NOTICES OF MEMOIRS.

ABSTRACTS OF PAPERS READ BEFORE THE BRITISH ASSOCIATION AT OXFORD, AUGUST 9–14, 1894.

I.—ON A KEUPER SANDSTONE CEMENTED BY BARIUM SULPHATE FROM THE PEAKSTONES ROCK, ALTON, STAFFORDSHIRE. By W. W. WATTS, M.A., F.G.S.

PROFESSOR F. CLOWES[1] has described a sandstone from the Himlack Stone, near Nottingham, in which the grains were cemented with crystalline barytes, the amount of this material varying from 28 to 50 per cent. in different specimens. This rock occurred at the base of the Keuper sandstone of that locality. A somewhat similar rock, occurring at about the same horizon, is described by Mr. A. Strahan,[2] from Beeston Castle in Cheshire, and the same author refers to the frequent occurrence of barytes in the Keuper breccias.

Bearing these facts in mind, the writer visited a curious isolated stack of rock, called the "Peakstones Rock," near the village of Alton in Staffordshire, which is figured in Professor Hull's Memoir on "The Triassic and Permian Rocks of the Midland Counties of England." This stack is made of the Lower beds of Keuper sandstone, but its outer portion has lost whatever cement it may once have contained. It is, however, situated at the end of a spur which projects into a valley, and exposes a good deal of bare rock. This rock contains what at first look like several veins of barytes two or three inches thick, striking along the spur and straight through the place occupied by the Peakstones Rock. On examination of specimens the veins are seen to be planes in the sandstone cemented by barytes. The specific gravity of the rock is 3·09, and, as the grains are chiefly subangular fragments of quartz and felspar, it must contain about 28 per cent. of barytes. This almost insoluble cement has undoubtedly given rise to the spur above alluded to, and almost as certainly has caused the survival of the Peakstones Rock. This is, however, so much exposed to the weather on all sides, and both to mechanical and chemical disintegration, that if any cement is still left it must be in the inner part of the mass, which cannot be reached by ordinary means. Another specimen from west of Kent Green, near Congleton, containing barytes, and with a structure very like that described by Mr. Strahan, was also referred to.

II.—SPORADIC GLACIATION IN THE HARLECH MOUNTAINS. By the Rev. J. F. BLAKE, M.A., F.G.S.

THE author drew a distinction between two results of glaciation—the one, negative, in which the rocks are rounded and striated, and all or nearly all the débris removed; the other, positive, in which the rocks are covered by a thick deposit of drift with

[1] Rep. Brit. Assoc. 1885, p. 1038; 1889, p. 594; 1893, p. 732; and Proc. Roy. Soc. vol. xlvi. pp. 363–369.

[2] Mem. Geol. Survey. Exp. Quarter Sheet, 80, S.W. p. 7.

boulders. In the Harlech Mountains district areas showing these opposite results lie side by side. Most of the glaciation is of the negative kind, but the areas drained by the Crawewellt and the Ysgethin are covered by glacial cones of dejection. This difference is accounted for in the first instance by the local drainage being opposite to the general drainage, and in the second by the small size of the gathering ground for the ice. From these results it was argued: 1. That drift deposits are, as a rule, left beyond the area of ice-flow. 2. That no submergence could possibly have taken place here since the Glacial period, or the features above noted would have been obliterated.

III.—On the Mechanics of an Ice-Sheet.—By the Rev. J. F. Blake, M.A., F.G.S.

