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ERRATA

Page 3, paragraph 4, line 3: Pontypridd for Pontypool.

Page 4, last paragraph,
lines 7 and 8: Jurassic, Cretaceous or Tertiary for Devonian, Carboniferous or Permian.

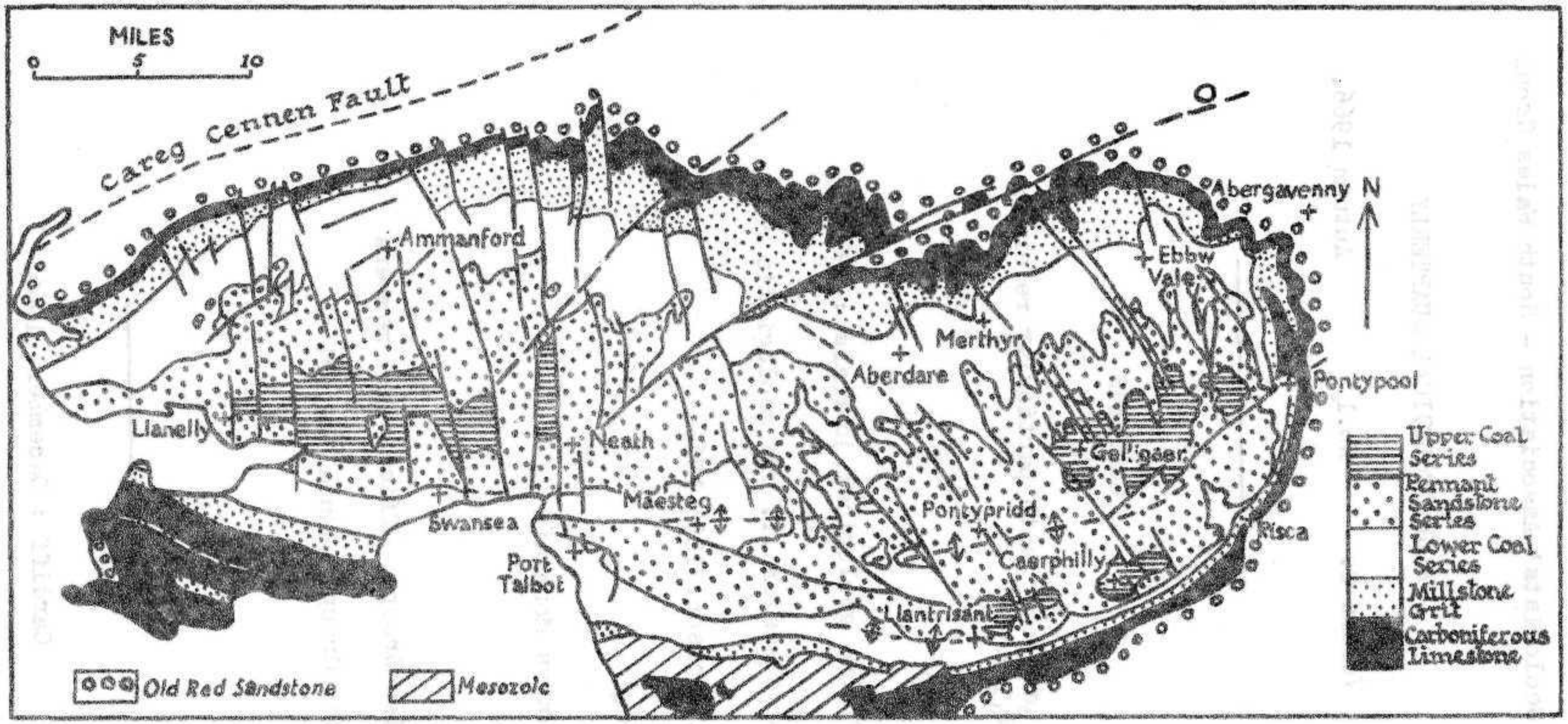

Fig. 1. Geological map illustrating the structure of the South Wales coalfield.

THE ANTHRACITE PROBLEM: WITH PARTICULAR REFERENCE TO SOUTH WALES

T.R. Owen

The South Wales coalfield is unique amongst British coalfields in the variety of its coals. It possesses the three main types - anthracite, steam and bituminous - as well as the many intermediate grades. The regional distribution of these various types of coal has intrigued geologists for well over a hundred years, and yet, despite intensive studies by individual investigators and by the officers of national bodies such as the Geological Survey, the Coal Survey and the N.C.B.,* which together have produced a vast array of data, there is no really satisfactory answer to the problem. Many theories have been put forward and many of them outlined comprehensively by Dr. F.J. North in his book Coal, and the coalfields in Wales (1931, pp.177-189). The present communication is concerned with the two most likely suggestions.

Because the problem is one whose solution involves the consideration of a wide diversity of geological evidence - stratigraphical, structural, chemical, petrological and palaeogeographical - the "morphology" of the basin is outlined briefly before discussing the hypotheses in some detail.

Structure

The South Wales coalfield is an oval-shaped basin of Carboniferous rocks extending from Pontypool to Kidwelly (fig. 1) with a narrow linear extension cutting across south Pembrokeshire. The major axis of the main basin trends approximately east-west. Because of the basin structure, the older Carboniferous strata, i.e. the Carboniferous Limestone and Millstone Grit, form narrow rims around the outer boundary of the coalfield, thereby enclosing an appreciable tract of the overlying Coal Measures.

The structure of the main basin is, however, complicated by a number of minor folds and by a large number of faults. The more important of these folds include the Pontypool Anticline, and the Pengam, Caerphilly and Gowerton synclines. The faults follow three particular trends: (i) NNW-SSE (becoming NE-SW in the eastern part of the coalfield); (ii) E-W; (iii) NE-SW. The first group comprise both wrench and gravity faults. Examples are the Cwmllynfell, Dyffryn and Tredegar faults. The second group include thrust, lag and gravity faults. The most important E-W fracture is the Moel Gilau Fault. The third group include the important Neath and Swansea Valley disturbances, narrow belts of intense folding and fracturing which have determined the courses of the Neath and Tawe valleys. A similar belt, but occurring beyond the northern boundary of coalfield, is responsible for the limestone outlier at Careg Cennen.

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* See note at end of article.

The structure of the Pembrokeshire coalfield is much more complex with fairly intense east-west folding and parallel thrusting. Along the south-western boundary of this coalfield the great Johnston Thrust has pushed Silurian and Precambrian rocks over the Coal Measures.

Stratigraphy and sedimentation

The main coal seams occur in the upper part of the Carboniferous succession, in the so-called "Coal Measures". These measures attain a maximum thickness of some 8,000 feet near Swansea, thinning towards the north and east.

For many years the sequence was subdivided into three parts as follows:-

		Thicknesses
Upper Coal Series	Predominantly shales with coals and subsidiary sandstones	Nil to 1,000 feet
Pennant Series	Mainly massive sandstones with shale belts and some coal seams	1,000 to 4,000 feet
Lower Coal Series	Predominantly shales with many coal seams and subsidiary sandstones	1,000 to 3,000 feet

In 1957, however, as a result of detailed resurveying of parts of the coalfield by the Officers of the Geological Survey, a radical revision in the classification was suggested. In the new scheme the Upper Coal Series, the Pennant and a small part of the Lower Coal Series are grouped together as the Upper Coal Measures , and the remainder of the Lower Coal Series is divided into Middle Coal Measures and Lower Coal Measures.

The Upper Coal Series has been largely removed by erosion from much of the coalfield and only about 800 feet are left along synclines in the Llanelly, Gowerton, Caerphilly and Pengam areas. As suggested later in this article, the original thickness of this unit may have been very much greater.

Seams of coal occur in all three divisions but are particularly abundant in the Lower Coal Series and, to a lesser extent, in the highest parts of the Pennant Series. The seams are usually about two to six feet thick but can be as much as eighteen, as, for example, the Six Feet Seam at Glynneath. Each coal is underlain by a bed of fireclay which represents the compaction of the muddy slime in which the Coal Measures forests had their tangle of roots.

The coals represent the compacted alteration product of what were originally beds of peat, formed of the dead masses of Late Carboniferous vegetation. What is now a three-foot seam of coal was originally as much as sixty or more feet of peat. All sorts of gradation from peat to very hard coals are known in the upper layers of the Earth's crust, the softer peats being of very recent origin, intermediate "brown coals" or lignite occurring in relatively young geological systems such as the Devonian, Carboniferous or Permian. Carboniferous coals are about 280 to 310 million years old.

The Anthracite Problem

The true coals are subdivided into three types depending on their carbon content and amount of volatile matter. They are: the relatively soft and friable bituminous coals with a carbon content of 84%-90% and 20%-40% of volatile matter; the hard anthracite coal with a carbon content over 93% and only 4%-10% volatile matter; and the intermediate steam coal with 10%-15% of volatile matter.

The South Wales coalfield is of considerable interest because it possesses all three types of coal. The regional distribution of these varieties, however, poses a problem that has still not been solved.

The variation in the coals is evident both in the vertical and horizontal dimensions. At any given locality (in Wales or elsewhere), the seams nearer the surface contain a smaller proportion of carbon than those at greater depths (see figure 2b). The statement that the more deeply buried the coal seam the greater will be the carbon content of the coal is known as Hilt's law. Whereas this law is applicable in all British coalfields, it is only in South Wales that the true anthracite grade is attained.

In addition to variation in the vertical sense, it can be shown (fig. 2a) that the carbon content of any one coal seam increases when traced from the eastern and south-eastern rims of the coalfield across to the north-western fringe - that the same seam may yield bituminous coal in Monmouthshire and high-grade anthracite at Pontyberem. There is thus (fig. 2b) a much thicker unit of anthracite coal in the north-western than in the eastern and central areas. This lateral variation, which appears at first glance to have nothing to do with Hilt's law, is really the crux of the anthracite problem in South Wales.

