liquid in which the ice floats is denser than ice, and the liquid in which it sank is less dense than ice. The teacher writes these relationships on the board.

"Okay, here's your assignment: Using these liquids, which are, by the way, water and rubbing alcohol, you will measure the density of an ice cube. You will need

scales, beakers and the liquids. Go to it."

From this point on, the teacher's role is to act as director of inquiry who turns student questions back on the results of the demonstration, their knowledge of the technique of measuring density, and their own ideas as to how the problem might be solved. Several groups decide on different ways of solving the problem; they are concerned at first about the differences in their approach. The teacher tells them that they should try what they proposed and evaluate the results. There is not, he assures them, an *only* way to reach the solution.

Throughout these multiple approaches the students "discover" the variables that might affect their results, such as the melting of ice in the alcohol-water solution mentioned by our first teacher. They also become aware of the change in volume of the ice while the mass is being measured on the scales. The materials themselves guarantee that these variables will become apparent.

What fundamentally was the difference in the two approaches? In both, the students were *doing* something. In both, they were manipulating materials. Both would be categorized by an outside observer as a laboratory approach to science. So again, let us ask what the difference in approach is.

In the first classroom, the students performed as the teacher told them to. In the second, they performed as they thought they should perform. In the first, science was being done by recipe; in the second, it was being done by inquiry. If the students gained confidence in anything in the first classroom, it was in the safety of following the teacher's instructions. In the second, it was likely that they gained confidence in using their own minds in the process of inquiry.

Perhaps the most discerning summary of discovery-type inquiry was stated by Bruner (1963). Bruner describes the advantages of discovery learning under four headings: (1) the increase in intellectual potency, (2) the shift from extrinsic to intrinsic rewards, (3) the learning of the heuristics of discovering, and (4) the aid to conserving memory.

Figure 2. Measuring the volume of the alcohol-water mixture.

Increased Intellectual Potency. Discovery learning increases intellectual potency by allowing students to recognize fundamental order and relationships through their own framework of perception and experience. Rather than receiving the order through the perception of the teacher, who in turn probably received it through the perception of scientists, the student perceives *real* order because it *happened* during his inquiry. The relationships perceived by direct inquiry will be much more relevant than any recipe-type order handed down in terms of content or process.

Shift from Extrinsic to Intrinsic Rewards. Quoting Bruner's introduction to this section, we find the essence of this advantage of discovery learning:

"Much of the problem in leading a child to effective cognitive activity is to free him from the immediate control of environmental rewards and punishments" (p. 87).

In the first classroom the students were operating in an environment in which their observance of the teacher's rules provided the reward. In the second, the extent to which they used their minds was much more closely related to the reward pattern. In the first, the environment defined their course of action. In the second, their course of action defined their environment.

The Heuristics of Discovery. It is only through the process of making discoveries that a student will be able to learn how to make discoveries. If, through discovery, a student defines his particular style of inquiry, then it is probable that the style will become part of this thought process in the face of further inquiry.

Conservation of Memory. The body of information

composed of facts that are "stored" in our memories is often considered to be the knowledge we possess. This view has retarded progress in science education more than most other notions. We are all alert to those things which we "memorized" dozens of times and promptly forgot. Certain facts have not been forgotten, and this is most often related to the use of these facts. In order to use information, it must be "retrieved from storage," to use Bruner's terminology. The retrieval process is enhanced by discovery-type inquiry and thus memory, as such, is similarly enhanced.

If as seems likely, these notions have validity and are the results of discovery-type inquiry, then what can be our role as teachers of science? It appears that to teach science we must retain the intellectual honesty of science in our teaching. If science is inquiry and its knowledge is the product of inquiry, then we must allow the students to inquire.

It is difficult to relinquish the role of alerting the students to the elegant logic of the teacher's mind. But we must, for what we really want is for the students to become confident in the use of their own minds. We want their minds to become facile enough to enjoy the tentative and adhere to the restrictions imposed by the nature of scientific inquiry, rather than the restrictions imposed by the recipes offered by authoritative teaching. The excuse that "there isn't enough time to teach this way" is not valid, for there is too little time *not* to teach this way.

Reference Cited

Bruner, Jerome, 1963, *On Knowing: Essays for the Left Hand*: Harvard Univ. Press, 1963, 165 p.

WELSH GEOLOGICAL ABSTRACTS : 1966

Containing abstracts of papers dealing with geology and its allied subjects for Wales and the three border counties, published during 1966; with subject and locality indexes.

Douglas A. Bassett
(National Museum of Wales)

Welsh Geological Abstracts is a successor to the bi-annual bibliographies of the geology of Wales and the Borders* which were superseded in 1964 by British Geological Literature, issued by the Coridon Press and compiled by E.L. Martin of the Geological Survey and A.P. Harvey of the British Museum (Natural History).

The present work is based on a systematic survey of the journals listed in the Bibliography and index of allied sciences for Wales and the Welsh Borders 1897-1958 (Cardiff: National Museum of Wales, 1961) and the new serials which have appeared since 1961. Wherever possible the abbreviations suggested in the World List of scientific publications have been adopted.

Where the authors' abstracts have been quoted, additional comments are inserted in square brackets.

- * List of papers, books, theses, etc., on the geology of Wales and the Welsh Borders, 1959-1960. Lpool Manchr.geol.J., 3, 1962, 33-40.
List of papers, books, theses, etc., on the geology of Wales and the Welsh Borders, 1961-62. Geol.J., 4, 1964, 35-42.
List of papers, books, theses, etc., on the geology of Wales and the Welsh Borders, 1963-1964. Geol.J., 5, 1966, 7-14.

ADAMS, H.F., BRADBURN, E. and G.C. BOON. Coal from the legionary fortress of Caerleon, Monmouthshire. Geol.Mag., Lond., 102(for 1965), 470-473.

Fragments of coal found in contexts of the third century A.D. at the legionary fortress of Caerleon (Isca) and submitted to the Scientific Department, N.C.B., were chemically analysed at the S.W. Division laboratories at Cardiff (two analyses are noted in the paper) and the petrology, palynology and reflectance studied in the laboratories of the Yorkshire Division. The evidence pointed strongly to a source on the outcrops of the Big, Three Quarter or Black seams in the Pontypool-Risca area. There is a brief comment on the use of coal in Roman Britain.

AMSDEN, T.E. Microcardinalia protriplesiana Amsden. A new species of Stricklandiid brachiopod, with a discussion on its phylogenetic position. J.Paleont., 40, 1009-1016, 1 fig., 3 pls.

A new brachiopod species, Microcardinalia protriplesiana, is described from the Blackgum Formation (Llandoveryan) of Oklahoma U.S.A., and its phylogenetic development is compared with that of sub-species of Stricklandia lens. Type material of S.lens prima, S.lens lens, S.lens intermedia, and S.lens progressa is figured from the Llandoveryan of Carmarthenshire, South Wales.

ANDERSON, J.G.C. and C.R.K. BLUNDELL. The sub-drift rock-surface and buried valleys of the Cardiff district. Proc.Geol.Ass., Lond., 76(for 1965), 367-377, 3 figs.(incl.map showing position of bore-holes, rock head contours and buried channels), 1 table (details of 21 bore-holes).

Recent bore holes sunk in the Cardiff district by the Geology Department, University College, Cardiff, coupled with existing bore-hole records, showed that the superficial deposits consist mainly of glacial gravels, gravels derived by river action from the glacial deposits, and of estuarine clay. In detail, the deposit immediately below ground level is dark bluish-grey (weathering to brown) soft, stoneless clay up to 40 ft. thick, in places containing peat lenses up to 3 ft. thick. The clay is underlain, in most cores, by layers of coarse gravel (with a sand/silty clay matrix) that range in thickness from $4\frac{1}{2}$ to 29 ft. Rock-head is in Downtonian or Silurian rocks in the Rhymney valley, in Triassic marl in the Taff and Ely valleys. The rock-surface forms a gently undulating sub-sea level platform from near the Ely River eastwards to the edge of the Cardiff district. The rock platform is trenched by the buried valleys of the Rhymney, Taff and Ely rivers, with maximum depths respectively 28, 42 and 38 feet below O.D. The age of the buried channels is uncertain; a polyphase origin is likely. During the glacial epoch (or perhaps even before) the rivers eroded wide valleys with floors down to -25 ft. O.D. Melting of the 'Newer' ice sheet released great quantities of sediment, especially coarse gravel, which filled the valleys. At this time sea-level was relatively 100 ft. lower than now. The Severn flowed at -100 ft. O.D. and

its tributaries cut down through gravels into rock to depths of -50 ft. O.D. The final phase was mainly one of aggradation. While sea-level stood slightly higher than now, marine clay was deposited in the valleys up to heights of about 25 ft. above O.D.

The boreholes also showed that the Silurian strata of the Rumney inlier extend to the south-east under thick superficial deposits for over a mile beyond their previously known limit.

ANON. 1. Damage to property. Welsh geol.Qtly., 2, no.1, 26.

The news that the owner of Mary Knoll Valley (Ludlow anticline) refused access to his ground because of litter-louts precipitated a plea to all geologists who may visit the Welsh Borderland to do all they can to prevent this kind of offending behaviour. [Reprinted from the Ludlow Research Group - Bulletin no.12.]

ANON. 2. Research in progress at Swansea [University College]. J.Univ. Coll.Swansea geol.Soc., 4, 39-42.

A list of titles of work in progress by members of staff and research students.

BAILEY, R.J. 1. Scour ripples in the Ludlovian of south Radnorshire, Wales. Sedimentology, 7, 131-136, 1 fig., 1 table (orientation of scour ripples).

Calcareous siltstone beds in the sub-littoral marine sedimentary rocks of the highest Ludlovian (Upper Whitcliffian) in south Radnorshire [Painscastle, Aberedw, etc.] display symmetrical ripples with wave lengths around 30 cm. These structures are interpreted as having been formed by the deposition of calcareous silt layers in conformity with bottom surfaces previously scoured into a pattern of symmetrical, gently-rounded, crests and troughs; hence, they are termed scour ripples. There is some evidence of a longitudinal relationship between the scour ripples and the scouring and depositing currents involved in their formation.

(Author)

BAILEY, R.J. 2. Note on crinkle marks as palaeoslope indicators. Bull. Ludlow Res.Grp., no.13, 10-11. [abs.]

Brief summary (43 lines) of paper read at Denbigh meeting of the Ludlovian Research Group criticizing earlier work on the origin of crinkle marks.

BALL, D.F. 1. Chlorite clay minerals in Ordovician pumice-tuff and derived soils in Snowdonia, North Wales. Clay Minerals, 6, 195-209, 3 figs., 3 tables (chem. anal. of chlorite 508; x-ray powder data for chlorite 508; formulae for chlorites calculated from powder photograph data).

Calcareous volcanic ashes (pumice-tuffs) occur among Ordovician

rocks in Snowdonia, North Wales. The clays of these rocks and of the ecologically important soils derived from them are found to be almost mono-mineralic and to consist of chlorites. Chemical, differential thermal and X-ray analyses are given and discussed with particular reference to a clay-size chlorite from weathered pumice-tuff. There is no evidence for pedogenetic clay mineral transformations in the range of soils studied.

(Author)

BALL, D.F. 2. Late-Glacial scree in [North and Central] Wales. B.Peryglacialny [Lodz], no.15, 151-163, 1 fig.(location map), 7 pls.(photos.)

Slopes in Wales are often covered by scree deposits. These are relic formations resulting from periglacial conditions in the Late-Glacial period. Many are covered by soil and vegetation, others have been exposed by erosion and are subject to contemporary resorting and accretion. The distribution of these screes covers a wide range of altitude in the areas of Wales which carried glaciers in the Late-Glacial period. Elsewhere they are restricted to a smaller altitudinal range in hill districts which failed to support glaciers at that time. Their widespread distribution is an indication of the importance of periglacial activity in this glaciated region, in modifying land-forms, and in the consequent influences on soil development and ecology. [The sites noted are Coed Camlyn, Mer.; Cwm Cadian, Dovey Forest, Mer.; Bwlch Llyn Bach, nr. Cross Foxes, Mer.; Marian Rhaiadr Fawr, Aber, Carns.; Afon Rhiwillech, nr. Bala, Mer.; Llanelltyd, Mer.; Coedyrallt-Goch, Gwydyr, Betws-y-Coed, Carns.; Sychnant, Conway, Carns.; Cwm Bach, Tremadoc, Carns.; Cefn Pen-lan, St. Harmon, Radns.; Hafod-y-Rhiw, Eigiau, Carns.; Craig Ty Nant, Llanymawddwy, Mer.; Waun-y-Gadfa, on Bwlch-y-Groes - Lake Vyrnwy Rd., Mont.]

(Author)

BALL, D.F. 3. Brown podzolic soils and their status in Britain. J.Soil Sci., 17, 148-158, 3 tables.

The characteristics are outlined of freely drained soils, transitional in location, morphology and chemistry between modal Brown Earths and Peaty Podzols, which occur widely in western and upland Britain. They have been classified in a number of ways, which are discussed with reference to a review of American and European treatment of Brown Podzolic Soils. Although precise definition in terms of chemistry is not possible, evidence supports the continued distinction of such soils as Brown Podzolic Soils (or Sols Bruns Podzoliques) considered as a sub-group of Podzolized Soils.

(Author)

BASSETT, D.A. (Editor) 1. Current research in geology and allied sciences in Welsh colleges, laboratories, etc. [With Author, Locality and Subject Indexes.] Welsh geol.Qtly., 1, no.3, 7-37.