THE author attempted to explain how an ice-sheet can carry boulders up a slope, and leave them at a height of 1,000 feet or more above sea-level. The sides of the channel are, in the first instance, supposed to be parallel, so that the mass of ice may be represented in a diagram by its longitudinal section. Taking, for simplicity, the shape of the surface moved over to be represented by two straight lines, one corresponding to the slope down from the mountains, the other the slope up from the sea-bottom to the final destination of the boulders, and, taking the surface of the ice as flat, the ice-sheet is represented by a triangle. This is supposed to settle down in such a way that, though the level of the end is higher, the centre of gravity of the whole is lower. This fall of the centre of gravity is the effective cause of the motion of the ice-sheet, the resistance to be overcome being that of the ice to change its shape. If the ice-sheet be supposed divided into strips parallel to the slope from the mountains, these will be like a series of overlapping glaciers, and under the influence of the pressure will swell out at the bottom, and thus push the further end of the whole mass a little way up the counter-slope. Continual additions of snow at the end where the ice-sheet commences, or elsewhere on its surface, will be cumulative in their effects, and thus the further end of the ice-sheet will ultimately ascend as required. Again divide the triangle into strips by lines parallel to the counter-slope. The lower of these strips will be pressed together, and any point on the base will be carried on in the direction of the whole motion at a greater rate than the higher layers, and thus the stones, etc., on the sea-bottom will be pushed up to their final resting-place, and anomalies of distribution might thus be accounted for by the previous dispersal of the boulders. It was then shown that differences in shape of the ice-sheet and its spreading out at the further end will make little difference in the argument, and under certain conditions will aid the motion.

The author then discussed the question of the glacial erosion of lakelets, and indicated the conditions under which this is possible, particularly referring to the difference between an ice-sheet such as that dealt with in the paper and an ordinary glacier.

IV.—On the Deposit of Iron Ore in the Boring at Shakespeare Cliff, Dover. By Professor Boyd-Dawkins, F.R.S.

THE general results of the boring at Dover were laid before the British Association at Cardiff in 1892, so far as relates to the discovery of the South-eastern Coal-field. In the present communication the author treats of a bed of ironstone, which is likely to be of great importance in the new industries which will spring up sooner or later in Kent in consequence of the discovery of Coal in workable quantities.

The strata penetrated in the boring are as follows:—

		Feet.
Upper Cretaceous	Lower Gray Chalk and Chalk marl	130
	Glauconitic marl	8
	Gault	121
Neocomian	Folkestone Beds	64
	Sandgate Beds	77
	Hythe Beds	87
	Atherfield Clays	18
Oolitic	Portlandian	32
	Kimmeridgian	73
	Corallian	159
	Oxfordian, Callovian	188
	Bathonian	156
Coal-measures with twelve seams of Coal 23 feet 5 inches thick		1068½

The ironstone occurs in the Kimmeridgian part of the section, and as shown in the following details:—

Portlandian Beds:—	Feet.
Gray marl with oolitic grains of ferric oxide	2
Hard gray limestone	1
Brown calcareous sandstone	2
Gray shelly limestone with oolitic grains of ferric oxide	1
Dark-gray marl	2
Hard blue limestone with *Littorina*	1
Brown oolitic ironstone	12
Gray limestone	4
Dark bituminous clay	8
Flaggy sandstone	2
Gray sandy clay	4
Arenaceous limestone with *Cidaris*	7
Dark bituminous shale	27
Gray nodular limestone	2
Coralline Oolite with the usual fossils, *Pecten vagans*, etc.	27

The ironstone presents very singular physical characters. It is composed of small dark-brown shining grains of hydrated oxide of iron like millet seed, embedded in a crystalline base partly of calcium carbonate, and partly of iron carbonate. These grains are oolitic in structure, and are probably the result of the same chemical change by which the calcareous beds of the Inferior Oolite in Lincolnshire have been converted into iron ores. They occur, it will be noted, in several strata above the main bed, 12 feet in thickness in the above section.

This bed of iron ore is identical with that described by Blake and Hudleston at Abbotsbury in Dorset, where it occurs between the Kimmeridge clay above and the Corallian rocks below.

It is also physically identical with the valuable iron ore worked for many years at Westbury in Wiltshire, where it is met with at a lower horizon, being there separated from the Corallian limestones by 4 feet of marls and sands.

