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EDITORIAL

The reception given to volume 1 of the Welsh Geological Quarterly was a reasonably enthusiastic one. As a result of comments received from readers, it is proposed to include News and Notes in each number and to make annual features of the following items:-

1. The geological contents of general scientific journals - in the second number of each volume.
2. Definitions of various geological terms.
3. Welsh Geological Abstracts - in the fourth number of each volume.

It has also been suggested that detailed guides to famous geological localities should be included. The first of these is incorporated in this number, and further contributions would be appreciated. The next number will include an index of excursion guides to localities in the British Isles which have been published in the Proceedings of the Geologists' Association and elsewhere.

The annual subscription for this and for forthcoming volumes (including postage) will be 13/-.

Acknowledgements: The cover was designed and printed by Vivian S. James, Barry; and the text prepared and cyclostyled by Mrs. Jean Parsons and Alun J. Thomas.

THE MOVEMENT AND CONSOLIDATION OF MAGMAS - ILLUSTRATED WITH REFERENCE TO THE SUCCESSION OF ORDOVICIAN STRATA AND IGNEOUS ROCKS IN THE ARTHOG-DOLGELLAU DISTRICT

W.J. Phillips

The paper is a transcript of a lecture given at the course for teachers of geology in North Wales schools, organized by the Schools Service of the National Museum of Wales, and held at Dolgelley at Eastertime last year. The accompanying report of the excursion that took place after the lecture, gives full details of field occurrences.

Why sills and lava flows?

The existence of contemporaneous lavas in the Ordovician succession is now readily accepted, partly because the structural relationships are simple - the lava flows rest on top of older deposits, and partly because the actual extrusion of basaltic lava has been observed frequently and studied intensively, particularly at Kilauea on Hawaii.

Sills have long been recognized as igneous intrusions, but few workers seem to have been concerned about the reason for the intrusion of a sheet of magma within a succession of rocks rather than its extrusion on the surface.

Basaltic melts have densities of about 2.65 g/cc. It is probable that basaltic magmas form at depths of 45 to 60 km. in the earth's crust where the density of the adjacent material is estimated to exceed 3.3 g/cc. Consequently, the relatively light basaltic magma would tend to rise through the crust, but if it reached a level at which the density of the adjacent material was approximately equivalent to the density of the magma, then the magma would spread sideways to form a sill-like intrusion. The less dense material above would tend to float on top of the horizontal sheet of magma.

Since the density of unconsolidated sediments and of many sedimentary rocks is less than 2.65, the problem then becomes, why is heavy basaltic magma ever extruded? The answer is provided by studying present day volcanic action.

The film of the 1955 eruption of Kilauea shows clearly the sequence of events and the development of basaltic volcanic rocks during an eruptive cycle. The occurrence of fountains of red hot droplets of liquid lava carried into the air by the forceful rise of gases is vividly shown. The escape of large gas bubbles from lava lakes and the presence of vesicles in consolidated lava, also indicate the separation of gas (mainly steam) from liquid lava. It is clear, therefore, that one of the most important factors associated with volcanic activity is the vapourization of the water dissolved in the basaltic liquid.

If we consider that the temperature of the basaltic magma varies little from the observed 1100°C to 1200°C during its ascent in the crust, then the amount of steam dissolved in the magma can be related to the confining pressure.* The confining pressure decreases with decreasing depth of the overlying rocks so it is possible that at a certain level the magma would be saturated in dissolved steam. Above this level the magma would be over-saturated in dissolved steam, and this would then separate out as bubbles of gas in the liquid.

The volume of a quantity of gas varies inversely as the pressure (Boyle's law), so at depth the volume of gas would be relatively small and its density great. Nevertheless, the gas in the bubbles would be considerably less dense than the magma (0.4 cf. 2.65), so the formation of gas bubbles would lower the overall density of the vesiculated magma. Consequently, the vesiculated magma would continue to rise and the reduced confining pressure would have two effects, (i) more gas would come out of solution to form bubbles, and (ii) the gas in the bubbles would expand. The expanding bubbles would also rise through the liquid and would tend to concentrate at higher levels.

When water changes to steam at 100°C and atmospheric pressure the volume increases 1700 times. At 1100° the volume increase is about 7000 times, so although there might be only 1% of water by weight dissolved in the magma the release of this in the form of gas bubbles at the surface would result in the development of a froth in which most of the volume would be occupied by gas while the liquid would occur between the gas bubbles. When the gas bubbles coalesce the liquid loses its cohesion and the extrusion consists of a jet of gas with droplets of liquid which are carried high into the air by the rush of gas. The extrusion of lava fountains at the surface is due to the rapid increase in volume of the vesiculated magma.

It can be seen, therefore, that the main factors that control the movement of magma into sill intrusions, or its extrusion onto the surface are:-

(i) The density of the magma relative to the adjacent rocks.

(ii) The saturated vapour pressure which is related essentially to the amount of water dissolved in the magma and to the depth and density of the adjacent rocks.

If the density of the adjacent rocks is equal to the density of the magma then the magma will spread as a sill.

If the saturated vapour pressure is reached before the density equilibrium has been attained, then the magma will vesiculate and its overall density will decrease due to the increase in volume. The vesiculated

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* Henry's law states that at any given temperature and at equilibrium, the amount of gas absorbed by a given volume of liquid is directly proportional to the pressure of the gas.

magma will rise at a continuously accelerated rate as the gas bubbles expand and fountaining will occur on extrusion

The consolidation of basaltic magma

When it comes to rest basaltic magma consolidates as glass or more usually as a mass of crystals of the common silicate minerals, olivine, augite and labradorite, with iron oxide. Here we are concerned with another phase change - from liquid magma to solid crystal structures. The textures of igneous rocks often provide some indication of the rate of nucleation which in turn may be related to the rate of cooling of the magma during its migration and consolidation. The assemblage of minerals formed is related to the composition of the magma but variations (differentiation) may be produced by fractional crystallization which involves the partial separation of early formed crystals from the remaining magma. Detailed studies of individual differentiated intrusions such as the Palisade Sill,* indicate that the fractional crystallization of basaltic magmas results in the formation of small amounts of olivine gabbro on the one hand, and extremely small segregations of sodium and iron rich, quartz-albite granophyre on the other.

The basic volcanic groups of the Ordovician succession consist of piles of spilitic lavas - basic lavas consisting principally of sodic plagioclase (albite or oligoclase) and augite. Most spilites show considerable alteration with the development of much actinolite, chlorite and epidote. The spilites usually show well developed pillow structures, and since they were extruded onto submarine muds, it seems probable that they represent submarine extrusions. The sills which were intruded into the water saturated muds have spilitic mineral assemblages. Since many spilites show relict minerals characteristic of normal basaltic rocks it is worthwhile considering their formation from normal basalt magma, rather than speculate on the development of a primary spilite magma.

The widespread occurrence of albite in the spilites does not favour their correlation with the limited amounts of albite bearing basaltic and granophyric rock developed by the fractional crystallization of basaltic magma. It seems more likely that the marine environment of the spilites is directly responsible. Sea water is a possible source of the sodium and also the water characteristic of the minerals produced during alteration. If the magma was undersaturated with dissolved water before it was intruded into water-saturated sediment or extruded on to the sea floor, then the hot magma could absorb water together with sodium. It is possible also that the heated sea water adjacent to the magma might gain iron and silicon in sufficient quantity from the magma to account for precipitated chert, jasper sometimes associated with spilitic lavas.

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* There is a description of the Palisade Sill in "Igneous and metamorphic petrology" by F.J. Turner and J. Verhoogen. 1960, pp.209-215.

The acid volcanic rocks

The acid volcanic groups consist of massive, roughly bedded siliceous tuffs. The fragments consist of shards, pumice, felspar crystals and less commonly rhyolitic and granophyric rock. Recrystallization of quartz and some felspar has converted these rhyolitic tuff deposits into very hard rocks.

Some of the tuffs have eutaxitic textures and are characterized by the presence of discontinuous disc-like streaks formed of greatly flattened fragments of pumice lying parallel to the bedding. These beds are described as welded tuffs and it appears that the fragments were very hot and plastic when deposited: a feature suggesting subaerial conditions. It is thought that the welded tuffs are deposited from subaerial glowing avalanches of dense, fragment-loaded gas, known as a nuée ardente. The complete deposit from such a nuée ardente is known as an ignimbrite. The ignimbrite deposit generally consists of a welded tuff with an eutaxitic texture at the bottom where the weight of the overlying material caused the flattening and welding, and an unwelded, unflattened upper portion known as a sillar. The presence of welded tuffs in the acid volcanic series suggests that some of the tuffs were deposited under subaerial conditions from nuée ardente, while others may be more normal deposits from ash showers.

General environment of deposition of the Ordovician rocks

The unconformity and the coarse detrital sandstones at the base of the Ordovician indicates subaerial or shallow water conditions of erosion and then deposition. The welded tuffs in the Lower Acid series suggests at least temporary local subaerial conditions associated with volcanic activity. There then followed a long period during which clays were deposited from suspension to form the muds. During this period no coarse detrital material other than volcanic debris reached the area, and the dark colour of the muds and their graptolite fauna suggests relatively deep water. After the early deposition of tuffs interbedded with the muds, spilitic pillow lavas were extruded at two distinct periods to form the basic groups. Finally during the period of deposition of the Upper Acid volcanic series containing welded tuffs, local subaerial conditions may have occurred again, probably as the result of doming associated with the volcanic activity.

The sill intrusions

Dolerite sills of spilitic character are present in all the strata below the Upper Basic volcanic series. These sills generally follow particular stratigraphical horizons which were levels of hydrostatic equilibrium for the magma.

The Llyn-y-Gader granophyre forms a thick sill-like, or laccolite intrusion emplaced in the Llyn-y-Gader Mudstones. There is clear evidence at the east end of the exposure that the granophyre magma lifted

the roof rocks along a fault zone, by 1500' - the thickness of the sill. At this eastern end the granophyre extends upwards as a thick boss-like intrusion on Mynydd-Moel. R.G. Davies* has shown that the granophyre is connected with the uppermost rhyolitic tuffs of the Upper Acid series.