Abstracts of work in progress, prepared by research students and members of staff at:- the departments of Geology & Geography, University College, Aberystwyth; the Nature Conservancy, Bangor; the departments

of Botany and Soil Science and the Marine Science Laboratories, University College, Bangor; the National Museum of Wales, Cardiff; the Soil Survey of England and Wales, Cardiff; the departments of Botany, Geology, Microbiology, Mining Engineering and Physics, University College, Cardiff; the Robertson Research Company Limited, Llanddulas; the departments of Geography and Geology, University College, Swansea.

BASSETT, D.A. 2. List of papers, books, theses, etc., on the geology of Wales and the Welsh Borders, 1963-64. Geol.J., 5, pt.1, 7-14.

The third and last supplement to the Bibliography and index of geology and allied sciences for Wales and the Welsh Borders, 1897-1958 (Cardiff, 1961). These supplements are superseded by Welsh Geological Abstracts. Eightyone papers and 11 theses are listed for 1963; 101 papers and 8 theses for 1964.

BASSETT, D.A. (Editor) 3. Welsh Geological Abstracts : 1965. Welsh geol.Qtly., 1, no.4, 1-28.

Abstracts of 87 papers, books and reports on the geology of Wales and the Borders.

BASSETT, D.A., WHITTINGTON, H.B. and A. WILLIAMS. The stratigraphy of the Bala district, Merionethshire. Quart.J.geol.Soc.Lond., 122, 219-271, 11 figs., 1 pl., 3 tables.

About 45 square miles of Ordovician and Silurian rocks exposed around the town of Bala have been mapped and their brachiopod-trilobite faunas studied in order to revise the stratigraphy of the Bala Group and effect a more exact correlation with other standard Ordovician sections. The succession established by Elles [Quart.J.geol.Soc., Lond., 1922] has been emended to include a quartzite more or less contemporaneous with the Hirnant Limestone and an ash at the revised base of the Glyn Gower Siltstones, and to allow for hitherto unsuspected complications due to unconformities and faulting. The proposed changes in stratigraphical terminology have been framed in accordance with the American Code of Stratigraphical Nomenclature. The infra-Rhiwlas Limestone unconformity, first indicated by Bancroft [Geol.Mag.Lond., 1928] is now known to have involved great variation in the depth of erosion, especially northwards. Sudden localized changes in oversteps have been attributed to pre-Rhiwlas Limestone faulting. An outlier of high Ashgillian and Llandovery rocks west of their main outcrop has revealed the presence of another unconformity within the higher part of the Ordovician succession which may also be due to contemporaneous fault slip. These breaks suggest that the use of 'Bala Series' as a standard subsystemic division of the Ordovician should be discontinued although the term 'Bala Group', divided into 'Lower' and 'Upper' at the main unconformity, may be retained for Upper Ordovician successions of the region.

The discovery of new fossil localities, particularly in the Nant Hir Mudstones and Glyn Gower Siltstones, the recognition of assemblage zones

in the Allt Ddu Mudstones, and a faunal succession in the Gelli-grin Calcareous Ashes permit correlation with the type-Caradocian although it has not been possible to locate the Caradocian stage boundaries precisely. The Lower Bala Group can be dated as Costonian to Longvillian in age, the base of the Lower Longvillian being more or less coincident with the base of the Gelli-grin Calcareous Ashes. The Rhiwlas Limestone, the basal member of the Upper Bala Group, contains a rich trilobite fauna that compares closely with assemblages from other British strata containing Phillipsinella parabola and is regarded as Middle Ashgillian in age. The Foel y Ddinas Mudstones, emended to include the Hirnant Limestone as a member, contain the youngest Ordovician shelly fauna known in Britain.

(Authors)

BATES, D.E.B. The geology of Parys Mountain. Welsh geol.Qtly., 2, no.1, 27-29, 1 fig.(g.sk.map).

A brief note on recent exploration in and around Parys Mountain.

BEAUMONT, P. Current research in geomorphology. British Geomorphological Research Group. 74pp., illus.

A list of 351 persons who are working on geomorphology in Britain, giving the field of interest and techniques used. The distribution of research activity is given in map form and a classified index is provided.

BELDERSON, R.H. and A.H. STRIDE. Tidal current fashioning of a basal bed. Marine Geol., 4, 237-257, 14 figs.(incl.maps and asdic records).

The floor of the northeastern part of the Celtic Sea with its bed transport paths converging from the Bristol and St. George's Channels and tidal currents of up to 3 knots, has been examined by means of asdic and echo-sounder, grab and corer.

A rudaceous deposit, marking the post-glacial rise of sea level is being buried by the basal bed of the present sea. The new bed shows a progressive decrease in grain size down the velocity gradient of the tidal currents. It can be divided into five successive zones, whose character also depends on the nature of the floor, its hydraulic properties and the supply of material. The distinctive features of these zones are: (1) predominance of erosion; (2) sand ribbons; (3) sand waves; (4) continuous beds of sand and muddy sand; (5) sand patches with intervening shell-gravel.

(Author)

BIRD, P.F. See BURKE, A.R.

BLUNDELL, C.R.K. See ANDERSON, J.G.C.

BOON, G.C. See ADAMS, H.F.

BOWEN, D.Q. Dating Pleistocene events in south-west Wales. Nature, Lond., 211, 475-476, 1 fig.

A broadly identical stratigraphy of coastal Pleistocene deposits in Cardigan Bay (Porth Clais, Druidston Haven, Newquay and Llansantffraid) and Gower (Minchin Hole) is described and discussed. The radio-carbon dates given by B.S. John (Welsh geol. Abstr., 1965) are questioned.

BOWEN, D.Q. See also GREGORY, K.J.

BRADBURN, E. See ADAMS, H.F.

BROOKS, M. A study of density variations in New Red Sandstones from the English Midlands. Geol. Mag., Lond., 103, 61-69, 3 figs.

Methods are outlined by which density changes due to burial and compaction can be studied, and results are briefly discussed of an application of these methods to New Red Sandstone rocks from the English Midlands. From density measurements on surface rocks and compaction tests on a disaggregated sandstone it is concluded that there is no significant increase in density with depth down to 10,000 feet if the original, depositional, porosity of the sediment is low. Compaction tests suggest that sands with a high original porosity will, over a similar depth range, undergo permanent (i.e. non-elastic) deformation producing a 10 per cent increase in density.

(author)

BULMAN, O.M.B. Walter Frederick Whittard. 1902-1966. Biogr. Mem. Fellows R. Soc., 12, 531-542 (incl. bibliography), portr.

BURKE, A.R. and P.F. BIRD. A new mechanism for the formation of vertical shafts in Carboniferous Limestone. Nature, Lond., 210, 831-832, 2 figs. (diagrams). [Corr.]

A previously unrecorded process of spelaeogenesis observed in a newly discovered series of caverns in Carboniferous Limestone at Ystradfellte.

BURNHAM, C.P. See MACKNEY, D.

CHAPLIN, E.M. and L.P. THOMAS. On a new exposure of the Cefn Coed marine band horizon and underlying "cockshot" sandstone at Bryn Pica near Aberdare. J. Univ. Coll. Swansea geol. Soc., 4, 20-22, 2 figs.

Brief descriptions of the marine band and "cockshot" horizons in the opencast coal workings at Bryn Pica.

CRAMPTON, C.B. 1. Certain effects of glacial events in the Vale of Glamorgan, South Wales. J. Glaciol., 6, 261-266, 2 figs. (maps), 1 table (soil profiles).

In South Wales there is evidence for two phases of intense glaciation and an interglacial phase during the Pleistocene. During the closing

stages of the earlier glaciation in the west of the Vale of Glamorgan two overflow channels were cut by melt water from an ice lobe off the Glamorgan upland, abutting against ice from the Irish Sea. During retreat, ice from the Irish Sea and local ice deposited material on the Lower Lias outcrop on which two contrasting soils developed. Soils normally associated with a Mediterranean climate developed locally on the outcrop of the Carboniferous Limestone during the interglacial phase.

(Author)

CRAMPTON, C.B. 2. An interpretation of the pollen and soils in cross-ridge dykes of Glamorgan. Bulletin of the Board of Celtic Studies, 21, 376-390, 6 figs., 1 pl.

Pollen in soils buried beneath selected cross-ridge dykes in the Glamorgan upland is used to date their construction by reference to a standard established for the area by Crampton and Webley (1964). Pollen analyses suggest the dykes were built in heathland vegetation and thus help to confirm their early Medieval construction as suggested by Fox and Fox (1935). Simultaneously, a study of the internal morphology of the dykes in terms of their soils, by reference to the surrounding soils, provides some information about the historical development of soils in the region. Today podzols and peaty gleyed podzols tend to occur in coarse-textured parent materials, whereas 'podzols with gleying' and peaty gleyed soils mostly occur in parent materials containing more clay. Since early Medieval times the clay and silt content have possibly increased by weathering of the shale in the parent material of the 'podzol with gleying' and the peaty gleyed soil, the gleying also being a feature of post-Medieval times.

(Author)

CRIMES, T.P. 1. Palaeocurrent directions in the Upper Cambrian of North Wales. Nature, Lond., 210, 1246-1247. [Corr.]

A critical comment on the validity of the palaeocurrent reconstructions based on cross-stratification readings given by A.M. Evans, P. Garrett and J.H.McD. Whitaker, 1966. (See below.)

CRIMES, T.P. 2. The relative age of some concretions in Cambrian sediments of St. Tudwal's Peninsula, North Wales. Geol.J., 5, pt.1, 33-42, illus. (incl.sk.map).

Concretions which occur in the upper Cambrian (Maentwrog) turbidites of St. Tudwal's peninsula are considered to have an early diagenetic origin, according to field observations based on a new genetic classification of concretions. The classification proposes six types of concretion: allogenetic; perigenetic; syngenetic; early diagenetic; late diagenetic; and metamorphic. Within the Maentwrog sediments, the sequence of formation seems to be: deposition of turbidite units with typical current structures; formation of convolute lamination; growth of concretions; and in some cases erosion by late turbidity currents.

CROOKALL, R. Fossil plants of the Carboniferous rocks of Great Britain. [Second Section.] Mem.Geol.Surv.Gt.Brit., Palaeont., 4, pt.4, xiii-xx, 355-572, 53 figs., 25 pls.

Part 4 of the Memoir, dealing with the genera Sigillaria, Archaeosigillaria, Onphalophloios, Ulodendron, Lepidostrobus, Polysporia, Lepidocarpon, Lepidophyllum, Cyperites, Sigillariostrobus, Stigmaria and Stigmariopsis complete the Lycopodiales group. As with the previous part, Kidston's MS, re-written by Dr. Crookall, has been edited for publication by Mr. S.W. Hester. Species based on type specimens from Welsh and Welsh border localities are:- Sigillaria kinletensis Arber, Sigillaria sp. cf. S.lenticularis Sauvcur and Sigillaria pringlei Kidston from Westphalian strata at Kinlet Quarry, near Highley, Shropshire; Lepidostrobus intermedius Lindley and Hutton sp. - Coal Measures, Leebotwood, Shropshire; Lepidostrobus anthemis Koenig sp. - Coalbrookdale, Shropshire; Lepidostrobus goodei Jongmans - Rickets Head Vein (Westphalian) at Rickets Head, Pembrokeshire; Lepidophylloides lesquereuxi sp.nov. - Monmouthshire; Cyperites bicarinatus Lindley and Hutton - (Westphalian) Leebotwood, Shropshire.

DAVIES, B. Rock-hunting in the British Isles. Rocks and Minerals, 41, 918-919.

DAVIES, M. Recent cave discoveries in South Wales. S.Wales Caving Club Newsletter, no.52, [5-10].

Very brief notes on 12 caves and one Roman mine discovered by the British Nylon Spinners Speleology Section since the publication of "Caves in Wales and the Marches" (1963: compiled by D.W. Jenkins and A.M. Williams).

DEARNLEY, R. Ignimbrites from the Uriconian and Arvonian. Bull.Geol. Surv.Grt.Brit., no.24, 1-6, 1 pl.(photomicrographs).

Occurrences of welded and unwelded glassy shard tuffs (ignimbrites) are described from the Pre-Cambrian (Uriconian and Arvonian) volcanic rocks of Shropshire and Caernarvonshire. (Author)

DENNIS, R.A. Some aspects of the geology of the Glyderau (Caernarvonshire). J.Univ.Coll.Swansea geol.Soc., 4, 6-12, 1 fig.(map).

Brief descriptions of: olivine-dolerite dykes; microgranophyres at Mynydd Perfedd and in the Afon Gafr-Llymllwyd area; rhyolites in Cwm Bochlwyd and near Llyn Ogwen; an augite-dolerite dyke, etc.

DODSON, M.H. See THOMAS, J.E.

DREGHORN, W. Geology and the Severn Bridge. 2nd Ed. Cheltenham: The Author. 24pp., 14 figs.(incl.g.sk.maps and field sketches).

The sub-title of the booklet reads, 'why the engineers chose the site from Beachley to the cliffs of Aust - being a scientific explanation for the layman of the geological difficulties which were encountered by the builders'.

EVANS, A.M., GARRETT, P. and J.H.McD. WHITAKER. Palaeocurrents in the Upper Cambrian of North Wales. Nature, Lond., 209, 1230, 1 fig. (map of palaeocurrent directions for Maentwrog and Ffestiniog beds).