This stratum, although probably of purely local origin, is to be looked for in the beds above the Corallian throughout the whole of Southern England, from Dorset eastwards. Its discovery at Dover is only second in importance to that of the South-eastern Coal-field. It will have to be taken into account in the future development of the Coal-fields in Southern England.

V.—The Volcanic Phenomena of Vesuvius and its Neighbourhood. Report of the Committee, consisting of Mr. H. Bauerman, Mr. F. W. Rudler, Mr. J. J. H. Teall, and Prof. H. J. Johnston-Lavis. (Drawn up by Prof. H. J. Johnston-Lavis.)

SINCE the last report lava has continued to pour forth from the top of the new lava-cone in the Atrio del Cavallo, sometimes in small quantities, at others in considerable abundance. On no occasion, however, did the lava issue beyond the limits that it had reached in the years 1891–92. In fact, the whole of that eastern part of the Atrio known as the Val d'Inferno has not been invaded at all by the new lava during or since its issue in the spring of 1891. The consequence of this has been that it has continued to pile itself up around the line of fissure by which it issued, and still further add to the dimensions of the great lava-cone that it had built up in the Atrio. So great has this cone become that it constitutes a prominent feature in the outline of the volcano as seen from Naples. The eminence of Somma is separated from Vesuvius by the depression of the Atrio. This notch, so to speak, in the general outline was terminated below by an almost horizontal line, which is now replaced by an obtuse cone, so that many people speak of three summits to the Vesuvian volcano. This is rather an exaggeration, for although the new lava-cone is of very considerable dimensions, for the time occupied in its growth, yet it cannot compare with that of the cone of Vesuvius on one side or the ridge of Somma on the other.

The whole of this new cone is entirely built up of lava, by far the greater part being of the *pahoehoe* or corded type; only now and then, during marked activity, has there been produced any lava with a rugged scoriaceous surface. The occasion was therefore a very valuable one to determine the slope of such a lava-cone. This was done only normally to the line of fissure by which the lava issued, and which makes the cone terminate in an elongated ridge rather than in a point. Practically all these clinometric observations, which were taken with great care, gave angles varying from 13° to 15°.

Comparing this angle with that of such mountains as Etna or Mauna Loa we must consider that both are composite cones, and have experienced many disturbing influences, such as the formation of parasitic eruptive outlets, from which lava streams have issued far away from the summit, and have thus diminished the general slope of the volcano. Those mountains are usually considered to have an average slope of 10°. The Hawaiian lavas are, as is well known, exceptionally fluid, and we could hardly expect cones of greater slope than 10°. At Etna the lavas have always been more viscous from their lower temperature and the compound or false viscosity given to them by the large number of porphyritic crystals already existing in the magma at the time of emission, just as earth mixed with water may produce a viscous mud. These new lavas of Vesuvius, as is the case with all those that issue high up on the volcano and in small quantities, were very viscous owing to their low temperature and advanced crystallisation, so that soon after the material poured out it was prevented from flowing by slight further cooling. We may take, therefore, this average slope of 14° as the best and most correct estimate for a lava of this nature.

This recent outflow exhibits most of the varieties of surface to be met with in the type of lava above mentioned, such as corded shapes of different kinds, irregular globular surfaces, sheets, and plates either in position or reared on end, and tunnels of every variety, frequently with continuations as walled canals. A magnificent lava hump was formed right under the escarpment of Somma. The origin of these humps is still obscure. They are common on most large flows of corded lava of Vesuvius, but, unfortunately, I have never been present at their formation, nor do I know of anyone who has.

The points of issue of the lava occurred at various spots along a line corresponding with the strike of the radial dyke to which it owes its origin, so that the new lava has as a summit an irregular ridge running nearly north and south. Of course the actual highest point is nearly always that where the last lava issued. Generally more than one spot along this line gave out lava at the same time. The fluid rock flowed sometimes on one side, sometimes on the other, so that the general public at Naples were only from time to time treated to a glimpse of Nature's fireworks, and when the lava flowed in the opposite direction it was often announced that it had altogether stopped.