Many theories have been put forward to explain the origin of anthracite but they can be broadly categorised into two kinds.

The first (and least likely) group infer original differences in environment, local circumstances of accumulation and variations in the types and nature of the decaying Carboniferous vegetation. Whilst it is true that certain broad changes happened to the flora of the Coal Measures as time progressed - the higher floras reflect, for example, a somewhat drier habitat - nevertheless there is very little difference between the plant assemblages associated with any one coal over the whole coalfield. Local changes might account for slight differences between two adjacent coals but cannot be invoked for the broad changes which take place across the coalfield or downwards in any one vertical succession.

The second group of theories involve a low-grade alteration or metamorphism of coals due to increases in heat and pressure, which can drive off the volatiles and expel any moisture. In the first place, this could be due to an intrusion from below of hot molten material and coals have been somewhat altered in this way, e.g. in Northern Britain, through such baking. Could there then be a hidden granite mass beneath the north-western portion of the South Wales coalfield? We do not know the answer to this question but we do know that an area of mineralization (which could be related to a granite pluton) occurs at Bolahaul, near Carmarthen. Again Dr. Margaret Rowlands has recently demonstrated that there is an increase westwards across the coalfield of certain trace elements, again suggesting the marked influence of granitic-type mineralization.

Intense earth-movements can, through buckling and fracturing the rocks, cause considerable rises in heat and pressure. Rocks may, for instance, be bent downwards into deeper levels of the crust, i.e. into areas of greater heat. Again, the friction produced when rocks are pushed over one another may also produce increases in heat. Now this is the basis of the theory propounded by Dr. F.M. Trotter in 1948 to account for the "two-dimensional" variation of coal type in the South Wales coalfield. He believes that the rocks of the coalfield have been pushed "en masse" towards the north-west along a great basal thrust-plane (a flat-lying fault) which underlies the whole region but which gradually slopes upwards to emerge on the surface as the Careg Cennen Fault (fig. 3). This fracture runs just south of, and broadly parallel to, the Towy Valley and extends past Careg Cennen to Porth-y-Rhyd, Llangyndeirn and Ferryside (fig. 1). As a result of the frictional heat generated during this crustal push, the coals of that portion of the coalfield nearest to the thrust (X in fig. 3) were more affected by this heat than portions further to the east or south (Y in fig. 3), i.e. further away from the downward sloping fracture. This could then account for (a) the anthracitic character of the coals in the north-western area, as opposed to the less-altered, bituminous kinds in Monmouthshire and south-east Glamorgan, and (b) the increase, with depth in the succession, of the carbon content at any one locality within the coalfield.

One point in favour of this theory is that a similar phenomenon occurs in relation to thrusting in the Pennsylvanian Coalfield of America. Some geologists are, however, critical of the theory because (a) the inferred magnitude of this thrust, and (b) the possibility that the Careg Cennen Fault has been produced by a "sideways" movement rather than by over-thrusting. In this respect, it could then compare with the parallel faults along the Tawe and Neath valleys. One other difficulty is the presence of pebbles of coal (even of anthracite) within the Pennant sand-stones. The thrusting would, however, have occurred long after the de-position of the Pennant Series.

The remaining theory, championed particularly by Professor O.T. Jones, is that depth of burial of peat beds (later to become coal seams) is the main cause. The Coal Measures may, according to him, have originally reached a total thickness of 15,000 feet or over, and as a result the lower coals in the succession would have been particularly affected by increases in heat and pressure. This effect would lessen upwards and so would be reflected in changes of coal-type. This is, in other words, the appli-cation of Hilt's Law. The difficulty with this theory is that whilst it explains the vertical dimension it does not readily explain the regional variation, i.e. the lateral dimension of change. Moreover, many geologists point out that this theory would demand the greatest thickness of Coal Measures accumulated in the Ammanford-Gwendraeth belt, whereas the total preserved succession is thickest in the Swansea area. H.W. Wellman, an officer of the New Zealand Geological Survey, has answered this criticism by suggesting that a considerable thickness of Permian rocks could have been deposited over the north-western fringe and subsequently removed by erosion.

In connection with this "depth of burial" or "load" theory, isopachytes drawn by the author for parts of the succession (fig.4) show that the area of maximum thickness of basal Coal Measures rocks lies on the South Crop, that of the Middle Coal Measures, near the axis of the basin, and (bearing in mind that the thickness changes in the highest Coal Measures are difficult to reconstruct), there are indications that the centre of greatest subsidence moved even nearer to the north-western margin of the coalfield. Several thousands of feet of high Westphalian and Stephanian Coal Measures could have accumulated on what is today the north-western border of the coalfield, with very much thinner accumulations being deposited in the southern and eastern portions of the present coalfield. Areas like south Gower might even have been folded, uplifted and undergoing erosion when these late Coal Measures were forming further north.

The problem is, however, not yet resolved. Even the above theory does not explain the awkward pebbles of anthracite coal in the Pennant Sandstone (unless the peaty substance of the pebbles was later to become altered to anthracite). New techniques, e.g. geochemical methods, may perhaps help one day to give us the correct answer. It may of course be that all these answers are correct and that the true explanation is a combination of all these theories.

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* Very briefly, the history of investigation is as follows: Starling Benson drew a remarkably accurate map illustrating the changes in the quality of the coal in the coalfield in 1848, but it was not until 1901, however, when preparations for a Geological Survey memoir on the coals of S.Wales was begun, that any attempt was made to survey accurately and systematically the properties of the coal seams. The next systematic survey of the chemical properties of the seams was started by the Fuel Research Coal Survey in 1930, when the examination of the representative and widely recognizable Nine Feet Seam was begun. A summary of the progress of the work was published in Fuel Research Survey Report No.55 - The Coals of South Wales (1942) - in which a general statement on the lateral variation in the properties of the seams was given, and the variation illustrated cartographically. A little later a more accurate and detailed map was published - Isovol Map of the South Wales Coalfield. As a result of improvements in the standardizing of the methods of analysis, it was possible at this time to determine the volatile content with reliability and to plot lines of equal volatile content - isovols - which provided a valuable index of the physical and chemical nature of the coal (fig.2a). In 1959 the N.C.B. published a folio of seam maps (for the main coalfield) based on records of seam structure, thickness, quality and rank.

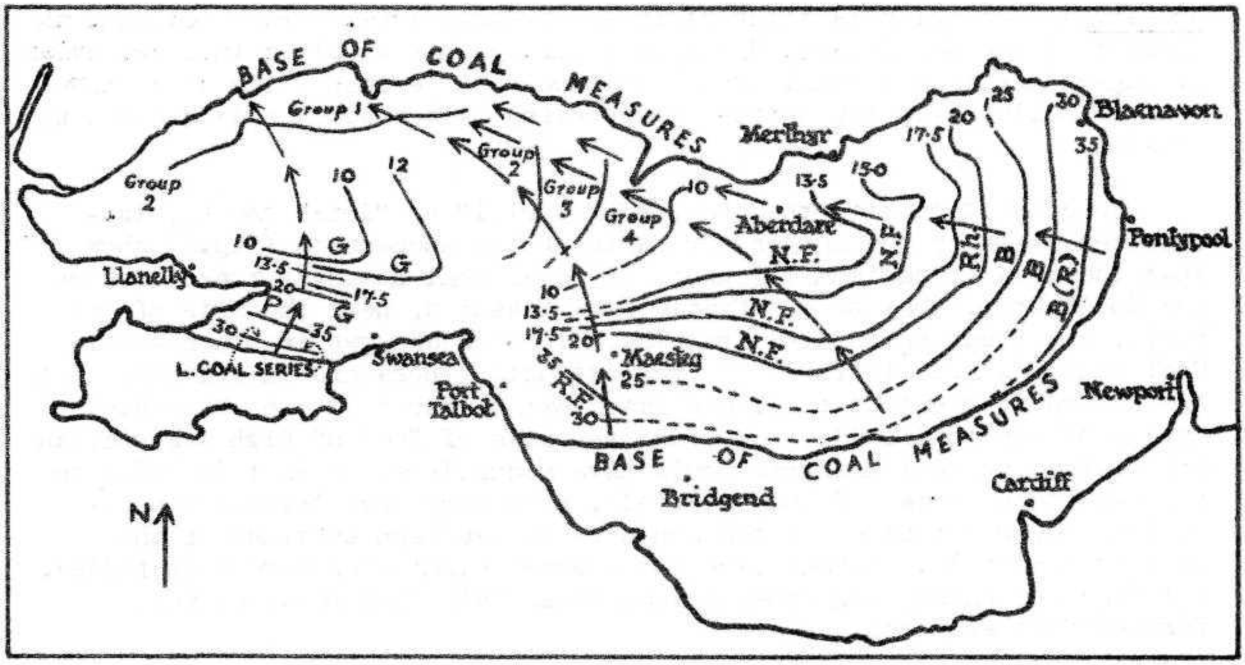


Fig.2a. Simplified Isovol Map of the South Wales coalfield (after Fuel Research Board), showing rank changes in one seam. Black (Rock) Vein, B(R): Black Vein, B: Rhaslas, Rh: Nine Feet, N.F.: Rock Fawr, R.F.: Graigola, G: Penlan, P. Other and higher seams are included in the western part of the coalfield.