Reconstruction of palaeocurrent directions in the Maentwrog Flags and the Ffestiniog Flags (Upper Cambrian) on the basis of flute cast, tool mark, and cross-stratification measurements near Fairbourne, Arthog, Harlech, Portmadoc, Llanberis and Bethesda.

EVANS, I. An interpretation of the geology of the Fan Quarries. J. Univ. Coll. Swansea geol. Soc., 4, 18-19, 1 fig. (g.s.k. map).

An interpretation of the structural relations of the S₂ zone limestones at Fan quarries near Meinciau, Carmar., with surrounding rocks.

FERRARA, G. See THOMAS, J.E.

FLETCHER, K. See WEBB, J.S.

GARRETT, P. See EVANS, A.M.

GIBSON, F.A. See VASSILAKI, M.

GODWIN, H. and V.R. SWITSUR. Cambridge University Radiocarbon Measurements VIII. Radiocarbon, 8, 390-400.

The only Welsh record in this year's report is archaeological rather than geological - charcoal from a layer in the B soil horizon of a soil of the Denbigh series near Llanafan, Cardiganshire.

GREGORY, K.J. and D.Q. BOWEN. Fluvioglacial deposits between Newport (Pemb.) and Cardigan. Deglaciation, ed. R.J. Price, (British Geomorphological Research Group), Occasional Paper 3, 25-28, 1 fig.

Deposits formerly interpreted by Charlesworth as end-moraines are now recognised as of fluvioglacial origin. This implies an ice cover more extensive than formerly envisaged. Sub-glacial channels are also mapped and a reconstruction of the later phases of deglaciation is suggested.

(D.N. Mottershead in Geographical Abstracts A Geomorphology, 1966/3, p.187.)

HARDING, D.M. See HOWE, G.M.

HARPER, C.T. Potassium-argon ages of slates from the southern Caledonides of the British Isles. Nature, Lond., 212, 1339-1341. [Corr.]

The results of analyses of rocks are given from 13 localities in Wales and the Borders. They are: Longmyndian (Welsh Borders); Cambrian slate (Dinorwic, Nantlle, Llanbedr, Llan Ffestiniog, Portmadoc and St. Tudwal's); Ordovician slate (Berwyn Dome, Nant Peris, Blaenau Ffestiniog and Frongoch); Llandoveryan slate (Welsh Borders); Wenlock Slate (Corwen and Glyn Ceiriog).

HARVEY, J.G. Large sand waves in the Irish Sea. Marine Geol., 4, 49-55, 6 figs. (incl. maps, echographs and histograms of bottom samples).

Topographical charts of parts of the Irish Sea are presented. The most detailed of these shows a series of ridges, mostly symmetrical in cross-section and typically 15 m. high, running across a hollow at the northern end of St. George's Channel. Bottom samples obtained in the hollow were composed predominantly of coarse sand, and the ridges are therefore interpreted as large sand waves. Factors possibly responsible for the existence of these sand waves are discussed.

(Author)

HAWKINS, T.R.W. Boreholes at Parys Mountain, near Amlwch, Anglesey. Bull. Geol. Surv. Gt. Brit., no. 24, 7-18, 3 figs., 2 pls.

Eleven inclined boreholes were drilled in 1961-62 on the northern part of Parys Mountain. Thick sedimentary breccia beds were proved close to the Carmel Head Thrust near the western end of the mountain, and black shales were found at the top of the Parys Shales. Although no fossils were found it is suggested that these shales and breccias may be of mid- or early Ordovician age. The 'felsite' is composed of at least three rock types - rhyolite, fine-grained sediment and lithic tuff, all of which have suffered some degree of silicification, mineralization and low-grade metamorphism. The tuffs are the first Ordovician volcanic rocks to be recorded in Anglesey. No evidence of the Rhwnc Thrust intersecting the fold structures at depth was found; the Corwas Thrust is shown to be a high-angle reversed fault; and minor thrusts occur below the Carmel Head Thrust.

(Author)

HOLDER, C. and W.H. MANNING. Regional archaeologies. South Wales. (General Editor: D.M. Wilson.) London: Cory, Adams and Mackay. 88pp.

Includes chronological table (Palaeolithic to Modern) and sections on: Britain in the Ice Age; The earliest hunters of Britain; The 'Red Lady of Paviland'; The coastline of the cave dwellers; The changing coastline of S. Wales, etc., including maps showing coastline at 8,000 B.C. and 5,000 B.C.

HOLLAND, C.H. See WARREN, P.T.

HOWE, G.M., SLAYMAKER, H.O. and D.M. HARDING. Flood hazards in mid-Wales. Nature, Lond., 212, 584-585, 5 figs.

The catchment areas of the Severn above Montford Bridge and the Wye above Erwood were studied - a total area of 1,277 square miles. Twelve river gauging stations, each with at least five years of records were selected for flood frequency analysis, using the flood-index method.

(Authors)

HOWELL, F.T. Does the Irish Sea hold oil or gas. New Scientist, 31, 265-266.

The discoveries in the North Sea encourage re-examination of other off-shore possibilities. The north-east Irish Sea seems to possess

geological features similar to those in the productive region of the North Sea and, hopefully, therefore, may also conceal commercially significant oil or gas fields.

(Author)

HUMPHRIES, D.W. The booming sand of Korizo, Sahara, and the squeaking sand of Gower, S. Wales: a comparison of the fundamental characteristics of two musical sands. Sedimentology, 6, 135-152, 6 figs., 6 tables.

The occurrence of the rare phenomena of a booming sand is recorded and an account given of its behaviour in the field. Its sedimentological properties are compared with those of a squeaking sand from the seashore. Both sands are moderately to well-sorted, and show similar roundness and sphericity. The desert sand is silent, whereas the seashore sand can be made to emit a noise in the laboratory. The marked distinction between the sands lies in the mechanical analyses based on the number frequency of grains, rather than on the weight frequency. A "body-centred cubic" packing has been proposed for the desert sand and a "rhombic" packing for the seashore. Shear-box tests on the disturbed sands appear to support the hypothesis of two different modes of packing. The source of the characteristic booming sound is discussed but it is suggested that an explanation is more likely to be forthcoming from field investigation than from small-scale laboratory studies.

(Author)

INSTITUTE OF GEOLOGICAL SCIENCES. Annual Report 1965. Part I: Summary of progress of the Geological Survey of Great Britain and the Museum of Practical Geology. H.M.S.O. 114pp., 3 figs., 13 photos., refs.

The volume includes reports on field work in the areas around Ammanford (Sheet 230), Gloucester (Sheet 234), Aberystwyth (Sheet 163), Rhyl (Sheet 95), Denbigh (Sheet 107); and details of the Gronant (Pentre Quarry) Borehole.

Maps published in 1965 include: one-inch sheet 108 (Flint-solid and drift) - a new impression of a colour-printed reprint; six-inch sheets SN50 N.W., N.E., S.W., S.E. (Llannon, Felinfoel, Llangennech, etc.) and SN.60 W. (Garnswilt).

ISHERWOOD, K.H.C. A beginners' geological field trip to the Welsh Borderlands. Amateur Geologist, 1, 5-8, 2 figs. (sk. maps).

A report of an excursion to Llyncllys, Breidden Hill, Cardeston, Hampton Beech and Betton Farm.

JAMES, D.M.D. and L.P. THOMAS. Palaeocurrents in some Gower oolites. A Swansea Geological Society project. Preliminary Report. J. Univ. Coll. Swansea geol. Soc., 4, 5.

Measurements of cross-bedding in the Caninia and Seminula Oolites.

JOHNSON, H.M. Silurian Girvanella from the Welsh Borderland. Palaeontology, 9, 48-63, 3 figs., 7 pls.

A general survey of the calcareous algae from Silurian limestones of the Welsh Border has yielded many algal remains particularly of the genus Girvanella. Nine species of this genus are here described, eight of which are new; and they are grouped according to their size and mode of growth. The Sarmenta group includes three new species, G.sarmenta, G.fragila, and G.prolixa; the Problematica group two new species, G.pusilla, G.incompta as well as G.problematica and its var. lumbricalis; the Media group with one new species G.media, and the Ramosa group two new species G.ramosa and G.effusa. The basis for subdividing the genus is given and the distribution of the specific forms in the varied lithology of the limestones are recorded.

(Author)

JONES, D.G. See OWEN, T.R.

JONES, D.G. and T.R. OWEN. The Millstone Grit Succession between Brynmawr and Blorenge, South Wales. Proc.Geol.Ass., Lond., 77, 187-198, 5 figs. (incl. g.sk.maps) and g.map $3\frac{1}{2}$ in. - 1 ml.

The Namurian and lowest Westphalian beds of the Millstone Grit are mapped between Brynmawr and Blorenge, South Wales. It is shown that a phase of secondary dolomitisation is related to zones of close jointing of post-Carboniferous age. This has led to easier weathering of the more friable dolomite which in turn has resulted in irregularities along the Millstone Grit-Carboniferous Limestone junction. Details of an easterly directed overstep of Namurian B (R₂) age are described together with a further possible overstep of early Westphalian (lenisulcata Zone)

(Authors)

JONES, M. On the value of a Welsh dictionary when doing geological mapping in Wales, with examples from the Llandeilo district, Eryri and the Pontypridd-Maesteg area. J.Univ.Coll.Swansea geol.Soc., 4, 17.

KATO, M. A new Silurian rugose coral from Britain. J.Fac.Sci.Hokkaido Univ. ser.IV (Geology and Mineralogy), 13, 257-260, 1 pl. (photo.)

Wenlockia thomasi gen. et sp. nov. (Family Tryplasmataceae Etheridge 1907). The holotype is "from the Wenlock limestone at a quarry on the north side of the Church Stretton-Much Wenlock road, about $1\frac{1}{4}$ miles from Much Wenlock. The species is named after the late Dr. H. Dighton Thomas.

KELLING, G. See OWEN, T.R.

KELLING, G. and B.P.J. WILLIAMS. Deformation structures of sedimentary origin in the Lower Limestone Shales (basal Carboniferous) of south Pembrokeshire, Wales. J.sediment.Petrol., 36, 927-939, 11 figs. (incl. locality map, vertical lithological sections, field-sketches and photographs, cumu-

curves of dimensions of folds and rosette diagrams of fold orientation).

Examples of structures ascribed to penecontemporaneous deformation in the [Lower Limestone Shales of West Angle Bay, and Drinkim Bay, Caldy] ... are recorded. The structures occur in units within a neritic calcareous sequence and appear to be developed at a similar stratigraphical level at several localities.

Evidence derived from a critical study of the geometry of the deformed bodies and their mutual relationships, in many cases, cannot be completely reconciled with theories of origin involving only foundering or with those which require only sub-horizontal shear deformation and translation. It is suggested that many structures may have originated through a combination of these two modes of deformation. Further support for this hypothesis arises from the strong preferred orientation of the structures observed in many of the deformed units. However, when assessed in the light of regional paleogeography and with the evidence of the directional criteria in associated beds, the orientation of the deformed bodies appears to be more intimately controlled by local rather than regional factors.

(Authors)

LARGE, N.F. See SAVAGE, R.J.G.

LEWIS, C.A. The Breconshire end-moraine. Nature, Lond., 212, 1559-1561, 2 figs. (maps).

Evidence is put forward refuting Charlesworth's suggestion that the Newer Drift glaciation of Wales reached Swansea Bay and included much of the Vale of Glamorgan. The author believes in the existence of a local Mid-Wales ice-cap during the Last Glaciation, much of which melted in situ, and the southern limit of which is the Breconshire end-moraine.

LISTER, T.R. Ludlovian chitinozoa from the type area. Bull. Ludlow Res. Grp., no.13, 3-4, 1 table. [abs.]

Brief summary (2pp.) of paper read at the Denbigh Meeting of the Ludlovian Research Group on work in progress on the chitinozoans, acritarchs, sporomorphs, spores and scolecodonts of the Ludlovian rocks of Ludlow.

LOWTON, R.J., MARTIN, J.H. and J.W. TALBOT. Dilution, dispersion and sedimentation in some British estuaries. Proceedings of the Symposium on the Disposal of radioactive wastes into seas, oceans and surface waters, Vienna, 1966, 189-206.

The effects of salinity and temperature distribution, wave transport tidal range, fresh-water inflow and bottom topography are discussed in relation to soluble effluents and sediments. Estuaries to which particular reference is made are the Severn, Blackwater and the Solway Firth.

MACKNEY, D. and C.P. BURNHAM. The soils of the Church Stretton district of Shropshire [Sheet 166]. Mem. Soil Surv. Gt. Britain, vii + 247. [With soil map 1:63,360.]

MANNING, W.H. See HOLDER, C.

MARTIN, J.H. See LOWTON, R.J.

MITCHELL, M. and D.E. WHITE. Catalogue of figured, described and cited Carboniferous corals in the collections of the Geological Survey and Museum. Bull. Geol. Surv. Gt. Brit., no. 24, 19-56.