During the last year several new conical spiracles were formed, but none of them comparable in perfection of form to those described in the last two reports, or exhibiting equally interesting features.

No very interesting minerals were produced as sublimates. In fact, only two species are worthy of mention. On one occasion a small quantity of tenorite was formed in one of the spiracles. Soon after the lava had entirely stopped flowing in February, sublimates of potash-bearing halite were very abundant around the vents, in beautiful fern-like skeletons, in which a number of feathery branches radiated at right angles from a stem representing usually about three edges of a cube, and were themselves so many edges of smaller cubes. Sometimes this halite was gray, from minute hæmatite crystals being deposited with the salt, which likewise was in some cases greenish from copper impurities. Most, however, were of a beautiful snow white. One small cavity in particular, about the size of a man's body, was clothed with the most glistening white lining, and from the roof and walls showers of crystals fell from time to time. These were not visibly red-hot in bright diffused daylight, but looking towards the shaded inner extremity of the cavity, a bright red incandescence was visible. In a short time, with suitable apparatus, I collected over two kilogrammes of this material absolutely free from mechanical impurities.

Along many of the cracks of the lava beautiful glassy crusts of halite, more or less impure, were formed, and often showed a dull red heat in daylight. These crusts on being removed become rapidly opaque and milky in hue, and audibly cracked into starch-like columns, due to the rapid contraction on cooling—producing, in fact, a miniature basaltic structure.

About February 5th, 1894, the lava was issuing in very small quantity, and by the 7th showed no trace of movement. Yet even in May cracks in the lava near its point of exit were incandescent some distance in, and the saline incrustations mentioned above were in full perfection.

Coincident with the arrest of the lateral outflow, the lava rose in the chimney, and the red reflection from the top of Vesuvius that had been absent for so long, with rare exceptions, was again almost daily visible. The level of the lava in the main chimney soon rose to the bottom of the new crater that had been forming, and increasing in size during the time the lateral issue of lava had been going on, and commenced the filling up of that cavity by the formation of a cone of eruption, so that almost coincident with the arrest of the leakage of lava laterally the central activity changed from the crater- and dust-forming stage to the lava cake- and cone-forming stage.

I made a careful examination of the summit of Vesuvius about the middle of May. The crater in an east and west direction was about 150 m. in diameter, and its depth, then decreasing, was about the same. The walls were remarkably steep, in some places even vertical or overhanging. The bottom could be seen with difficulty owing to the crumbling nature of the edges. The walls are nearly all covered by sublimates or dust that has adhered and crusted them over, so that several dykes, both solid and hollow, can no longer be distinguished. This is especially the case with the one formed during the 1891 outburst. The details of the great rift of the 1880–81 and subsequent eruptions on the east side of the great cone were still easily discernible. On the south side, and a little to the east, a wall of rock stands out from the side of the crater and is directed nearly towards the centre. It is capped by a pinnacle of rock, and is really the old dyke of the 1885 eruption.

Just to the east of that wall, and partly owing to its existence, the slope of the inside of the crater is less in that direction. Here the guides had made a little path for a few metres down. On examining carefully the condition of things from its lower termination, which so far aided little the view of what was going on at the crater-bottom, I found that by extending it down a slope, and then cutting a ledge farther round to the east at a suitable point, a bracket-like platform some metres square could be reached, which is about half way down the crater. Later the path was further widened by me and made more commodious, and now gives easy access to the platform, from which one can look right into the vent of the volcano and watch with ease the boiling up of the lava and the ejection of the great blobs and cakes that are rapidly filling up the crater. Unfortunately, owing to the well-like shape of the crater, the shadows due to the vapour column spreading out overhead, and the dark colour of the rocks, instantaneous photography could not be utilised to record this interesting and everchanging scene.