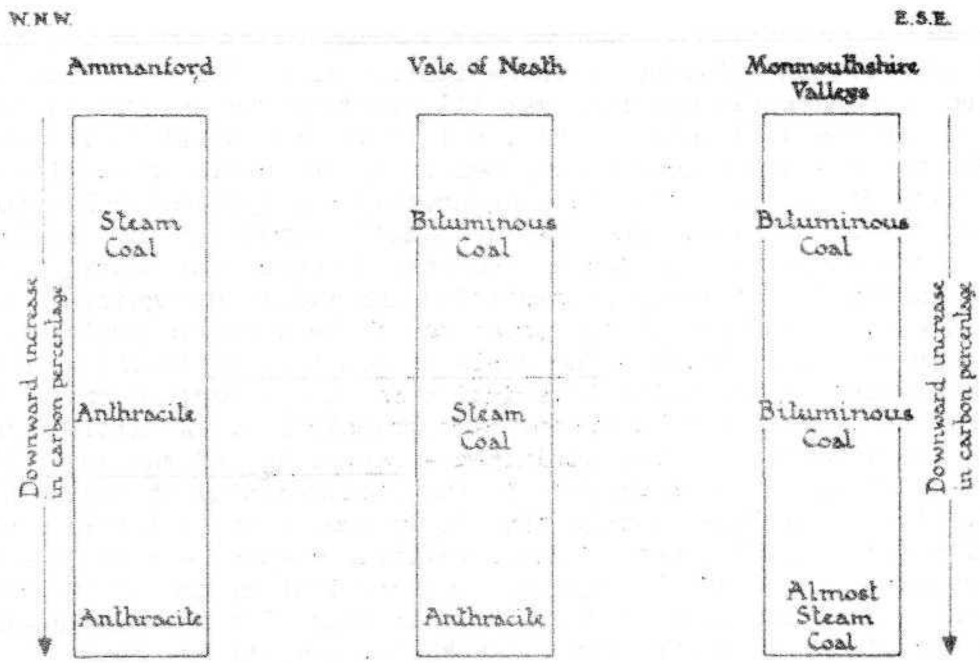


Fig. 2b. Variations in the coals of South Wales.

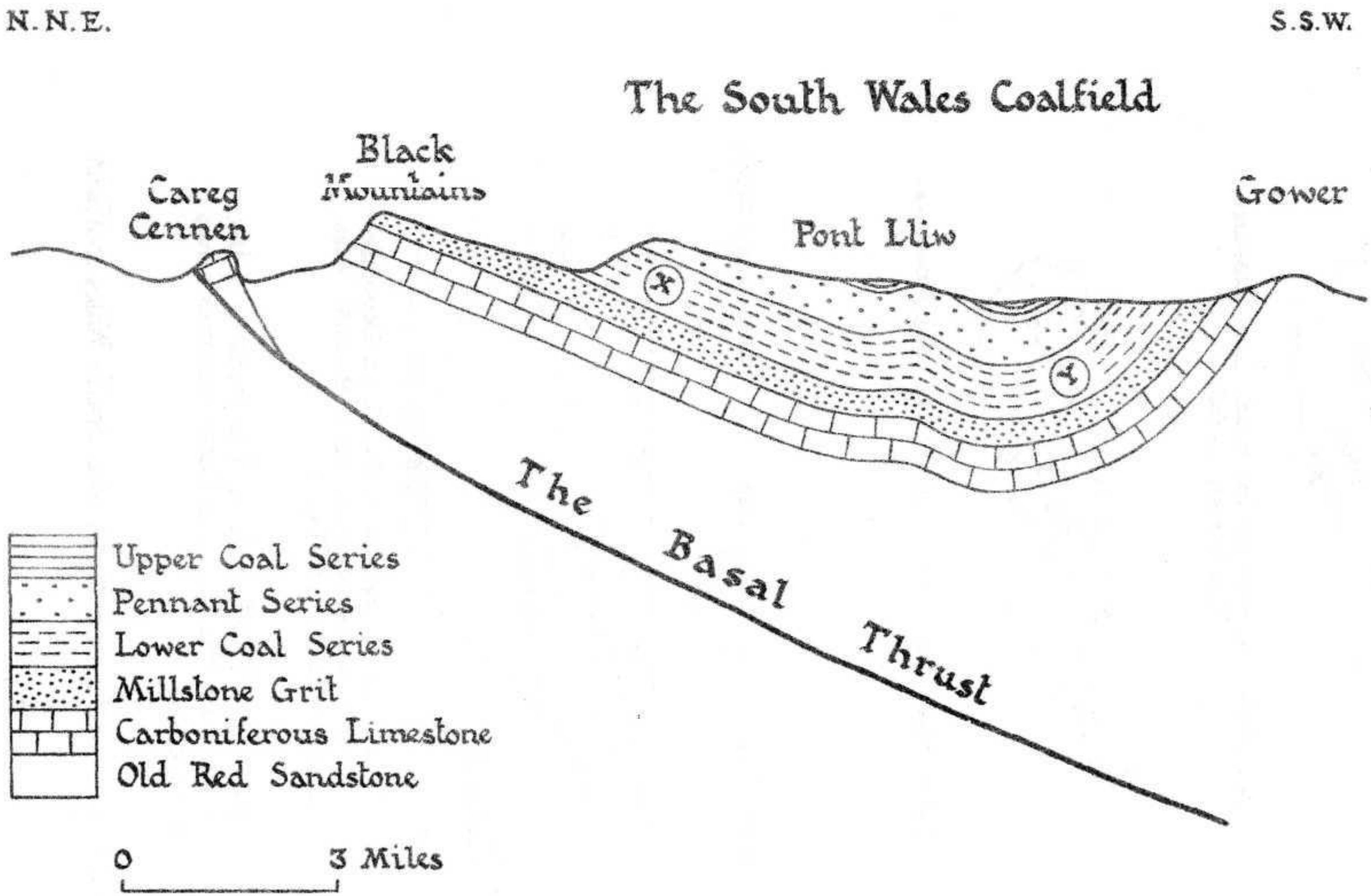
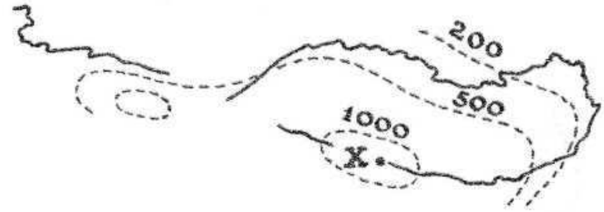
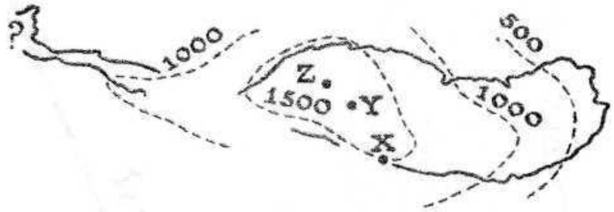


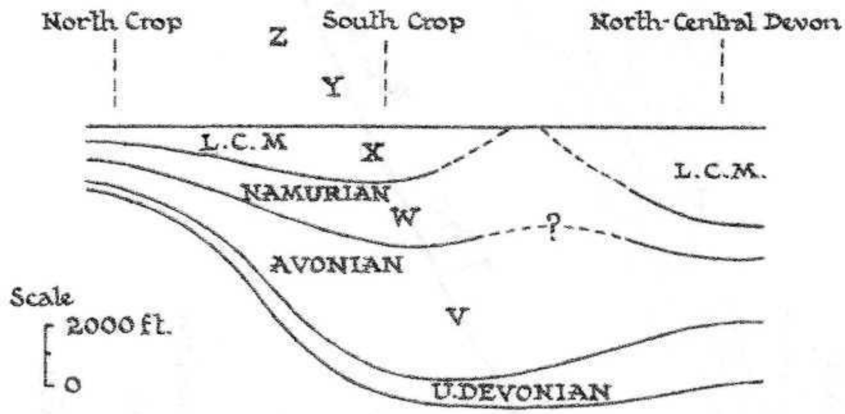
Fig. 3 "The Basal Thrust."



Isopachyte diagram for the basal Coal Measures.
Thickness in feet.



Isopachyte diagram for the Middle Coal Measures.



Thickness variations in the Upper Devonian-Lower Westphalian successions of South Wales and north-central Devon.

The letters V to Z indicate the position of the maximum thickness as Carboniferous times progressed.

Fig.4. The early growth of the South Wales coalfield.

THE GEOLOGICAL MAP

"A geological map shows the nature of the rocks found at the surface of the earth and the area which each kind occupies; it shows the ages of the rocks and the relations which exist between them. It is the most important method of recording geological information and of making known geological discoveries. It reveals the extent and accuracy of knowledge; it is the basis for current and future research."

W.J. Pugh - The geological map of Great Britain. Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 95(1953-54), p.85.

"The geological map is an index of the extent and accuracy of Geological knowledge at the time of its production, and it is also the basis of future research. It is the vehicle by which men communicate to one another their discoveries relating to the nature and arrangement of the rocks of the earth's crust, and the very fact of its production makes possible the prosecution of further research concerning the distribution of rocks, their origin, and the evidence of the life of the past which they may contain."

"The geological map may, therefore, be regarded as the dynamic force in Geology, and the history of its evolution and development is really the history of the birth and growth of that branch of science, and of the application of its principles in the service of man."

F.J. North - Geological maps: their history and development with special reference to Wales. Cardiff: National Museum of Wales. 1928, p.1.

"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. It is to be taken strictly at its face value, so to speak. 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. Publications. 1955, p.80.

"The Lithosphere consists of an amazing complex of masses of rock, exceedingly varied in their natures and their forms, and arranged in varied, often complicated manners. Vast numbers of these masses emerge at and occupy certain tracts of the surface, so that the boundaries of each such tract or outcrop are really the lines of intersection between two curved superficies, one being the bounding-surface of the formation itself, the other being the denudation-surface of the land. The only exceptions to this are certain accumulations (such as alluvia, lavas, and so on) too recent to have been appreciably modified by erosion, so that their boundaries are simply the original limits of the accumulation. Thus, were the Lithosphere swept clean like a polished table, it would present itself to us as a mosaic of bands and patches which we could distinguish by their different shades and colours. To represent this mosaic on a map is the end and aim of Geological Cartography."

