internal reflections; hence rays cannot emerge freely at right angles to the plate.

Further, if a plate of brown phlogopite be rotated in its own plane when in an oblique position, it exhibits axis-pleochroism, the axial colours being the same as those observed when the plate is examined with a nicols prism or a dichroscope. The varieties which show this axis-pleochroism in ordinary light to best advantage are the rich brown phlogopites, which show the pronounced axial tints on the base.

A plate of coloured muscovite or ordinary biotite, if examined in the manner here described, shows no pleochroism.

A basal cleavage plate of brown phlogopite therefore provides an instance of a mineral which exhibits axis-pleochroism when examined in ordinary light, without the use of a polarizer or a dichroscope.

NOTICES OF MEMOIRS.

I.—Preliminary Note on the Classification of the Permian of the North-East of England.[1] By David Woolacott, D.Sc., F.G.S.

SEDGWICK, Howse, and King classified the Permian according to the nature of its stratification or of the structures occurring in it; but as the bedding of the different divisions is often alike, and as the structures—whether concretionary, brecciated, pseudo-brecciated, or cellular—are not confined to particular horizons, divisions named on this basis are misleading and unsatisfactory. The use of the term 'fossiliferous' to mark off a division is also inadmissible. In the following classification the limestone is typically developed at the place the name of which is used to designate a group of strata. The divisions in descending order are—

Middlesbrough Red Beds with Salt.—Red marls, marly sandstones and lenticular beds of salt, anhydrite, and gypsum with fœtid fossiliferous magnesian limestones. 300 feet.

Roker Limestone.—Yellow limestone, regularly bedded; some beds compact, others formed of minute hollow spheres. 100 feet.

Fulwell Rocks.—Bedded yellowish and brownish concretionary (of various types) and non-concretionary limestones, in places highly fractured and brecciated; cemented crush breccia occurs locally. Base often much disturbed by beds from below being forced into it, and by falling of lower layers into fissures and gashes. Irregular beds of amorphous marl are associated with these beds. Two fossiliferous horizons occur: one of fish remains at Fulwell, and the other of invertebrata at Byers Quarry. 150 to 200 feet.

Marsden Rocks.—Bedded yellow and brown limestones, slightly concretionary in places. Irregular masses of white limestone resembling Mountain Limestone occur. Brecciated beds (cemented crush breccias) occur at different horizons. In places highly folded and fractured, but sometimes little disturbed. Breccia-fissures and breccia-gashes

[1] Abstract of Paper read at British Association Meeting, Winnipeg, in Section (C) Geology, August, 1909.

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are found principally in this division. It is sometimes 'cellular', due to solution of fragments out of cementing material of brecciated beds. This horizon has been a zone of thrusting, the amount of brecciation being determined by the relative compressive strength and rigidity of the strata. A flexible limestone occurs near the top of this division. 150 to 200 feet.

Claxheugh Limestone.—Yellow, earthy, friable, and crystalline limestone. Generally unbedded, in places very fossiliferous, sometimes brecciated (crush breccia) and highly fractured. Its upper surface is very irregular. Some of the brecciated beds between Frenchman's Bay and Marsden, on Tynemouth Cliff, and at Blackhall Rocks are included in this division. Outcrops roughly parallel to coast as a continuous band. Brachiopods and most of the other genera of Permian fossils stop at this horizon in Durham. 50 feet.

Houghton Limestone.—Regularly bedded, thinly at base, more coarsely above. Top layers often highly displaced and tilted up; in one or two places it is entirely thrust out of position. Thickens greatly from north to south of county, and width of outcrop increases. Often full of geodes. 10 to 400 feet (?).

(The total thickness of magnesian limestone proved by boring is about 800 feet.)

Marl Slate.—Greyish, yellowish-brownish, and blackish arenaceous and argillaceous laminated limestone. Numerous fish remains. 3 or 4 feet thick.

Thin band of calcareous clay a few inches thick.

Yellow Sands.—An incoherent sandstone generally yellow along outcrop, occasionally variegated (iron oxides and manganese dioxide). In pit sections often greyish or bluish. Very variable in thickness. Top originally regular, but floor on which it rests irregular. Generally false-bedded, although in places, especially near the top, it is regularly bedded. Grains rounded. 0 to 150 feet.

II.—Limestone Unconformities, and their Contemporaneous Pipes and Swallow-holes.[1] By E. E. L. Dixon, B.Sc., F.G.S.