The Crogenen granophyre sheet is 1200' thick and transgresses upwards from the Tremadoc Slates in the north east to the Llyn Cau Mudstones in the southwest. Cox and Wells** suggested that the granophyre sheet was intruded as a horizontal sheet after the tilting of the Ordovician strata and older sill intrusions.

Summary of succession (based on A.H. Cox, Q.J.G.S. 1925)

11.	Talyllyn Mudstones (Bala) 4000'	
10.	Upper Acid volcanic group 1200'	
9.	Llyn Cau Mudstones 500'	
8.	Upper Basic volcanic group 500'.	Dolerite sills below this horizon.
7.	Llyn-y-Gader Mudstones 500'.	Llyn-y-Gader Granophyre Sill.
6.	Lower Basic volcanic group.	Crogenen Granophyre Sill transgressing from the Basement beds to the Llyn Cau Mudstones.
5.	Cefn-hir Ashes 500'	
4.	Crogenen Mudstones 300'	
3.	Bryn Brith Ashes 200'	
2.	Lower Acid volcanic group 750'	
1.	Basement sandstones (Arenig)	

Report of field excursion to Crogenen Lakes.

After viewing the transgressive contact of the Crogenen granophyre with the underlying Cefn-hir Ashes from the opposite side of the lake, the party studied the upper contact of a dolerite sill with the Moelyn Slates containing Didymograptids, near the quarry. (1) (See map on page 9.)

Subsequently a careful study was made of the beds known as the Cefn-hir Ashes above the Moelyn Slates. The lowest unit consists of a vesicular spilitic lava in which the vesicles have been drawn out during flowage. (2) Above this lava there are several thick beds which consist of angular fragments of rhyolitic and pumice material and slabs of mudstone contained in a mud matrix. (3) Interbedded with the mixed mud and agglomeratic beds are thin mudstones with thin, well bedded, often graded, crystal and pumice tuffs. The presence of pumice fragments in mudstones suggest that the volcanic fragments were deposited in water from fine ash showers. The discontinuous nature of some of the thin graded tuff beds may be due to the uneven distribution of the volcanic debris. The thick mixed beds have many of the characteristics of turbidite deposits such as (a) thick beds with rough grading from a sharp base to a more fine-grained,

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* Q.J.G.S. 1959. ** Q.J.G.S. 1921 and Proc.Geol.Ass.,Lond. 1927.

sometimes laminated top, (b) virtually no disturbance of the underlying muds during deposition of the unit, (c) almost completely unsorted lithology, (d) the occurrence of slabs of mudstone which retained cohesion during transportation, yet were plastic enough to fold, and have angular volcanic fragments pressed into their surfaces in the manner of armoured clay balls.

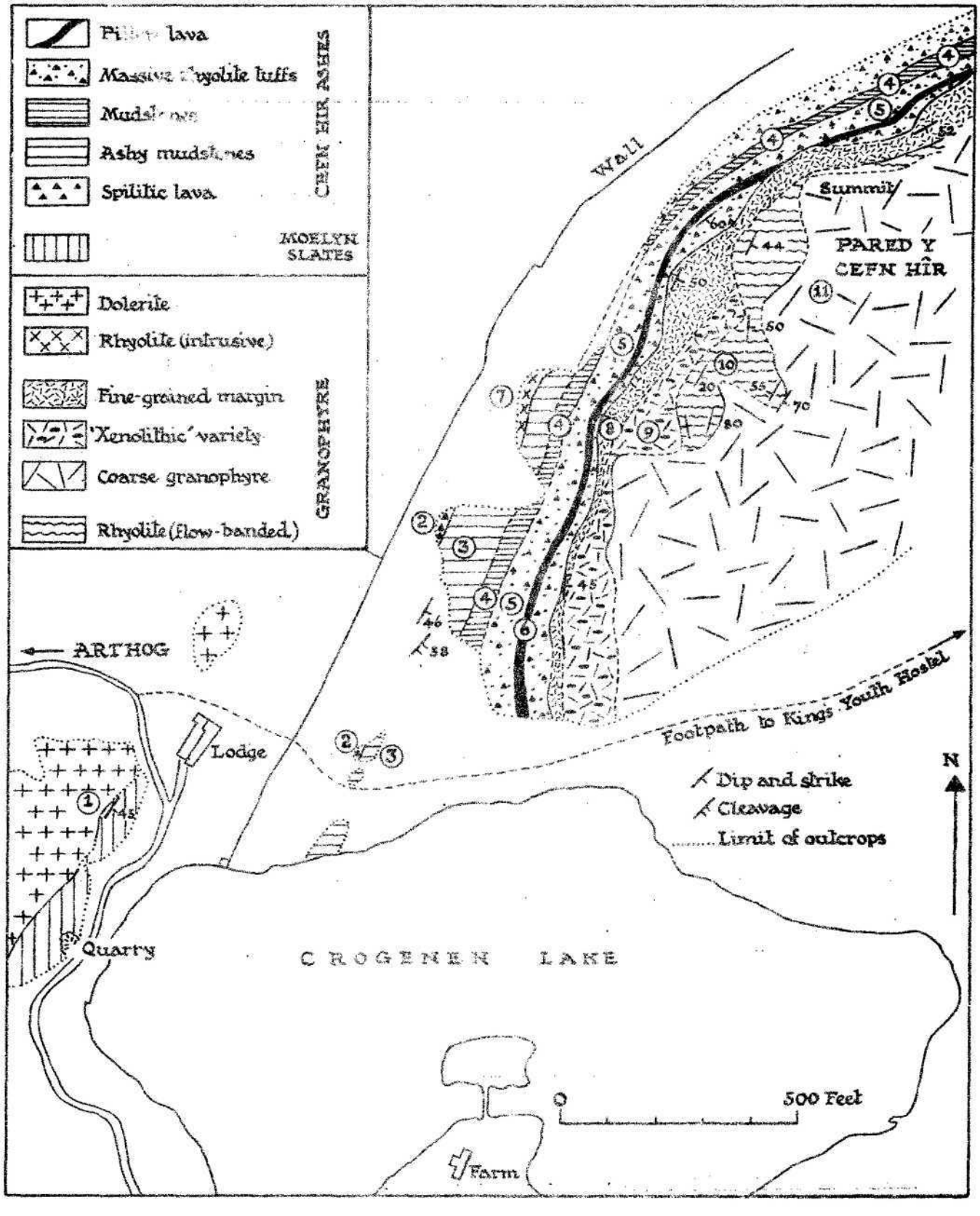
It seems likely, therefore, that these thick beds are mud and agglomerate turbidites. It was suggested that they originated when accumulations of volcanic debris near a vent were disturbed and slipped down a submarine slope. At first the mud floor was eroded, but subsequently a turbidity current loaded with mud and volcanic fragments flowed into and settled in an area where mud with some ash showers were being deposited slowly in relatively undisturbed conditions. Local discontinuities within some of the thick mud and agglomeratic beds indicate that they are sometimes composite beds and that erosion of the earlier deposits was affected by the later turbidity flows.

The submarine tuffs and turbidite deposits are succeeded by mudstones (4) and then by massive rhyolitic tuffs which contain little mud. (5) There is little sign of flattening of the volcanic fragments though some modifications were produced during the formation of the cleavage, particularly in the muddy tuffs below. A pillow lava (6) 10' to 20' thick is interbedded with the rhyolitic tuffs and this suggests that the whole sequence was deposited in water.

Part of a small rhyolitic intrusion (7) which is in contact with the mud and agglomeratic beds was also studied. The rhyolitic rock shows continuous flow banding in places, but it is particularly interesting because the contact zone shows autobrecciation. This takes the form of brecciated rhyolite with tuffsite-filled fractures presumably formed by the release and expansion of gas and its escape along the fractures. Subsequent recrystallization of the autobreccia has produced a rock which appears to consist of partly rounded xenoliths in a fine-grained crystalline rock.

The cross cutting contact (8) of the fine grained marginal phase of Crogenen granophyre sill was followed for some distance. The Crogenen granophyre is an irregular composite intrusion and the main rock types are well displayed on the southwestern end of Pared y Cefn-hir. Above the dark grey, fine grained marginal rock, the granophyre is light grey in colour and contains innumerable randomly oriented xenoliths of altered sedimentary rock, granophyre and rhyolite. (9) Masses of flow banded rhyolite (10) occur between the marginal and xenolithic granophyre and in places spherulites due to the recrystallization of the very fine grained rock have grown across the flow banding. The southeastern slope of the ridge consists of a light grey, coarser granophyre which contains large ill-defined spherulite masses in places. (11)

Welsh Geological Quarterly, vol.2, no.2, pp.3-9.


Pillow lava
Massive rhyolite tuffs
Mudstones
Ashy mudstones
Spilitic lava
CEFN HIR ASHES
MOELYN SLATES
Dolerite
Rhyolite (intrusive)
Fine-grained margin
'Xenolithic' variety
Coarse granophyre
Rhyolite (flow-banded)
GRANOPHYRE
Wall
Summit
PARED Y CEFN HÎR
ARTHOG
Lodge
Quarry
Footpath to Kings Youth Hostel
Dip and strike
Cleavage
Limit of outcrops
N
CROGENEN LAKE
0
500 Feet
Farm

INTERNATIONAL COOPERATION IN STUDY OF THE CAMBRIAN SYSTEM

Sir James Stubblefield and Dr. J.W. Cowie

Papers and discussion on Cambrian stratigraphy at the International Geological Congresses in Mexico (1956) and Norden (Copenhagen, 1960) led to the formation of the Cambrian Subcommission of the Commission on Stratigraphy. This Commission, formerly a Commission of the International Geological Congress, is now a constituent part of the International Union of Geological Sciences. Preparations are being made for two days of discussion meetings of Subcommission members, under the Presidency of Sir James Stubblefield, F.R.S., during the International Geological Congress in Prague in the August of 1968. Membership of the Subcommission, by invitation of the Commission on Stratigraphy, is intended to give, as far as is possible, a world-wide representation of present-day research on the Cambrian System. There is at present an international membership of eleven (including officers), which is considered to be close to the optimum size for a body of this character.

It is planned that papers and discussions at the Prague meeting in 1968 will be devoted primarily to:-

1. Reviews of the Cambrian stratigraphy of the U.S.S.R. and China and correlations with the rest of the world, published in one of the Western official languages of the International Geological Congress.