E. Greenly and H. Williams - Methods in geological surveying. London: Thomas Murby. 1930, p.81.

"Although the term 'geologic map' refers specifically to maps that show the manner in which rocks crop out at the surface and the probable extent of the beds below alluvium, soil, or glacial cover, a large variety of maps in use at present are actually 'geological' in the broad sense of the word. These maps, however, are designated as stratigraphic, structural, facies, isopach, tectonic, etc., depending upon the special aspect of the rock body that is being illustrated."

M.S. Bishop - Subsurface mapping. New York: John Wiley. 1960, p.1.

"A geological map is one on which are recorded the geological features of a region, particularly the delineation of outcrops, the occurrence of faults, mineral veins, fossil localities, etc. and, by conventional signs, the directions and quantities of dip, cleavage, etc."

John Challinor - A dictionary of geology. 2nd Ed. Cardiff: University of Wales Press. 1964, p.105.

Welsh Geological Quarterly, vol.2, no.1, pp.11-12.

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PREPAREDNESS FOR DISASTER ... The Geologist's Role.

By Ian Campbell.

(Reprinted from Mineral Information Service, vol.18, no.3, 1965, pp.51-53, by kind permission of the Editor.)

October 9, 1963 - barely a year ago - saw the worst dam disaster in all history (3000 lives lost, a major reservoir virtually obliterated, millions of dollars of damages sustained). This was the Vaiont Reservoir tragedy in Italy, in the upper reaches of the Piave River. It involved the world's second highest dam (825 feet). The dam itself, the world's highest thin-arch structure, sustained no major damage - testimony to the sound engineering that had gone into this structure. The damage came from a landslide, upstream from the dam, which - involving over 300,000,000 cubic yards of earth - in a matter of a few seconds completely filled the reservoir and generated a tremendous airblast and a water wave which far overtopped the dam and wiped out everything for many miles downstream.

Less than a year ago, the Baldwin Hills reservoir in Los Angeles failed. That tragedy is so close to us in space and time, I need not recount any details here.

And on Good Friday, 1964, came the Alaska earthquake, resulting in over $300,000,000 of damage, the largest part being in Anchorage.

Here are three disasters all within the past 12 months, widely separated in geography, each resulting from a different kind of "geologic hazard", but alike in that the hazard was known - even documented well in advance of the event. What was wrong? Why were not these tragedies averted?

At Vaiont, the trouble came from a landslide. A much smaller landslide had occurred in the reservoir area in 1960. The geologic formations were known to be landslide-prone. Engineers were "keeping an eye" on this possible hazard. They had in fact, done some drilling (unfortunately it had stopped too short) to disclose the slide plane. Measurements of the slide's rate of creep were being continued. The deductions were that some land was moving, but it was moving very slowly, and only small masses were involved. Then came heavy rains at the end of September. Seemingly no one had anticipated the implications: a filled reservoir, a well-lubricated slide plane, increased weight as rainwater saturated the mass of porous rocks. Three hundred million cubic yards moved into the reservoir in less than 60 seconds, and the Vaiont dam became history. The geologic information already on hand, plus a little foresight and imagination, might have prevented the disaster. Either the dam would not have been built in the first place, or rigorous measures would have been taken to stabilize the landslide mass and to keep it under better surveillance.

At Baldwin Hills, a reservoir was placed directly over a fault known to be part of the active Newport-Inglewood fault zone. Absence of any recorded earthquake epicenters on the line of this particular fault may have provided a certain sense of security, but the geologic evidence clearly placed the fault in an active zone. As is now well known, it was not an earthquake that triggered the Baldwin Hills disaster. Rather, to quote one of the reports, "slow but inexorable forces" were at work, causing disruption of foundation material. Evidence of these continuing forces was provided, for many months by cracks in a highway and a playground along the strike of the fault, which developed - and continued to develop - subsequent to the installation of the reservoir. The geologic information already on hand, plus a little foresight and imagination, might have prevented the disaster. Either the reservoir would not have been built in that particular location, a different design selected, or arrangements would have been made for periodic drawdowns, inspections, and repairs in the slowly failing foundation zone.

Although there is much still to be learned from the Alaskan earthquake, the situation at Anchorage is sufficiently well known to provide one more pertinent illustration. Alaska and California are this country's two most seismic states. Damaging earthquakes in both states are a matter of abundant record. In the Anchorage area the U.S. Geological Survey had completed an excellent geologic map and had published a bulletin on the area in 1959 which specifically pointed out the hazards presented by one of the geologic formations present in the area - the Bootlegger Cove clay. Yet it was in an extensive area of this clay, and in an area where the topographic situation added to the hazard, that some of Anchorage's most expensive residences were built. The geologic information already on hand, plus a little foresight and imagination - while these could not have prevented the earthquake - could have lessened the amount of damage and otherwise ameliorated the situation. Either the type of structures or density of population in the most hazardous areas might have been restricted, or special stabilization measures might have been instituted long in advance of the earthquake which everyone knew was bound to come - sometime.

Admittedly, "hindsight is better than foresight". But how much of a gap must there be? In none of these three situations was there ignorance; in none was hindsight really needed. Landslides were known to be active at Vaiont; slow earth movements along a fault were known to be taking place at Baldwin Hills; earthquakes were known to be severe in the Anchorage area, and the Bootlegger Cove clay was known to provide a most hazardous foundation material in a seismic situation. Why wasn't disaster avoided? There is no simple answer, but if I may generalize, there was a lack of appreciation of the possible magnitude of these geologic forces in terms of man's works and his population density.

When the pioneers first came west, there was a saying among them that "one smoke to a square mile is enough". When population density got any greater than that, it was time to move on! When we lived only one smoke to a square mile, only the miner was concerned with the condition of the earth beneath his feet. Landslides, floods, earthquakes were part of a continuing natural cycle and few persons fell victims - partly because these men had sense enough, for example, not to set up a tent or build a home in a canyon in cloudburst country, but largely of course because the population was so small.

Now, however, rather than one smoke to a square mile, we are living 10,000 to a square mile - and smoke problems and foundation problems have increased enormously. Man today <u>needs</u> to know what is below his feet, and not just immediately below, but perhaps 10 or even 100 or 1000 feet below, and all around him. It is the role of geology to provide this knowledge. Geologic knowledge is best presented in the form of geologic maps. The general uses of maps are well known, and that there are different purposes, is also well known. What is not so well known is that a <u>geologic</u> map is a particularly sophisticated kind of map - it is a map that is vital to a sophisticated society - and perhaps I should add and even emphasize that it should only be read and interpreted by sophisticated people!

A geologic map provides evidence of the rock, or soil formations, not only at the surface, but to some depth below the surface. It indicates the character of rocks, whether they are hard or soft, porous or tight, light or heavy; it shows their attitude and structure - are they lying flat (as good rocks should) or are they standing on end (not an uncommon situation in California). More than this, the geologic map shows the location of faults, and direction of their movement (if known). It is a map that, properly understood and employed, can be of enormous use to planners, developers, construction agencies, and individuals as well as to those who wish to put it to its more traditional uses of oil and mineral exploration.

A geologist, in preparing a map that will satisfy man's basic "need to know" what lies below, provides constructive information, as well as information as to where destruction may lurk. A map that shows potential landslides and faults will also have delineated sand and gravel deposits that - in the course of good planning - might well be zoned for mineral production before being engulfed in "urban sprawl".

California needs geologic maps. We <u>need to know</u> much more about our geology. What is the situation? Our Division of Mines and Geology is just completing the first good geologic atlas of the state. The scale is one inch equals four miles. This is a very small scale, but in the present state of our knowledge for considerable portions of California, it is all that is now justified. If from this you deduce that California is still far from being geologically fully explored, you'd be right. But that's another story.

A geologic map at four miles to the inch isn't going to help the city manager and the city planner any more than a map showing the major highways from here to New York is going to help a driver find his way around the Los Angeles freeways! What we need for most local planning situations are maps of larger scales, and more detail. We have some, for, in addition to our atlas sheets, there are published and in preparation a good many one-inch-equals-one-mile geologic "quadrangle" maps. But it will take some 700 quadrangles to cover California, and we and the U.S. Geological Survey, a cooperating agency, are a long way from completing that job. On the very important work of "urban mapping" or "environmental mapping", involving scales of four inches to a mile, and larger, we have made only a small start. But the value of this mapping has already been demonstrated. And it is to the credit of the Los Angeles County Flood Control District that this "environmental geology" mapping has gotten underway in California.

As an example of the importance and the success of this type of geologic work, I might point out that in our cooperative work with Los Angeles County in the Palos Verdes Hills area, the cost of the mapping has amounted to around one dollar per acre. "Dirt cheap", I think you will agree. Moreover, even in advance of final publication of the maps, they have proved a great help to the County Engineer, to engineering firms, and to private consultants. If, as a result of this mapping, only one $40,000 home has been saved, or if only one street has been so located as to avoid future extensive and perhaps continuing repairs, the work has already more than paid for itself. And that the maps will continue to pay dividends for years to come is now a foregone conclusion.

A question - a very proper question - that arises in discussion of urban or environmental geology, concerns who should do it: federal government, state, city, county, private contractor, consulting firm? My answer - in view of the magnitude and the importance of the job to California and to Californians - is to say that all should be doing this work: there is certainly more than enough work for the relatively few organizations and people qualified to do it. The state has one paramount responsibility in all such mapping (involving as it does the safety and well being of all our citizens) which stems from the fact that geologic formations and geologic phenomena pay no attention to city limits or county boundaries - in fact not even to state lines! Important geologic relationships which may be obscure or wholly concealed in one district, may be revealed and projected from an adjoining district. Too often, in the nature of his work, the consultant, the city geologist, or even the county geologist does not have opportunity for the broad look at surrounding regions, which puts his problem into proper perspective. It is the old problem of "not seeing the woods because of the trees". The function of the state, then, is to do sufficient mapping in sufficient detail in key areas to provide guides and standards which will enhance and speed the work of those who are doing the important work of interpretation and of making still more detailed maps at home-site, plant-site, district, city and county levels.