Includes the following Welsh material:- Caninia juddi (Thomson), Tyn-y-gongl, Anglesey; Caninia juddi cambrensis Lewis, Puffin Island; Cryptophyllum hibernicum Carruthers, Castlemartin and Stackpole Quay, Pembs.; Cyathophyllum archiaci Edwards and Haime, Llanymynech, Salop.; Cyathophyllum stutchburyi Edwards and Haime, Lilleshall, Salop.; Hapsiphyllum [Zaphrentis] cf. konincki (Edwards and Haime), Cwar Blaen-Dyffryn, Brecks.; Lithostrotion maccoyanum Edwards and Haime, Oswestry; Lonsdaleia duplicata duplicata (Martin), Hafod y Calch, Corwen; Lonsdaleia floriformis (Martin), Llangollen; Lophophyllum tortuosum (Michelin), Bullums Bay, Caldy Island; Orionastraea edmondsi laciniosa Hudson, Felin-newydd, Flints.; Orionastraea phillipsi (McCoy), Corwen; Zaphrentis cylindrica (Scouler), Treflasch, Oswestry; Zaphrentis disjuncta Carruthers, Sweeny Mountain, Oswestry; Zaphrentis sp. nov., Pencaedrain Tunnel, Neath; ?Caninia cornucopiae Michelin, Cyathaxonia cf. rushiana Vaughan, Zaphrentis postuma Smith, and Emmonsia parasitica (Phillips), Cefn Coed Colliery, Crynant.

MOHR, P.A. Genetic problems of some sedimentary manganese carbonate ores. The Middle Cambrian manganese carbonate rocks of Newfoundland and Wales: the source and conditions of precipitation of the manganese. Contributions from the Geophysical Observatory, Series A-5, 22pp. [Haile Sellassie I University, Addis Ababa.]

It is suggested on the basis of detailed geochemical studies that the manganese carbonate sediments of basal Middle Cambrian age in the Acadian and Welsh geosynclines (considered to be a single unit prior to continental drifting) owed their origin to the coincidence of three essential factors: the presence of penecontemporaneous spilitic and keratophyric lavas at source, the severe weathering conditions operating temporarily at source, and the existence of isolated basins of marine water in which the manganese salts could be concentrated and precipitated.

The stagnant marine waters of the basal Middle Cambrian basins of S.E. Newfoundland and Harlech - St. Tudwal's were warm, highly saline, alkaline and probably saturated with carbon dioxide. Silica, aluminium hydroxide and manganous carbonate were precipitated and flocculated under these conditions, the abundance of carbon dioxide and a rather low Eh preventing significant oxidation of the manganous ion. Cyclical banding, reflecting long-term climatic changes on land, was caused by variations of Eh-pH of the waters of the basin which thus notably affected

the ferric/ferrous iron ratios in the precipitates. The presence of manganese oxide in the black bands of the Welsh Manganese Ore (corresponding to the green bands of the Newfoundland manganese bed) is not explicable solely in terms of Eh-pH, however.

(Author)

MOORBATH, S. and R.M. SHACKLETON. Isotopic ages from the Precambrian Mona complex of Anglesey, North Wales (Great Britain). Earth plant.Sci.Lett., 1, 113-117, 2 tables.

The results are given of potassium-argon measurements on micas and of rubidium-strontium measurements on micas together with the corresponding total rock carried out on specimens of Coedana Granite, mica-hornfels from the immediate vicinity of the granite, biotite-gneiss and mica-schist from the New Harbour Beds.

NATIONAL MUSEUM OF WALES. Fifty-ninth Annual Report. 1965-66. Cardiff. 92pp.

The main donations to the Department of Geology were: approximately 600 fossils, mainly from the Lias of Charmouth, from J.F. Jackson; and collections of trilobites from the Caradoc and Ashgill rocks of the Bala area and from the Henllan Ash of Arenig from Professor H.B. Whittington.

NICHOLS, R.A.H. Petrology of an irregular nodule bed, Lower Carboniferous, Anglesey, North Wales. Geol.Mag., Lond., 103, 477-486, 1 fig.(location map), 3 pls.(photos. and photo-micrographs).

Some of the nodules described are similar to trace-fossils described by Donaldson and Simpson and some ichnofossils described by Seilacher, but many appear to be structures produced by sedimentary boudinage. These do not seem to be a result of organic or concretionary action. It is suggested that currents deposited thin bioclastic calcarenites with interbeds of calcite silt, and that crinoids and coral patches developed only sporadically during deposition. A few scavengers re-worked the bioclastic calcarenites and calcite silt layers thus forming the trace-fossils; many of the irregular-nodules, however, were probably formed by differential compaction and segregation in the calcite silt beds, and may represent sedimentary boudins, which are relicts of former layers.

(Author)

NICHOLSON, R. The problem of origin, deformation and recrystallization of calcite-quartz bodies. Geol.J., pt.1, 117-126, 2 figs., 2 pls.

The calcite-quartz bodies which occur in the Upper Wenlock slaty succession of Llangollen have a distinctive fabric of platy calcite crystals and coarse, sometimes euhedral, quartz. The calcite internal deformation lamellae and folds and boudins formed in the bodies during the production of the folds and cleavage of the country rock are described together with the recrystallization fabrics of some of the calcite. Note is made of similar rocks from Ribblesdale and Coniston and their origin discussed.

(Author)

NORTH, F.J. 1. James Frederick Jackson, 1896-1966. Welsh geol.Qtly., 2, no.1, 19-25.

An obituary notice in the form of a biographical sketch of the well-known amateur fossil collector.

NORTH, F.J. 2. The "Red Lady" of Paviland. In Glamorgan Historian (edited by S. Williams), Vol.III, 123-137. Cowbridge, Glam.

A chronological account of the published descriptions of the early exploration of Paviland Cave in Gower.

OKADA, H. Non-greywacke "turbidite" sandstones in the Welsh geosyncline. Sedimentology, 7, 211-232, 15 figs.(statistical diags.), 2 pls.(photomicrographs) 1 table (modal analyses of 38 sandstone specimens).

In contrast with the commonly accepted notion regarding ancient turbidites, non-greywacke sandstones are not uncommon in the typically graded turbidite facies of the Cambrian [Rhinog, Barmouth and Gamlan Grits] and Silurian [Aberystwyth and Denbigh Grits] sediments in north Wales. The sandstones are the arkosic and lithic types of Pettijohn (1957 [Sedimentary rocks, 2nd ed. New York]) or the feldspathic and lithic arenites of Gilbert (1954 [in Petrography by H. Williams, F.J. Turner and C.M. Gilbert, San Francisco]) and occur at the bottom of graded beds when the grain size tends to be above medium grade. Petrological features suggest that debris forming the sandstones in north Wales was not significantly modified during transportation and original provenance characters are well preserved.

The occurrence of such sandstones implies that: (1) the current concept of ancient graded greywackes in the turbidite facies should be revised; (2) non-greywacke sandstones in ancient turbidites are comparable in petrological features to recent deep sea sands; (3) these sandstones are important in connection with the origin of the clay matrix in greywacke.

(Author)

OWEN, T.R. 1. Geology and scenery. In A guide to Gower. Gower Society [Royal Institute, Swansea].

A 5-page outline including a geological sketch map and section.

OWEN, T.R. 2. The anthracite problem: with particular reference to South Wales. Welsh geol.Qtly., 2, no.1, 2-10, 4 figs.(incl.g.sk.map and isovol map).

A consideration of the two most likely suggestions put forward to explain the distribution of anthracite in the South Wales coalfield - the tectonic theory and the "burial" theory.

OWEN, T.R. See also JONES, D.G.

OWEN, T.R., RHODES, F.H.T., JONES, D.G. and G. KELLING. Summer (1964)
Field Meeting in South Wales. Proc.Geol.Ass., Lond., 76, 463-495, 9 figs.

Reports of excursions to: The Tenby District; The Vale of Glamorgan via Earlswood; The Llandilo Region; The Gower Peninsula; Pontsticill and the Brecon Beacons; Neath, Rhondda and Avan Valleys.

PITCHER, W.S. The rocks of Merseyside. Part 1. The naming of the Red Rocks. Amat.Geol., 1, pt.1, 9-13, 1 fig.(map).

The first of three articles concerned with the definition and nomenclature of the Triassic rocks of the Liverpool district.

POOLE, E.G. Late Weichselian glaciation in the Cheshire-Shropshire basin. Nature, Lond., 211, 507.

G.S. Boulton and P. Worsley's paper (see Welsh Geol.Abstracts: 1965) is criticized, for ignoring the fact that the Upper Boulder Clay is cut into and therefore is older than the highest stages of the Lake Llanoworth sequence, formed during the retreat of the Upper Boulder Clay ice-sheet.

POOLE, E.G. and A.J. WHITEMAN. Geology of the country around Nantwich and Whitchurch. (Explanation of one-inch geological sheet 122.) Mem.Geol. Surv.Gt.Brit. vii + 154, 13 figs., 8 pls. [With contributions by D. Magraw, R.V. Melville, H.C. Ivimey-Cook, D.T. Donovan and B.J. Taylor.]

Thick deposits of glacial debris cover most of the area, and these have provided the basis for a further contribution to the elucidation of the complex and controversial history of the Great Ice Age in Britain. This same drift, however, also effectively conceals the solid rocks beneath, and for this reason little has hitherto been known concerning their exact nature and disposition. The Roman legionaries knew of the brine springs of Nantwich, and used them as a source of salt when they occupied their fortress at Chester (Deva). Exploratory boring, described in this memoir, now shows that the deposits of rock salt in the Keuper Marl are so great that if only one tenth of one per cent were regarded as workable, this would form the basis of a substantial chemical industry for many years. Sand and gravel, peat, building-stone and reserves of underground water are among the other mineral resources described.

(From the description on the dust jacket of the book.)

POTTER, J.F. 1. [Variations in both lateral and vertical distribution of the Long Quarry Bed faunas in the region between Builth and Llandeilo, South Wales.] Bull.Ludlow Res.Grp., no.13, 5. [abs.]

Brief summary (15 lines) of paper read at the Denbigh meeting of the Ludlovian Research Group.

POTTER, J.F. 2. Rotational strike-slip faults, Llandeilo, Wales. Geol. Mag.Lond., 102 (for 1965), 496-500, 3 figs. (outline g.maps and block-diagrams).

A number of rotational strike-slip faults in the Ludlovian-Downtonian deposits of the Llandeilo region, Carmarthenshire, are described.

POTTER, J.F. and J.H. PRICE. 1. Comparative sections through rocks of Ludlovian-Downtonian age in the Llandovery and Llandeilo districts. Proc. Geol.Ass.,Lond., 76, 379-402, 8 figs.

Four well-exposed sections [Clawdd British, Cwm Dwr, Sawdde and Cennen valley] are used to present a brief description of the Ludlovian-Downtonian boundary rocks in the region. Short faunal lists are provided and correlations made both within the region and with the type area at Ludlow.

(Authors)

POTTER, J.F. and J.H. PRICE. 2. Written discussion to the Summer (1964) field meeting in South Wales Report. Proc.Geol.Ass.,Lond., 77, 384.

A note drawing attention to differences that exist between certain details described in the Field Meeting report (T.R. Owen et al, 1966 - see above) and the conclusions of the authors.

PRICE, J.H. See POTTER, J.F.

REX, D.C. See THOMAS, J.E.

RHODES, F.H.T. See OWEN, T.R.

RICKARDS, R.B. See WARREN, P.T.

ROBERTS, J.C. A study of the relation between jointing and structural evolution. Geol.J., 5, pt.1, 157-172, 3 figs. (incl.sk.map).

The results of a survey of joints and small scale faults along the line of the Neath disturbance between Crickhowell and Glynneath are recorded. The rocks range in age from Lower Old Red Sandstone to the Middle Coal Series. The following conclusions are presented: a well-defined joint system exists, which is of regional significance in south Wales, and which can be correlated with both micro- and macro-structural trends; the joint system comprises up to six sets of joints which display systematic variation with regard to both lithology and tectonic setting; the majority of the joints are shear fractures, and the joint system formed early in the deformational history of the area in brittle rocks as part of the Armorican orogeny; the macro-fracture trend parallels the joint trends, and must be at least in part controlled by them; all the joint and fault trends developed in response to a general N-S compression, either by primary fracturing or by resolved, second-order shearing stress.

SALMON, L. See VASSILAKI, M.

SAVAGE, R.J.G. and N.F. LARGE. On Birgeria acuminata and the absence of labyrinthodonts from the Rhaetic. Palaeontology, 9, 135-141, 1 pl.

A maxilla of Birgeria acuminata from the Rhaetic of the Bristol Channel is described. Previous records of labyrinthodonts from the British Rhaetic are shown to belong to this piscine genus.

SCOFFIN, T.P. Note on the sedimentary petrology and reef structures of the Wenlock Limestone, Shropshire. Bull.Ludlow Res.Grp., no.13, 11-12. [abs.]

Summary of Ph.D. thesis submitted to University of Wales in 1965.

SHACKLETON, R.M. See MOORBATH, S.

SHERGOLD, J.H. 1. A revision of Acaste downingiae (Murchison) and related trilobites. Palaeontology, 9, 183-207, 5 figs., 3 pls. (85 illustrations), 1 table.

Three species of Acaste, A.downingiae (Murchison), A.inflata (Salter), and A.subcaudata (Murchison); two species of Acastocephala gen. nov., A.macrops (Salter) and A.dudleyensis sp. nov.; and Acastoides constricta (Salter) are described from rocks of Wenlockian age from the West Midlands, Welsh Borderlands, and South Wales. Their relationships to later Silurian and early Devonian acastomorph genera are discussed.

(Author)

SHERGOLD, J.H. 2. Wenlock/Ludlow boundary correlation N.E. of Ludlow. Bull.Ludlow Res.Grp., no.13, 6. [abs.]