2. Lower Cambrian zones.

3. The Lower/Middle and Middle/Upper Cambrian boundaries.

4. The Base of the Cambrian System.

The President and Secretary of the Subcommission hope that this programme will arouse wide interest in all research workers on the Cambrian who may have new results and opinions which should be drawn to the attention of this international body. Accommodation will be available for a limited number of non-Subcommission members to attend the meeting.

Welsh Geological Quarterly, vol.2, no.2, p.10.

THE CONTENTS OF SOME GEOLOGICAL JOURNALS : 1966

The Quarterly Journal of the Geological Society of London

Vol.122, pt.1. K. Coe - Intrusive tuffs of west Cork, Ireland. K.A. Jones and A.K. Galwey - Size distribution, composition, and growth kinetics of garnet crystals in some metamorphic rocks from the west of Ireland. G.P.L. Walker and D.H. Blake - The formation of a palagonite breccia mass beneath a valley glacier in Iceland. P.T. Walsh - Cretaceous outliers in south-west Ireland and their implications for Cretaceous palaeogeography.

Vol.122, pt.2. P.J. Leggo, W. Compston and B.E. Leake - The geochronology of the Connemara granites and its bearing on the antiquity of the Dalradian Series. J. Nolan - Melting-relations in the system $NaAlSi_3O_8$ - $NaAlSiO_4$ - $NaFeSi_2O_6$ - $CaMgSi_2O_6$ - H_2O, and their bearing on the genesis of alkaline undersaturated rocks. G.A. Chinner - The distribution of pressure and temperature during Dalradian metamorphism. D.L. Dineley - The Dartmouth Beds of Bigbury Bay, south Devon.

Vol.122, pt.3. D.A. Bassett, H.B. Whittington and A. Williams - The stratigraphy of the Bala district, Merionethshire. P.F. Friend - Clay fractions and colours of some Devonian red beds in the Catskill Mountains, U.S.A. V.V. Belousov - Modern concepts of the structure and development of the Earth's crust and the upper mantle of continents. G.Y. Craig and G. Oertel - Deterministic models of living and fossil populations of animals.

Proceedings of the Ussher Society

Vol.1, pt.5. Conference of the Ussher Society held at Bideford, 1966. J.R. Hawkes and K. Chaperlin - The Dartmoor Granite: a summary of the Geological Survey's findings to date in relation to the Cornish bodies and granites in general. M. Stone - Some aspects of variation in granitic rocks with particular reference to the granites of S.W. England. B. Booth - Potassium metasomatism in a thermo-chemical gradient (Abstract). A.N. Lane - The structure and stratigraphy of the Lower Devonian rocks of the Looe area, S.E. Cornwall (Abstract). J.L.M. Lambert - The structure of south west Cornwall: a study of tectonic facies. M.C. McKeown - Breccias of the Goran Haven area. G.A. Gauss - Some aspects of the slaty cleavage in the Padstow area of N. Cornwall. S. Simpson - Kink-bands of Bigbury Bay. E.M.L. Hendriks - Correlation of south and north Cornwall. S.C. Matthews - Lower Carboniferous stratigraphy in the St. Mellion area. A.F. King - Structure and stratigraphy of the Upper Carboniferous Bude Sandstones, north Cornwall. S.C. Matthews - Lower Carboniferous zone-fossils (Abstract). E.B. Selwood - Derived fossils from the Upper Culm Measures south of Launceston, Cornwall. N.J. Money - Carboniferous rocks of north Devon: the Appledore Formation. F.J.W. Holwill - Conglomerates, tuffs and concretionary beds in the Upper Devonian of Waterside Cove, near Goodrington Sands, Torbay. W.R. Dearman - Superposed structures in the Trebursye Beds of Launceston, Cornwall. S.C. Matthews - Remarks on the geology of the St. Mellion area. J.E. Prentice - Facies changes in

the Chert Formation (Lower Carboniferous) of north Devon. R.H. Belderson and A.H. Stride - Tidal current fashioning of a basal bed. M.E. Cosgrove and D.L. Salter - The stratigraphical distribution of kaolinite in the post-Armorican formations of south-west England. P. Floyd - Greenstone sills and metamorphic zoning in the Land's End aureole at Newlyn, Cornwall. G.M. Power - Secondary tourmaline from the granitic rocks of S.W. England. J.M. Thomas - Sedimentation on Instow beach, N. Devon. M.R. House - D.Phil. and B.Sc. theses submitted at Oxford since 1950 on the geology of Devon and Cornwall.

Scottish Journal of Geology

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Vol.2, pt.2. I.W.D. Dalziel - A structural study of the granitic gneiss of Western Ardgour, Argyll and Inverness-shire. D.K. Ferguson - The structure of the Queen's Cairn Rhyolite, Glen Coe, Argyllshire. W.D.I. Rolfe and M.A. Fritz - Recent evidence for the age of the Hagshaw Hills Silurian inlier, Lanarkshire. R.R. Harding - The Mullach Sgar Complex, St. Kilda, Outer Hebrides. R.G. Park - Nature and origin of Lewisian basic rocks of Gairloch, Ross-shire. J.L. Roberts - Sedimentary affiliations and stratigraphic correlation of the Dalradian rocks in the south-west Highlands of Scotland.

Vol.2, pt.3 K.A.G. Shiells and W.R. Dearman - On the possible occurrence of Dalradian rocks in the Southern Uplands of Scotland. J. Turner - The Oxford Clay of Skye, Scalpay and Eigg. W.D.I. Rolfe - Woolly rhinoceros from the Scottish Pleistocene. J. McManus - An ice-wedge and associated phenomena in the Lower Limestone Series of Fife. J.D. Hudson - Hugh Miller's Reptile Bed and the Mytilus Shales, Middle Jurassic, Isle of Eigg, Scotland. T.S. Ghaly - The Lewisian geology of the area between Loch Shieldaig and Loch Bràigh Horrisdale, Gairloch, Ross-shire. C.D. Gribble - The thermal aureole of the Haddo House norite in Aberdeenshire.

Welsh Geological Quarterly, vol.2, no.2, pp.11-12.

THE GEOLOGICAL MAP (2)

"During the period of my own experiences there was for much of the time only a gradual, almost imperceptible, change in techniques [in field geology] through the introduction of geophysical and geochemical methods and aerial survey. In the last two decades these aids have increased in emphasis and have, in some cases most suited to their use, become the dominant partner in investigations. If the exposures are good and the mapping reliable, the drawing of cross-sections is relatively simple and the prediction of what will be found below the surface may be fairly accurate. It is here that imagination is called in and we move away from the purely objective. The less the field evidence, the more the assistance that is required from physics and chemistry to provide clues which will help to foretell the place and shape of hidden structures."

"In some quarters, it has become fashionable to assert that the new techniques can now replace the field man; that his day is done; and that the enquirer can interpret his structures from electric well-logging and other indirect evidence or from geophysical recording of wave velocities and comparisons of densities, or from chemical examination of rock samples collected on some regular grid. This, in my emphatic view, is an erroneous doctrine and a most dangerous one."

J.V. Harrison - The role of the field geologist. Advancement of Science, 22, 1965, p.453.

"Topographical and geological maps are radically different from each other both in conception and construction. The former is a straightforward representation of surface features, both natural and artificial. Within the limitations imposed by the scale of a map, its boundary lines define precisely the areas and relative positions of the features shown, and it takes no cognizance of anything beneath the ground surface. A geological map, on the other hand, is three-dimensional in conception, and basically is the pattern that is produced on the upper surface of a solid block composed of various layers, and sometimes irregular masses, of rock. These may be arranged in any manner from simple to highly complex. Such a pattern may be intricate even on a plane surface; but the pattern made on the ground surface by the outcrops of the strata is still further complicated by the irregularities of surface relief. On this view alone a geological map would seem to be largely a matter of solid geometry. That is true to a certain extent, but it is much more. It is vitally alive, as it were, not merely a cold piece of geometry. It carries a challenge to its user to interpret, from its face, the nature and arrangement of the strata which remain unseen below the ground as well as those which occupy the surface; and to read the geological history of the area represented."

F.H. Edmunds - Geology and ourselves. London: Hutchinson's Sci. and Tech. Pubns. 1955, p.80.

"For most people, the geological map, with its scheme of contrasting colours, apparently unequivocal structural symbols, and sharply drawn contacts between rock units, creates the impression that it is, like most other types of maps, a factual and objective record of data derived from observations made on different classes of rocks clearly distinguishable from each other by well-defined physical characteristics. For most geological maps this impression is fallacious. A good geological map is much more than an objective presentation of the distribution of rock units, their structure and their relations; it is also a subjective presentation of interpretations based on a multitude of observations and, to a greater or less degree, based on theories and prejudices held at the time the map was made. This is true of the first maps made by Guettard, Lehmann, Packe, Smith and other pioneers, and it is true of the maps made today. We have accumulated much more knowledge since the days of the pioneers, and we hope we are producing maps more closely approximating the truth. But geological maps are not static or timeless; as the science evolves, so will the maps that portray our evolving concepts."

"Consider the preparation of a modern geological map. We may assume the geologist has an accurate topographic map and air photographs, and that he will assemble all available geophysical, geochemical and other useful data pertaining to the area. From these he makes his first interpretative study and produces a rough outline of the geology. With it he plans critical traverses and selects sections for detailed study. Only then will he begin examination of the rocks and deposits themselves, including classification of the different rocks according to their physical characteristics and his interpretation of their origin. He must, in other words, decide on his classification before he can show it on the map. He must decide, for example, whether the rock is magmatic or migmatic, whether it is volcanic or intrusive, whether two rocks represent different formations or different facies of the same formation, whether the rock was formed from a volcanic, marine, or continental sediment, whether it is metamorphic or metasomatic, and so on. The fact that the classification must be made in the field is probably unique in the scientific disciplines. It would indeed be a rash geologist who, in an area of even moderate complexity, would make a geological map based on a collection of hand specimens."

"Not only is he concerned with the classification of the rocks, but also with the structural data - relative significance of unconformities, relationship of cleavage to folds and faults, relative movement on faults, age of structural deformation, age of igneous intrusions, and all the complexities of rock relationships. These data, together with those available from geophysics and geochemistry, borehole records, and other sources will be used to extend lithologic and structural units beneath the overburden. Even in areas where rocks are relatively well exposed, only a small part of the bedrock crops out, and these croppings, moreover, are usually not uniformly distributed."