While geologists are scientists and strive for objectivity, they are also people, and inevitably respond, as people do, to public and private and even pecuniary pressures. The further from the local scene that a geologist derives his mapping directives, the less he is likely to be subject to such local pressures - which can be intense - and the more scientifically complete and objective will be his maps and reports.

In the last analysis, the important thing is that we need - and in many of our urban and suburban areas, we urgently need - good geological information. Furthermore, city managers and city planners need geologists on their staffs who can interpret this information, who have the foresight to point out both the dividends and the hazards that lie ahead, and who have the ability to make the information and the foresight count where it has to count. Besides the "need to know", there is a "need to heed", else our knowledge is valueless.

Every city manager and every city engineer knows that he cannot be too arbitrary. He must have the public, certainly the better informed segments of the community, with him in planning and in decisions. To educate the public so that they will aid us in making forthright and forehanded decisions on geologic hazards is another job for all of us: individual geologists, consulting firms, city, county, and state. We have a lot of educating to do, but if it is done well we should find a public eager to learn.

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JAMES FREDERICK JACKSON, 1896-1966

F.J. North

James Frederick Jackson was born in Mold in Flintshire in 1896, and whilst still a child went with his parents to Hunstanton in Norfolk. Little can be said about his early days for he was reluctant to speak of them beyond hinting that his father made them difficult and unhappy. When about six years old he was attracted by some of the shaped stones - that he was later to learn were fossils - which he found amongst the debris that fell from the cliffs, and encouraged by his mother took some of them home to form a little museum of his own.

The writer first came to know him through correspondence in 1910 when he was helping to support his then widowed mother by working as assistant to a house painter and as beach-chair attendant. By this time collecting had been followed by observation, and noticing the arrangement of the colourful rocks in the local cliffs and the changing pattern of clay, gravel and peat as the sand and shingle which covered them were shifted by wave and wind, the boy began to make notes of what he saw, and to read all that he could about them in the limited literature available to him.

These activities laid the foundation of an interest in geology but in the circumstances in which he lived it is unlikely that the interest would have developed into more than a hobby affording relief from his uninspiring daily work had he not been seen collecting by Mr. Bellerby Lowerinson, principal of a private school at Heacham a few miles away. Mr. Lowerinson was so impressed by the lad's knowledge of the local geology that he encouraged him to write what was, in 1910, published as a booklet of about 60 pages entitled The Rocks of Hunstanton and its neighbourhood. This, in scope and content indicated a degree of knowledge, a breadth of outlook, and a capacity for expression that was unique in one so young - he was only 15 - and with so restricted an educational background.

In some "Afterwords" Mr. Lowerinson who had seen the booklet through the press, drew attention to the difficulties under which young Jackson worked and expressed the hope that help might be forthcoming for a "gifted lad, heavily handicapped by the struggle for bread". This hope was so far realised that when a second edition of the booklet was published in 1911 he was able to report that "the lad is now at school working hard at Latin and Mathematics".

The new edition incorporated interesting notes and inferences about beds of peat that were intermittently exposed on the foreshore, and lists of books that could be consulted by persons whose interest had been aroused, indicating those he possessed himself and could recommend from personal knowledge. The lists included several of the less expensive books then available, such as W.W. Watts' Geology for Beginners, F. Rutley's Mineralogy, J.E. Marr's Introduction to geology, and J.W. Judd's Students Lyell.

It is difficult to realise that the booklet with its description of the area and records of his own observations, written with the assurance of an adult, could have been produced by one so young and, apart from geology, so indifferently educated.

Unfortunately his efforts at school showed that his flair for geology was not matched by an aptitude for all the other subjects that were required for matriculation, or entry into a service such as the Geological Survey where in due course full use could be made of his ability as a collector, and it seemed as if a potentially open door had been closed to him. He was born too soon to benefit from the educational facilities so readily and so cheaply available in later years and taken for granted by the present generation. In other circumstances his life would have been much easier and geology much richer, but in spite of difficulties and disappointments that would have deterred most of his contemporaries he made a position for himself in the geological world equal to that achieved by many, who by birth, education, and opportunity, had advantages that he never enjoyed.

The establishment of a Department of Geology in the National Museum of Wales in 1914 provided an opportunity to give Jackson the helping hand to which Mr. Lowerinson referred, and he was appointed as "General Assistant" to help the writer unpack and organise the collections that had been transferred from the Cardiff Municipal Museum and to collect material to supplement them. Unfortunately, during the writer's absence on military service, circumstances connected with the war deprived Jackson of his post and for the next few years he supported himself by working as a jobbing gardener.

In spite of his limited means Jackson managed to take what he called "geological holidays" each year, living and travelling as economically as possible. One such holiday in Dorset brought him into contact with the late S.S. Buckman who was preparing the second of his papers on Jurassic Chronology (Q.J.G.S., vol.78, 1922, 378-438). He asked to see the material that Jackson had already collected, especially that from the Junction-bed of the Middle Lias at Watton Cliff, arranged for him to prepare an appendix to the forthcoming paper, and encouraged him to continue the work.

The Junction-bed deposits were unusual and intricate but with characteristic care, both for his own safety and for the accuracy of his work, he described and elucidated them, making several visits to Dorset for the purpose. The results were published as The Junction-bed of the Middle and Upper Lias of the Dorset Coast (Q.J.G.S., vol.82, 1926, 490-525). Many of the fossils were used by Drs. D.V. Ager and M.K. Howarth in the preparation of their papers on the Middle Lias, published by the Geological Society in 1956 and 1957.

He was elected a Fellow of the Geological Society in 1923, and in the summer of that year began to make plans to return to Hunstanton, thinking that his mother would enjoy better health there than in Cardiff; but before the plans materialised he received an invitation from Mr. F. Morey, F.L.S., whose acquaintance he had made during a visit to the Isle of Wight some years before, to become his personal assistant (he was an enthusiastic amateur palaeontologist) and to collect specimens for the Museum at Sandown.

A few months later Mr. Morey, who was Secretary to the Isle of Wight Natural History and Archaeological Society, arranged for Jackson to be appointed Joint-Curator of the Museum with the Revd. J.C. Hughes, but as Mr. Hughes spent most of his time in Shanklin he was Joint-Curator in little more than name.

Amongst the services Jackson rendered to the Museum was the formation of a representative collection of the fossils of the Island and he re-arranged the entire collection on modern lines, adding many explanatory labels, maps, and models with a view to making it instructive to beginners and interesting to the general public. The arrangement and display were highly commended by Professor W.W. Watts when, under his presidency, the Geologists' Association visited the Museum in 1931.

In 1925 Jackson compiled a Catalogue of the fossils from the Eocene deposits of the Island. It contained the names of 613 species and indicated the horizons at which each of them occurred. It was published in the Proceedings of the Society and was followed in subsequent years by similar lists of the fossils of successively older formations. By 1933 the list had increased to about 1,500 species. Other papers by him published in the Society's Proceedings included studies of the lithological variations and fossils of the Headon Beds (1924), of the base of the Chloritic Marl (throwing light upon the conditions of deposition of that deposit) (1926), a note on the fossiliferous nodules in the Carstone near Niton (1938), and an Account of the Geology of the Isle of Wight (1942).

After Mr. Morey died, towards the end of 1925, Jackson acted as Secretary to the Society and Editor of its Proceedings. It was because Mr. Morey's sister, Miss Catherine Morey, continued the financial support provided by her brother that Jackson was able to continue his work in the Museum until Miss Morey died in 1942.

In 1937 the Geological Society awarded him a moiety of the Lyell fund in recognition of his work on the Junction-bed and in the Isle of Wight. This was a specially appropriate award because as he once said to the writer, "I brought myself up, largely, on Lyell's works", and like Lyell he was successful in his attempt to write in language that would be understood by persons of average education. Also in 1937 he became a member of the Geologists' Association.

His interest in the Isle of Wight inspired the preparation of the typescript of a book that he hoped to publish. It was to be called The fossils of the Isle of Wight: how and where to find them. The text ran to well over 100,000 words with a list of all the fossils known to have been found in the Island, but post-war conditions did not favour the acceptance by publishers of a work of such magnitude on a subject of rather limited interest.

The text was an embodiment of his own attitude towards geology and geologists and emphasised throughout the importance of accurate observation, on-the-spot recording, careful collecting and proper treatment of the collected material. An introduction including useful notes on "When to come" concluded with the warning - based upon his own experience - "The fossil collector cannot expect, and does not deserve, success unless he is willing to give honest hard work and put up with a little dirt".

The text, which takes the visitor systematically over the Island describing what was to be seen and how it could be interpreted, was followed by sections containing hints on Tools and appliances, Preservation and packing of fossils, and, very necessary in view of the double tides in the Solent which could trap unwary explorers of the coast, a note on The tides.

Soon after settling in the Isle of Wight he bought an inexpensive camera with the intention of recording all the features of geological interest in the Island. This, in present circumstances would be so natural a venture as not to be worth mentioning in an account of a geologist's achievements, but in 1924, and for one with very limited means, it was no mean undertaking. Although able to collect and clean delicate fossils Jackson was, in matters unrelated to geology, somewhat heavy handed and the manipulation of the camera followed by developing and printing in an improvised darkroom did not come easily, especially, as he said, as a matter of fact and not complainingly (for he was not bound by regulations) that his work in the museum and for the Society kept him busy for about 60 hours a week - and photography was an extra.

