

## NOTICES OF MEMOIRS.

*Abstracts of Papers read in Section C (Geology), Meeting of British Association, Birmingham, September 10–17, 1913.*

1. ON VARIOUS OCCURRENCES OF PILLOW LAVAS IN NORTH AND SOUTH WALES. By A. HUBERT COX, M.Sc., Ph.D., F.G.S., and Professor O. T. JONES, M.A., D.Sc., F.G.S.

Pillow lavas were described from four localities, viz. :—

- (a) Strumble Head, in Pembrokeshire.
- (b) Cader Idris, in Merionethshire.
- (c) Sarn Mellteyrn, near Pwllheli, Carnarvonshire.
- (d) Careg, 2 miles N.N.W. of Aberdaron, Carnarvonshire.

(a) Strumble Head (A. H. Cox).—References were made particularly to the work of Reed and Elsdon. The rocks were formerly regarded as intrusive, and were described as of composite characters and possibly of later date than the main folding.

Variolitic rocks were described by Reed, who referred to the 'pillow structure' as 'spheroidal jointing'. The whole mass appears to consist largely of highly vesicular, basic flows, some with well-developed pillow structure, others showing transitions to non-pillowy types. Abundant chert occurs in association with the lavas, particularly those showing pronounced pillow structure. The most perfect pillows vary from a foot to 18 inches in diameter, and consist of typical spilites, with thin, rod-like feldspars of refractive index about 1·542, corresponding to oligoclase—the rocks are considerably decomposed, especially to calcite, chlorite, and epidote.

Among the above rocks are ophitic diabases, showing marked columnar jointing, which may in part represent sills.

(b) Cader Idris (A. H. Cox).—A thick band of pillow lavas forms the highest point of the Cader Idris range, and then strikes W.S.W. Its distribution is described in detail, and reference is made to the work of Ramsay and Geikie. A comparison of these rocks with those of Strumble Head discloses certain differences, especially in their uniformly less vesicular character and smaller amount of associated chert. Under the microscope the rock shows the character of a typical spilite; both rod- and lath-shaped feldspars occur, the former being oligoclase, the latter somewhat richer in soda (refractive index below 1·541). The rock is considered to resemble most closely that of Mullion Island. In close association with it is the 'Eurite' (soda-granophyre) of Cole and Jennings. These lavas appear to occupy a stratigraphically higher horizon than the beds which yielded *Didymograptus bifidus* and *D. murchisoni* to Lake and Reynolds. The detailed examination of the area is still incomplete.

(c) Sarn Mellteyrn (O. T. Jones).—References were made to the work of various authors, viz. Ramsay, Harker, Raisin, Elsdon, Matley.

The rocks are exposed by the roadside three-eighths of a mile south-west of Mellteyrn Church, where 10 to 12 feet of typical pillow lavas overlain by a similar thickness mainly of non-pillowy rocks of allied characters are followed by flinty mudstones and micaceous shales.

The spaces between the pillows are occupied by closely-jointed dark-grey chert. The sediments dip to the east at a moderate angle, and probably pertain to the lower part of the Arenig. The pillow lava is finely vesicular and considerably decomposed; the felspar is oligoclase and forms lath-shaped microliths. From its structure and mineralogical character the rock is referred to the spilitic suite.

(d) Careg, near Aberdaron (O. T. Jones).—These rocks have been described in detail by Raisin, and the pillow structure noted as ‘spheroidal structure’. The present notes are intended to supplement that description in certain respects.

The pillow structure is seen near Careg quarries and near the coast; individual pillows have a length of about 2 feet, and are composed of a fine-grained rock with small vesicles. The felspars have the extinction-angle and refractive index of oligoclase-albite, and are highly charged with decomposition products. These rocks are undoubted spilites, and were claimed as such by Dewey and Flett; they are associated with ‘limestones’ of a peculiar character, together with beds and strings of jasper, which in places wrap round the pillows in the same manner as the chert near Sarn. The association of that rock with a pillow lava may perhaps be regarded as confirming Greenly’s suggestion that the jaspers of Anglesey were originally cherts. The associated rocks at Careg have an extraordinarily complicated structure, and probably belong to the pre-Cambrian.