Brief summary (36 lines) of paper read at the Denbigh meeting of the Ludlovian Research Group.

SIMPSON, I.M. Temporary exposures at Oversleyford brickworks, Ringway, Cheshire. Amat.Geol., 1, pt.1, 22-25, 1 fig.(map).

Brief references to exposures in a claypit which will shortly disappear as a result of the proposed southward extension of the main runway of the Ringway airport.

(Author)

SKEVINGTON, D. The lower boundary of the Ordovician System. Norsk Geologisk Tidsskrift, 46, 111-119.

The lower boundary of the Ordovician System has long been in dispute. Interest in this question has been revived following a recent article by Whittington and Williams (1964), who, for historical reasons, site the boundary at the base of the Arenig Series. An attempt is made to justify placing the boundary at the base of the Dictyonema flabelliforme sensu lato Zone of the Tremadoc Series, in the belief that on this occasion there are grounds for allowing ease of application to overrule priority.

(Author)

SLAYMAKER, H.O. See HOWE, G.M.

SQUIRRELL, H.C. See DOWNING, R.A.

STEPHENS, N. and F.M. SYNGE. Pleistocene shorelines. In Essays in geomorphology (edited by G.H. Dury), 1-51, 22 figs. London: Heinemann.

An examination of "some of the principles and problems inherent in the study of the Pleistocene shorelines, making use of examples drawn from the coasts of northwest Europe.

STRIDE, A.H. See BELDERSON, R.H.

SULLIVAN, R. The stratigraphical effects of the mid-Dinantian movements in south west Wales. Palaeogeog., Palaeoclim., Palaeoecol., 2, 213-244, 9 figs.(incl.locality, isopach,facies and palaeogeog. maps, and comparative sections), 8 pls.(photos.), 1 table.

The mid-Dinantian earth movements may be considered an early phase of the Hercynian orogeny. Two periods of movements have been recognized, the sub- and intra-Viséan phases. The movements resulted in few recognizable tectonic structures, but had instead important stratigraphical effects. The main palaeogeographical control on sedimentation was the massif of St. George's Land. The Dinantian rocks were deposited in east-west facies belts on the shelf south of the landmass. The rocks are composed dominantly of shallow-water marine limestones. Four main facies may be recognized in the Dinantian rocks: (1) "zaphrentid-phase" facies; (2) "standard" facies; (3) "lagoon-phase" facies; and (4) reef facies.

Over the greater part of the area, the limestones are of the "standard" development of the South Western Province. The "standard" limestones are well-sorted, light-coloured, mud-free bioclastic and oolitic limestones deposited in a shallow, open-sea environment. In the extreme south of the area, in the Bosherton-Stackpole Quay outcrop, a large part of the Dinantian succession is made up of the "zaphrentid-phase" facies. This facies is composed of a rhythmical succession of fine-grained, dark-coloured, mud-rich, bioclastic limestones and interbedded calcareous shales and mudstones rich in solitary corals. The "zaphrentid-phase" deposits were deposited on the seaward side of the shelf in muddier, quieter and deeper water.

The mid-Dinantian movements produced important and widespread palaeogeographical changes on the shelf which is reflected in the lithology of the mid-Dinantian rocks. The trend of the shoreline of the shelf sea appears to have been affected by the incipient growth of the Ritec fault. Movements along the fault resulted in breaks in sedimentation (represented in the succession by the sub- and intra-Viséan unconformities) and the development of widespread, restricted coastal flats (represented by "lagoon-phase" deposits) in northern outcrops. Elsewhere in South West Wales there are no apparent discontinuities in the succession as a result of the mid-Dinantian movements. Instead, the movements are reflected by

marked lithological and faunal changes in the succession. In southernmost Pembrokeshire, reefs grew in response to the widespread shallowing of the sea resulting from the mid-Dinantian movements. Reefs are developed at two horizons in the lower part of the Viséan in the Bosherton-Stackpole Quay outcrop.

(Author)

SYNGE, F.M. See STEPHENS, N.

TALBOT, J.W. See LEWTON, R.J.

THOMAS, J.E., DODSON, M.H., REX, D.C. and G. FERRARA. Caledonian magmatism in North Wales. Nature, Lond., 209, 866-868.

A report on "the results of potassium-argon and rubidium-strontium age determinations on biotites from hornfels associated with the Tany-grisiau 'microgranite', Ffestiniog, North Wales" and a brief discussion of the significance of these results in investigations of Caledonian magmatism.

THOMAS, L.P. See CHAPLIN, E.M. and See JAMES, D.M.D.

THOMAS, T.M. The North Sea and its environs: future reservoir of fuel? Geogr. Rev., 56, 12-39, 4 figs. (incl. map of England and Wales indicating oil-fields, gasfields and areas licensed for possible future production).

The paper includes sections on: oil and gas fields in Britain; exploration and prospects in Britain; the Irish Sea.

THOMPSON, D.B. The occurrence of an insect wing and branchiopods (Euestheria) in the Lower Keuper Marl at Styal, Cheshire. Mercian Geologist, 1, 237-245, 3 figs., 1 pl.

These fossils occur in dolomitic, illitic, silty shales deposited in the upper parts of thin, generally fining-upwards cyclothem. The occurrence of the broken wing in tranquil flow evaporitic sediments is consonant with its transportation and settling from floodwaters which have entered a shallow lake or lagoon. There is some evidence that the branchiopods may have lived in the basin and undergone little transportation.

(Author)

THOMPSON, D.B. and P. WORSLEY. A late Pleistocene marine molluscan fauna from the drifts of the Cheshire Plain. Geol. J., 5, pt.1, 197-207.

Some recent finds from two working pits in the outwash sands of the Cheshire Plain are recorded [Sandiway Quarry, Cuddington; Shaw Cross Quarry, Alderley Edge].

The opportunity is taken to discuss the dating and ecology of the fauna in relation to past and present theories of environment in the late Pleistocene, and their relationship to the fauna of the Macclesfield New Cemetery Beds.

(Authors)

THORNTON, I. See WEBB, J.S.

TINKLER, K.J. Slope profiles and scree in the Eglwyseg Valley, North Wales. Geogr.J., 132, 379-385, 4 figs.(incl.sk.maps).

The Eglwyseg limestone escarpment extends for nearly five miles, and is frequently noted as a type example for escarpment screes, although it differs considerably from others in form and in history in upland Britain. Detailed stages in the escarpment are difficult to trace, but the presence of till below scree and clitter on all parts of the escarpment indicates that the basic morphology dates, at least in part, from the last interglacial. Several profiles and scree counts were made, the latter on the lines of the profiles, at random intervals. A histogram of slope angles at World's End, on the northern tip of the escarpment, shows that 35 degrees is persistent. The very limited range (6-7 degrees) of scree angle values and the high percent of the findings of 35 degrees justifies speaking of a constant slope, particularly as the scree does not rest at an angle of repose. Clitter grades into scree upslope, but the junction is usually sharp. Burkalow's (1945) finding that fine material has a steeper angle of rest than coarse when perfectly sorted, but the reverse when imperfectly sorted, holds true for nearly every natural scree slope in this study.

(D.D. Brodeur in Bibliography and index of geology exclusive of America, 31, no.4, 1967, p.764.)

TRESISE, G.R. Mammoth tusk at Llay, near Wrexham. Welsh geol.Qtly., 1, no.4, 17.

A brief note (29 lines) about the discovery of a fragment of a mammal tusk in a working gravel pit at Llay.

VASSILAKI, M., SALMON, L. and F.A. GIBSON. Measurement of radioactivity in soil. Geochim Cosmochim Acta, 30, no.6, 601-606, illus.

To determine the possible variations of activity in local rock types so that the radiation background could be computed, a series of soils in England and Wales which originate from different rock types were examined for their radioactive contents.

WALMSLEY, V.G. Enteletacean brachiopods in Silurian/Lr.Devonian correlation. Bull.Ludlow Res.Grp., no.13, 6. [abs.]

Brief summary (21 lines) of a paper read at the Denbigh meeting of the Ludlovian Research Group concerning current work on some 50-60 species of enteletacean brachiopods.

WARREN, P.T., RICKARDS, R.B. and C.H. HOLLAND. Pristiograptus ludensis (Murchison 1839) - its synonymy and allied species - and the position of the Wenlock/Ludlow boundary in the Silurian graptolite sequence. Geol.Mag., Lond., 103, 466-467. [Corr.]

A reinvestigation of the Salopian graptolite faunas of North Wales and of some of the type-specimens in the Elles and Wood Collections at

the Sedgwick Museum, Cambridge and Birmingham University and a study of the graptolites of the Wenlock Shales and Wenlock Limestone and comparisons with Polish graptolite material (for which we are indebted to Dr. L. Teller of Warsaw), have together yielded significantly new information on the graptolite sequence of the Upper Wenlock and Lower Ludlow Series.

A comprehensive paper is in course of preparation, but the authors believe their conclusions - which are summarized in the letter - to be of significant interest to merit prior publication; particularly since they affect the preparation of future maps of the Silurian based on graptolite sequences and the worldwide correlation of the Wenlock and Ludlow Series.

WATSON, E. 1. Periglacial structures in the Aberystwyth region of central Wales. Proc. Geol. Ass., Lond., 76, 443-462, 6 figs. (location map and sections), 11 photos.

Examples of involutions, U-shaped structures in glacial or other drifts, believed to have developed in the active layer (mollisol) in areas of frozen ground, and of vertical stones, bouldery or stony horizons where a large proportion of the elongate stones have their long axes vertical, are described from Llanon-Aberayron, Lampeter, Llanwnen, Llanbadarn, Aberystwyth, Nant-y-moch, and their origin discussed. Examples of wedge structures, narrow vertical intrusions tapering downwards, and filled with disturbed material similar to that of the adjoining or overlying beds, are described from Abergynolwyn, Talybont, Lampeter, Nant-y-moch, Devil's Bridge, Ponterwyd, Dol-goch. The distribution of these involutions and wedge structures is considered in relation to the several limits of ice advances during the Würm glaciation which have been put forward.

WATSON, E. 2. Two nivation cirques near Aberystwyth, Wales. Biuletyn Peryglacjalny, no. 15, 79-101, 14 figs.

In the uplands of Wales, both glacial and nivation cirques occur. In late glacial times, the former were occupied by cirque glaciers which have the ability to move debris out of the cirque. These cirques are characterised by erosion features, usually a lake basin enclosed by a moraine. The nivation cirques on the other hand were occupied by a perennial snow patch, incapable of movement. Their floors are characterised by deposition, for debris, produced by freeze - thaw, moved underneath the snow to the lower part of the snow patch and accumulated there to form a drift platform.

In the drift platform of Cwm Du [Upper Ystwyth valley], stream sections expose these drifts to depths of 50 feet (15 metres) showing beds of unsorted rock debris in a tough matrix of blue-grey silty clay alternating with more stony layers, usually yellow-grey in colour. The former are typical of the solifluction deposits on the local rock type, while the latter are interpreted as poorly washed residues of the deposit from which snow melt has washed some of the muddy matrix.

Sometimes, as in Cwm Tinwen [Upper Ystwyth valley], a protalus or pseudo-moraine occurs, usually associated with a steep high backwall so

that debris from the exposed backwall, instead of lodging on the snow patch slides down its steep surface to form a ridge at its foot.

(Author)

WEBB, J.S., THORNTON, I. and K. FLETCHER. Seleniferous soils in parts of England and Wales. Nature, Lond., 211, 327, 2 tables. [Corr.]

"Geochemical reconnaissance by stream sediment samples of 3,000 square miles in the Midlands, North Wales and South-west England disclosed extensive areas characterized by abnormally high molybdenum contents of 5-60 p.p.m. compared with normal background of < 2 p.p.m." As in other areas selenium was present in stream sediments in each of the anomalous molybdenum areas with maximum values ranging from 3.8 to 9.0 p.p.m. selenium compared with the normal background of < 0.2 p.p.m.

The principal bedrock source of the selenium and molybdenum seems to be certain marine shale facies of the Lower Carboniferous in both Staffordshire and Devon, and of the Ordovician of North Wales. Partial analyses are given of four rock types from North Wales.

WEIR, J. A monograph of British Carboniferous non-marine lamellibranchia. Part XI. Pal.Soc.Monograph, 321-372, 2 figs., 8 pls.

Contains diagnosis and description of the genus Anthraconaia Trueman and Weir, 1946. Fourteen species are described belonging to the genus, including one new species (Anthraconaia ellipsoides). Tables of dimensions are given for each species.

WHITAKER, J.H.McD. See EVANS, A.M.

WHITE, D.E. The Silurian rugose coral Microplasma lovenianum Dybowski from Monmouthshire. Palaeontology, 9, 148-151, 1 pl.

Specimens of Microplasma lovenianum Dybowski 1874 from the Wenlock Limestone of the Usk Inlier, Monmouthshire, are described and illustrated. This is the first record of the occurrence of Microplasma in Britain. The diagnosis of the genus is restated and a diagnosis of M. lovenianum is also given.

(Author)

WHITE, D.E. See also MITCHELL, M.

WHITEMAN, A.J. See POOLE, E.G.

WHITTARD, W.F. The Ordovician trilobites of the Shelve Inlier, west Shropshire. Part VIII. Pal.Soc.Monograph, 265-306, 1 fig., 5 pls.

