175 feet. This drainage would then escape by a narrow notch between Adwick-on-Dearne and Swinton into the Don at Mexborough.

A further advance would bring the Wombwell-Swinton valleys into use as overflows, and the Hooton Roberts valley would be the route into the Don. The damming of the Dearne at Barnsley by a lobe of ice would bring into use a couple of small valleys at Barnsley as overflow channels. The gradual advance of the ice across the Conisborough gorge would cause the blocking of the Don, with the formation of a constantly enlarging lake, which would overflow first by the Hooton Roberts valley (180 feet), and then by a series of cuts through the 275-foot contour on Conisborough Parks, first draining into the Don behind Castle Hill, then, as the Warmsworth watershed was reached by the ice, into the Balby valley, and, when this was closed by the ice, over the low watershed into the Loversall valley.

The further advance of the ice-front to Edlington caused a shallow cut to be made through the 300-foot contour, discharging into the Loversall valley and thence into the Trent. This channel, which bends round in a semicircle, became the permanent course of the Wadsworth drainage on the retreat of the ice, the old channel at Balby having been filled up with till. When the ice rose above the 330-foot contour the gorge of the Don was entirely closed, and the drainage of the great lake, reaching from Bretton Park and Cawthorne, north of Barnsley, to Clay Cross and Heath, south of Chesterfield, would all be discharged by the Kiveton gorge into the river Ryton.

This explanation may be thought to rest too largely on suggestions, but where the evidence is so scattered and imperfect it is difficult to see how this can be avoided if any explanation is to be attempted.

NOTICES OF MEMOIRS, ETC.

I.—Note on Lower Cretaceous Phosphatic-beds and their Fauna. By G. W. Lamplugh, F.G.S.[1]

IT has been customary to regard the fossils more or less imperfectly preserved in the condition of phosphatic casts in different parts of the English Lower Cretaceous series as derivative from the Jurassic rocks. In previous papers the writer has brought forward evidence to show that the fauna of such beds at Speeton and in Lincolnshire is not derivative, but occurs at its proper horizon and, so far as it goes, indicates the life of the period. Personal investigation of the localities, and of the fossils obtained from the 'coprolite-beds' at Upware, Potton, and Brickhill, has led him to conclude that in these deposits also the greater part of the so-called derivatives are really of Lower Cretaceous age. Thus, one of the

[1] Abstract of paper read before the British Association, Cambridge, Section C (Geology), August, 1904.

most abundant phosphatic fossils of these places is the ammonite, usually fragmentary, which has habitually been named *Amm. biplex*, but belongs in almost every case to one or another of several allied species of Lower Cretaceous Olcostephani. Most of the lamellibranchs can likewise be best matched by Lower Cretaceous forms; and there are good grounds for suspecting that many of the Saurian and fish remains from the above-mentioned places and from the Faringdon 'Sponge-Gravels' which have been classed as Jurassic are true Lower Cretaceous forms.

It is acknowledged that the presence of transported pebbles of older rocks in the deposits at Upware, Potton, and Faringdon renders the occurrence of derivative fossils at these places more probable than in the case of the Speeton and Lincolnshire 'coprolite-beds'; and in the collections examined a few specimens were noticed that seem to have been washed from older rocks. But the writer believes that these instances are exceptional, and he urges that no fossil should be set down as derivative unless the evidence is conclusive, as much confusion has arisen through the unquestioning adoption of the hypothesis of derivation.

While there is still much to be learnt as to the physical conditions requisite for the concretion of phosphatic nodules and for their segregation into bands, it seems clear that an important determinative was the existence of submarine currents occasionally impinging upon the sea-floor with sufficient strength to sweep away the matrix in which the nodules had been formed, so that there was a gradual accumulation of the partially eroded nodular residues. Such residues, though of inconsiderable thickness, may represent a long period of submarine conditions. The term 'aggregate deposits' has been suggested by J. F. Blake for beds of this character.

II.—On the different Modifications of Zircon. By L. J. Spencer, M.A., F.G.S.[1]

SOME very irregularly developed crystals of zircon from the gem-washings of the Balangoda district in Ceylon were found to have characters differing widely from those of zircons of more common occurrence. Although of low specific gravity (4·0), they are not increased in density when strongly ignited, as are many zircons of specific gravity below 4·7. They further differ from ordinary zircon in their very feeble, or absence of, birefringence. The crystals are dark brown in colour and almost opaque, but after ignition they are bright green and quite transparent.

While some of the crystals consist wholly of zircon of this type, others contain an intergrowth of a second kind, which may be present in greater or less amount. The latter has a higher specific gravity, and increases in density when ignited; it is optically biaxial with very strong birefringence. A section cut perpendicular to the

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principal axis of such a compound crystal shows, when moved across the microscope-stage in convergent polarised light, a gradual transition from a biaxial to a uniaxial figure, the coloured rings at the same time moving outwards and becoming further apart owing to the diminution in the strength of the double refraction, which is positive throughout; finally, when the rings have all moved out of the field of view, the black cross also disappears, and the corresponding portion of the section is optically isotropic. The mean refractive index has about the same value in all portions of the section.