2. CRITICAL SECTIONS OF THE CAMBRIAN AREA CALLED THE CWMS IN THE CARADOC-COMLEY REGION OF SHROPSHIRE. By E. S. COBBOLD, F.G.S.

THE work of excavation of critical sections in the Cambrian rocks of Shropshire has been continued by the writer at intervals during the past year, and has furnished palæontological proofs of the prolongation of the Lower and Middle Cambrian rocks of Comley into the Cwms area to the south. The sections opened up confirm and amplify those excavated in previous years.

Excavation No. 53 supplies details of the upper portion of the Wrekin Quartzite and the lowest part of the Lower Comley Sandstone, near the base of which three fossiliferous bands are found, yielding species provisionally referred to *Kutorgina*, *Hyolithus*, *Hyolithellus*, and *Archæocyathus*.

Excavation No. 54 exhibits a section of the junction of the Middle and Lower Cambrian beds, which is very closely comparable with those of the Quarry Ridge at Comley.

The beds in descending order are as follows:—

e. Shale with Grit Bands = The Quarry Ridge Shale, top not seen	ft.
	4
d. Hard, ringing, glauconitic Grit = The Quarry Ridge Grit	28
c. Conglomerate = The Quarry Ridge Grit, conglomeratic portion	9
b. Dark Grey, Purplish, and Red Limestones = The Black, Grey, and <i>Olenellus</i> Limestones of Comley	about 4
a. Green, Micaceous Sandstones, with spotted bands = The Lower Comley Sandstone; base not seen	10

The conglomerate *c* is plentifully charged with fragments of the Black and other Lower Cambrian Limestones, and it is now proved for the first time that the Black Limestone must be grouped with the Lower Cambrian.

The surface of the solid Black Limestone is coated with a phosphatic(?) skin, and a similar deposit in the Comley Quarry has within the last two or three years yielded recognizable fragments of *Paradoxides* sp. and *Dorypyge Lakei*, Cobbold. The black skin must, therefore, be regarded as the lowest deposit of the Middle Cambrian age that is known in the district.

Among the numerous fossil fragments that occur in the Lower Cambrian Limestones of this excavation the following have been identified: *Anomocare* (?) *pustulatum*, Cobbold, *Callavia Callavei*, Lapworth (?), *Microdiscus Atileborensis*, S. & F., sp., *Protolenus* sp., *Kutorgina* sp., *Linmarssonia* (?) sp.

Excavation No. 55 exhibits a faulted junction between the Middle and Lower Cambrian, the hard, ringing Grit (beds *d* above) being brought into contact with the Green, Micaceous Sandstone (beds *a* above).

Excavation No. 56 proved the existence of both the Quartzite and the lower part of the Lower Comley Sandstone at another point in the area.

A section constructed embodying the results of these excavations provides evidence that the Lower Comley Sandstone has a thickness of about 480 feet.

3. *ESTHERIA* IN THE BUNTER OF SOUTH STAFFORDSHIRE.<sup>1</sup> By T. C. CANTRILL, B.Sc., F.G.S.

RECORDS of fossils in the British Bunter are few in number, and some are open to doubt in respect either of their organic character or of the stratigraphical position of the beds that yielded them. Omitting those cases where the horizon formerly supposed to be Bunter has been corrected later and is now accepted as settled, the following appears to be a complete list, in chronological order of their discovery:—

1. *Dictyopyge catoptera* (Ag.), a small fish, from Rhone Hill, 3 miles south-east of Dungannon, co. Tyrone. Upper Bunter (f<sup>3</sup>). With this was associated *Estheria portlocki*.

2. 'Annelid tracks' at Hilbre Point, Wirral, Cheshire. Lower part of the Bunter Pebble Bed (f<sup>2</sup>).

3. Plant-remains, referred to *Schizoneura paradoxa*, Schimper and Mougeot, at Sneinton Vale, near Nottingham. Uppermost bed of the Bunter Pebble Bed (f<sup>2</sup>).

To these three older records can now be added the following new discovery<sup>1</sup>:—

4. *Estheria* cf. *minuta* (Alberti), from Ogley Hay, near Walsall, South Staffordshire. Bunter Pebble Bed (f<sup>2</sup>).