Twenty five species of trilobites are described and figured. Seven genera are new (Lordshillia, Cochliorrhoe, Macrogrammus, Procephalops, Rorringtonia, Gastropolus, Thymurus) and eleven species are new (Geragnostus scoltonensis, Myttonia multiplex, Incaia simplicior, Lordshillia confinalis, Cochliorrhoe inquilinum, Bergamia matura, Macrogrammus scylfense, Procephalops hopense, Rorringtonia flabelliforme,

Gastropolus brevicaudatum, Thymurus incertum).

The stratigraphy of the Shelve area is discussed and the ranges and stratigraphic value of the trilobite faunas are plotted and assessed.

WHITTINGTON, H.B. 1. A monograph of the Ordovician trilobites of the Bala area, Merioneth. Part 111. Pal.Soc.Monograph, 63-92, 2 figs., 10 pls.

Contains descriptions of twenty one species of trilobites. One species (Astroproetus berwynensis) is new. Type specimens are selected and figured for new and existing taxa.

WHITTINGTON, H.B. 2. Trilobites of the Henllan Ash, Arenig Series, Merioneth. Bull.Br.Mus.nat.Hist., 11, 489-505, 5 pls.

New collections have been made from the only beds in the type area of the Arenig Series that yield a shelly fauna. These beds are termed the Henllan (rather than Calymene) Ash, and the Erwent (rather than Ogygia) Limestone is considered to be an upper member of this Ash. The five species include two identical with, and three similar to, species recently described from extensus Zone beds of the Mytton Flags of West Shropshire. This fauna may be widespread in Wales, and is like faunas of similar age in southern Europe but unlike those of Sweden. One new species, Myttonia fearnsidesi, is described.

(Author)

WHITTINGTON, H.B. See also BASSETT, D.A.

WILLEY, E.C. Nomenclature of the Keuper-Lias facies of the Bristol Channel region. Nature,Lond., 211, 398-399. [Corr.]

A proposal that the terms 'proximal' and 'distal' be used for the two main facies of the strata from Keuper to Lias rather than terms such as 'near-shore' and 'off-shore'.

WILLIAMS, A. See BASSETT, D.A.

WILLIAMS, B.P.J. See KELLING, G.

WOBBER, F.J. A study of the depositional area of the Glamorgan Lias. Proc. Geol.Ass.,Lond., 77,, 127-137, 2 figs.

Orientation studies of echinoid spines and sponge spicules, coupled with a study of small-scale sedimentary structures, suggest that a principal direction of Lias sedimentation in the Vale of Glamorgan was from the south. The absence of northerly derived Coal Measure or Millstone Grit lithoclasts in the nearshore and offshore Liassic sediments in Glamorgan support this view. The present South Crop of the South Wales Coalfield was presumably not exposed during the Lias.

(Author)

WORSLEY, P. Some Weichselian fossil frost wedges from East Cheshire. The Mercian Geologist, 1, 357-365, 2 figs., 2 pls.

The occurrence of intra, inter and supra-formational horizons of frost wedge growth within alluvial and till deposits are recorded. They are interpreted as signifying recurrent permafrost episodes within the last glaciation. (Author)

WORSLEY, P. See also THOMPSON, D.B.

ZEIGLER, A.M. 1. Unusual stricklandiid brachiopods from the Upper Llandovery beds near Presteigne, Radnorshire. Palaeontology, 2, 346-350, 1 pl., 1 table.

Both smooth and strongly ribbed stricklandiid brachiopods occur together in early Upper Llandovery beds (C₁-C₃) at Presteigne. Aenigmastricklandia contorta gen. et sp. nov. is proposed for the ribbed species, while the smooth species is assigned to Stricklandia lens aff. progressa Williams. Aenigmastricklandia appears to be an early ribbed offshoot of the main stricklandiid line; a parallel development is seen in Costistricklandia, which appeared toward the end of Upper Llandovery time (C₅-C₆). (Author)

ZEIGLER, A.M. 2. The Silurian brachiopod Eocoelia hemisphaerica (J. de C. Sowerby) and related species. Palaeontology, 2, 523-543, 6 figs., 2 pls., 7 tables. [Appendix - Description of localities.]

The atrypaecean Eocoelia occurs widely in the Upper Llandovery and is now known from the lower Wenlock. It shows evolutionary trends in the progressive suppression of ribs and in the modification and strengthening of the articulatory mechanism. These trends are used to define four successive species, Eocoelia hemisphaerica (J. de C. Sowerby) of C₁-C₂ age, E.intermedia (Hall) of C₃-C₄ age, E.curtisi sp. nov. of C₅ age, and E.sulcata (Prouty) of C₆-Wenlock age. The taxa Eocoelia hemisphaerica sefinensis (Williams) and Eocoelia quebecensis Amos and Boucot are relegated to the synonymy of Eocoelia hemisphaerica. Because of the abundance of Eocoelia at some localities, the term Eocoelia Community seems appropriate; this community probably occurred in a near-shore environment. Brachiopod lineages, such as the Eocoelia lineage, provide a reliable basis for fine-scale correlation.

(Author)

WELSH GEOLOGICAL ABSTRACTS : 1965 (Supplement)

HOARE, R.H. Tonsteins. Geol.Mag., Lond., 102, 347-349.

With reference to a paper on tonstein occurrences in Westphalian (Carboniferous) localities of England and Wales, by D.L. Slater, problems of identification, nomenclature, and stratigraphic significance of tonsteins in general are discussed. Whether any one tonstein recognized in a sequence of Coal Measures can be accepted as a continuous and widespread marker bed of significance for precise correlation is open to question.

JONES, H.A. Ferruginous oölites and pisolites. J.sediment.Petrol., 35, 838-845, illus.(incl.sk.map).

The oolitic texture of ironstones associated with laterites capping erosion surfaces at various localities in Nigeria has generally been considered secondary in origin and to have developed during formation of the surface laterite. Study of two major occurrences associated with upper Senonian (Cretaceous) deposits near Lokoja and comparison with oolitic and pisolitic laterites and with ferruginous pisolites in basal Carboniferous Limestone deposits of Skrinkle Haven, South Wales, lead to the conclusion that oolitic textures can develop in ironstones by two entirely different processes. One process involves accretionary growth around separate nuclei in a high-energy environment prior to deposition; the other involves diffusion and oxidation of iron in the solid rock during weathering.

KINGSBURY, A.W.G. Tellurbismuth and meneghinite, two minerals new to Britain. Miner.Mag., 35, 424-426.

An examination of a number of specimens from the Clogau and Vigra mines, Merioneth, in collections at Oxford and identified as tetradymite, are shown to be tellurbismuth.

MINISTRY OF HOUSING AND LOCAL GOVERNMENT. River Wye basin-Hydrological Survey. (Hydrometric area No.55.) H.M.S.O. 57pp., illus.(incl. simplified g.map and relief map).

In 1959 the Central Advisory Water Committee, which was appointed by the Minister of Housing and Local Government, published the first report of their Sub-Committee on the Growing Demand for Water. This report recommended that detailed hydrological surveys should be carried out to involve a "comprehensive examination in each river

basin of rainfall and run-off, public and private sources of supply, effluent discharges, re-use of water and potential storage sites". The Surface Water Survey Centre of the Ministry of Housing and Local Government was accordingly instructed to prepare the present survey of the Rive Wye Basin, which is the eleventh in the series.

From the Foreword.

PROUDFOOT, P. (Compiler) Current research in geomorphology (British Geomorphological Research Group). 48pp., 1 fig.(key map).

The second issue of the Register which lists 304 persons working on geomorphology in Britain during the academic year 1964-65. Forty-nine of these were concerned with parts of Wales and the borders.

WATSON, E. Grèzes litées ou éboulis ordonnés tardiglaciaires dans la région d'Aberystwyth au centre du Pays de Galles. [Grèzes litées or stratified screes of late glacial age in the Aberystwyth region of central Wales.] Bull.de l'Assoc.de Géographes Français, 338-9, 16-25, 3 figs., 4 pls., 1 table.

On the well-cleaved greywackes and mudstones of the Aberystwyth region, the screes of the steeper valley sides frequently form a three-fold series. The upper and lower members consist of relatively coarse and unsorted scree separated by beds very similar to the stratified screes of France and Belgium. In the shallower upper parts of the valleys, the slope deposits show a parallel development consisting of two heads separated by water-laid gravels. On the upper head and the upper scree is developed the modern soil so that it seems probable that both sets of deposits are late-glacial in age, the stratified screes and the gravels being Aller/d. This association of stratified screes with moister conditions (as suggested by the gravels), is in agreement with the views of those French authors who believe that snow-melt played an important part in their formation. It is also in line with their large-scale development during the last glacial period in the oceanic margins of Europe south of the British Isles ice-sheet.

(Author)

LOCALITY INDEX

(The index is cumulative: page numbers of items in the Welsh Geological Abstracts for 1965 are given in brackets.)

- | | | |
|------------------------------------|---------------------------------|---------------------------------|
| Aber (Marian Rhaiadr Fawr) 4 | Bryn Heulog Qry. (5) | Colwyn Bay (5) |
| Aberayron 24 | Brynmawr 13 | Coniston 16 |
| Aberbargoed (11) | Bryn Nantllech (18) | Conway estuary (21) |
| Abercynon (11) | Bryn Pica 7 | Corvedale (17) |
| Aberdare 7 | Buckley (5) | Corwen 10,15 |
| Aberedw, Radn. 3 | Builth 18 | Craven Arms (17) |
| Abergavenny (10) | Bullum's Bay, Caldý 15 | Crickhowell 19 |
| Abergynolwyn 24 | Bwlch y Groes (Waun-y-Gadfa) 4 | Cross Foxes (Bwlch Llyn Bach) 4 |
| Aberystwyth 12,24,29 | | Crumlin (11) |
| Alderley Edge (10,21) | Cae'r ceiliog, nr. Llanrwst (7) | Cuddington (Sandiway Qry.) 22 |
| Alderley Edge (Shaw Cross Qry.) 22 | Caerleon 2 | Cwar Blaen Dyffryn, Brecs. 15 |
| Amlwch 11 | Caernarvonshire (4, 19); 9 | Cwm Bochlwyd 9 |
| Ammanford (10); 12 | Caldý 14,15 | Cwm Du, Cards. 24 |
| Anglesey (2,3,4); 11, 16 | Cardeston 12 | Cwm Dwr, Carms. 19 |
| Arenig 16 | Cardiff (15); 2 | Cwm Tinwen, Cards. 24 |
| Arthog 10 | Cardigan 10 | |
| Aust 9 | Cardigan Bay (11,13) | Denbigh (10); 12 |
| Avan valley 18 | Cardigan Bay (coast) 7 | Denbighshire (18,20) |
| | Cardmarthenshire (11); 2,19 | Devil's Bridge 24 |
| Bala (21); 5,16,26 | Castlemartin 15 | Devil's Kitchen (10) |
| Bar Hill (6) | Cefn Coed Colliery, Crynant 15 | Devon 25 |
| Beachley 9 | Celtic Sea 6 | Dinas Bran (5) |
| Belgium 29 | Cennen valley 19 | Dinorwic 10 |
| Benthall Edge (15) | Ceseiliau Duon (6) | Dolgellau (5) |
| Berwyn Hills 10 | Ceseiliau Moelwyn (6) | Dol-goch 24 |
| Bethesda 10 | Charmouth 16 | Dovey estuary (2) |
| Betton Farm 12 | Cheshire (6); 18,20, 22,27 | Dovey Forest (Cwm Cadian) 4 |
| Blackwater estuary 14 | Chester 18 | Dovey river (S.of) (11) |
| Blaenau Ffestiniog (6); 10 | Church Stretton (7, 10); 13,15 | Drinkim Bay, Caldý 14 |
| Blorengé 13 | Chwilog (19) | Druidston Haven (4); 7 |
| Borth (2) | Clawdd British 19 | Dyserth (5) |
| Borth Bog (2) | Clee Hill (2) | |
| Bosherston 21,22 | Clogau mine 28 | Earlswood 18 |
| Bourton (17) | Clun Forest (5) | Eglwyseg 23 |
| Brecon Beacons 18 | Coedana 16 | Eigiau (Hafod-y-Rhiw) 4 |
| Breconshire 14 | Coed Camlyn, Mer. 4 | Ely valley 2 |
| Breidden Hills 12 | | England, S.W. 25 |
| Bridgend (10) | | Erwood 11 |
| Bristol Channel 6,20,26 | | Eryri. See Snowdonia |
| Brithdir (5) | | Even Wood Qry. (16) |

Fairbourne 10
 Fan gries. 10
 Felinfoel 12
 Felin-newydd, Flints.
 15
 Ffestiniog 22
 Fforest Fawr (9)
 Fishguard (6)
 Flint 12
 Forest of Dean (18)
 France 29
 Fron-Fawr (18)
 Fron-goch 10

Gafr river 9
 Garnswllt 12
 Glamorgan (14,23); 8,
 26
 Glamorgan, Vale of.
 (5,7); 7,8,14,18,26
 Gloucester (10); 12
 Glyderau (Glyders) 9
 Glyn Ceiriog (5); 10
 Glynneath 19
 Gower 7,12,17,18
 Great Orme's Head (5)
 Griffithstown (11)
 Gronant 12
 Gullet Qry. (7,20)
 Gwern-y-Brain (8)
 Gwydyr (Coedyrallt
 Goch) 4

