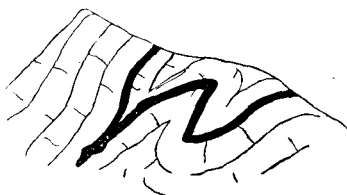


flexures in them, every section almost, of a few yards in length, affording an indication of disturbance.

Between Clovelly and Portledge Mouth the Upper Culm Measures consist of grey, lilac-grey and reddish thick-bedded even grits, with intersratification of dark grey shale. The even-bedded character of this series renders the flexures in the cliffs very apparent, especially when dark grey shale bands are affected by them, as at 31 chains

FIG. 3.



from Clovelly Pier where sharp inverted curves are shown, V shaped flexures are visible about 14 chains from the Pier, and from 18 to 22 chains from the Pier the beds are contorted and faulted. At about 70 chains from Clovelly beautiful examples of marine tunnelling are afforded by the Black Church rock, in which two tunnels

have been excavated along the bedding, and by a neighbouring reef in which the sea attacked the opposing strike surface, the tunnel being roofed by a massive bed dipping landward.

To enter more fully into the many inverted and ordinary curves exposed in this interesting coast would be beyond the purport of this paper. I have not attempted to give a digest of the numerous notes I have made of the Culm Measure area, nor do I think it would be possible to do so; but I trust that I may have succeeded in directing attention to a large district practically unknown to geologists, and in showing that, in spite of the confusing complexity of detail, it is possible to obtain something like a definite sequence. To make out the structure thoroughly would require years of patient labour on the 6 inch scale, and is in no sense feasible in holiday rambles; but there are curious structural phenomena which would amply repay the labours of the casual visitor.

III.—NOTES ON "CONE-IN-CONE" STRUCTURE.

By W. S. GRESLEY, F.G.S.

IN Decade III. Vol. II. of the GEOLOGICAL MAGAZINE, for 1885, at page 283, an abstract of a paper on "Cone-in-Cone" by Mr. John Young, F.G.S., of Glasgow, was given. The author of this interesting paper has kindly presented the writer with a copy of it, to which, since it was read in Glasgow last year, has been added some additional remarks, together with two very beautiful plates, by 'photogravure,' in illustration of some of his typical Scottish specimens.

The result of Mr. Young's labours in this connection have warranted him in arriving at the following conclusion respecting the origin and formation of cone-in-cone structure, which, briefly stated, is this:—That the formation is due to the "upward and successive escape of gases generated in the lower portion of the stratum in which the structure is found, probably by the decay of

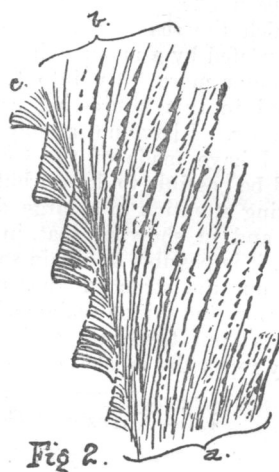
organic matter in the deposit whilst still in the process of formation and in a soft, sedimentary condition; each ebullition of gas being marked by a new or successive layer of sediment within each cone.” “That the cones, large and small, have their apices invariably directed towards the lower portion of the stratum.”

As, in the course of the last year or two (due chiefly to the occurrence of some interesting examples of cone-in-cone in the breccias of the Permian? series in Leicestershire, see Q. J. G. S. vol. xli. Proceedings, page 109, and the “Midland Naturalist,” vol. ix. No. 97 [new series]), the writer has given some attention to this interesting rock-structure, his observations in the field and elsewhere have brought to his knowledge several important facts, and such as have reluctantly prevented him from accepting Mr. Young’s theory.

Although Mr. Young has gone very fully into the question, he does not appear to have noticed one or two important points often seen in cone-in-cone structure, which I will now endeavour to describe.



$\frac{1}{2}$ nat. size.



4 times nat. size.

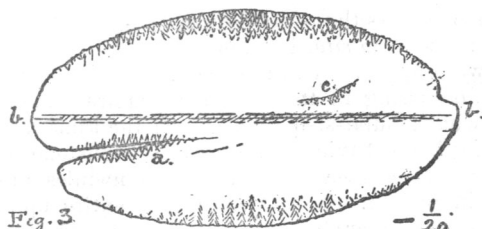
(a) In the case of large, strong, well-developed cones, often four or five inches in length (see Fig. 1), and generally composed of compact siliceo-ferruginous sandstone in the Coal-measures, which I will call ‘master cones’ because they seem to cut out the feebly developed ones in their upward expanding growth; the walls, or substance of the cones, or conical-shaped cups or portions of such (for whole hollow cones are rarely met with), often as much as a quarter of an inch in thickness between the usual concentric layers of corrugations more or less filled with clayey material, are themselves composed of cone-in-cone formation (also possessing their clay-filled serrations); the bases of the cones abutting upwards upon the clay wrinkles which separate each great cone or part of a cone. A reference to

Fig. 2 will probably better explain what is intended to be noticed above. It represents a portion of a vertical section of one of the master cones enlarged about four times. The specimen is from a bed of clay-ironstone occurring above the fire-clays of the Western division of the Leicestershire Coal-field—a horizon which has furnished the writer with more than one illustration of the way in which cone-in-cone structure occurs.