CALCAREOUS rocks differ from other commonly occurring types in being appreciably soluble in atmospheric waters, and, in consequence, being eroded along underground channels where situated above saturation-level. Thus it is that one of their most striking physiographic characteristics is the occurrence in them of numerous caves and swallow-holes, of all sizes and shapes, often containing either debris of overlying rocks or deposits formed in them *in situ*. It is the purpose of this note to draw attention to the way in which this characteristic is reflected in the nature of certain unconformable junctions of limestones with younger rocks.

Unconformities may be divided, for our purpose, into two groups. In the first the underlying rocks have an approximately plane upper

[1] Abstract of Paper read at British Association Meeting, Winnipeg, in Section (C) Geology, August, 1909.

surface, the plane of the unconformity, and have evidently been base-levelled, by either marine denudation or peneplanization, before the deposition of the upper set upon them. With this group any limestones which occur below the unconformity appear to be devoid of pipes or swallow-holes contemporaneous in origin with the plane of the unconformity. Example : the junction of the Carboniferous Limestone with Triassic or Jurassic formations at most places, such as Upper Vobster, in the Bristol district, already described by many authors.

In the second group the rocks below the unconformity have not been maturely eroded before the deposition of those above, and the junction may in consequence be very uneven. Where the underlying rock is limestone the unevenness becomes most marked, for there the junction is complicated by pipes and swallow-holes contemporaneous with the unconformity and filled with material similar to that of the overlying formation, which has been deposited in them *in situ*. An example in which the unconformity, and consequently the piping, has been but slight is afforded by the junction of the upper and lower subzones of the *Syringothyris*-zone of the Carboniferous Limestone—i.e. by the mid-Avonian unconformity—at West Williamston, in Pembrokeshire.[1] There the basement-bed of the upper subzone fills pipes, up to 8 feet deep, in the upper part of the Caninia-oolite (the top of the lower subzone) below, the evidently undisturbed state of both the in-filling and the rest of the basement-bed above showing that the pipes have been formed before the deposition of the upper subzone. At a short distance from West Williamston the pipes in the oolite disappear as we approach the area characterized by continuous deposition of the Avonian; but at Pendine,[2] in the opposite direction, where the unconformity in the middle of this formation is greater than at West Williamston, the piping has extended for a greater depth into the limestones below.

A still more advanced stage of solution-erosion is shown by the Carboniferous Limestone at Ifton, in Monmouthshire, near Severn Tunnel Junction. The unconformity in this case occurs between the Carboniferous Limestone and the Millstone Grit; in the former have been eroded large steep-sided cavities, comparable only with swallow-holes, as well as small pipes resembling those at West Williamston, and both swallow-holes and pipes have been filled with an original deposit of Millstone Grit. This occurrence is the more interesting because the Carboniferous Limestone and the Millstone Grit have subsequently been covered up with Trias, but the junctions of both with the latter form an even surface, evidently a base-levelled plane, below which there are no contemporaneous—i.e. Triassic—pipes in the limestone.

Finally, an extreme case of solution-erosion preceding unconformable deposition on limestone is afforded by huge breccia-filled cavities in the Carboniferous Limestone of Pembrokeshire.[3] These cavities

[1] *Summary of Progress for* 1906, Mem. Geol. Surv., 1907, p. 55.

[2] *Summary of Progress for* 1902 (p. 43), 1904 (p. 44), and 1905 (p. 55); and "The Country around Carmarthen" (in the press), Mems. Geol. Surv.

[3] *Summary of Progress for* 1904, Mem. Geol. Surv., 1905, pp. 46–7.

often extend from top to bottom of cliffs ranging up to more than 100 feet in height, and in some cases continue horizontally for over 100 yards. They are almost completely filled with blocks of limestone, of all sizes up to masses weighing hundreds of tons, which have fallen from the roof and sides, but also contain a little interstitial Triassic material *in situ*. The formation of the cavities, therefore, preceded the deposition of the Trias, and took place during the long period represented by the great unconformity between the latter and Carboniferous rocks. In this district, most, if not all, of the succeeding younger formation (the Trias), deposited on the upper surface of the limestone, has been removed, but there is evidence that that surface was a base-levelled plane. This belief, however, does not invalidate the conclusion that such planes are devoid of contemporaneous swallow-holes, because the plane which is believed to have existed in this case must have truncated some of the breccia-filled cavities, and therefore have been of later origin.

III.—Investigation of the Igneous and Associated Rocks of the Glensaul and Lough Nafooey Areas, Co. Galway.[1] By C. I. Gardiner.[2]

Mr. C. I. GARDINER and the Secretary visited Connemara in April and completed their field work on the Glensaul district, commencing, in addition, to map the Lough Nafooey district.