Hafod y Calch 15
 Halkyn Mt. (5)
 Hampton Beech 12
 Harlech 10
 Harlech dome 15
 Harrock Hill (5)
 Haverfordwest (19)
 Hayscastle (11)
 Henllan (13)
 Highley 9

Irish Sea (13); 8,11,
 22

Kerry (5)
 Kidwelly (11)
 Kinlet Qry., nr.
 Highley 9
 Korizo, Sahara 12

Lampeter 24
 Leebotwood 9
 Lilleshall 15
 Liverpool 18
 Llanafan 10
 Llanbadarn 24
 Llanbedr 10
 Llanberis 10
 Llanddono (21)
 Llandeilo (16); 13,
 18,19
 Llandovery 19
 Llandudno (5,15)
 Llanelltyd 4
 Llan Ffestiniog 10
 Llangennech 12
 Llangernyw (18)
 Llangollen (5); 15,
 16

Llanharry (17)
 Llanefydd (18)
 Llannon, Carms 12
 Llanon, Cards. 24
 Llanrwt (4,7)
 Llansannan (18)
 Llansantffraid,
 Cards. 7
 Llansantffraid,
 Glyn Ceiriog (5)
 Llanwnen 24
 Llanymawddwy (Craig
 Ty Nant) 4
 Llanymynech 15
 Llanystumdwy (15)
 Llay 23
 Llechryd (23)
 Lleyn (4,19,20)
 Llymllwyd 9
 Llyncllys 12
 Llyn Idwal (10)
 Llyn Ogwen 9
 Llyn-y-Cwm (10)
 Ludlow 14,19,20

Macclesfield 22
 Maesteg (11); 13
 Malvern Hills (4,7)
 Manod (6)
 Margam (8)
 Marros (4)
 Mary Knoll valley 3
 Meinciau 10

Mellte river (11)
 Menai (14)
 Menai Straits (22)
 Merioneth (14,21); 26
 Merseyside 18
 Midlands of England
 17,20,25
 Minchin Hole 7
 Moelwyn (6)
 Moel Ysgyfarnogod (14)
 Monmouthshire 2,9,25
 Montford Bridge 11
 Morfa Harlech (18)
 Much Wenlock (17); 13
 Mullock Bridge (7,13)
 Mynydd Perfedd 9

Nantlle 10
 Nant Peris 10
 Nantwich 18
 Nant-y-Gamar (15)
 Nant-y-moch 24
 Neath valley (22); 18
 Nevern (11)
 Newcastle Emlyn (13)
 Newfoundland 15
 Newport, Pems. 10
 Newquay 7
 Nigeria 28
 North Crop (4,15,16)
 North Sea 11,12,22

Old Radnor (11)
 Onny (17)
 Oswestry 15
 Oversleyford brickworks
 20

Painscastle 3
 Parbold (5)
 Parys Mt. 6,11
 Paviland 11,17
 Pembrey (11)
 Pembroke Dock (19)
 Pembrokeshire (2,4,6,11,
 12,13,19); 13,22
 Pencaedrain tunnel,
 Neath 15
 Pendine (19)
 Penylan Qry., Cardiff
 (15)
 Ponterwyd 24

Pontsticill 11, 18
 Pontypool 2
 Pontypridd (11), 13
 Porth Claais 7
 Porth Cwyfan (21)
 Portmadoc 10
 Prestatyn (5)
 Presteigne 27
 Puffin Island 15
 Pumlumon (Plynlimon)
 (19)

 Radnorshire 3, 27
 Rhiw (12)
 Rhiwillech river,
 nr. Bala 4
 Rhondda valley 18
 Rhyl (10), 12
 Rhymney valley 2
 Ribblesdale 16
 Rickets Head 9
 Ringway airport 20
 Risca 2
 Rumney inlier 3

 St. David's Head (11)
 St. George's
 Channel 6, 11
 St. Harmon (Cefn Pen-
 lan) 4
 St. Tudwal's 10, 15
 Sarn Badrig (8)
 Sawdde 19
 Settling Nose (4)
 Severn Bridge 9
 Severn estuary 14
 Severn river 2, 11
 Shelve inlier 25, 26

Shropshire (6, 8, 10, 15,
 16); 9, 15, 18, 20, 25, 26
 Skellow Clough (5)
 Skrinkle Haven 28
 Snowdonia 3, 4, 13
 Solway Firth 14
 Southerndown (7)
 South Wales. See
 Wales, S.
 Stackpole Quay 15, 21,
 22
 Staffordshire 25
 Stout Bay (7)
 Styall 22
 Swansea (4, 23)
 Swansea Bay 14
 Sweeny Mt. 15
 Sychnant, Conway 4

 Taff river (10)
 Taff valley 2, 9
 Talybont 24
 Tan-y-grisiau 22
 Teifi valley 13
 Tenby (18); 18
 Thurstaston (5)
 Treflasch 15
 Trefor (5)
 Tre-lllys (13)
 Tremadoc (19)
 Tremadoc Bay (8)
 Tremadoc (Cwm Bach)
 4
 Tremerchion (21)
 Tre-pys-lllygod (18)
 Trevor Hall (5)
 Trimsaran (11)
 Tŷll Du (9, 10)

Ty-canol (5)
 Ty'n-y-gongl 15

 Upholland (5)
 Usk inlier 25

 Vigra mine 28
 Wales (5, 11, 17, 18,
 19, 23); 5, 15
 Wales, C. (11); 4,
 11, 14, 24
 Wales, N. (4, 8, 15,
 21); 4, 8, 10, 22, 23, 25
 Wales, N.E. (10)
 Wales, S. (3, 5, 6, 9, 11,
 19, 22, 23); 9, 11, 13,
 17, 18, 19, 20, 26
 Wales, S.C. (16)
 Wales, S.W. (13); 7, 21
 Wales, W. (13)
 Welsh Borders (2, 3, 4,
 5, 8, 12, 13, 20); 3, 5,
 10, 12, 13, 20
 Welshpool (8)
 Wenlock Edge (17)
 West Angle Bay 14
 West Williamson (19)
 Whitchurch, Salop.
 (6); 18
 Wirral (5)
 World's End 23
 Wrexham (6); 23
 Wye 11, 28

 Y Llethr (14)
 Ynyslas (8)
 Ystradfellte 7

SUBJECT INDEX

(The index is cumulative: page numbers of items in the Welsh
Geological Abstracts for 1965 are given in brackets. The
 index is classified under 47 headings.)

ARCHAEOLOGY (21); 2,
 8, 9, 11, 17, 18

BIBLIOGRAPHIES
 Geol. Survey (14)

Theses (5); 5
 Wales 5

BIOGRAPHIES
 W.E. Logan (23)
See also Obituaries

BOREHOLES (4, 21); 2,
 11, 12, 18

CAVES AND CAVE SCIENCE
 7, 9

CONSERVATION 3

EARTH MOVEMENTS

- Caledonian (3,20); 22
- Dinantian (Mid.) 21
- Hercynian 19,21
- Holocene (8)
- Magnetism 22
- Malvernian (10); 9

ECONOMIC GEOLOGY

- Brine springs 18
- Building stone 18
- Clay refractories (23)
- Gas and oil 11,12
- Iron ore (17)
- Mining (Metallif.) (21)
- Opencast coal working 7
- Underground water 18

EDUCATION

- Exams. (C.S.E.) (4)
- Museum Schools Service (15)

FACIES (10); 17,18,21,26

See also Palaeogeography

FIELD EXCURSIONS

(5); 12,18,19

FOSSILS

- Acritarchs 14
- Algae
 - Girvanella 13
- Asterozoa (16)
- Brachiopods
 - Aenigmastricklandia gen.nov. 27
 - Clorinda (23)
 - Costistricklandia 27
 - Dalmanella (2)
 - Eococlia (23); 27
 - Isorthis (2)
 - Lingula (23)
 - Microcardinalia 2
 - Pentamerus (23)
 - Salopina (20)
 - Stricklandia (23); 2
 - See also (8,9,15,23); 5

Branchiopods

Euestheria 22

Bryozoa. See Polyzoa

Cephalopods

- Goniatites (4)
- Leurocycloceras (13)
- Orthoceras (13)
- Orthoceratites (12)

Chitinozoa 14

Conodonts (7)

Corals

- ?Caninia 15
- Caninia 15
- Cryptophyllum 15
- Cyathophyllum 15
- Cyathoxonia 15
- Emmonsia 15
- Hapsiphyllum [Zaphrentis] 15
- Lithostrotion (14); 15
- Lonsdaleia 15
- Lophophyllum 15
- Microplasma 25
- Orionastraea 15
- Wenlockia gen.nov. 13
- Zaphrentis 15
- See also 16,21

Crinoids

- Iocrinus (5)
- See also (15); 16

Echinoids 26

Foraminifera

- Ammonia (2)
- Elphidium (2)
- Jadammina (2)
- Protoelphidium (2)

Graptolites

- Monograptus (7)
- Pristiograptus 23

Ichnofossils 16

Insects 22

Lamellibranchs

- Anthraconaia 25
- Gryphaea (7)

Mollusca (13,21,23); 22

Plants

- Archaeosigillaria 9
- Cyperites 9

Lepidocarpon 9

Lepidophyllites 9

Lepidophyllum 9

Lepidostrobos 9

Omphalephloios 9

Polysporia 9

Sigillaria 9

Sigillariostrobus 9

Stigmara 9

Stigmariopsis 9

Ulodendron 9

Polyzoa

- Amplexopora? (16)
- Eridotrypa (15)
- Homotrypa (16)
- Leioclema (15)
- Monotrypella (15)
- Nicholsonella (15)
- Rhombopora (15)
- See also (15)

Scolecodonts 14

Spores

- Lagenicula (18)
- Polypodium (9)
- Radiatisporites (18)
- Rotatisporites (18)
- Setosporites (18)
- Superbisporites (18)
- Zonalesporites (18)

Sponges 26

Sporomorphs 14

Trace-fossils 16

Trilobites

- Acaste 20
- Acastocephala gen. nov. 20
- Acastoides 20
- Angelina (19)
- Austroproetus 26
- Atractopyge (10)
- Bergamia 25
- Broegerolithus (10)
- Cochliorhoe gen. nov. 25
- Cybeloides (21)
- Deacybele gen.nov. (21)
- Gastropolus gen. nov. 26
- Geragnostus 25
- Incaia 25

Lordshillia gen.

nov. 25

Macrogrammus gen.

nov. 25

Myttonia 26

Phillipsinella 6

Procephalops gen.

nov. 25

Rorringtonia gen.

nov. 25

Thymurus gen. nov.

26

See also (9); 5,6,

16

Vertebrates

Birgeria 20

Labyrinthodonts 20

Mammals (14)

Mammoth tusk 23

GEOCHEMISTRY

Aluminium hydroxide

15

Chem. anal. (4,10,14,

20); 3,4,25

Diff. thermal anal. 4

Eh and pH 15,16

Manganese carbonates

15

Molybdenum and Selen-

ium 25

Silica 15

Stream sampling 25

X-ray anal. (22); 3,4

GEOCHRONOLOGY

Pollen analysis 8

Potassium-argon dates

10,16,22

Radio-carbon dates

(7,11,13); 7,10

Rubidium-strontium

dates 16,22

See also (17,20)

GEOGRAPHY

Current research

6,29

Slope profiles 23

Theses (5)

See also Glacial/Peri-

glacial geology, Marine

Geology, and Physical

Geology

GEOPHYSICS

Density variations 7

Gravity surveys, etc.

(10,11,19)

Seismic surveys (14)

See also Maps

GEOTECTONICS

Continental drift 15

GLACIAL/PERIGLACIAL

GEOLOGY

Deglaciation 10

Fluvioglacial de-

posits 10

Glacial deposits

(13,14); 2,4,14

Glaciation (14);

7,18

Periglacial con-

ditions (6,13); 4

Permafrost (9,22)

Solifluction de-

posits 24

Superficial deposits

2,3,7,18,22

See also Rocks: sedi-

mentary; and Struc-

tures: periglacial

HISTORY OF GEOLOGY

"Red Lady" (Paviland)

17

HYDROLOGY

Mid-Wales 11

Wye 28

INSTITUTIONS, SOCIETIES

MUSEUMS, ETC.

British Museum (5,10)

British Nylon Spinners

Speleology Section 9

Cardigan Bay Research

Project (2)

Inst. of Geological

Sciences (incl. Geol.