But further, I would point out that the concentric serrations between the cones, and shown as adhering to the exterior surface of one of them at *c*, Fig. 2, are also composed of scaly or semi-cone-in-cone structure. This, though of minute development, can readily be detected with a pocket lens, especially upon partially weathered samples. The bases of these tiny flakes seem to terminate against the serrations of the master cones, and upon the sides of the cone-structure forming their walls (see Fig. 2). In short, this specimen (and doubtless it is a typical one) appears to be wholly built up of 'cone-in-cone,' of at least three separate and distinct developments, *a*, *b*, and *c*. For this curious three-fold structure I fail to see how the ebullition-of-gases theory can satisfactorily account.

With reference to the question of cone-in-cone found upon the under as well as the upper surface of a stratum or a concretionary mass, Mr. Young would have us believe that when this does occur it has probably been due to the shrinkage of the mass, such contraction having actually carried the coned surface round to the underside. I think the following instances of reversed or double cone-in-cone at once upset his theory.

(*b*) In a stratum of blue shale or 'bind' at the village of Donisthorpe in the Leicestershire Coal-field, occur some large concretionary masses—often several tons in weight—of hard and compact fine-grained siliceo-ferruginous sandstone, locally called 'cank,' whose upper and lower surfaces are often largely covered with cone-in-cone formation. That upon the under surface, however, is always the most feebly developed. Now, as the coned surfaces are always most strongly formed in the centre of the mass, or, in other words, as the



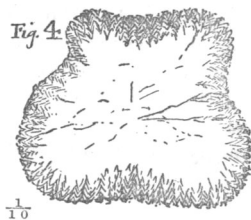
edges towards *b b* (see Fig. 3, which represents a transverse section) are almost devoid of cone structure, it is at once apparent that the cones upon the under side cannot have been brought into their present position by any known process of shrinkage or curling up, or downwards, of the nodules. Besides, in one instance, we have at *a*,

a double cone-in-cone development on the surfaces of a large crack or cavity in the side of the specimen; whilst at *c*, in the interior of the same nodule, occurs a small and rather feeble development of the same structure, in no way connected with the top and bottom cone-in-cone layers. Again, as the band marked *b b*, which is a layer of three or four inches of argillaceous ironstone, is crowded with well-preserved leaflets of *Neuropteris gigantea*, surely these organic remains must have greatly suffered had contraction of the mass taken place to any extent, which is not the case.

(c) Very good hand-samples of whole disc-shaped clay-ironstone nodules, exhibiting on both flat surfaces well-formed cone-in-cone structure, are preserved in the Geological Museum of Owens College, Manchester, and here again we find that this structure is much more strongly developed on one side than on the other, and that the coned surfaces are confined to the central parts of the nodules, as shown in Fig. 3, which is roughly half the size of the Manchester specimens. As these nodules were not labelled, I cannot give their locality, etc.

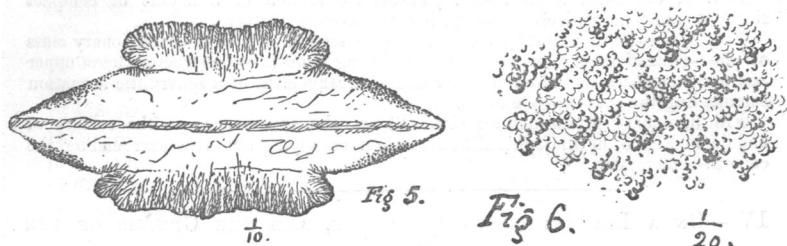
(d) In the Museum of the Yorkshire College of Science, Leeds, there is a small specimen of earthy limestone from the Wealden beds, Brixton Bay, Isle of Wight, upon whose upper and lower surfaces cone-in-cone formation is seen—very minute upon the underside—the upper one commencing in contact with a layer of fossil bivalve shells whose uneven surface corresponds with that of the apices of the cones.

(e) I have quite recently noticed in the shale “baring” of the fire-clay opencast workings in the Leicestershire Coal-field singular nodular masses of hard flinty fine-grained stone (a worthless variety of clay-ironstone), one of which is shown in cross-section in Fig. 4. Upon the surface of this specimen the cone-structure has the appearance of having been subjected to considerable shrinkage, as the cones or rather wedge-shaped scales of cone-in-cone structure, occur in curious wrinkles or ridges upon the general surface of the stone. As these singular examples were not seen *in situ*, I cannot say which sides were uppermost in the shale.



(f) Again, occurring in the same stratum are some large concretionary somewhat tabular-shaped masses of the same kind of rock as that last noticed, and having a kind of clay-ironstone band running through their centres (see Fig. 5). These nodules are sometimes several tons in weight. Now, forming the entire upper and lower portions of these singular stones are cone-in-cone structures as shown in the sketch; and occupying zones lying between the cone-in-cone portions and the rather sharp edges or peripheries of the masses, both upon upper and lower surfaces, are formations of innumerable little spheres or spherulitic concretionary masses, and, as it were, grown together,—very perfect and distinct upon the surface, but rapidly dying out towards the interior of the stone, and apparently grading

into the cone-in-cone formation on the one hand and disappearing in the opposite direction, namely :—towards the periphery of the nodule (see Fig. 5).