"The geologist always collects much more information than he can show on the map, so he must select the data he considers most significant. For example, he determines the mineral assemblages in scores of thin sections so that he may refine his classification of the rocks, or distinguish half a dozen metamorphic facies. These classifications, in turn, lead to conclusions concerning the geological history of the area. He may make a statistical analysis of hundreds of field observations to determine the shape of folds, the position of faults, directions of paleocurrents in ancient seas and rivers, or the significance of fossil assemblages. These investigations constitute the author's laboratory research, and he includes his interpretation of the results on his map along with his interpretations of geochemical analyses, geophysical measurements and isotope abundances."

"Finally, the geologist must select the symbols and the scheme of presentation for all this information so that the map will best portray his selection of data and interpretations. They must permit the user to look into the map, so that he may visualize the distribution and relationships of the rocks beneath the surface of the earth."

"When all this material is synthesized, the final product is a lithographed geological map that looks as positive and incontrovertible as a colour photograph, at least to the layman and perhaps also to some geologists. Actually, it represents the sum of analyses made by an individual, using information that never can be complete. The results are conditioned by the 'conventional wisdoms' of the day and to that extent the map represents the 'geological knowledge at the time of its production' (North, 1928,* p.1). Moreover, in many instances, more than one interpretation can be made of the information presented on the map; another geologist may make interpretations quite different from those of the author and may even see more than the author realized was there."

J.M. Harrison - Nature and significance of geological maps. The fabric of geology, 1963, pp.226-227, 230.

"From his [William Smith's] primitive hand-coloured maps, upon which he 'plotted' what he personally investigated in the field, to the colour-printed geological and mineralogical maps now being issued in enormous numbers by every civilized State in the world, is a line of scientific progress rarely followed. Yet in few directions has the pet hobby of a scientific crank, as 'Strata Smith' was then considered, become so necessary and so economically essential in every part of the world."

T. Sheppard - The evolution of topographical and geological maps. Report of the British Association, 1920, pp.395-396.

* Geological maps: their history and development with special reference to Wales.

"Few geological maps, ... , are complete in themselves. Obviously, over many parts of the world, much more essential geological information is to be gained over a square mile of country than can be conveyed, for instance, on the square inch of paper which is its equivalent on a 1 inch to 1 mile map. Maps require amplification by means of written descriptions, and by drawings, to give detailed accounts of the strata which cannot be printed on the map itself. These adjuncts are necessary to assist the map user to appreciate the method on which the surveyor worked, and so to aid him in interpreting the three-dimensional structure of the country represented. Geological memoirs, therefore, are normal complements to maps produced by all geological surveys. The use of such a written account may be well brought out by an apparent absurdity long current among geologists, yet one that contains much truth: that the function of a geological memoir is to contradict its map. In other words, geological maps are, in many cases, interpretive generalizations of a mass of detail."

F.H. Edmunds - Geology and ourselves. London: Hutchinson's Sci. and Tech. Pubns. 1955, p.87.

"A perfect geological map should represent - 1st. A full and accurate topography, with the form of the surface and heights in contour-lines, shading, or otherwise. The Ordnance Survey maps of Britain on the scale of six inches to a mile may be taken as an admirable example. 2nd. All geological deposits, from the most recent to the most ancient, which may occur in the district embraced by the map, with their boundary-lines accurately traced, and the relation of their distribution to the external form of the ground clearly depicted. 3rd. The geological structure of the region, that is, the relation of the rocks to each other, their inclination downwards from the surface, their curvatures and dislocations; in short, all particulars necessary to enable a geologist to apprehend the manner in which the rocks of the crust of the earth beneath the region in question have been built up. 4th. Information which may have special economic value, such as the nature and distribution of the soils, the position of available building materials, the direction, thickness, and extent of ores, coal-seams, or other useful minerals, the best sources of water supply, etc."

Archibald Geikie - Outlines of field-geology. 2nd ed. London: Macmillan. 1879, p.33

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

a) Work started in 1966.

CRIDDLE, A. Mineralization of the Carboniferous of the East Crop of the South Wales Coalfield. (Wales: Cardiff.) For M.Sc.

GEORGE, G.T. Sedimentation of the Namurian rocks of Pembrokeshire. (Wales: Swansea.) For Ph.D.

GRAVES, L.J. Geophysical exploration in St. George's Channel. (Birmingham.) For Ph.D.

HARRISON, S. (Miss) The relationship of storm waves to the longshore drift in the evolution of the coastline of parts of Cardigan Bay. (Wales: Aberystwyth.)

HEATH, R.J. The palaeoecology of the Whitcliffian of the Welsh Borders (shelf and basin facies). (Leicester.) For Ph.D.

JARVIS, J. A physical investigation of tidal phenomena in the environment of some North Wales estuaries. (Wales: Aberystwyth.)

MACHIN, A. (Miss) Periglacial deposits and landforms of the upper Dovey estuary. (Wales: Aberystwyth.)

OGUIKE, R.O. Sedimentation of the Middle Shales (Namurian) in the South Wales Coalfield. (Wales: Swansea.) For Ph.D.

ROSEN, C.R (Mrs.) High and low energy coasts (of parts of Cardigan Bay). (Wales: Aberystwyth.)

STEAD, J.G. Stratigraphy and sedimentation of the Newgale Beds and associated formations in west Pembrokeshire. (Wales: Swansea.) For M.Sc.

WHITCOMBE, P.J. The sedimentation and diagenesis of the Lower Limestone Shales (Carboniferous) in South Wales and adjoining counties. (Wales: Cardiff.)

b) Work started in 1965.

DIGGENS, J.N. Some aspects of the sedimentary petrology and palaeoecology in the Caradocian of Shropshire and eastern Montgomeryshire. (Liverpool.)

GILBEY, J.W.G. The mineralogy, paragenesis and structure of the ores of the Dolgellau Gold Belt, Merionethshire, and associated wall rock alteration. (London: King's College.) For Ph.D.

PALMER, D.C. The geology of the Long Mountain. (Dublin: Trinity College.)

SHARMAN, R.A.F. Hydrological studies in Central Wales. (Wales: Aberystwyth.)

WILSON, C. (Mrs.) Sandstone pipes in the Carboniferous of Anglesey. (Manchester.) For M.Sc.

c) Work started prior to 1965

HORSNAIL, R.F. The significance of some regional geochemical patterns in North Wales and South-west England. (London: Imperial College.) For Ph.D.

THORNTON, I. The application of regional geochemical reconnaissance to agricultural problems. (London: Imperial College.) For Ph.D.

D.A.B.

Welsh Geological Quarterly, vol.2, no.2, pp.17-18.

NEW YEAR CONFERENCES : 1967

(1) The Pre-Cambrian and Lower Palaeozoic Rocks of Wales

(Alan Wood and Denis Bates)

A highly successful symposium on the above topic was recently held at the University College of Wales, Aberystwyth, in honour of Professor O.T. Jones and Sir William J. Pugh, both former Professors of the College. Twenty four papers were read, and 164 people attended the three-day conference.

Professor O.T. Jones was unfortunately prevented by ill health from attending the meeting, but everyone was delighted to welcome Sir William Pugh. The social highlight of the symposium was a dinner on the 5th January in Pantycelyn Hall, when Sir William gave us an insight into the College of 1910, and the start of his career under "O.T.".

Geologically the meeting may have marked a significant advance in the study of the Welsh Lower Palaeozoic rocks, in that a radically new concept of the "geosynclinal" basin of Wales has emerged. Several speakers, in papers and in contributions to discussion, have built up a picture of the region as resting on basement blocks, which moved along master faults and by their relative subsidence controlled the sedimentation and contemporary vulcanism. Subsequently, during the tectonic phases, folding and faulting of the Lower Palaeozoic sediments was similarly controlled. The master faults between the blocks are, from the south-east to north-west, the Church Stretton and Pontesford disturbance, the Bala Fault, the major faults of south and central Anglesey, and the Carmel Head Thrust. The Anglesey region is seen, not as a simple geanticline, but as a persistent upfaulted horst-like area, or the south-eastern edge of one. In effect Professor Boswell was probably right when he claimed that the Welsh geosyncline was no geosyncline at all, in the classical sense, but simply a subsidiary basin on the margin of the Scandinavian-Scoto-Appalachian geosyncline.

The proceedings of the symposium will, it is hoped, be published by the University of Wales Press, as a "festschrift" to Professor O.T. Jones and Sir William Pugh.

The programme included the following contributions:-

BAILEY, R.J. (Liverpool). Ludlovian sedimentation in south central Wales.
BASSETT, D.A. (Cardiff). The structure of the Lower Palaeozoic rocks of Wales: a review.
BATES, D.E.B. (Aberystwyth). Some aspects of the Arenig faunas of Wales.
BATES, D.E.B., BROMLEY, A.V. and JONES, A.S.G. (Aberystwyth). The geology of the Bishops and Clerks.
BRENCHLEY, P. (Liverpool). The relationship between vulcanicity and sedimentation in the Caradocian rocks of North Wales.
BROMLEY, A.V. (Aberystwyth). Plutonic acid igneous activity in the Ordovician of North Wales.