Zircon of the first type has been previously described by Professor A. H. Church (1875) and by Dr. S. Stevanović (1903), and from the researches of these and other authors it would seem that there are, at least, three modifications of zircon, viz.:—

α. Those of specific gravity 4·0, which do not increase in density when ignited.

β. Those of specific gravity 4·7, also not increased in density when ignited.

γ. An unstable form of specific gravity about 4·3, which when ignited is increased in density to 4·7.

That these different kinds are often intergrown in the same crystal is shown by the frequent occurrence of zonal structures in zircon, and further by the behaviour of the crystals when heated. A crystal consisting of an intergrowth of *α*-zircon and *γ*-zircon will be increased in density on ignition, but not to the higher limit of 4·7; on the other hand, an intergrowth of *β*-zircon and *γ*-zircon will reach the higher limit when ignited.

In crystalline form and chemical composition (as far as could be determined by qualitative tests) *α*-zircon and *β*-zircon are identical, and these appear to be also the same for *γ*-zircon.

III.—On Derived Plant Petrifactions from Devonshire. By E. A. Newell Arber, M.A., F.L.S., F.G.S.[1]

SOME interesting plant petrifications in which the structure has been to some extent preserved by means of a mineral agent have recently been discovered in the higher beds of the Upper Culm Measures (Upper Carboniferous) in Western Devon. Although the preservation is not sufficiently good to render this discovery of any botanical importance, the manner in which the fossils occur is interesting from a geological point of view. The plant remains consist of small rolled fragments of stems, of an inch or less in length, arranged without order in a fine-grained sandstone. They are in all probability derived from some pre-existing beds, and are not contemporaneous with the sandstone in which they are found. Such derived plant remains are very rare, if not unknown, from the Palæozoic rocks.

[1] Abstract of report read before the British Association, Cambridge, Section C (Geology), August, 1904.

IV.—On the Fossil Plants of the Upper Culm Measures of Devon. By E. A. Newell Arber, M.A., F.L.S., F.G.S.[1]

THE Upper Culm Measures form by far the largest portion of the Carboniferous sequence in Devon and the adjacent counties. Fossil plant remains are abundant in these beds, but their preservation is rarely sufficiently good to permit of even generic determination. A number of well-preserved specimens have, however, recently been obtained from the one horizon in which coal or 'culm' occurs in these beds in the Bideford district. They include *Calamites undulatus*, *Calamocladus charæformis*, *Alethopteris lonchitica*, *A. Serli*, *Neuropteris obliqua*, *Sigillaria tessellata*, and many others. *Neuropteris Schlehani* and *Megalopteris* (?) sp. are also recorded from Britain for the first time.

This flora confirms the previous conclusions with regard to the Upper Carboniferous age of these beds, and indicates that the coal-bearing beds of the Bideford district are the equivalents of the Middle Coal-measures elsewhere in Britain—a higher horizon than has previously been assigned to these beds.

V.—On the Occurrence of Pebbles of White Chalk in Aberdeenshire Clay. By A. W. Gibb, F.G.S.[1]

THE record of the Cretaceous period in the north-east of Scotland is a very fragmentary one. The principal traces hitherto noted consist of a deposit of the nature of a Greensand—not proved to be *in sitû*—at Moreseat, Cruden, and large numbers of flints scattered over the surface of the ground in the same locality between Buchanness and the Hill of Dudwick.

Further indications of Cretaceous strata have recently been found at Strabathie, in the district of Belhelvie—about five miles north of Aberdeen—in a bed of laminated clay close to the sea. The clay is found to contain pebbles of white chalk in considerable abundance. Some of the pebbles measure nearly a foot in length, but the majority are small. Some of them inclose flints. That they have been worn off an adjoining land surface is shown by the fact that numbers of them are markedly glaciated, and that pebbles of other rocks, identical with or similar to the rocks of the district, are found in the same pit. These facts indicate that Upper Cretaceous beds have once been, and perhaps somewhere are still, *in sitû* in the locality.

It has been ascertained by boring that the clay deposit covers a considerable area, and as fresh exposures are constantly being made in the process of working the bed further finds may be anticipated.

[1] Abstract of paper read before the British Association, Cambridge, Section C (Geology), August, 1904.

VI.—Edenvale Caves, Co. Clare.—Final Report. By Dr. R. F. Scharff (Chairman), Mr. R. L. Praeger (Secretary), and a Committee appointed to explore Irish Caves. (Drawn up by the Chairman.) [1]

SINCE our last report was submitted to the British Association, Mr. Ussher has completed the excavations of the extensive caves of Edenvale, co. Clare, and sent altogether a collection of more than 50,000 bones to be named. Besides these there were flints and implements used by primitive man and relics of various periods, on which it is proposed to submit a detailed report to the Royal Irish Academy during next winter.