Survey) (20); 12,15

Ludlow Research Group

(4,8,16,17); 3,14,

16,20,23

Manchester Museum (16)

National Coal Board

2

National Museum of

Wales (15); 5,16

National Physical

Laboratory (7)

Nature Conservancy 4

Robertson Research

Co. Ltd. 5

Royal Institute of

S. Wales, (23).

Sedgwick Museum, Cam-

bridge (7,8); 24

Soil Survey of England

and Wales 5

University: Birmingham

(11); 24

Univ. College, Aberyst-

wyth 4

Univ. College, Bangor 5

Univ. College, Cardiff

2,5

Univ. College, Swansea

(7); 3,5

University: Reading (13)

University: Sheffield

(18)

MAPS

Aeromagnetic (10,19)

Geological (1-inch and

6-inch) (10); 12

Isopachyte (3); 21

Isopleth (5)

Palaeocurrent (3)

Rock-head contours (3)

Sub-crop (3)

Topographical (sub-

marine) 11

MARINE GEOLOGY AND

OCEANOGRAPHY (8); 6,11,

14,15

METAMORPHISM

Diagenesis (2,23); 8,9

Dolomitization 13

Induration (9)

Lithification (2)

Recrystallization 16

Silicification 11

MINERALS

Biotite 22

Calcite (15)

Chlorite (22); 3,4

Clay minerals 3
 Galena (21)
 Illite (2,22)
 Kaolinite (22)
 Meneghinite 28
 Mica 16
 Plagioclase (12)
 Quartz (16,22); 16
 Tellurbismuth 28
 Tetradymite 28

MISCELLANEOUS
 Research 3,4,6
 Rock-hunting 9
 Welsh dictionary 13

OBITUARY NOTICES
 Jackson, J.F. 17
 Whittard, W.F. 7

PALAEOECOLOGY 16,22,27
 Burrowing organisms (23)
 Fossil communities (23); 27

PALAEOGEOGRAPHY (2,3,8, 23); 14,21
 Alluvium (O.R.S.) (2,3)
 Alluvium (Trias) (5)
 Coastal flats (Carb.) 21
 Deltas (Coal Measures) (10)
 Drainage: Glacial (6,10,16)
 Drainage: Tertiary-Recent (14)
 Flood-plain deposits (Carb.) 9
 Flood-plain deposits (Coal Measures) (10)
 Fore-reef (Carb.) (15)
 Lacustrine deposits (O.R.S.) (3)
 Lagoon (Keuper) 22
 Lake (Keuper) 22
 Lake Lapworth 18
 Lakes: glacial (10, 13,14,16)

Palaeocurrents (Camb.) 8,10
 Palaeocurrents (Carb.) 12
 Palaeoslopes (Sil.) 3
 Piedmont deposits (O.R.S.) (3)
 Playa deposits (O.R.S.) (3)
 Reef-knoll (Carb.) (15)
 St. George's Land (3); 21
 Sea-stacks (Sil.) (7)
 Shorelines (5000 B.C.) 11
 (8000 B.C.) 11
 (Carb.) 21
 (Pleistocene) 21
 Soils (Coal Meas.) (10)
 Sub-aerial delta (Coal Meas.) (10)
 Turbidity currents (Camb.) 8

PALAEONTOLOGY
 Figured specimens 15
 Fossil communities (23); 27
 Palaeontographical Society Monographs 25,26
 Palynology 2

PETROFABRICS 16

PETROLOGY: SEDIMENTARY (3,8,16,22,23); 2,12, 16,17,20

PHYSICAL GEOLOGY
 Erosion (8,13,17,18,19)
 Soil erosion (6,17)
 Weathering 15

PHYSIOGRAPHIC FEATURES, ETC.
 Backwall 24
 Benches (6)
 Channels (buried) 2
 Channels (glacial) (6)
 Channels (overflow) 8

Channels (sub-glacial) 10
 Chutes (sub-glacial) (6)
 Cirques (nivation) 24
 Drainage: structural control (14)
 Escarpment 23
 Estuaries 14
 Gorges (13)
 Marshes (2)
 Moraine (End-) 14
 "Moraines" 10
 Outwash sand 22
 Platform (Sub-sea level) 2
 Protalus 24
 Pseudo moraine 24
 Raised beaches (21)
 River terraces (13)
 Rock-head 2
 Scree 4,23,29
 Sea-level 2
 Tors (6)
 Valleys (buried) (21); 2

ROCKS: IGNEOUS
 Albite-diabase (4)
 Andesite (20)
 Dolerite (12); 9
 Felsite (20)
 "Felsite" 11
 Granite 16
 Granodiorite-porphyry (20)
 Hornblende picrite (12)
 Keratophyre 15
 "Microgranite" 22
 Microgranophyre 9
 Picrite (12)
 Rhyolite (19,20); 9,11
 Spilite 15

ROCKS: METAMORPHIC
 Biotite-gneiss 16
 Hornfels 22
 Mica hornfels 16
 Mica-schist 16
 Slate (19); 10

ROCKS: PIROCLASTIC

Agglomerates (6)
Ash (6)
Ignimbrite 9
Tuff (20); 3,4,11

ROCKS: SEDIMENTARY

Anthracite (16); 17
Arenite. See Sandstone
Biomicroite (15)
Biomicrodite (15)
Boulder clay. See Till
Breccia 11
Calcarenite (15); 16
Calcilutite (23)
Calcirudite (15)
Calcite silt 16
Chert (23)
Clay (22,23); 2,3,4
Clitter 23
Coal (23); 2
Conglomerate (2,3, 5,7)
Conglomerate (slide-) (5)
Dolomite 13. See also Shales
Evaporites 22
Gravel 2,6,29
Greywacke 17
Intrasparudite (15)
Ironstone 28
Limestone (2,8,11,15, 19,23); 10,13,21,23
Limestone (bioclastic) 21
Limestone (conglom.) (7,19)
Limestone (oolitic) 21
Micrites (23)
Mudstones (23)
Oolite 12,28
Peat (7,8,21); 2,18
Phosphorite (8)
Pisolite 28
Salt 18
Sand 6,7,11,12
Sand and gravel 18
Sandstone (2,3,16); 17
Shale (3,8,23); 11,21, 22,25

Siltstone (3)
Till (6,9,13); 23
Tonstein 28
Underclay (22)

SOIL PROFILES 7

SOILS (4,8,9,15,23,25)

Brown Earth 4
Clay 8
Gley (peaty) 8
Podzol (9); 4,8
Podzol (peaty) 4
Red soils 9
Seleniferous 25
Sols Bruns Podzoli-ques 4

STRATIGRAPHICAL

HORIZONS

Aberystwyth Grits (Sil.) 17
Allt Ddu Mudstones (Ord.) 6
Angulata Zone (7)
Arenig Series 26
Arvonian 9
Ashgillian 5,16
Avonian (5)
Bala Group (Ord.) 5
Bala Series (Ord.) 5
Barmouth Grits (Camb.) 17
Blue Lias 23
Bodafon Beds (O.R.S.) 3
Calymene Ash (Ord.) See Henllan Ash
Cambrian 10,17
Cambrian, Md. (14); 15
Cambrian/Ordovician bdry. 20
Cambrian, Up. 8,10
Caninia Oolite 12
Caninia Zone 19
Caradocian (5,16); 6,16
Carboniferous 9,25
Carboniferous Lst. (14); 7,8,13

Carboniferous, Lwr. (5,15); 16
Cefn Coed Marine band (Carb.) 7
Coal Measures (4,10, 18,22); 9,26
Costonian (Ord.) 6
Crafnant Volcanic Series (Ord.) 4
Denbigh Grits (Sil.) 17
Devonian. See O.R.S.
Devonian, Lwr. 23
Dibunophyllum Zone 14
Dicranograptus clin-gani Zone 8
Dictyonema flabelli-forme Zone (Tre-madoc) 20
Dinantian (19); 21
Downtonian 2,19
Erwent Lst. (Ord.) 26
Extensus Zone 26
Farlovian (O.R.S.) (3)
Ffestiniog Flags (Camb.) 10
Foel y Ddinas Mudstones (Ord.) 6
Gamlan Grits (Camb.) 17
Gelli grin Calcareous Ashes (Ord.) 6
Glacial. See Pleistocene
Glyn Gower Siltstones (Ord.) 5
Gmuendense-bucklandi Zone (7)
Grovesend Beds (Carb.) 4
Henllan Ash 16,26
Hirnant Lst. (Ord.) 5,6
Holocene 2,8
Ice Age. See Pleistocene
Interglacial 7,8,23
Keuper 26
Keuper Marl 18,22
Lenisulcata Zone 13
Lias (23); 16,26
Lias, Lwr. 8
Llandoveryian (7,8,23); 2,5,10
Llandovery Beds, Up. (C5-C6) 27
Llanvirnian 5
Llynfi Beds (Carb.) (10); 9

Longmyndian 10
 Long Quarry Beds 18
 Longvillian (Ord.)
 6,10,20
 Lwr.Lst.Shales (Carb.)
 (3); 13
 Ludlovian (5,12,13,16,
 17,18,20); 3,14,19,24
 Ludlovian/Downtonian
 bdry. 19
 Ludlow Bone Bed (Sil.)
 (12,19)
 Macclesfield New Cem-
 etery Beds 22
 Maentwrog Flags (Camb.)
 8,10
 Millstone Grit (4,15);
 13,26
 Moelwyn Volcanic
 Series (Ord.) (6)
 Mona Complex 16
 Monian (Pre-Camb.) (4)
Monograptus uniformis
 Zone (12)
 Mousterian (21)
 Mytton Flags 20
 Namurian 13
 Nant Hir Mudstones
 (Ord.) 5
 Newer Drift 14
 New Red Sandstone 7
 Nod Glas (Ord.) 8
Ogygia Limestone. See
 Erwent Limestone
 Old Red Sandstone (2,3,
 19,20)
Onnia gracilis Zone (8)
 Onnian (Ord.) (8)
 Ordovician (5,21); 3,5,
 10,11,25,26
 Palaeozoic (16)
 Pebidian (4)
 Pen-y-Garnedd beds
 (Ord.) (8)
 Permian (5)
 Pleistocene (6,10,13,
 16,21,22); 4,7,11,
 14,18,21,22,29
 Porth y Mor Beds
 (O.R.S.) (3)
 Post Glacial (8,13,21)
 Pre-Cambrian (4); 16
 Recent (14)
 Rhaetic 20

Rhinog Grits (Camb.)
 17
 Rhiwlas Lst.(Ord.) 6
 Rhondda Beds (Carb.)
 (10); 9
 Salopian 23
Seminula Oolite 12
Seminula Zone (15)
 S₂ Zone (Carb.) 10
 Silurian (3,15,20,23);
 2,5,13,17,23,25,27
 Siluro-Devonian (12)
 Southerndown Beds
 (Jur.) (23)
 Sutton Stone (Jur.)
 (23)
 Swansea Beds (Carb.)
 (4)
 Tertiary (4,14)
 Tournasian (Carb.) (3)
 Tournasian Main Lst.
 (19)
 Traeth Bach Beds
 (O.R.S.) (3)
 Traeth Lligwy Beds
 (O.R.S.) (3)
 Trias (5,14); 2,18
 Up. Boulder Clay 18
 Uriconian (4); 9
 Viséan 21
 Weichselian (6); 18,
 27
 Wenlockian (7,15);
 10,16,20
 Wenlock Lst. 13,20,24
 Wenlock/Ludlow bdry.
 20,23
 Wenlock Shales 24
 Westphalian (18); 13,
 28
 Whitcliffian, Up. 3
 Würm glaciation
 (13,21); 24
 Y Glog Volcanic
 Series (Ord.) (6)
 STRATIGRAPHY 5,7
 American Code 5
 Keuper-Lias Nomen-
 clature 26
 Outlier 5
 Overstep 5,13
 Unconformities (4);
 5,21

STRUCTURES: IGNEOUS
 Bosses (6)
 Dykes (4); 9
 Intrusions (12, 20)
 Sills (6)
 Textures (12)
 STRUCTURES: PERIGLACIAL
 Frost wedges 27
 Involutions (22); 24
 Mollisol 24
 Polygons (22)
 Stone stripes (22)
 U-shaped structures 24
 Vertical stones 24
 Wedge structures 24
 STRUCTURES: SEDIMENTARY
 26
 "Boudinage" 16
 Concretions (11); 8
 Convolute lamination 8
 Crinkle marks 3
 Cross-stratification
 (3); 8,10,12
 Cycles (3)
 Cyclical banding 15
 Cyclothems (2); 22
 Deformation structures
 13
 Flute casts 10
 Folds (penecontemp.) 14
 Graded beds 17
 Nodules 16
 Reef structures 20,22
 Ripples 3
 Shafts (in lst.) 7
 Slumps (5)
 Tool marks 10
 Turbidites 8,17
 STRUCTURES: TECTONIC
 Boudinage 16
 Cleavage (11); 16
 Faults (16,18); 5,11,
 19,21
 Fracture (axial) (11)
 Joints (11,16); 13,19
 Thrusts 11
 Unconformity
 Infra-Rhiwlas Lst. 5
 Viséan 21

A SOURCE-BOOK OF GEOLOGICAL, GEOMORPHOLOGICAL
AND SOIL MAPS FOR WALES AND THE WELSH BORDERS
(1800-1966)

by

Douglas A. Bassett

1967. 4to. cloth, pp.xi,240. Price 63s. Postage 4s. 6d. extra.

This source-book is the third in a series of reference works being compiled by the Keeper of the Department of Geology on the geology of Wales. Its contents are:-

1. THE DEVELOPMENT OF GEOLOGICAL, GEOMORPHOLOGICAL
AND SOIL MAPS

The birth of the idea. The first geological maps. Mapping the Lower Palaeozoic rocks. A national geological survey. Some contemporary problems of cartography. Subdividing the stratigraphical column. Emphasizing the third dimension. Facies variation. Soil maps. Physiographical or relief maps. Reconstructing the past. Review. Notes to supplement the text.

2. LISTS OF MAPS AND CHARTS

List of maps published in journals, monographs and books (2,326 items). List of maps published by the Geological Survey and Museum (403 items). List of maps published by the Soil Survey of England and Wales (8 items). List of charts published by the Admiralty (49 items). List of maps published by the Ordnance Survey (154 items).

3. BIBLIOGRAPHY AND INDEXES

Bibliography and partial Author Index. Locality Index. Stratigraphical Index. Subject Index.

Orders, with remittance, should be addressed to:

The Director, National Museum of Wales, Cardiff.