CATTERMOLE, P. (Aberystwyth). A preliminary geochemical study of the Mynydd Rhiw igneous complex, Lleyn.
CRIMES, P.T. (Liverpool). The palaeogeography of the Cambrian rocks of Wales.
CUMMINS, W.A. (Nottingham). Patterns of sedimentation in the Silurian rocks of Wales.
FITCH, J. (London) and MILLER, A. (Cambridge). Isotopic age determinations on rocks from Wales and the Welsh Borders.
HOLLAND, C.H. (Dublin). The Welsh Silurian geosyncline in its regional context.
JAMES, D.M.D. (Swansea). Ashgillian transport pattern in west central Wales.
KELLING, G. (Swansea) and WOODLANDS, M.A. (London). The stratigraphy and sedimentation of the Llandoverian rocks of Rhayader and Llandovery.
RAST, N. (Liverpool). The relationship between Ordovician structure and vulcanicity in Wales.
ROACH, R. (Keele). The composite nature of the St. David's Head and Carn Llidi intrusions, north Pembrokeshire.
ROBERTS, B. (London). Some aspects of the Llwyd Mawr ignimbrite and its associated volcanic rocks.
SHACKLETON, R.M. (Leeds). The Pre-Cambrian rocks of Wales.
SKEVINGTON, D. (London). The classification of the Ordovician System in Wales.
SMITH, A.J. (London). The Upper Llandovery sediments of Wales and the Welsh Borderlands.
TREMLETT, W.E. (Glasgow) Caradocian vulcanicity in the Lleyn Peninsula.
WELSH, W. (Aberdeen). A new interpretation of basement control of sedimentation and structures in the Lower Palaeozoic rocks of Wales.
WILLIAMS, A. (Belfast). Ordovician faunal provinces with reference to brachiopod distribution.
WOOD, D.S. (Leeds). 1. The base of the Cambrian System in Caernarvonshire. 2. The structural significance of the Caledonoid faults of north-western Wales.

(2) British Sedimentological Research Group

(G. Kelling)

The 5th Annual Meeting of the British Sedimentologists Research Group (B.S.R.G.) was held at the Department of Geology, University College, Swansea, during the weekend of 6th-9th January. There were 110 geologists present.

The B.S.R.G. is an informal body of geologists who share a common interest in the sedimentological aspects of the subject and who meet at approximately annual intervals to present, through the media of exhibits and short talks, interim-reports on research in progress and the results of research completed. The meetings also provide a forum for the exchange of views, information and (let it be admitted) professional gossip. The carefully cherished informality and the enthusiasm of the predominantly

young participants have ensured that previous meetings have been lively affairs and the Swansea conference proved to be no exception!

In his welcoming address, Professor F.H.T. Rhodes stressed the contributions made to the understanding of sedimentary processes and environments, particularly in the Carboniferous and Mesozoic rocks of South Wales, by eminent predecessors such as Sir Arthur Trueman and Professor T. Neville George and paid tribute to the continuation of this tradition by the present school of research in the Department.

During the Meeting the participants were bombarded with some twenty different talks, each followed by discussion, on topics ranging from "computable models of sedimentary processes" to "sediments in a submarine canyon to the west of the English Channel".

The lengthy intervals between groups of talks were spent consuming food, tea or coffee and in examining and discussing (sometimes with considerable heat!) the 28 exhibits which had been mounted by participants. These again included a wide range of topics, including Seismic Marine Profiling equipment (by Huntings Surveys), sedimentary structures from the Middle Coal Measures of South Wales, ordering in early diagenetic pyrite in Recent sediments of the Wash and the "Cow Head Breccia", Newfoundland.

Two other items of interest were: the showing of a 40-minute colour film, entitled "Flow in Alluvial Channels" - made for the U.S. Geological Survey and made available by the School of Engineering, Colorado State University; and a short excursion to examine aspects of sedimentation in the local Coal Measures, led by Dr. G. Kelling and Mr. T.R. Owen.

The venue for the next meeting is Leicester and those interested in attending should contact Mr. J. McD. Whitaker of the Geology Department, Leicester University.

The programme included the following contributions:-

BENFIELD, A.C. (I.G.S.). Deltaic and marginal environments in the Huddersfield White Rock cyclothem (Namurian-Rs) in the central Pennines.
CALVERT, S.E. (Edinburgh). Silica deposition in the sea.
COLLINSON, J.D. (Oxford). Large scale cross-bedding in the Kinderscout Grit of Derbyshire.
FRANCIS, E.A. (I.G.S.) The sedimentary structures of glacial deposits.
HAMILTON, D. (Bristol) and SMITH, A.J. (U.C. London). Sediments in a submarine canyon to the west of the English Channel.
JAMES D.M.D. (Swansea). Some aspects of conglomerate sedimentation in the Ashgillian of west central Wales.
JEANS, C.V. Large ammonites and the preservation of aragonitic fossils in the Lower Chalk.
LOUDON, T.V. (Reading). Computable models of sedimentary processes.
LOVE, L.G. (Sheffield). Ordering in early diagenetic framboidal pyrite in Recent sediments of the Wash.
MACDOUGALL, J.D.S. Characteristics of Weald Clay shoreline deposits.

PHILCOX, M.E. Sedimentation of Upper Devonian stromatactis bioherms, western Canada.
READ, W.A. (I.G.S.) Factor analysis of data from coal-bearing Namurian rocks in central Scotland.
READING, H.G. (Oxford). Coal-bearing strata in the Upper Carboniferous of the Cantabrian Mountains.

SELLEY, R.C. (I.C. London). The facies profile: a graphic method for presenting sedimentological data.
SMALLEY, I.J. Mudcrack networks and related sedimentary structures.
WALTON, E.K. (Edinburgh). Divergent approaches in studies of cyclic sedimentation.
WILLIAMS, B.P.J. (Swansea). Diagnostic features of the lacustrine Escuminac Formation (U. Devonian) of eastern Quebec.
WILLIAMS, P.F. (Swansea), The Pembrokeshire Coal Measures: a brief indication of facies types and sedimentary history.
WILSON, R.C.L. (Kingston C.T.). A facies model for the Osmington Oolite Series (U. Oxfordian) at outcrop in southern England.
YOUNG, C.P. (Swansea). The Old Red Sandstone of the Slieve Bloom Mountains, Ireland.

(3) Institute of British Geographers

(T.M. Thomas)

This year's Annual Conference was held at Sheffield University from the 3rd-7th January.

The first session of lectures was devoted to the geography of the local region. Professor R.S. Waters gave a general account of the geomorphological aspects and problems of the region; Dr. A. Straw and Mr. R.D. Brown described more detailed localised studies on the drainage history of the Wye-Derwent confluence and some examples of Derbyshire landslides, respectively; and Mr. B.E. Coates described in detail the general drift of mining from the exposed to the concealed sections of the South Yorkshire Coalfield and the trend for concentration of activity at larger and obviously deeper pits.

At another session the papers published in the recently issued Transactions No.39 (Vertical displacement of shorelines in Highland Britain) were discussed. These papers were concerned almost wholly with raised beach forms in Scotland and northern Ireland. Fierce arguments raged over problems of interpretation and the accuracy of the original field surveys. In this field of study much arduous measuring and detailed observation had obviously been undertaken by Dr. J.B. Sissons (Edinburgh University) and his associates.

At yet another session devoted entirely to geomorphology, Dr. R.J. Price and Mr. P.J. Howarth (Glasgow University) gave an account of recent

field work concerned with moraines near Breidamerkurjokull and Fjallsjokull, Iceland; Mr. J.C. Doornkamp described his extensive survey of erosion surfaces in a section of the rift valley uplands in East Africa (Uganda); Mr. A.F. Petty dealt with the scale and significance of solutional loss from the limestone tract of the southern Pennines; and Mr. T.M. Thomas discussed the imprint of structural grain on the micro-relief of the Welsh uplands.

The full-day field excursions (January 6th) were closely related to the lectures given on specific aspects of the geography of the Sheffield region. In addition a group led by Mr. R.A.G. Savigear (Sheffield University) gave a demonstration on some quantitative geomorphological field techniques with emphasis on methods of instrumenting drainage networks and denudational processes on slopes.

INTERNATIONAL CONFERENCES

During the period September 2nd-9th, 1965, three symposia were held in Ottawa in conjunction with meetings of the International Upper Mantle Committee. Their titles were: Drilling for scientific purposes; The World rift system; and Continental Margins and Island Arcs. Papers presented at the first two symposia have been published as Geological Survey of Canada papers 66-13 and 66-14 (1966). A final report on Continental Margins, etc., will appear as Paper 66-15.

The World Rift System

The World Rift System was highlighted as a symposium subject because it is the theme of one of three international programs selected by the Upper Mantle Committee at its meeting in Moscow in May, 1964 for emphasis as part of the Upper Mantle Project. It is significant in this connection that the concept of a world-encompassing rift system is relatively new. As was pointed out by Professor B.C. Heezen during the symposium, the existence of such a system has been recognized only in the last 15 years even though it is now generally considered to involve about one quarter of the earth's surface. In view of this novelty, vastness and undoubted importance, it was considered an opportune time for scientists studying the Rift System in different parts of the world to meet, "compare notes" and become familiar with one another's methods of study, findings, and interpretations. The program of the Ottawa symposium was therefore designed to bring together the authorities on the different parts of the World Rift System, and theorists from the specialized disciplines involved in its study, to summarize the current knowledge of this important feature and formulate goals for future work.

Quoted from the Introduction to Geological Survey of Canada, Paper 66-14.

MARINE GEOLOGY AT THE NATIONAL INSTITUTE OF OCEANOGRAPHY

A.P. Lubbock and G.H.S.V. Prasada Rao.

The main work of the National Institute of Oceanography is in the fields of physics and biology, like wave research and its applications, research on storm surges, study of ocean circulation, study of organic production, study of distribution of marine animals and the study of Antarctic whales. The Institute's geological studies aim to reveal the nature of processes which operate beneath the sea. The studies that have been made cover both the loose sediment and the rock occurring in depths ranging from relatively shallow continental shelf to abyssal ocean floors and plains. Such breadth is necessary because of the inter-relation of these aspects and because of the scale of certain sea floor features and processes. It has been found that the results of such work are purely descriptive unless the area studied is big enough to include a complete dynamic unit i.e. the smallest area within which the main processes or elements of relief can be distinguished from local detail.

At present marine geological studies are concentrated on the following problems:

1. Study of sedimentation and tidal current environment on the shelf
   a) Pleistocene sedimentation
   b) The mechanism of basal bed formation
   c) Quantitative studies of shelf sediments
2. Evolution of the continental margins - both sedimentational and erosional aspects
3. Coordination of the marine geological work with water movement studies.