In due course when the collection numbered about 200, he presented the negatives to the British Association Committee concerned with the preservation of photographs of geological interest. He had been invited to serve on the Committee on the advice of Professor S.H. Reynolds with whom he collaborated on a paper on the Isle of Wight Undercliff for the Proceedings of the Natural History Society (1937). Unfortunately the whole collection, with many others, was destroyed in the air raid that devastated the Bristol Museum, where they were housed. He felt the loss very keenly especially as many of the photographs recorded sections that had been changed by erosion since they were taken. This brought his photographic venture to an end because, due to war-time restrictions, the early replacement of the negatives was not possible, and the death of his benefactress made the hobby too expensive.

Jackson left the Isle of Wight after the death of his mother and for the next six years lived in a small wooden bungalow at Goodrington near Paignton, but in 1951 he was able to fulfil a long cherished desire to retire to Charmouth which he had visited at intervals for nearly 40 years. Here his cottage afforded more space for his collections and soon became a store house for local fossils to which visitors came in search of ammonites and the like as souvenirs, just as they had visited the home of Richard Anning and his famous fossil-collecting daughter, Mary, in Lyme Regis more than a century before.

An added advantage of the removal to Charmouth was that Dr. W.D. Lang, formerly Keeper of the Department of Geology in the British Museum (Natural History) had settled in Lyme Regis after retirement. He befriended the newcomer in many ways and his was one of the gardens in which Jackson worked as he built up a local clientele, but it was as a fellow geologist that he was received by the Lang family.

In 1953 Jackson found some fossil insects in nodules of limestone on the beach at Lyme. Such remains had not been recorded previously although the region had for so long been a hunting-ground for collectors. This, he suggested, was because "the nodules in which the fossils occur were so huge and hard that few geologists visiting the region possessed either the tools or the inclination to break them up .... I count myself lucky if I get one remains to a cwt. of limestone". In 1957 he wrote: "Now I am bothered by shortage of material as I seem to have cleared the beach and will have to rely on further cliff falls".

The insect remains were acquired by the Natural History Museum through the good offices of Dr. E.I. White. There were about 450 specimens including counterparts, and the more important of them - six species of dragonflies, of which three were new to science, a new genus and species of orthoptera and three species of beetles - were described by the late F.E. Zeuner (<u>Bulletin, British Museum (Natural History)</u>, <u>Geol</u>., vol.7, no.5). The Museum also acquired three Ichthyosaur skulls, the skeleton (headless) of a small armoured dinosaur, some fishes and a few plants. Visits by Dr. White to Dr. Lang provided opportunities for calls upon Jackson, who derived great satisfaction from them.

In 1954, with the support of three or four of those who knew him best, an application was made to the Murdoch Trust for indigent widowers and bachelors who had made significant contributions to scientific studies, and Jackson was awarded an annual grant from Trust funds. This came at a time when his health was giving some concern, and he welcomed the quite substantial addition to his hitherto meagre income, because, as he wrote, it would release him "from the most burdensome part of the load of gardening" and leave him with more time to devote to geology during the next few years or for so long as his health held out. The amount of the grant was increased some ten years later.

In 1959 his work was brought to the notice of a wide audience when Dr. W.E. Swinton, who was working on Jackson's reptilian discoveries, arranged for a B.B.C. team to make a film showing him at work, splitting a slab to reveal a fossil and conducting the party along the cliffs from which he had collected so many fine ammonites.

A continuous background to his varied locations and activities was his interest in the National Museum of Wales. Almost every year from 1915 onwards the Annual Reports of the Museum contain references to donations he made or to specimens he was, from time to time, commissioned to collect.

The donations by far outnumbered the specimens for which he received honoraria. His annual holidays took him into various parts of Wales, e.g., localities in Glamorgan, the country around Pont Erwyd, St. David's and N.W. Pembrokeshire, Aberdaron and Lleyn, and the neighbourhood of Dolgellau. Many other localities were visited because they were likely to yield material useful for comparison with rocks of corresponding ages in Wales. These included the Lizard and other parts of Cornwall, and the south of Devon, whilst in later years, when his financial position had improved, his journeys ranged father afield to the Yorkshire coast, the Isles of Eigg, Skye, Arran, Iona, the North West Highlands and Portsoy in Banffshire.

Jackson's passion for collecting was accompanied by an indifference to fatigue that was remarkable in one who never enjoyed really good health. He would undertake long journeys on foot, returning with heavy loads of specimens. Realising that the essential character and structure of rocks were not always illustrated in small hand-specimens he did not hesitate to bring back really large blocks weighing ten or fourteen pounds. Such specimens add greatly to the value of many of the display cases in the Geological gallery of the Museum.

It was only natural that he wished to retain some of the material he collected, partly because it pleased him to have it around him and partly to meet requests from would-be purchasers, but it had always been his intention to bequeath to the Museum in Cardiff what remained at his death - mainly Liassic fossils. In 1960, realising that the effects of his strenuous life and its privations were beginning to make themselves felt, he decided that he would rather let the bulk of the residue be taken to the Museum while he was still able to superintend the packing and removal. This new donation comprised some 2,000 specimens including many specially fine ammonites, brachiopods and crinoids. The most spectacular specimen was a group of Pentacrinus on a slab weighing about 2 cwts. The opportunity was taken to give publicity to the gift when the donor came to Cardiff in the following year to assist in sorting the material and it was made the subject of a news item on B.B.C. radio and television.

In 1964 he made the last of his long excursions, a second trip to Arran, which he described as "the worst fortnight of persistent rain and rough winds I ever had the bad luck to encounter". The trip disappointed him not only because he was unable to collect as much as in former years, but because it convinced him that he would be unable to undertake further journeys in difficult terrain.

In the autumn of 1965 Jackson had the misfortune to be knocked down by a car near his home, and although he did not suffer serious injury the after-effects of the accident hastened the general deterioration of his health and he decided to hand over to the Museum what still remained of his collection (about 600 specimens in all) including a number of choice fossils that he had retained for sentimental reasons. This brought the number of specimens by which he had enriched the collections to about 10,600. Many of his specimens had been arranged on shelves that he had constructed with drift wood from the local beach, and after the last batch had been taken to Cardiff he wrote: "The empty shelves, now used for apples, are dismal reminders of the days that are over". This was as near as he ever came to complaining of his lot, but his collecting days were, indeed, over.

In the following year he was often in considerable pain arising from heart and throat trouble, and stiffening joints that restricted his movements, whilst incipient cataract affected his eyes. All this made life increasingly difficult especially as he lived alone and was too independent to seek help and reluctant to accept it when offered. He died on September 29th, 1966, and had expressed the wish that his ashes should be scattered on the slopes of Carn Llidi in Pembrokeshire by a member of the staff of the Geological Department of the Museum. He directed that his capital should be equally divided between the Museum and the People's Dispensary for Sick Animals - these had been the two main interests in his life. The bequest for sick animals came as no surprise to those who knew him well for he had been a cat-lover since babyhood, and during many years of loneliness found companionship in the homeless and often ailing cats that found their way to his cottage. None was ever turned away and he often had as many as three or four at a time.

Welsh Geological Quarterly, Vol.2, no.1, pp.19-25.

DAMAGE TO PROPERTY

Dr. T.H. Whitehead (Ragleth House, Little Stretton, Shropshire), Chairman of the Geological sub-committee of the Shropshire Conservation Trust has reported to us the very disturbing news that the owner of Mary Knoll Valley (Ludlow anticline) now refuses access because of litter, cans, polythene bags, rock chippings and broken fences left by persons unknown, but believed to be geologists. To members of this Ludlow Research Group, the Ludlow anticline, including Mary Knoll Valley has a special significance and it is disastrous that access to any part of it should be expressly denied. It seems odd that part of the price to be paid for publishing details of an area enabling others to study it, is the loss of goodwill and permission of landowners because of thoughtless and irresponsible actions on the part of some visitors who, in many cases, would not have known of the localities until publication. The owners of the Darran Farm, Usk inlier, Monmouthshire, also now refuse access as a result of similar experience. A special plea is made to all members who may visit the Welsh Borderland area, alone or with parties, to do all they can to prevent this kind of offending behaviour. It seems most unlikely to have been caused by any research geologist and indeed in one case was proved to be the result of thoughtless enthusiasm by a party of school-children, but we have a duty to protect the very areas we are investigating.

From: Ludlow Research Group - Bulletin no.12, p.8, January 1965. Edited by Dr. V.G. Walmsley.