<sup>1</sup> Communicated by permission of the Director of the Geological Survey.

These fossils were discovered in May, 1911, when Mr. C. H. Cunningham and I were mapping the Triassic rocks bordering the eastern side of the coal-field. I suggested to my colleague that if fossils could be found anywhere in the Bunter they would most likely be discovered in the thin marl-bands occasionally interbedded in the predominant sandstones and conglomerates; and Mr. Cunningham's hammer was the first to reveal the specimens.

We obtained them from two thin bands of red marl in a disused sand-quarry at Ogle Hay, 5 miles north-east of Walsall. The quarry forms a conspicuous excavation in the northern face of a sandstone hill, along the foot of which passes the Anglesey branch of the Wyrley and Essington Canal. The hamlet of New Town, on the Watling Street, lies 150 yards to the north of the quarry, while Ogle Hay Chemical Works stands 200 yards away to the south-east. Below a little drift gravel are exposed 22 feet of dull-red medium-grained soft sand-rock, in places false-bedded. Toward the bottom are two bands of red marl, about 1 ft. 8 in. apart, the lower one being about 2 feet above the bottom. They nowhere exceed 9 inches in thickness. Both marl-bands yielded poorly preserved remains, determined by Mr. H. A. Allen as *Estheria* cf. *minuta* (Alberti).

The ground is coloured on the old series 1 inch map (62 N.E.) as Upper Bunter (f<sup>3</sup>); but the sandstones are coarser and duller in colour than the typical Upper Bunter of other Midland districts, and would more suitably be included in the outcrop of the Pebble Beds (f<sup>2</sup>). The Triassic series dips at 3° to 5° toward E.N.E., in which direction the Pebble Bed subdivision appears to pass laterally into, and partly beneath, finer-grained and brighter-coloured sandstones that may be regarded as Upper Bunter. Above these follows the Lower Keuper Sandstone (f<sup>5</sup>). There is thus no question as to the beds in the quarry being Bunter, and every ground for referring them to the Pebble Bed subdivision.

4. THE RELATION OF THE RHIWLAS AND BALA LIMESTONES AT BALA, N. WALES. By Dr. GERTRUDE L. ELLES.

THE difficulties in the interpretation of the succession in the Bala district appear to be due largely to the impersistent nature of the limestones and their inconstancy as to horizon.

The succession is as follows:—

HIRNANT SERIES	{	Hirnant Limestone (impersistent). Hirnant Flags and Mudstones. Rhiwlas Limestone (impersistent). Bala Limestone (impersistent). Calcareous Ash. Mudstones. Coarse Ash.
BALA LIMESTONE SERIES	{	Mudstones and flags with thin impersistent Limestones. Ash. Sandy flags, with occasional impersistent Limestones. Ash. Sandy flags becoming shaly towards base.

The Rhiwlas Limestone is an impersistent limestone at the base of the Hirnant Series, and is found only in the northern part of the

area. The Bala Limestone is not developed as a calcareous bed in the northern part of the area, but is somewhat more persistent as a definite band in the southern and eastern portions of the district. The true relations of these horizons to each other is seen in the type section at Gelli Grin, where the Bala Limestone at its maximum thickness is overlain by light-coloured, pasty mudstones containing a typical Rhiwlas Limestone fauna. The fauna is not nearly so rich in individuals as that of the Rhiwlas Limestone itself, but all the more important genera and species seem to be represented. Confirmatory sections are also seen east of the fault near Gelli Grin Farm, and also on Bryn Cut.

5. THE SHELLY AND GRAPTOLITIC FAUNAS OF THE BRITISH ORDOVICIAN. By DR. GERTRUDE L. ELLES.

THESE are two main types of 'shelly' faunas of Ordovician age in the British Isles, and each of these can be further subdivided into a number of sub-faunas which can be correlated by reference to associated graptolite-bearing beds.

ORDOVICIAN FAUNAS.