Mr. Ussher has explored other districts of Ireland with the view to continuing the cave researches, but this Committee do not propose to apply for a further grant.

The Edenvale remains have not been fully determined, but so far they have yielded the following species:—

Man (*Homo sapiens*).
Bats (several species).
Hedgehog (*Erinaceus europæus*).
Domestic Cat (*Felis domestica*).
Wild Cat (*Felis caligata*).
Dog (*Canis familiaris*).
Fox (*Vulpes alopex*).
Irish Stoat (*Putorius hibernicus*).
Marten (*Mustela martes*).
Bear (*Ursus arctos*).
Badger (*Meles taxus*).
Arctic Hare (*Lepus timidus*).
Rabbit (*Lepus cuniculus*).
Irish Rat (*Mus hibernicus*).
Field Mouse (*Mus sylvaticus*).
Arctic Lemming (*Dicrostonyx torquatus*).
Domestic Ox (*Bos taurus*).
Domestic Sheep (*Ovis aries*).
Domestic Goat (*Capra ægagrus*).
Domestic Pig (*Sus scrofa domestica*).
Wild Pig (*Sus scrofa ferus*).
Red Deer (*Cervus elaphus*).
Giant Deer (*Megaceros giganteus*).
Reindeer (*Rangifer tarandus*).
Horse (*Equus caballus*).
Birds (many species).
Frog (*Rana temporaria*).
Fishes (several species).
Land Mollusca (many species).

VII.—Brief Notices.

1. Peat Moors of the Pennines.—In an article entitled "Peat Moors of the Pennines: their Age, Origin, and Utilization" (*Geographical Journal*, May, 1904), Mr. C. E. Moss remarks that the Pennine peat moors represent a valuable asset which is turned to little account: not only is there enormous value in products manufactured from peat, but he believes there is fuel enough to last the hillside population for a thousand years.

2. Najas in the Peat.—Mr. Clement Reid records the occurrence of *Najas marina* in the Megaceros-marl of Lough Gur (*Irish Naturalist*, vol. xiii). This little "submerged flowering plant" is known to exist in Britain only at a single spot in Hickling Broad, in Norfolk. It is found in the Cromer Forest-bed Series, and in

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later deposits in England and Wales, but has not hitherto been recorded from Ireland.

3. Rhodesia.—A useful pamphlet on "The Geology of Southern Rhodesia," by Mr. F. P. Mennell, has been issued by the Rhodesia Museum at Bulawayo. This is accompanied by pictorial and other illustrations, and by a sketch geological map on the scale of an inch to four miles. The author deals with the igneous rocks and schists, the coal series, superficial deposits, and scenery.

REVIEWS.

I.—Memoirs of the Geological Survey of the United Kingdom.

The Tertiary Igneous Rocks of Skye. By Alfred Harker, M.A., F.R.S., with Notes by C. T. Clough, M.A., F.G.S. pp. xi, 481, 84 text-figures, 27 plates, and one coloured map. (Glasgow, 1904. Price 9*s*.)

THE appearance of this memoir awakens the echoes of past controversies. The region with which it deals shows within a narrow compass such a complex group of rocks that diversities of opinion might well arise as to their mutual relations. Broadly speaking, two series of igneous rocks occur, an acid and a basic, ranging in both cases from plutonic masses and intrusive sills and dykes to lava-flows; and the views first enunciated, according to which the plutonic masses were regarded as the denuded cores of volcanoes from which the lavas (first the acid and then the basic) had been poured out, appeared to be a simple and reasonable explanation of the facts observed.

As is well known, very different views from the above as to the sequence of these igneous rocks were held by the late Director-General of the Survey, under whose direction, in fact, was planned much of the work the result of which is recorded in the present memoir. The result of Mr. Harker's researches, it may be here briefly stated, has been to convince him of the correctness of Sir Archibald Geikie's main conclusions that the basaltic lavas which cover such an extent of country in the Western Isles of Scotland and in the north of Ireland are amongst the earliest volcanic rocks of the region and were probably due to fissure-eruptions, that the gabbro-masses were intruded into them and are consequently of later date, and that finally these basic rocks were invaded by the granites and granophyres. Supporters of the earlier views will find, therefore, little encouragement in these pages, although here and there a glimpse may be caught of difficulties in the case of phenomena easily capable of misinterpretation, such as the presence in the earlier basic agglomerates of fragments of gabbro and granophyre identical in character with the later rocks which constitute the main mass of the Cuillins and the Red Hills, and the occurrence of basic dykes which traverse certain rocks freely and