A peculiarity in the appearance or arrangement of this spherulitic structure is that the surface of it often takes a beautiful wavy or fantastic stalagmitic form, giving the idea that the substance of the structure was in a semi-fluid condition during formation of the botryoidal structure. The aspect is not altogether unlike a number of flat bunches of very small grapes, disposed in more or less regular rows or terraces one above another (see Fig. 6). The globules or spheres forming the apices or lowest points of these little wavy ridges are always the largest or most perfectly developed of the individual groups or bunches. These tiny spheres contain a considerable percentage of lime, as do the cone-in-cone masses which are encircled by them.

With respect to the mineral constituents of cone-in-cone rock, Mr. Young seems to hold that calcareous matter was essential to its existence. As many of my specimens are not affected by the acid test, the lime, if originally present, has been since removed.

It may be interesting to remark here, that cone-in-cone structure occurs in the Upper Cambrian rocks—the Skiddaw slates—near Shap. Were it necessary, I could instance other interesting examples of cone formation, but from what has been said it will be obvious that, notwithstanding my admission of Mr. Young’s perseverance and care in having worked out so much and given a very reasonable explanation of cone-in-cone, which, had it not been for the discovery of the double and the complicated instances, I should certainly have accepted as the probable correct one, I am compelled to discard it as not being sufficient to account for all the observed facts.

It is exceedingly improbable that this kind of cone-in-cone structure can have been formed in one way as regards the upper layers of it; and in another way as to those found with their bases pointing downwards. I myself have no explanation to advance. The structures observed are, however, very complex, they seem to deserve a closer examination than they have yet been subjected to, not in the field only, but in the laboratory and also microscopically.

Fig. 1, natural size. Vertical section of portion of three ‘master’ cones.

Fig. 2, $\times 4$. Enlarged view of part of a ‘master’ cone. *a.* showing the cone structure in its walls. *b.* and *c.* the semi-cone formation of the clay serrations on the back of the ‘master’ cone.

FIG. 3, one-twentieth natural size. Transverse section of a large concretionary mass of compact siliceous ironstone, exhibiting cone-in-cone structure upon both upper and under surfaces, as well as in the interior of the mass, at *a* and *c*. The band *b*, *b*, is clay ironstone crowded with leaflets of *Neuropteris gigantea*.

FIG. 4, one-tenth natural size. Transverse section of a nodule of compact siliceous ironstone, entirely coated with cone-in-cone structure.

FIG. 5, one-tenth natural size. Transverse section of a large concretionary mass of close-grained ferruginous sandstone exhibiting cone-in-cone structure upon upper and under surfaces, and also a peculiar double arrangement of a spherulitic formation surrounding the cone-in-cone areas.

FIG. 6, one-twentieth natural size. Shows the appearance, on the surface of nodule in Fig. 5, of the spherulitic structures occupying the areas surrounding the cone-in-cone masses.

IV.—ON A DIAMANTIFEROUS PERIDOTITE, AND THE GENESIS OF THE DIAMOND.

By Prof. H. CARVILL LEWIS, M.A., F.G.S.

(Abstract of a Paper read at the Birmingham Meeting of the British Association for the Advancement of Science, September, 1886.)

THE discovery of diamonds at Kimberley, South Africa, has proved to be a matter, not only of commercial, but of much geological interest. The conditions under which diamonds here occur are unlike those of any other known locality, and are worthy of special attention.

The first diamond found in South Africa was in 1867, when a large diamond was picked out of a lot of rolled pebbles gathered in the Orange river. This led to the "river diggings" on the Orange and Vaal rivers, which continue to the present time.

In 1870, at which time some ten thousand persons had gathered along the banks of the Vaal, the news came of the discovery of diamonds at a point some fifteen miles away from the river, where the town of Kimberley now stands. These were the so-called "dry diggings," at first thought to be alluvial deposits, but now proved to be volcanic pipes of a highly interesting character. Four of these pipes or necks, all rich in diamonds, and of similar geological structure, were found close together. They have been proved to go down vertically to an unknown depth, penetrating the surrounding strata.

The diamond-bearing material at first excavated was a crumbling yellowish earth, which at a depth of about 50 feet became harder and darker, finally acquiring a slaty blue or dark green colour and a greasy feel, resembling certain varieties of serpentine. This is the well-known "blue ground" of the diamond miners.

It is exposed to the sun for a short time, when it readily disintegrates, and is then washed for its diamonds. This "blue ground" has now been penetrated to a depth of 600 feet, and is found to become harder and more rock-like as the depth increases.

Quite recently, both in the Kimberley and De Beers mines, the remarkable rock has been reached, which forms the subject of the present paper.

The geological structure of the district and the mode of occurrence of the diamond has been well described by several observers. As Griesbach, Stow, Shaw, Rupert Jones, and others have shown, the diamond-bearing pipes penetrate carbonaceous strata of Triassic age, which are known as the Karoo formation.