Graptolitic Graptolite Zones	Shelly	
	A	B
Zone of <i>Cephalog. acuminatus</i>	Staurocephalus fauna	Staurocephalus fauna
Zone of <i>Dicellog. anceps</i>		Exotic fauna . 4
Zone of <i>Dicellog. complanatus</i>	Calymene plani-marginata fauna with sub-faunas (a) Chasmops; (b) Asaphus Powisi	Exotic fauna . 3
Zone of <i>Pleurog. linearis</i>		
Zone of <i>Dicranog. clingani</i>		
Zone of <i>Climacog. Wilsoni</i>		
Zone of <i>Climacog. peltifer</i>	— — ? — —	Exotic fauna . 2
Zone of <i>Nemag. gracilis</i>	Ogygia Buchi fauna with Asaphus tyrannus sub-fauna	
Zone of <i>Glyptog. teretiusculus</i>		Exotic fauna . 1
Zone of <i>Didymog. Murchisoni</i>	Placoparia fauna	
Zone of <i>Didymog. bifidus</i>		
Zone of <i>Didymog. hirundo</i>	Ogygia Selwyni fauna	
Zone of <i>Didymog. extensus</i>		
Zone of <i>Dichograptus</i>		

The main shelly types may be described as—

- A. Asaphid-Trinucleid-Calymenid fauna.
- B. Cheirurid-Lichad-Enerinurid fauna.

Evidence suggests that fauna B is an exotic fauna, possibly southern in origin, which migrated into the British area. Becoming early established in South Scotland, it soon spread west into Ireland, but did not dominate the whole British area till Ashgillian times.

#### 6. THE BASAL CARBONIFEROUS BEDS AT LYE, IN SOUTH STAFFORDSHIRE.

By W. WICKHAM KING, F.G.S., and W. J. LEWIS, B.Sc.

IN the GEOL. MAG., Dec. V, Vol. IX, p. 437, 1912, we announced (*inter alia*) that purple beds of Lower Old Red age existed at Saltwells. Since then we have ascertained that 2 miles to the south, at Lusbridge Brook, Lye, below the Thick Coal, Carboniferous beds are exposed for a thickness of nearly 400 feet as against about 200 feet at Saltwells. These basal beds are difficult to interpret.

The succession below the Thick Coal in Lusbridge Brook is thus : (a) Various Clays and Coals, 280 feet; (b) Conglomerate, 27 feet; (c) Red Clays (Plants) and White and Yellow Clays, in which are embedded many pieces of quite unworn Cherts, and at base Limestone Grits and a Conglomerate, thickness 40 feet; (d) White, Red, and Yellow Clays. (d) is only exposed for about 30 feet. Total below Thick Coal, 377 feet. Mr. F. G. Meachem has kindly given to us data proving that the beds down to the base of (b) are the same thickness in the Freehold Pit, Lye, and that there, below (b), they pierced Red Marls for 150 feet.

The interesting zones are those in which the Limestone Grit and Cherts occur. Broken fossils occur in the Limestone Grit, which is made up largely of angular pieces of Limestone. In the Conglomerate (b) a pebble 18 inches in diameter of highly calcareous grit containing *Calamites varians* has been found, which is probably another type of this Limestone Grit. A precisely similar calcareous grit was found in situ at or below (b) in the Freehold Pit, and above (c) a nearly similar type occurs in the form of gigantic slabs 2½ feet thick in the Lye Cemetery.

The Cherts contain many casts of fossils, but they are so imperfect that we hesitate to name them. We found in the clays (c) a minute fragment of a Brachiopod with a straight hinge-line.

Pebbles of (*inter alia*) Limestone Grit and Cherts occur in the Conglomerates.

The Limestone Grits, Cherts, and Clays at Lye are such as might be laid down in the vicinity of a shore-line and there disintegrated in situ. In several respects they resemble the Rush Conglomerates of Lower Carboniferous age in Ireland. Compare Q.J.G.S., vol. lxii, p. 285.

In the Conglomerates there is distinct evidence of Inter-Carboniferous denudation which removed in places, as at Saltwells, the Coal-measure Ironstone (*Neuropteris*), Coal Seams, Grey Limestones, Limestone Grits, and Cherts.