Methods of Study. The sea floor has been examined at separate stations by well tried but slow methods such as photography and physical sampling by corer (2 inch bore Cambridge corer), grab (Shipek grab) and dredge (Naturalist dredge with Grommet bag) although much data is obtained by acoustic method while the ship is under way. In future Reineck box grab for getting undisturbed samples of sand and vibro corers also will be used. The first of the sonic methods used is the Boomer, a high power, low frequency precision echosounder which provides a continuous profile of interfaces beneath the sea floor, revealing buried channels, unconformities and dip of the rock beds. The second acoustic method is the sideways-facing Asdic (echo ranging technique), which "illuminates" the sea floor up to 1,000 yards from one side of moving ship. Single traverse with this method is sufficient to reveal the position and orientation of features in plan-view. In Asdic mapping of the sea floor each picture covers an area two miles by half a mile and can reveal patterns of sediments and of folds and faults on a rock floor. Interpretation of acoustic maps can be difficult when a number of patterns are superimposed. At present the institute is making an Asdic with an inclined range of ten miles for deeper work which is capable of working below the worst thermal stratification.

Copy of item in Commonwealth Geological Liaison Office Newsletter for December, 1966.

MINERALS AND FOSSILS ON SWISS STAMPS

J.E. Robinson

For many years, collectors of Swiss stamps have been able to learn of national costumes of the cantons of the country, of the colourful coats of arms of the towns, and more recently of the wild flowers and butterflies of the Alpine meadows. Between 1958 and 1961, however, the interest of geologists has been aroused through sets of stamps picturing Swiss minerals and fossils. This, of course, was a most appropriate choice of subject because there can be few countries where geology in its various aspects so dominates everyday life.

In a way minerals and mineral collecting were a spur to the study of the subject in the Alps. The minerals of metals such as iron, lead and copper had been known and worked since pre-Roman times, and in the late Middle Ages a famous mining geologist, Agricola (his German surname, Bauer, means 'farmer', but like many people at this time he preferred to use its latin equivalent 'Agricola'), described and drew typical mines and mineral workings of Switzerland

and Germany.

In the 16th and 17th centuries attention turned also to the non-metallic minerals - an expansion of interest which was clearly reflected in the specimens of quartz, garnet, fluorite, etc. which commonly took pride of place in the numerous gentlemen's "cabinets" of natural and artificial "curiosities".

Alpine mountain shepherds found that collecting minerals for this specialized market supplemented their rather meagre wage. Taking full advantage of their nimbleness of foot, they systematically scoured the mountain slopes, using as a combined staff and crowbar, a long iron rod, tapered at one end, and bent at the other. The collectors, known as "strahlers" - a name still used for collectors - adopted the iron rod as a badge of their trade.

The minerals illustrated on the stamps are:- deep red garnets set in a rock which is probably mica-schist (30 cents, 1958); agate - a collector's item from earliest times (10 cents, 1959); tourmaline crystals (20 cents, 1959); violet-tinted amethyst (30 cents, 1959); smoky-quartz (5 cents, 1960); orthoclase (10 cents, 1960); clusters of needle-shaped crystals of the copper carbonate azurite (30 cents, 1960); and fluorite (10 cents, 1961) - the characteristic pink variety from the Aar Massif.

Fossils are also illustrated on these sets of stamps. They represent objects which aroused angry debate as much as interest, and which played an important role in the history of palaeontology. Throughout the Middle Ages, fragments of shells found in rocks were referred to as either imperfect models of later created organisms, or as objects to trick men who wished to pry into the past. Then an idea grew in the minds of the pious that shells and plant fossils could be a record of The Flood. Up to 1725, no-one had found bones which could be regarded as belonging to Man amongst these Flood fossils, but in that year a Zurich doctor, Johann Scheuchzer, discovered in the Molasse rocks close to the village of Oeningen, a skeleton nearly five feet long with arms and legs and a flattened skull. Scheuchzer described this as surely a man of the time of The Flood, and not one who survived as a passenger on the Ark - Homo diluvii testis or Man witness to The Flood. Years later, Scheuchzer was proved wrong: his "Man" was in fact a salamander, although a giant of that form of amphibian.

"Homo diluvii testis" is illustrated on the 40 cent stamp of 1959. Another Scheuchzer fossil - Alethopteris lonchitica from the Coal Measures of Switzerland - figures on the 50 cent stamp of 1960. That these were leaves which settled on the sea bed after that event, was Scheuchzer's opinion when he wrote his "Herbarium Diluvi" (literally "Plants of the Flood") in 1723.

The remaining two fossils of the sets are both associated with colourful legends: an ammonite, possibly Harpoceras from the Lias (20 cents, 1958), and a distinctive lamellibranch - Gryphaea incurva (20 cents, 1960) also from the Lias.

The former were often regarded in the past as snakes turned to stone by saints (St. Hild at Whitby, St. Keyna near Bristol, or St. Patrick in Ireland), the reptiles coiling up as they petrified. Later the "Horn of Ammon" became a badge of pilgrims to the Holy Land. When ammonites were used like other shells to indicate that Alpine peaks had once been the bed of ancient seas, of which these were the fauna, the French philosopher and critic, Voltaire, said: "rubbish, these are tokens lost by returning pilgrims". The quarrymen of Switzerland, whether they speak French, German or Italian, will explain Gryphaea to you as "Devil's toenails", a name which you might hear in this country.

Welsh Geological Quarterly, vol.2, no.2, pp.25-27.

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Compiled by

Edward L. Martin Anthony P. Harvey

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NEWS AND NOTES

REVIVAL OF THAT OTHER JET AGE

After mining two or three years' supply of jet on the Yorkshire coast the Whitby Jet Company has just marketed its first batch of jet jewellery.

Whitby's own little jet age was a pretty swinging affair, too. In 1873, at its peak, about 1,200 people working for 50 firms dug, carved, or polished this velvety black coal-like substance. The biggest upsurge in trade followed Queen Victoria's insistence on jet for mourning jewellery after the death of Prince Albert. But when the decline came it came rapidly. At the beginning of this century jet was already out of fashion. Only small pieces were cut and polished as "souvenirs of Whitby" until Mr. William Cornforth, a civil engineer, decided two years ago that the time had come for a revival. He commissioned a geological survey and began to scoop out jet-bearing rock with a mechanical digger. The thickest seam he has found is about three in. But he has heard that the Victorians found thicknesses of up to 16 in.

The first marketing agents for Britain have been appointed and the first samples are going out to the United States. As Whitby suffers from chronic unemployment any industrial revival is welcome. Jet deposits are few in this country and Whitby jet is generally recognised as being the best in quality. All Whitby needs now is for the jet set to get jet gem sets.

The Guardian, 6th February, 1967.

THE FUTURE OF GEOLOGY : 1890 VERSION

The day has long gone by when geology could be reviewed "as a fashionable toy that everyone who has been to school is supposed capable of handling". No one now dares to touch its problems without some knowledge of physics, mathematics, biology, and chemistry. When Dr. Buckland led his tribe of random riders amongst the Oolitic strata of Oxford, or when Sir Roderick Murchison discoursed in sapient language on the rocks of Siluria, geology might have been a "fashionable toy". But not so now. The stern requirements of modern days have made it more accurate, and rendered it more sure. ... To be a geologist now, at least in the special phases of the science, a man must be either a mathematician, a physicist, a master of biology, or of chemistry.

Rev. G. Deane - The future of geology. Proceedings of the Birmingham Philosophical Society, 7, pt.2, 1890.

GOLD: OFFICIAL STATE MINERAL. SERPENTINE: OFFICIAL STATE ROCK.

On April 23, Governor Edmund G. Brown signed legislation designating native gold as California's official state mineral and serpentine the official state rock.

Authors of the bill making the designations, SB 265, were Senator Luther E. Gibson (D-Vallejo) and Assemblyman Pearce Young (D-Napa), who participated in bill signing ceremonies in the governor's office.

In signing the legislation, the governor said:

"It is fitting that gold, which played such an important role in California's early history and economic development, be chosen as our official mineral.

"It was gold more than a century ago that first brought California fame - and fortune - and gave us the designation of 'The Golden State'.

"Selection of gold as our state mineral is acknowledgement of the intimate part it has played in the history of our people and of the fact that mining is a major California economic activity."

Serpentine is a distinctive rock that has characteristic shiny outcrop surfaces in various shades of green and blue. Although it is by no means confined to California, there is more serpentine within the state than there is within any other state.

Indirectly, serpentine is of great economic importance to California. It is the host rock for the state's newest mineral industry - asbestos, which brings in several million dollars annually. It is also the host rock for most of the state's principal deposits of chromite, magnesite and cinnabar.

Unless very recent legislation has been passed in other states, the governor's signature makes California the first of the states to have both a state mineral and a state rock. South Dakota comes close, with a "state gem stone" - rose quartz.

Mineral Information Service, 18, no.6, June 1965, p.105.

TECTONIC MAP OF GREAT BRITAIN : 1966

The Institute of Geological Sciences recently published a Tectonic Map of Great Britain and Northern Ireland on a scale of 1:584,000 (approximately 25 miles to an inch) based on the work of the Geological Survey and other published data. It includes two inset maps: one illustrating dyke swarms in the British Islands; the other, dominant elements in the structure of the British Islands.

According to the compiler, F.W. Dunning, regional tectonic maps "show the age of rock deformation in folded zones, the thickness of cover and nature of the underlying basement in platform regions and the development of magmatism as well as structural and other data".

THE INSTITUTE OF GEOLOGICAL SCIENCES : A NEW DIRECTOR

Dr. Kingsley Dunham, F.R.S., has succeeded Sir James Stubblefield, F.R.S., as Director of the Institute of Geological Sciences.

Dr. Dunham, a graduate of Hatfield College, Durham, and formerly Commonwealth Fund Fellow at Harvard, served with the Geological Survey of Great Britain from 1935 to 1950, becoming head of the petrographical department for the last five years. Since then he has been Professor of Geology in the University of Durham.

His research work has been largely concerned with metalliferous mineral deposits, not only in the United Kingdom, but in North America, Africa, Australia and Europe. He was elected a Fellow of the Royal Society in 1955, and is at present a member of its Council. He is a past president of the Institution of Mining and Metallurgy, and is now President of the Geological Society of London. He has been a member of the 13-man Council for Scientific Policy, set up to advise the Minister of Education and Science, since its inception in 1965, and is a Trustee of the British Museum of Natural History.