As is usual at some period after an eruption, feathery gypsum is a common product in the cavities of the old scoriæ, and is associated at the fumaroles with a little sulphur (an exceedingly rare mineral at Vesuvius), with abundance of molysite and kermesite.

In the Campi Phlegræi little of novelty has come to light. A tunnel and a deep shaft which is being constructed in Naples to complete the drainage works have brought several interesting sections to light, but not of sufficient completeness to be yet worth recording.

VI.—On Certain Volcanic Subsidences in the North of Iceland.

By Tempest Anderson, M.D., B.Sc., F.G.S.

PERHAPS the most striking features in Icelandic scenery are the *giás* (pronounced "geow"), or fissures and chasms, which are so frequently met with in all the districts in which recent volcanic activity manifests itself. They are usually, and in most cases rightly, ascribed to the lower stratum of a molten lava stream, having obtained an outlet after the surface has consolidated into a crust of greater or less thickness.

Giás of this class are, so far as the author has been able to observe, confined within the limits of a single lava stream, and do not affect previously formed rocks. Usually there is a large giá roughly parallel with each side of the original lava stream, and the space between these has subsided considerably. Any giás in this subsided portion are much smaller, and obviously of secondary importance. Examples of this are to be found in the well-known Almanagiá, at Thingvalla, which has a throw of about 100 feet, while the sides of the smaller giás which enclose the Logberg in the subsided portion are practically on the same level.

There are also several such subsidences near Lón and Ásbergi, in the north of Iceland. The main subsidence at Ásbergi is a little more complicated, though evidently due to the same causes. Here a large roughly triangular area has subsided, the throw at the apex being probably nearly 300 feet, but a space in the middle has remained at its original height, so that a depression has been produced like a great V, the portions both between and outside the legs having remained standing. In the case of Thingvalla it appears not unlikely that the lava which flowed down into the lake solidified on coming in contact with the water, and formed a wall sufficiently strong to hold up the lava plain till it formed a firm crust, and that the giving way of this and the escape of the molten lower layers into the deeper parts of the lake caused the subsidence.

Similarly the lava which escaped from Ásbergi may have been that which now occupies the low ground near the estuary of the Jokulsá, in the direction of Lón.

On the east and south-east of Lake Myvatu a very extensive eruption, or series of eruptions, has taken place from a chain of craters locally called Gardr Borgir ("the castles of Gardr," which is the name of a farm). The lava flow has occupied nearly all the bed of Lake Myvatu, and flowed down the valley of the Laxá to its mouth at Laxamyri. All this stream of lava is very remarkable for the number and size of the spiracles with which it is studded, and a regular gradation of sizes exists, between spiracles the size of a haycock and cones some of which cannot be less than 200 feet high. These cones and craters, which constitute such a striking feature of Lake Myvatu, may probably be nothing more than spiracles formed by the escape of steam generated by the conflict of the hot lava with the water of the lake. The barrier which holds up the water of the present lake consists of this lava, and caves exist in it which are obviously channels by which molten lava has escaped. These and deeper-seated ones would be those by which the lava escaped and left the depression occupied by the present lake. Between the craters of eruption and the lake no spiracles were noticed, but there is a very remarkable series of rocks—the Dimmuborgir—masses of lava of fantastic shape, 30 or 40 feet high, which have remained standing while the intervening portions have subsided. They present slickenside marks where the subsiding portions have scratched the masses that have remained standing, and tide-marks where the crust has halted in its descent; also in many places bulgings, where the lava has been scarcely stiff enough to stand, and others where it has actually formed stalactitic masses.

So much for actual lava subsidences.

The special object of this paper is to draw attention to a subsidence on the slopes of Leirnukr, a volcano several miles north of this spot, where a large strip of land, perhaps 200 yards wide, and one mile or more long, has been let down to a varying depth, averaging perhaps 60 to 80 feet.