In Q.J.G.S., vol. lv, p. 123, 1899, Mr. King showed that all the pebbles in the Permian Conglomerates of the Severn Basin are referable to a local source, except only those of Lower Carboniferous age. The last-mentioned pebbles contain *Syringopora* and *Caninia*.

Some of the pebbles that he regarded as of Lower Carboniferous age are identical lithologically with the Limestone Grits and Cherts now found at Lye.

In Permian times the Lower Carboniferous Rocks provided, from original and derivative local sources, much of the material in the Permian Calcareous Conglomerates.

7. THE DEVELOPMENT OF THE MIDLAND COAL-FIELDS. By FRED. G. MEACHEM, M.E., F.G.S.

GREAT advances have been made in mining since the first meeting of this Association in Birmingham in the year 1839. Women were then employed in the mines, also children under 10 years of age, and all worked twelve hours or more in the pit. To-day women are not allowed to work in a mine, and no youth under 14 years, and the hours of labour are restricted by Act of Parliament to eight per day. Nearly all the mines worked in 1836 were shallow ones, and the output not more than 200 to 300 tons per week. The area of the coal-fields was about as shown below, as against the present known and concealed areas of coal.

Year.	South Staffs.	Leicester.	Warwick.	Salop.	Total square miles.
1836 . .	70	20	10	20	120
1913 . .	360	88	222	96	766

This last calculation includes the concealed coal-field between Chasetown, Aldridge, and West Bromwich on the west and the Warwickshire and Leicestershire Coal-fields on the east, and also the concealed coal-field between Cannock, Essington, and Stourbridge on the east of the Coalbrookdale and Forest of Wyre Coal-fields on the west.

The output since figures are available is as follows :—

Year.	South Staffs.	Leicester.	Warwick.	Salop.	Total in million tons.
1865 . .	10	1½	¾	1½	13½
1912 . .	7½	2½	4½	½	15½

This shows a great advance in industrial conditions and in Economic Geology, but the question of output does not show so great an increase; this I think is due, not to fear that the concealed coal-fields would not be profitable, but to the fact that some of the deeper mines have not proved remunerative. This is partly due to local conditions in the mines and also to the fact that the deeper coal costs more to get than the shallow coal, as regards actual working cost and the greatly increased capital needed, whilst the coal from both mines is sold in the same market, so that the shallow mine rules the selling price. As a few years pass by, and probably before the next meeting of this Association, the shallow mines will be exhausted, and the prices will be ruled by the deeper mines, with the usual economic results of increased prices in proportion to increased costs to get.

In the figures above, areas are included which were not thought of in 1836, but, as is fully shown by the report of the last Royal Coal Commission, 1905, coal will undoubtedly be found in the areas above named. The area between the South Staffordshire Coal-field and the Leicestershire and Warwickshire Coal-field will be found to be



one continuous coal-field, with its deepest part at Lichfield, Sutton Coldfield, and Coleshill, but the basin rising to the south as a whole, the thick coal of Sandwell and Hamstead will split up into two or three seams, and under these conditions will be worked Longwall, with better commercial results. The area between the Staffordshire Coal-field and Shropshire has been most vigorously investigated, and the proofs at Colwich, Huntingdon, Essington, Four Ashes, and Baggerridge show that this area is going to be rich in coals of good quality and laid down under conditions that will allow of remunerative working.

On the Shropshire side very little has been done to extend that coal-field to the west of either the Coalbrookdale or the Forest of Wyre Coal-fields; the edges of the Old Red Sandstone preclude any hope of extension, but in the Highley and Kinlet and Billingsley area it is most probable that future deeper sinkings will prove deeper coals than the two seams at present working, whilst the area to the east is full of promise. As soon as the Severn Valley Fault, which is some 300 to 400 yards downthrow east, is crossed, a new coal-field will be found, and I think the area between here and the old coal-field will be divided into two basins, with a Silurian anticline between them as proved by the Claverley boring.

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8. ON THE OCCURRENCE OF A WIND-WORN ROCK-SURFACE AT LILLESHELL HILL, SALOP, AND OF WIND-WORN STONES THERE AND ELSEWHERE. By FRANK RAW, B.Sc., F.G.S.