The Institute of Geological Sciences, one of the establishments of the Natural Environmental Research Council, incorporates the Geological Survey of Great Britain, the Overseas Geological Surveys and the Museum of Practical Geology, South Kensington. The scope of its research effort is to be substantially broadened to include projects such as the investigation of the geology of the continental shelf around the British Islands, and intensive studies of mineral and water resources at home and abroad. Increased emphasis is to be placed upon the techniques of pure and applied geophysics and geochemistry.

RELIEF FOR MAKERS OF RELIEF MAPS

Relief maps are normally prepared using a layer system in which material is cut to the shape of each contour and placed in the appropriate position. This system is time-consuming and wasteful of materials. In a new invention, demonstrated in London last week by the National Research Development Corporation, the relief is made from a single slab of medium-density rigid polyurethane foam.

The contours on a normal map are traced with a "pen", which is connected through a long arm to a rotating saw. This saw, similar to a dentist's drill, cuts the shape of the contours on the polyurethane sheet. When all contours have been cut, the sheet is placed on a special table; the "in-most" contour island - which will be the highest part of the relief map - is fixed to a cross-beam, and the table is accurately lowered through the desired vertical distance between contours. The material, which is thicker than the increment, is cemented around inside this contour, and the process repeated until a hollow model is formed.

The technique was invented by Mr. A.E. Godson, and the prototype machine was constructed for the NRDC by Packman Research Limited of Twyford, Berkshire.

New Scientist, 32, 10th November 1966, p.293.

BRIDGE OR BARRAGE ACROSS THE DEE?

The desirability of building a new road bridge over the estuary of the Dee, west of the existing bridge at Queensferry, has been a talking point for more than 40 years now, with nothing tangible to show for it. Yet such a venture could have enormous advantages, not only in bringing industry to North Wales - which could well do with it - but also in making it possible to reclaim land from the estuary or create a new fresh-water reservoir that could serve the greater part of the north west.

But how would a bridge alter the regime of the estuary? Or, as an alternative, would it be sound to build a complete dam across the mouth of the estuary, with road and rail links and a central gap to allow shipping to pass? It is to answer these questions that the Dee and Clwyd River Authority has commissioned the Hydraulics Research Station to conduct large-scale model-tests at its laboratories at Wallingford. The tests, which will cost about £78,000, will show the effects that different forms and alignments of crossing have on water-levels and shoaling. Economic, engineering and traffic considerations will not be lost sight of either, since a consortium of consultants is reporting independently on these matters to the Ministry of Land and Natural Resources, and any type of crossing they recommend will be tried out on the model.

The model has in fact been built, and is now being operated to ensure that it correctly reproduces the natural conditions. It covers the coastline from Rhyl to Hoylake, is moulded in concrete, and the estuary itself is moulded in granular bakelite to simulate movement of bed material. Tides and freshwater flow can both be reproduced. Data necessary for moulding the bed of the model were obtained from recently conducted surveys.

New Scientist, 32, 17th November, 1966, p.347.

DANGEROUS DINOSAURS

Touring in America, we visited Oak Hill, the home of President James Monroe in Leesburg, Virginia. Our guide pointed out the distinctive flagstone walk through the formal garden, informing us that the markings on several stones were thought to be footprints of dinosaurs. An astonished woman behind me turned to her companion and exclaimed, "I'm amazed they would come so close to the house!"

Reader's Digest, March 1966.

GEOLOGICAL SOCIETY OF LONDON. ENGINEERING GROUP.

The Department of Geology, University College, Cardiff, will be host to a regional meeting in September, 1967 of the Engineering Group of the Geological Society of London. It is planned to arrange a field excursion to visit sites of engineering interest in Wales.

THE GEOLOGICAL CONTENTS OF GENERAL SCIENTIFIC JOURNALS : 1966

The accompanying references and abstracts - taken from a number of the best known and most widely distributed journals devoted entirely to science and designed for both specialist and non-specialist - are designed to provide a key to progress in geology.

References and abstracts from Nature and from the July to December numbers of Science will be given in the next number.

Advancement of Science

BRONGERSMA-SANDERS, M. The fertility of the sea and its bearing on the origin of oil. (v.23, no.107, pp.41-46)

HARLAND, W.B. and J.L.F. HAECKER. 'Fossil' lightning strikes 250 million years ago. (v.22, no.106, pp.663-671)

MOORE, L.R. Frontiers in geology - geo-microbiology. [Presidential Address delivered to Section C (Geology).] (v.23, no.112, pp.313-330)

RUSSELL, L.S. The changing environment of the Dinosaurs in North America. (v.23, no.110, pp.197-204)

Discovery

BELLAMY, D.J. Peat and its importance. (June, pp.12-16)

"Ecologists now know something about the formation of peat and understand its importance to science and man. Peat deposits are storehouses of energy, water and history. The destruction of our peat lands could have far-reaching consequences."

DEARNLEY, R. Ancient mountain ranges - a clue to Earth's evolution. (February, pp.18-23)

"During the last ten years new evidence has been accumulating in favour of the theories of continental drift and an expanding Earth. Now, a recent survey on the remains of old mountain ranges lends further support to these ideas."

EDGERTON, H.E. Exploring the sea with sonar. (September, pp.40-45)

"The technique of measuring underwater distances using sound waves is well established in such applications as depth finders. The development of stronger sources of sound with short pulse length now gives oceanographers greater scope in deep-sea investigations and a new method of looking below the sea floor."

GORDON, M.S. Adapting to dry land. (April, pp.27-30)

"One of the biggest single evolutionary advances in the history of life came when our fish ancestors struggled from the restricting world of the sea and emerged onto dry land. Just what physiological and biochemical changes did this giant leap involve?"

McBIRNEY, A.R. Predicting volcanic eruptions. (April, pp.20-25)

"Dormant volcanoes are among the most unpredictable forces in nature. Geologists are only certain that an unforseen eruption will eventually destroy some major city. What responsibility have they in warning an apathetic public of this risk?"

THIRLAWAY, H.I.S. Seismology and fundamental geology. (May, pp.43-48)

"The political need to detect large underground explosions has led to the establishment of a world-wide network of sophisticated instruments. No matter what the outcome of future negotiations, this will remain operational for many years to provide geologists with a powerful tool for studies of the dynamic processes which occur within the earth."

Endeavour

WILSON, R.L. and S.E. HAGGERTY. Reversals of the earth's magnetic field. (v.25, no.95, pp.104-109)

"Studies in the magnetization of rocks raise some interesting problems. The rocks often show magnetizations that are reversed, compared to the ones that accord with the earth's present magnetic field. There are two theories - 'field reversal' and 'self-reversal' - that account for the finding, and this article discusses the evidence for, and the conflict between, these two theories."

Natural History

DE BEER, Gavin. Darwin's 'Origin' today. (August-Sept., pp.62-71)

HUNTER, B. Myriad colors in coral. (January, pp.30-33)

"Life forms on the Great Barrier Reef are best seen at low tide."

PATNODE, W. Polarized beauty. (April, pp.24,25)

"Mica flakes reveal inner forms."

SIGAFOOS, R.S. and M.D. SIGAFOOS. Flood history told by tree growth. (August-Sept., pp.50-55)

"Botanical detective work yields more knowledge of flood plains."

TILDEN, P.M. Singular metal from Cinnabar. (June-July, pp.26-31)

"Quicksilver has served man since the dawn of history."

WAESCHE, H.H. and D.L. PECK. Volcanoes tell secrets in Hawaii. (March, pp.21-29)

New Scientist

BLUMENTHAL, W.B. Zircons for profit. (v.30, pp.786-787)

"The brilliant stones yield compounds that are useful for surface finishing, water proofing, chemical protection, catalysis and other purposes, while their ingredient metal, zirconium, has played a key part in the development of nuclear power in the U.S.A."

CALDER, N. Australia's mineral discoveries. (v.30, pp.257-258)

"Huge new fields of iron, bauxite and other minerals have been found in the past few years, and by the end of the decade Australia's minerals export will exceed those of wool. But will Australians seize the chance to build new industrial cities in hitherto unpopulated regions."

CALDER, N. Britain's methane in perspective. (v.30, pp.514-515)

"The economic impact of the recent finds of natural gas depend not only on the extent of the reserves eventually proved but also on a number of technological factors concerning distribution and use."

EDGE, R.C.A. Intercontinental surveying by satellite. (v.30, pp.171-174)

"The use of satellites makes it possible to measure with unprecidented accuracy distances of many kilometres at a single step. A number of countries are working towards the establishment of a unified global network of surveying points.

FARQUHAR, O.C. Seamounts ancient and modern. (v.29, pp.698-699)

"Steep mounds of volcanic rock built upon the shelves of ancient sea trenches in the south-west Pacific are now land-based because of crustal movements. As fossil seamounts they provide valuable comparisons with seamounts in modern oceans which cannot be observed directly."

HOWELL, F.T. Does the Irish Sea hold oil or gas. (v.31, pp.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."

JAHN, T.L. Classifying species by computer. (v.29, pp.151-153)

"'Numerical taxonomy' is based on computed comparisons and comprehensive descriptions of plants and animals. There are forceful scientific reasons why it should replace the legalistic systems of the traditionalists, which are based on subjective 'weightings' of characters and shaky evolutionary theories."

LAUGHTON, A.S. The birth of an ocean. (v.29, pp.218-220)

"Recent work in geophysics points to the possibility that, in the Gulf of Aden and the Red Sea, an ocean basin is in the early stages of formation. The theory lends further weight to the case for continental drift."

McKERROW, W.S. The rise and fall of fossil organisms. (v.29, pp.23-24.)

"The fossil record seems to be marked at times by great proliferation of species, at others by mass extinctions. A meeting at Swansea of the Geological Society and the Palaeontological Association has reviewed present knowledge about such fluctuations of life forms and their possible causes."

SANDON, H. Cosmic conversation: a biologist's view. (v.30, pp.845-847)

"Arguments for the existence of intelligent forms of life in other parts of the universe have been strongly advanced by some astrophysicists. But study of evolutionary processes on the Earth indicate only a vanishingly small probability that the same sequences of events would be copied elsewhere."

SCHULTZ, C.W. Mining on the moon. (v.31, p.33)

"Research on using lunar resources, and in particular theoretical and experimental studies of possible mining and mineral processing techniques applicable on the Moon, can prepare for the day when decisions have to be taken about the feasibility of manned lunar bases."