The faults bounding it, like nearly all the fissures in this district, run north and south; and the east face, which is most perfect, cuts right through a thick stream of old columnar lava and through a large boss of tuff, round and over which the lava has bedded itself, and also through the tuff rocks at each side of the lava stream. It would appear worthy of consideration whether this great depression, which thus affects all the crust of the volcano impartially, may not have been caused by the falling in of one of the steam cavities which may be presumed to exist under volcanoes after the lavas have been expelled by the steam pressure.

This would accord with the observation that sedimentary rocks near volcanoes often dip towards those volcanoes. Mr. Goodchild has informed the author that the sedimentary rocks round Arthur's

Seat are much thicker the nearer they are to that old volcano, as if the ground had slowly sunk while they were being deposited.

Near Lón the author was shown a small giá, said to have been formed during an earthquake in February, 1885. The crack was of a freshness corresponding to such a date, and was only a few inches wide, and so short that it could not be determined whether it extended beyond one bed of lava. It certainly was not an example of the escape of liquid lava from below a crust, nor of a subsidence over a steam cavity, and its chief interest in this connection is as showing that at least three separate sets of causes are at work in producing the giás of Iceland.

VII.—On a New Method of Measuring Crystals, and its Application to the Measurement of the Octahedron Angle of Potash Alum and Ammonia Alum. By H. A. Miers, M.A., F.G.S.

THE two fundamental laws of Crystallography—namely (1) the constancy of the angle in crystals of the same substance, and (2) the law of simple rational indices—seem to be violated by those crystals which are liable to irregular variations in their angles, or those which have the simple faces replaced by complicated "vicinal" planes.

Both these anomalies are exhibited by potash and ammonia alum. Brilliant and apparently perfect octahedra of these salts show large variations in the octahedron angle; other crystals show low vicinal planes in place of the octahedron faces.

If it be true, as is supposed, that the octahedron angle varies in different crystals, it would be interesting to ascertain whether progressive variations can be traced during the growth of a single crystal, and whether some or all of the octahedron faces change their direction in space if the crystal be held fixed during growth.

In order to solve this problem a new goniometer has been constructed, in which the crystal is fixed at the lower end of a vertical axis, so that it can be immersed in a liquid during measurement.

This device is in reality an inversion of the ordinary goniometer with horizontal disc; the liquid is contained in a rectangular glass trough with parallel-plate sides; one side is placed rigidly perpendicular to the fixed collimator, and the other is perpendicular to the telescope, which is set at 90° to the collimator. The trough is supported on a table which can be raised and lowered, so that the crystal can be placed at any required depth in the liquid. If the liquid used be its own concentrated solution the crystal can be measured during growth, and the changes of angle, if any, can be observed at different stages.

In order that it may be held rigidly, the crystal is mounted, when small, in a platinum clip, which it envelops as it grows larger.

The results derived from the measurement of a large number of alum crystals are as follow:—

(1) The faces of the regular octahedron are never developed upon alum growing from aqueous solution.

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(2) The reflecting planes (which are often very perfect) are those of a very flat triangular pyramid (triakis octahedron), which overlies each octahedron face.

(3) The three faces of this triangular pyramid may be very unequal in size.

(4) The triakis octahedron which replaces one octahedron face may be different from that which replaces another octahedron face upon the same crystal.

(5) During the growth of the crystal the reflecting planes change their mutual inclinations; the triakis octahedron becomes in general more acute, *i.e.* deviates further from the octahedron which it replaces as the crystal grows.

(6) This change takes place not continuously, but *per saltum*, each reflecting plane becoming replaced by another which is inclined at a small angle (generally about three minutes) to it.

(7) During growth the faces are always those of triakis octahedra; if, owing to rise of temperature, re-solution begins to take place, faces of icositetrahedra are developed.