The Glensaul district is a small one, measuring only about 2 × 1 miles. It is about 3 miles south-west of the southern extremity of the Tourmakeady district, recently described,[3] of which it is clearly a continuation, the type of sedimentary rock met with in the two being practically identical. The general succession is:—

III. ?*Bala Beds*—conglomerate and sandstone. These have not been studied.

II. *Llandeilo Beds.*

(5) Calcareous gritty tuff, passing in places into fairly pure limestone, and enclosing bands and patches of limestone breccia and bands of highly fossiliferous limestone, which in some cases has been shattered by earth movement	Thickness doubtful.
(4) Very coarse tuff or breccia mainly composed of felsite fragments	750 feet.
(3) Tuff coarse and fine with occasional patches of calcareous beds	150 feet.
(2) Great felsite sill of Tonaglanna and Greenaun	1200 feet.
(1) Tuff with some grit	600 feet.

I. *Arenig Beds.*

(4) Coarse grit	150 feet.
(3) Fine grit and tuff associated with black chert, graptolitic shale, and a prominent band of breccia 30 feet thick	Thickness doubtful.
(2) Coarse grit	110 feet.
(1) Coarse conglomerate	About 600 feet seen.

[1] Abstract of Paper read at British Association Meeting, Winnipeg, in Section (C) Geology, August, 1909.

[2] Report of the Committee, consisting of Professor W. W. Watts (Chairman), Professor S. H. Reynolds (Secretary), Mr. H. B. Muff, and Mr. C. I. Gardiner. (Drawn up by Mr. C. I. Gardiner and the Secretary.)

[3] Quart. Journn. Geol. Soc., 1909, vol. lxv, pp. 104–53.

The black shales have yielded the following considerable series of graptolites, which have been kindly determined by Miss G. L. Elles, D.Sc., and indicate the zone of *Didymograptus extensus*. The associated cherts contain radiolaria:—

Graptolites from the Arenig Beds of Glensaul.

Dictyonema, sp.	*Thamnograptus*, sp.
A Dendrograptid.	*Didymograptus extensus*, Hall (common).
Tetragraptus pendens, Elles.	*D. filiformis*, Tullberg.
T. Amii, Lapworth M.S.	*D. fasciculatus*, Nich.
T. quadribrachiatus, Hall.	*D. bifidus*, Hall.
Clonograptus Lapworthi, Rued.	*D. gracilis*, Törnquist.

In the Llandeilo rocks, both limestone and tuff, a large number of generally rather fragmentary fossils was found, which are being determined by Mr. F. R. Cowper Reed.

The crystalline igneous rocks, all of which we believe to be intrusive, are by no means so varied as in the Tourmakeady district, and are practically limited to one broad band of felsite, which is noteworthy from the fact that it almost everywhere contains pyroxene.

The district is much faulted, large faults bound it on the east and west, a somewhat complicated system of faults approximately parallel to these bounding faults intersects it, and there are other dislocations of importance.

REVIEWS.

I.—Life and Letters of Peter and Susan Lesley. Edited by their daughter, Mary Lesley Ames. 2 vols. 8vo; pp. xii, 526, and v, 562, with 16 portraits, 17 sketch illustrations, and geological map. New York and London: The Knickerbocker Press (G. P. Putnam's Sons), 1909.

PETER LESLEY, the fourth in succession of that name, was born in Philadelphia on September 17, 1819, and died at Milton, near Boston, on June 1, 1903, in his 84th year. His great-grandfather belonged to Scotland, and was known as the "Miller of Fifeshire". His grandfather (Peter the second) settled in Boston, U.S.A., as a cabinet-maker, and his father (Peter the third) succeeded to this business. Peter the fourth, however, did not like his Christian name, and while during his father's lifetime he signed his name "Peter Lesley, Jr.", he subsequently transferred the J to the front, and became J. P. Lesley, in which form his name has been familiar to geologists.

In an interesting and appreciative obituary memoir, which formed part of the anniversary address delivered by Sir Archibald Geikie as Vice-President of the Geological Society in 1904, J. P. Lesley was described as "one of the most distinguished and lovable men of science in the United States"; and in the two volumes before us ample testimony is given of the justice of those words.

In early years Lesley received from his father, who was a man of high principle and wide culture, a valuable training in mechanics, in perspective and machine drawing; he was sent to the best schools,

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