STUBBS, P. Coral timekeepers of the slowing earth. (v.30, pp.828-829)

"The fine ring-like banding which is displayed by the skeletons of some corals may represent a daily variation in growth. If so, identical features on fossil corals should provide a powerful method of determining the Earth's rate of rotation in past eras."

STUBBS, P. The promise of the North Sea strata. (v.30, pp.658-659)

"The recent rich gas strikes in the North Sea are highly gratifying. But what is known about the geology, coupled to the high rate of success which has attended the drilling programmes, indicates that the ultimate prospects could be very exciting indeed."

STUBBS, P. Surveyor's results. (v.29, p.80)

"The first formal analysis of the results of the American soft-landing on the Moon last month [June] has been published. The most striking aspect of the lunar surface at close range is its fragmentary nature."

STUBBS, P. The mechanism of continental drift. (v.32, pp.616-617)

"Although measurements of the natural magnetism of rocks lend credence to the theory of continental drift, sceptics have continued to question the mechanism. Magnetic traverses across mid-oceanic ridges now indicate strongly that the ocean floors are indeed ponderously spreading outwards from them."

WILSON, E.M. Barrages for British estuaries. (v.31, pp.371-373)

"Imaginative proposals now abound for exploiting the dents in Britain's coastline. The magnitude and complexity of decisions involved in implementing the various schemes put forward should not be allowed to obscure their contribution to water supplies, shipping and power generation."

The Barwell meteorite. (v.29, p.72)

"While people were occupied with seasonal festivities, a big meteorite fell almost unnoticed in Leicestershire on 24 December. Events of this nature and magnitude are not common and the Barwell meteorite is certain to prove of considerable scientific interest."

Christmas Eve fireball - by Dr. A.J. Meadows.

Analysis and record - by Dr. M.H. Hey [incl. a list of previous falls].

Bridgehead on the Moon. (v.29, pp.330-332)

Two articles on the scientific and technological aspects of the Soviet soft-landing on the Moon.

What Luna 9's pictures show - Dr. R.A. Lyttleton and Dr. P. Stubbs.

The problems of soft landing - Dennis Carton.

Reactions to Surveyor - 1. (v.30, pp.632-635)

"Two astronomers give quick comments on the achievement of a soft-landing on the Moon by the Americans with the Surveyor-1 spacecraft on 2 June and on its first pictures of the lunar surface. Howard Simons reports on Surveyors relevance to the lunar programme, and on other concurrent space operations."

Soft-landing of Surveyor-1 - by Dr. R.A. Lyttleton.

The surface of the Moon - by Prof. G.P. Kniper.

Most ambitious week in space - by Howard Simons.

More reactions to Surveyor-1. (v.30, pp.699-700)

"The chief exponent of the 'lunar dust' theory and a leading geologist comment on the early pictures from the Surveyor-1 spacecraft on the Moon. Although they share enthusiasm for the photographs. their interpretations differ widely, as did those of the commentators in last week's issue."

First impressions of the implications - by Prof. T. Gold.

A geological comment - by Prof. J. Sutton.

Microscopes past and future. (v.29, 140-143)

"Although as a basic instrument the light microscope retains little scope for improvement, the search for better ways of using it is still proceeding successfully. A second article tells how the Japanese have taken an initiative in the development of extremely powerful electron microscopes - which Britain will follow."

The evolving light microscope - by Dr. P. Stubbs.

Giant electron microscopes - by David Fishlock.

Science (January to June only)

BROECKER, W.S. Absolute dating and the astronomical theory of glaciation. (v.151, pp.299-304)

"Changes in climate occur in response to periodic variations in the earth's tilt and precession."

DONN, W.L. and M. EWING. A theory of ice ages III. (v.152, pp.1706-1712)

"The theory involving polar wandering and an open polar sea is modified and given a quantitative basis."

FAUL, H. Tektites are terrestrial. (v.152, pp.1341-1345)

"Age determinations link the origin of some tektites to specific impact craters on the earth's surface."

FLAWN, P.T. Geology and the new conservation movement. (v.151, pp.409-412)

"Geologists, conspicuous by their absence from today's conservation groups, can make a contribution."

HASKIN, L.A. and F.A.FREY. Dispersed and not-so-rare earths. (v.152, pp.299-314)

"The relative abundances of these elements reflect the earth's geochemical evolution from primordial matter."

MOORE, J.G., NAKAMURA, K. and A. ALCARAZ. The 1965 eruption of Taal volcano [Phillippines]. (v.151, pp.955-960)

NESS, N.F. Earth's magnetic field: a new look. (v.151, pp.1041-1052)

"The solar wind confines the geomagnetic field to form the magnetosphere and magnetic tail."

PRESS, F. and W.F. BRACE. Earthquake prediction. (v.152, pp.1515-1584)

"Recent developments reopen the question of the predictability of earthquakes."

SIMPSON, G.G. The biological nature of man. (v.152, pp.472-478)

"The answer to the question 'What is man?' must be based first on man's biological character."

UREY, H.C. Biological materials in meteorites: a review. (v.151, pp.157-166)

"If found in terrestrial objects, some substances in meteorites would be regarded as indisputably biological."

Science Journal

FOTHERGILL, C.A. Salt domes and oil. (July, pp.44-49)

"Development of salt domes from a deeply buried salt layer results in deformation of the overlying strata, often trapping oil and gas. Research into the formation of salt domes will aid oil and gas exploration in such areas as the North Sea."

FUCHS, V. Antarctica: the international laboratory. (November, pp.48-53)

"In Antarctica temperatures have been known to fall to -88°C and the climate is as arid as many hot deserts. Continuous international scientific studies, started ten years ago, have replaced the periodic expeditions of the past."

HODGSON, J.H. Earthquake mechanisms. (April, pp.30-36)

"The mechanisms by which immense forces within the Earth are released as earthquakes have recently been studied by computer. This analysis of all the reliable seismological information on record may also help us to understand the nature of the forces within the Earth's crust."

JOHNSON, M.A. Turbidity currents. (January, pp.69-73)

"Sediment breaking away from the edge of continental shelves may flow out to the deep sea as turbidity currents moving at speeds of up to 30 knots. These currents help to explain many of the physical features of the ocean floor.

MORRIS, I. Is science really 'scientific'. (December, pp.76-80)

"Conventionally, scientific method is thought of essentially as a series of observations leading to a hypothesis. In practice the hypothesis often, if not usually, comes first and the process of 'thinking it up' involves such 'unscientific' factors as inspiration and creativity." [With references to the work of Darwin, Poincare, Popper, etc.]

NEEV, D. and K.O. EMERY. The Dead Sea. (December, pp.50-55)

"Lying nearly 400 metres below mean sea level and saltier than any other sea, the Dead Sea is a truly remarkable body of water: among the strange findings of recent surveys is the fact that the water below 40 metres is 'fossil' water."

OLDS, G.C.E. New ceramics. (August, pp.58-64)

"Modern technologies call unceasingly for materials which are strong at very high temperatures, chemically inert and electrically insulating. To meet these and other demands the field of ceramics has widened to rival the importance of metals and plastics."

OLIVER, J. Prospects for earthquake prediction. (February, pp.44-49)

"Although no reliable method of predicting earthquakes is yet available, recent research holds promise that one may soon be found. A programme for evaluating the methods so far suggested should yield results within a decade."

ROBIN, G. de Q. The origin of the ice ages. (June, pp.52-58)

"Ideas about what led to the onset of the Earth's ice ages are still proliferating: although they involve some of the most grandiose concepts known to geophysicists, the final solution has yet to be found out but may combine suggestions already made."

SALISBURY, J. The Moon's surface. (November, pp.31-37)

"Surveyor 1 has sent back important information about the nature of the Moon's surface. This supports theories which claim that no mechanism exists on the Moon for 'sorting' different size particles into layers and that, therefore, the hazards of lunar dust must be minimal if not non-existent."

The October number of Science Journal was a special issue devoted almost entirely to The New Universe, with contributions by Sir Bernard Lovell, Sir Richard Woolley, Sir Martin Ryle, and others.

Science Progress

GOOD, R. The botanical aspects of continental drift. (v.54, pp.315-324)

"The significance of plant-geography in the problem: the Flowering Plants and their distribution. endemism: discontinuous distribution: tropical floras: the chief features of world geography: plant dispersal: the special interest of Australasia: Australasian floras and their mutual relationships: the geographical anomaly of the Australian flora: the 'Antarctic' flora."

RUNCORN, S.K. Rock magnetism. (v.54, pp.467-482)

"The processes by which a rock formation acquires a magnetization having the same direction as that of the Earth's magnetic field at the time are described. Evidence for the reliability of this fossil magnetism as a record of the changes in the Earth's magnetic field and the position of the continents relative to the pole are given. Palaeomagnetic observations in different continents do not agree unless continental drift is postulated to have occurred."

Scientific American

AMBROGGI, R.P. Water under the Sahara. (May, pp.21-29)

"Below the arid surface of the great desert are huge natural reservoirs of water. These resources are now beginning to be studied and exploited for the benefit of the Saharan nations."

HOWELLS, W.W. Homo erectus. (November, pp.46-53)

"This species, until recently known by a multiplicity of other names, was probably the immediate predecessor of modern man. It now seems possible that the transition took place some 500,000 years ago."

LEOPOLD, L.B. and W.B. LANGBEIN. River meanders. (June, pp.66-70)

"The striking geometric regularity of a winding river is no accident. Meanders appear to be the form in which a river does the least work in turning; hence they are the most probable form a river can take."

NEVERS, N. DE. Tar sands and oil shales. (February, pp.21-29)

"The world's largest potential liquid-hydrocarbon reserves are not recoverable by ordinary oil-producing methods. The pace of their exploitation depends on technical, economic and political factors."

C.F. POWERS and A. ROBERTSON. The aging Great Lakes. (November, pp.94-100)

"Like all the other lakes, they are subject to physical and biological processes that will eventually result in their extinction. These processes, however, are being accelerated by human activities."

S.K. RUNCORN. Corals as paleontological clocks. (October, pp.26-33)

"Banding on certain corals evidently represents annual, monthly and daily growth. Ancient corals thus provide clues to the length of the year in past eras and to changes in the earth's rotation."