Conclusions:—The above observations prove that the growth of an alum crystal expresses an ever-changing condition of equilibrium between the crystal and the mother liquor. It does not take place by the deposition of parallel-plane layers; new faces are constantly developed: since these succeed one another *per saltum* they doubtless obey the law of rational indices, though not that of *simple* rational indices.

From the mutual inclinations of these vicinal faces it is possible to calculate with absolute accuracy the angle of the faces to which they symmetrically approximate. This angle is found to be that of the regular octahedron, $70° 31\frac{3}{4}'$. The octahedron angle of alum is not, therefore, as appeared from the observations of Pfaff and Brauns, subject to any variation.

The angle at which a given vicinal plane is inclined to the octahedron is independent of the area of the plane, and of the temperature of the solution, and of the barometric pressure: it appears to be conditioned by the concentration of the solution at the surface of the plane.

In confirmation of this view it is found that the upper and lower portions of an octahedron face which stands vertical are often replaced by two different triangular pyramids; also that the three faces of one such pyramid are, at a given moment, not necessarily equally inclined to the octahedron face which it replaces.

When, as is often the case, one of the three vicinal planes is large, and the other two are too small to give a visible reflection, the face appears to be a single reflecting plane. It is this which has been mistaken for the octahedron face in previous observations.

Similar phenomena of growth are exhibited by crystals of other substances belonging to different systems. The conditions of equilibrium between the crystal and the solution are such that vicinal planes appear in place of simple forms; these vary with the concentration of the solution, and give rise to variations in the measured angles, which are only apparently anomalous. Their true position can be determined on a crystal of cubic symmetry (such as alum) whose theoretical angles are known.

A further study of the faces developed during the growth of crystals will, it is hoped, lead to a better understanding of the reasons why a simple face like the octahedron should not be a surface of equilibrium, and of the relation between the vicinal planes and the structure of the crystal.

REVIEWS.

I.—MEMOIRS OF THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM. THE JURASSIC ROCKS OF BRITAIN. Vol. IV. The Lower Oolitic Rocks of England (Yorkshire excepted). By HORACE B. WOODWARD, F.G.S. 8vo. pp. xiv. and 628, with 2 Plates and 137 Woodcuts. (London: Kegan Paul, Trench, Trübner & Co., Limited, 1894.) Price 10*s*.

THIS is, practically, a third instalment of the important work now in course of publication by the Geological Survey, of which the previous volumes have already been noticed in the GEOLOGICAL MAGAZINE. Vol. iv. contains an account of the Lower Oolites (Inferior Oolite and Great Oolite) throughout their long outcrop from the English Channel to the Humber.

In his preface Sir A. Geikie observes that much assistance has been derived by Mr. Woodward in the preparation of the present volume from the previous Memoirs of the Survey, especially those dealing with the Oolitic rocks by Professors Hull, Green, and Judd, and more recently by Messrs. Ussher and Jukes-Browne. The Director-General also does justice to the work of other observers in this field, commencing with William Smith, whose original labours are commemorated in the names given by him to many of the subdivisions of the Oolites.

The author, in fact, has largely availed himself of the assistance to be derived from previous publications, both official and non-official; and he likewise acknowledges the help which he has from time to time received from the personal communications of those interested in the Jurassic geology of this country, It is of course obvious that with such a work as Judd's Geology of Rutland in hand, the path of the surveyor in the East Midlands must have been made comparatively easy.

After some introductory remarks by Mr. Woodward, dealing with the Oolitic rocks as a whole, we have some petrological notes from Mr. Teall; nor is the subject of *Girvanella*-tubes forgotten in connection with the possible origin of Pisolite. Two plates of sections of Oolitic limestones and ironstones illustrate this portion of the work.

THE INFERIOR OOLITE SERIES (*Bajocian*). Chapters ii. to vii. inclusive, are devoted to this series, which, in its course throughout England, is justly described as exhibiting almost every variety of stratified rock. The base, Mr. Woodward considers, is not always