THE GEOLOGY OF PARYS MOUNTAIN

Denis Bates

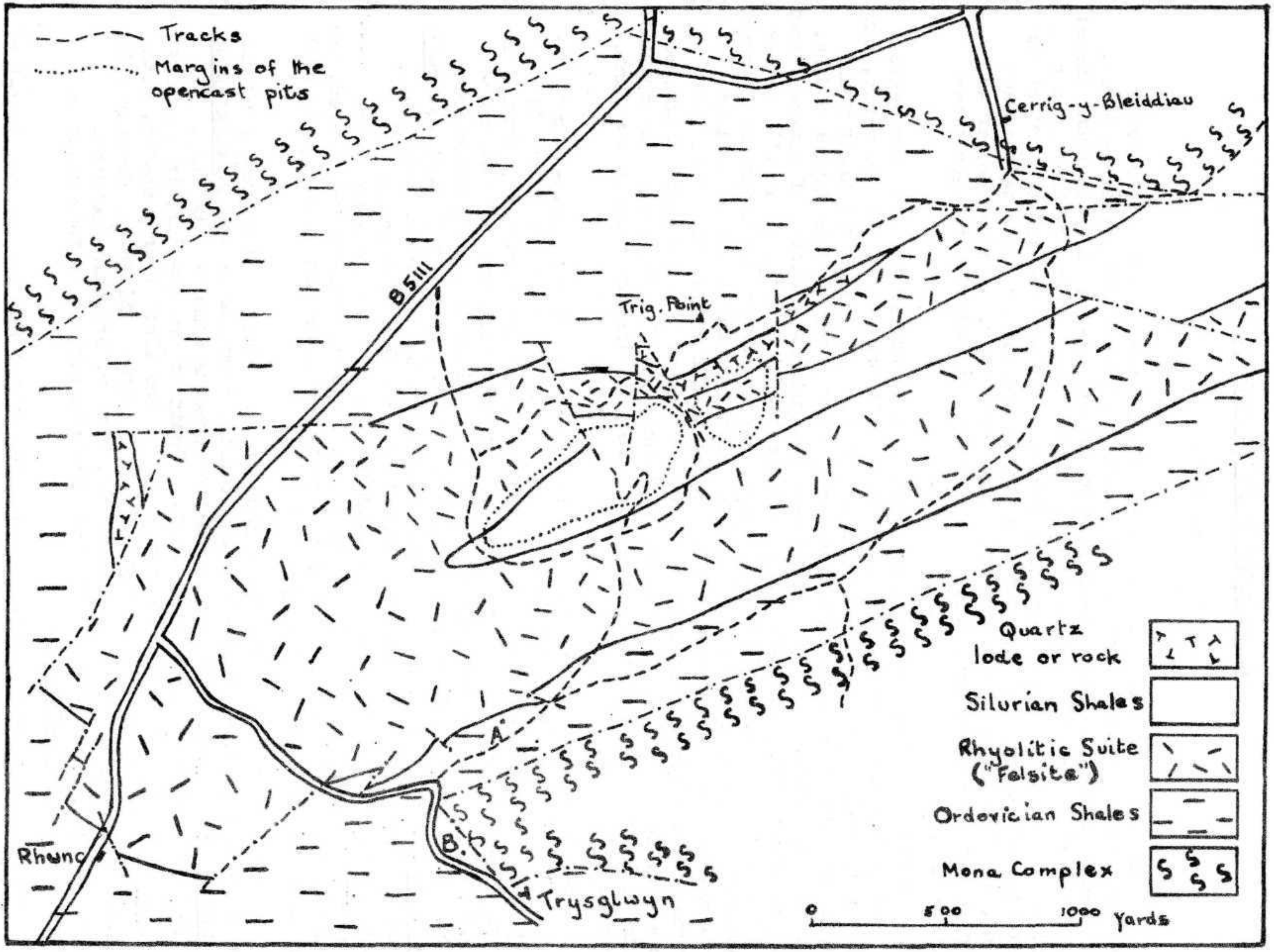
Parys Mountain lies in the north of Anglesey, a whale-back ridge aligned in an ENE-WSW direction and rising to over 500' above sea level. It became famous in the mid-eighteenth century when copper was found there; and for the space of a hundred years was the site of the richest copper mines in Europe. Mining activity declined through the latter part of the nineteenth century, as the more accessible and richer lodes were worked out, and finally ceased before the First World War, although copper and ochre were recovered from water issuing from the adits until about two years ago.

Intermittent exploration has been carried out in the past few years, first to determine the amount of copper still present in the old mines, and later to drill both beneath and beyond them. In 1957-8 the underground workings were thoroughly explored above water level by John Taylor & Sons, Mining Engineers, London. In 1961-2 Northgate Exploration of Canada formed a subsidiary Company, Anglesey Copper Mines (U.K.) Ltd., to drill a series of holes to the north of the old mines, but abandoned the programme to concentrate their activities on deposits which they had found in Ireland. A few months ago another company, the Canadian Industrial Gas & Oil Ltd., commenced drilling, hoping to complete and extend the Northgate programme. However, in spite of the extensive workings, and exploration on the mountain its geology is incompletely known, and there is disagreement on its fundamental structure.

The topography of the mountain is determined by a hairpin-shaped outcrop of hard rock, with the bend of the pin to the west, described by Greenly as a felsite. The rock contains a sheeting structure, dipping in both limbs at about 60° to the north. Greenly believed the rock to be a thick sill, intruded into the Ordovician and Silurian shales which form the country rock. However, cores from the Northgate bores (Hawkins, Bull. Geol.Surv., in press), and the appearance of some of the less altered surface outcrops, show that the "sill" is a complex of extrusive(?) rhyolites, rhyolitic tuffs and autobrecciated rocks, with some interleaved shales. Much of the suite is silicified, cleaved and sheared, and the sheeting structure is determined by the cleavage and shearing, as well as original banding or bedding.

To the north and west of the mountain are cleaved blue-grey, grey and grey-green shales, which contain graptolites from low in the Didymograptus bifidus zone (Lower Ordovician), and the igneous complex (the Parys Formation) apparently rests on these. South of the complex, in a narrow belt between it and the Pre-Cambrian rocks, are similar grey shales, with a fauna of poorly preserved graptolite fragments. Elles (in Greenly 1919, p.482) believed them to be monograptids, but Dr. Strachan (personal communication) has described them as unidentifiable, and they could be fragments of Didymograptus.

Silurian shales lie between the limbs of the rhyolite in the "core" of the mountain, but the nature of the contact between the two rocks is unknown. These shales are blue-grey to grey in colour, banded with very fine



Geological sketch map of Parys Mountain, Anglesey.

siltstones, and worm-burrowed in part; cleavage is strong and they are partly silicified to a blue flinty rock in which the cleavage is completely healed up.

Three main interpretations have been proposed of the structural relationships between the rocks. Manning (1959) interpreted the shales as being in a simple overturned succession younging south, with the Parys Formation as a gigantic forked dyke intruded in two structural horizons. Greenly (1919) believed that the Silurian shales in the "core" of the mountain lay in a syncline, and that the southerly outcrop of the rhyolite contained an anticlinal fold, with the shales to the south forming part of the inverted limb. The third interpretation, which is put forward by the writer, is that the rhyolites are disposed in a simple syncline, with the Silurian shales in the core, and Lower Ordovician shales cropping out on both the north and south slopes of the mountain beneath the igneous suite.

The Silurian shales in the opencast pits show evidence of strong folding, probably synclinal; in the west pit there are synclinal folds exposed at both ends. The banding in the rhyolitic suite at the west end of the mountain also indicates a possible synclinal fold, as it swings round parallel to the contact between the suite and the Ordovician shales.

A more positive proof would be afforded by the collection of more fossils from the southerly shales, in order that their age may be settled. Greenly's specimens came from the shales on the southerly scarp, 330 yards north of Trysglwyn (Locality A), and from an old quarry by the road 200 yards WNW of Trysglwyn (Locality B). Extensive search by the writer has so far proved fruitless, but further search, particularly by a number of people, may be rewarded by the solution to the problem.

In the sketch map no attempt has been made to differentiate between proven and inferred boundaries; much of the mountain is covered by spoil heaps, and the lower ground by drift. A good excursion may be made by taking the minor road to the south side of the mountain, just north of Trysglwyn, and making a traverse from there back to the main road via the opencast pits.

References

GREENLY, E. 1919. The Geology of Anglesey. Memoir of the Geological Survey of England and Wales, Volume 11.

MANNING, W. 1959. The Parys and Mona Mines in Anglesey. In: The future of non-ferrous mining in Great Britain and Ireland: a symposium, 313-328. The Institution of Mining and Metallurgy.

NEWS AND NOTES

G.C.E. RESULTS IN GEOLOGY FOR 1965

	A level			O level		
	Entries	Passes	% Passing	Entries	Passes	% Passing
Cambridge	147	99	67.3	522	342	65.3
J.M.B.	521	373	71.6	1,289	768	59.6
Oxford	130	104	80.0	996	695	69.7
Oxford and Cambridge	126	94	74.6	602	371	61.6
London	272	176	64.7	719	394	54.9
Southern	-	-	-	152	121	79.5
Associated Examining Board	6	6	100	28	11	39.3
W.J.E.C.	276	213	77.2	671	400	59.6
TOTALS	1,478	1,065	76.5	4,979	3,102	61.2

A GEOLOGICAL COLUMN LEAFLET

A year or so ago Dr. R.M.C. Eagar of Manchester Museum prepared a coloured pamphlet illustrating the geological column. It contains six panels illustrating: The chief divisions of geological time; The evolution of animal life; Some stages in the course of plant evolution, with special reference to Britain; Climate and the nature of the rocks ...; Earth movements and phases of igneous activity ...; A comparison of thicknesses of sediments and their age as determined by radioactive minerals. The pamphlet, which sells at 1/6d, has proved to be extremely popular: the printer (Richard Bates, Southmoor Road, Wythenshawe, Manchester 23) has already distributed 24,000 copies.

NEW FIELD CENTRE IN WALES

The Field Studies Council have received a gift of £25,000 from the Worshipful Company of Drapers to mark the sexcentenary of the Drapers' first charter. The money is to be used to found a field centre in the Conway valley a mile from Bettws-y-Coed. A house has already been purchased and work is going ahead so that students may be accepted in 1966.

Nature in Wales. Vol.9, no.4, 1965, pp.248-249.

CHALLENGE ON EVOLUTION

A 24-year-old schoolteacher in the Southern state of Arkansas, Mrs. Susan Epperson, has filed a suit challenging the state law prohibiting the teaching of evolution in schools.

The hearing which opened yesterday, has awoken echoes of the famous 'monkey trial' of 1925, in which Clarence Darrow argued against William Jennings Bryan in defence of John T. Scopes, a schoolmaster accused of defying Tennessee's anti-evolution statutes.

Yesterday's hearing in Little Rock was a marked contrast in style to that which took place 40 years ago in Dayton, Tennessee, and which later formed the basis for the film 'Inherit the Wind'. The judge repeatedly refused to allow the State Attorney-General to ask any questions bearing on Mrs. Epperson's own religious beliefs and ruled as irrelevant any discussion, requested by the state, of the validity of evolution theories.