**L**ILLESHELL HILL, lying some  $5\frac{1}{2}$  miles north-east of Wellington, and extending north-east and south-west, is a 'hogsback' of Uriconian, and is largely bare rock. The exposed rock of its south-east side consists towards the north-east of very hard hälléfintas, interstratified with somewhat softer tuff, and to the south-west of this and opposite the Monument of still harder felsite conglomerate and grit.

Practically the whole of this rock-surface has been ground smooth and, where hardest, has been highly polished, the smooth surface being traceable everywhere except where it has obviously been removed by weathering or quarrying. The surfaces of projecting masses of the conglomerate are perfectly fresh, being ground smooth, deeply fluted, and polished as by wind-blown sand, the radiating flutings showing the paths of escape of the prevalent wind. To the north-east the rock-surfaces have been much more even, perhaps based on a previously glaciated surface, and the flutings are parallel and in that direction less and less highly inclined, till at the north-east end they lie at an inclination of  $15^{\circ}$  to  $20^{\circ}$  up to the north in north and south planes.

From the south-west end of the wind-worn surfaces already described similar polishing can be traced across the hill to the north-west on the steep rock-surfaces of quartz-veined hälléfintas which bound on the south-west the highest part of the hill.

South-west of this the crest of the hill is fairly flat and covered with grass. Here two reservoirs have been constructed for the



Lilleshall water supply, and several of the stones thrown out were found to be beautifully wind-worn and polished. Two trial excavations made near by yielded a considerable proportion of wind-worn stones embedded in fine soft red sand.

In one of the excavations carried to a depth of 29 inches there also occurred immediately beneath the turf a definite layer of white even-sized wind-worn sand, the grains measuring about  $\frac{3}{16}$  inch in diameter, above the fine red sand with wind-worn stones.

The occurrence of wind-worn stones is also recorded from other localities in the Midlands, and specimens in illustration are exhibited.

9. PLANT PETRIFICATIONS IN CHERT AND THEIR BEARING ON THE ORIGIN OF FRESHWATER CHERTS. By MARIE C. STOPES, D.Sc., Ph.D.

THE author described, and illustrated with photos, petrifications of the plants in the freshwater cherts of Lulworth (Purbeck) and Asia Minor (Tertiary). The author drew special attention to the Asia Minor cherts, which are remarkably interesting and contain well-preserved plant debris. These were described by Mr. Haydon in his presidential address to the Liverpool Biological Society, but his work seems not to have reached most geologists and palæobotanists. The cherts contain beautifully preserved pollen grains, fungi, stem debris, etc.; and the existence of these delicate soft tissues so well preserved suggests that Sollas's view of flint formation can only be applied with caution to these freshwater cherts.

The author drew attention to the recent 'Sapropel' observed by Potonié, and the likeness it has to the debris in the Asia Minor chert; concluding that the chert may be taken as practically pure petrified 'Sapropel', a phenomenon which must interest those who are concerned with the methods of plant petrifications.

## REVIEWS.

### I.—GEOLOGICAL SURVEY OF A PART OF SOUTH DEVON.

THE GEOLOGY OF THE COUNTRY AROUND NEWTON ABBOT. By W. A. E. USSHER, F.G.S.; with contributions by CLEMENT REID, F.R.S., J. S. FLETT, D.Sc., F.R.S., and D. A. MACALISTER, A.R.S.M. 8vo; pp. vi, 148, with 3 plates and 14 text-illustrations. London: printed for H.M. Stationery Office, 1913. Price 3s.

THE country described in this memoir is a highly interesting and picturesque portion of South Devon, wherein are to be seen the fossiliferous Devonian limestones of Bradley Woods and elsewhere near Newton Abbot, and other Devonian strata with interbedded and intrusive igneous rocks; the Culm Measures with chert-beds and fossiliferous shales at Waddon Barton, near Chudleigh, and intercalated igneous rocks to the west, including portions of the Dartmoor granite at Lustleigh. Then the coast is dominated by fine cliffs of Red Rocks, ranging in upward succession from the Permian terra-cotta clay of Watcombe through the bold masses of conglomerate and breccia, sandstone and marl which extend to Teignmouth, Dawlish, and Exmouth. Beyond is the famous Bunter pebble-bed of Budleigh