Mrs. Epperson rested her case on the fact that the current law infringed her constitutional rights of free speech. Arkansas, Mississippi and Tennessee are the only states still to have anti-evolution laws on their statute books.

The Observer, 3rd April, 1966.

HYDROGEOLOGY

The Institute of Geological Sciences recently introduced a new series of "Hydrogeology Reports". The first publication in the series is the "Hydrogeology of the Bunter Sandstone in Nottinghamshire" by D.H. Land and published by the Natural Environment Research Council.

A PROPOSED ASSOCIATION OF GEOLOGY TEACHERS

As a result of the survey now being carried out by the British Association Section C Subcommittee, it appears that there is very good support for the proposal to form an association of teachers of geology in the schools (and colleges) of the United Kingdom. Of the 930 questionnaires sent by post, 419 have been completed and returned of which 370 are favourable. Some 140 of the teachers who replied have submitted a total of over 200 additional names of people who might be interested. Replies are still being received and the total of people in support is confidently expected to exceed 400. Preliminary work has already commenced on the organizing of a conference on the teaching of geology which will be held in a conveniently placed university next year and at which it is hoped that the association of teachers of geology will be formed. Further information giving final details will be made available in the New Year.

INTELLIGENCE-TEST SCORES

In an age group of the population of the U.S.A. numbering about 2,400,000 there arises an annual crop of about 8000 Ph.D's in all fields, the physical and biological sciences together comprising about half the total. Taken by fields, the variation is as follows:-

Physics	140.3	Social sciences	132.0
Mathematics	138.2	Natural sciences	131.7
Engineering	134.8	Chemistry	131.5
Geology	133.3	Biology	126.1
Arts and humanities	132.1	Education	123.3

(Figures taken from: "The high school backgrounds of science doctorates" by L.R. Harmon. Science, 133, 1961, p.679.)

GEOLOGICAL SURVEY IN THE SOUTH-WEST

A five-year geological survey in south Devon is to be made for the new Geological Sciences Institute by the Department of Geology at Exeter University. The department have received a research contract from the Natural Environment Research Council.

The project arises out of an approach by Professor Scott Simpson, head of the geology department, to the Geological Survey of Great Britain, now incorporated in the institute.

He suggested the devising of a scheme for postgraduate students to work under the joint supervision of the university and survey. This would enable the survey to get to know promising young men whom they might wish to recruit later into their organization.

Six research assistants, each working for a three-year period, will be employed by the geology department. The project involves not only the production of a one-inch geological map but also investigations into fundamental geological problems.

The Times, 11th August, 1966.

A CENTENARY

Memoirs of the Geological Survey of Great Britain, and of the Museum of Practical Geology, Vol.111. The Geology of North Wales, by A.C. Ramsay, F.R.S., with an Appendix on the Fossils, by J.W. Salter, A.L.S., F.G.S. 8vo. pp.381; Plates 28. (Longmans & Co.) [1866]

This long promised Work will be heartily welcomed, more especially by those geologists whose affections centre chiefly in Palaeozoic rocks, and who are perhaps of opinion that the exploration of newer geological territories has of late years occupied somewhat exclusive attention. At the same time, however, the work before us will be scanned with interest by those who are so eager in their enquiries into the causes which have given rise to the contour of the land. Its appearance cannot fail to remind us of one, now alas! no more, whose ability, joined to his enthusiasm, few could rival - the late Sir Henry De le Beche. Under his direction the survey of North Wales was begun, and so many years have elapsed since then, that those of his associates who at that time were comparatively young as geologists, have now come to rank among our most eminent experts. Those to whom the greater share of the work in North Wales fell, are Professors Ramsay and Jukes, and Messrs. Aveline and Selwyn.

The beautiful maps, of which this memoir is descriptive, have long testified to the great labour and the admirable skill employed in their construction. The careful delineation of the chief rock-divisions in a profoundly faulted and contorted region must always be tedious and difficult, but when, in addition to this, there are innumerable beds and masses, of volcanic and metamorphic origin, - many of them of singularly erratic character, - to be defined upon the map, perhaps only those who have had a like task to perform can appreciate the degree of mental and bodily fatigue involved. As an example of the skill with which the disjointed strata have as it were been pieced together, we might instance the recognition of the felstones and ashes of the wild Snowdonian district as the equivalents of the Bala limestone beds. The numerous sections and copious details supplied in the memoir in regard to this point, amply bear out the conclusions expressed on the large 'six-inch' sections of the Survey, which have now been before the public for some years.

Extract from: Review of Ramsay's Memoir in The Geological Magazine, Vol.111, 1866, pp.558-559.

GETTING DOWN TO OIL - FILM

Sound, colour; 21 minutes for part 1, 19 minutes for part 2. (Shell Film Unit; free loan from Shell International Petroleum Co. Ltd., Shell Centre, London S.E.1.)

Reviewed in Discovery, May 1966, pp. 65-66.

CHEMISTRY ON THE RED SEA FLOOR

Oceanographic exploration is revealing an increasing number of peculiarities about the Red Sea which, to all appearances, is an incipient ocean in the process of formation.

The latest find, made with the RV Atlantis 11 and now reported in Geochimica et Cosmochimica Acta (Vol.30, p.341), is of sedimentary deposits rich in iron and other heavy metals in deep "hot water holes" on the floor of the Red Sea.

The hot water holes - depressions extending down to some 2000 m below the surface - were reported by teams on several research vessels operating in the Red Sea in 1964. In one of them, the Atlantis 11 Deep, water temperatures reach 56° C and the salt concentrations are some 10 times greater than normal sea water values. These hot, dense brine concentrations are also weakly acidic.

Last year A.R. Millar and his colleagues of Woods Hole Oceanographic Institute took core samples from the sediments lining the Atlantis 11 Deep. They obtained a black ooze, magnetic when dry, which was largely composed of iron oxides - up to 80 per cent in some samples. Zinc also occured in concentrations up to about six per cent, and copper to about one per cent. The brine in the holes contained 1000 to 50,000 times the normal concentrations of dissolved zinc, copper, iron and manganese. The size of these iron-rich deposits has not yet been determined.

There appears to be a clear-cut relationship between the mechanism that concentrates the salt and the deposition of the heavy metals. The researchers suggest that the acidic brines, which are without oxygen, react with normal, weakly alkaline, oxygenated Red Sea water to deposit the metals as sulphides and oxides. The brine, they believe, may arise by the solution of salt beds underlying the Red Sea and be heated by the submarine release of hot water from sources of unknown origin which might well be connected with ocean-forming processes now going on beneath the floor of the Red Sea. The resulting chemistry is of considerable interest as there is here a geochemical factory in which nature is still producing ore.

New Scientist, 14th April, 1966, p.107.

MORE ABOUT MARY ANNING

Geological history repeats itself in the discovery by a schoolgirl of a fossil head of the prehistoric reptile Ichthyosaurus at Charmouth. .... It was on this stretch of the Dorset coast that another girl, Mary Anning, found the first skeleton of an Ichthyosaurus in anything like a complete condition. Her father, a cabinet maker, used to take her fossil-hunting along the beach and cliff at Lyme Regis.

One day, after her father's death, a visitor offered Mary half-a-crown for an ammonite she had just tapped out on the beach, and the girl geologist saw at once that here was a solution to the family's financial worries. She began collecting and selling fossils, which were displayed alongside the fresh fish in her mother's shop, and, soon afterwards, found the Ichthyosaurus specimen, which the lord of the manor bought for £25. This particular fossil has since been lost, but Mary had hardly started. Tales of her fossil discoveries reached London and distinguished geologists began the pilgrimage down to Lyme. By 1848 the president of the Geological Society could include an obituary and appreciation of her work in his annual address.

Extract from: The Times, 9th September, 1966.

GEOLOGISTS' ASSOCIATION - SOUTH WALES GROUP

1966-1967

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Welsh Geological Quarterly ; Editor, D.A. Bassett, Ph.D.
Assistant Editor, J.N.M. Firth, B.Sc.

ANNUAL REPORT

Session 1965-1966

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

9th October, 1965. (Cardiff)	"Geology and Geologists in Wales and the Welsh Borderland" - Dr. D.A. Bassett, National Museum of Wales.
6th November, 1965. (Swansea)	"The Lower Swansea Valley Project" - Mr. W.B. Walker, University College, Swansea.
11th December, 1965. (Cardiff)	"Aspects of the geomorphology of Western U.S.A." - Professor T.N. George, The University, Glasgow.
15th January, 1966. (Swansea)	Members' Meeting: "Minerals of Glamorgan" - Mr. J.N.M. Firth, Midland Silicones Ltd., Barry. "Staining carbonate minerals" - Mr. J.A. Dixon, U.C. Cardiff. "Minerals and x-rays" - Dr. J.I. Langford, U.C., Cardiff.
5th February, 1966. (Cardiff)	"Landforms and scenery in Western Canada" - Mr. T.M. Thomas, M.H.L.G., Welsh Office, Cardiff.
12th March, 1966. (Swansea)	Eighth Annual General Meeting. "The personality of geology" - Mr. D.J.W. Thomas, Canton High School for Boys. (Chairman's Address.)

2nd April, 1966.	Field visit - "Periglacial landforms of the Brecon Beacons" - Mr. Colin Lewis, University College, Dublin.
23rd April, 1966.	Field visit - "The succession in the basal Coal Measures between Abercrave and Aberdare" - Mr. T.R. Owen, University College, Swansea.
7th May, 1966.	Field visit - "Geology of the Chepstow, Beachley, Severn Bridge and Monmouth areas" - Professor J.G.C. Anderson, University College, Cardiff.
8th-9th October, 1966.	Week-end excursion to the Ludlow-Wenlock Edge district. Dr. V.G. Walmsley, University College, Swansea.

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