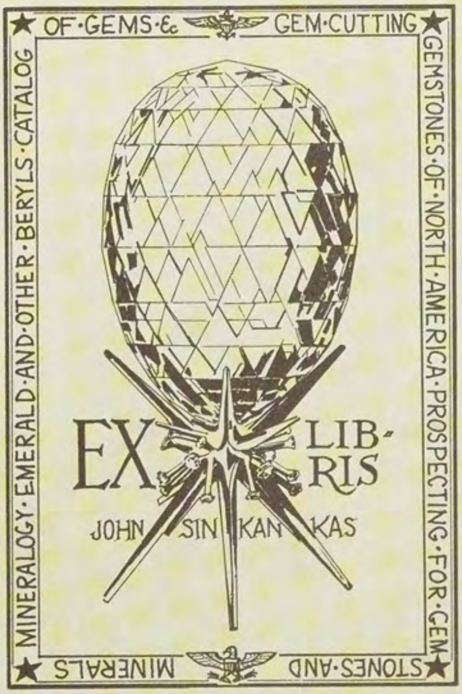
OF·GEMS·&c GEM·CUTTING
GEMSTONES·OF·NORTH·AMERICA·PROSPECTING·FOR·GEM
STONES·AND MINERALS
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SEMI-PRECIOUS STONES OF CARRICK.

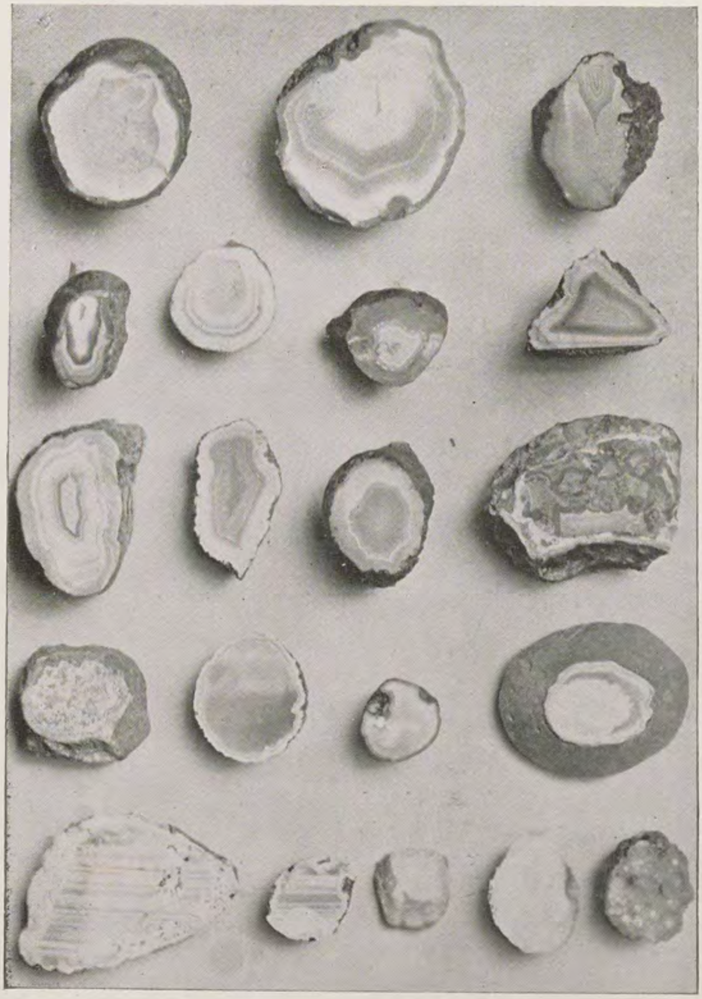

PLATE I.

(Frontispiece)

To the Misses Corrie
With the Author's Compliments.

SEMI-PRECIOUS STONES OF CARRICK

BY

JOHN SMITH

AUTHOR OF
"Prehistoric Man in Ayrshire,"
"Stalactites and Stalagmites of Cleaves Cove,"
"Botany of Ayrshire,"
"New View of the Arran Granite Mountains,"
"Condonts of the Ardovecian Rocks of the Southern Uplands of Scotland,"
"Drift Deposits of Ayrshire,"
"Upland Fauna of the Old Red Sandstone Formation of Carrick, Ayrshire,
etc.

"A thing of beauty is a joy for ever."

KILWINNING:
A. W. CROSS, 110 MAIN STREET.

INS AN CUIMHNE.

CLACHAN ALUINN MATHAIR

CHACHAN ALUINN.

PREFACE.

For a long time, in all likelihood ever since man first put his foot in Carrick, the Cornelians, Agates, Jaspers, Onyxes, Opals, Sards, etc., of the Volcanic Rocks of that part of Ayrshire have had a great attraction for all classes of the community, and the visitor to the Carrick Coast seldom returns without carrying away a few of these SEMI-PRECIOUS STONES to have them cut into trinkets as a momento of his or her visit. During the recent extensive cuttings made through the Lava Flows of the Upper Old Red Sandstone Period for the construction of the Coast Railway I had ample opportunities of studying these substances in their native homes, and as it is not often one has a 100 navvies digging out specimens galore, from which he may hammer, pick, and choose at his own sweet will, I took advantage of the opportunity offered and visited sometimes twice a week for several years the excavations, taking notes and collecting such examples as would throw light on the manner in which the semi-precious stones of Carrick had been formed. The specimens that could be obtained were simply in myriads and I had no difficulty in selecting a suitable series shewing the different forms of structure of these remarkable "seds." As openings like these may never occur again I take this opportunity of putting the record of my researches in print as a small contribution to the knowledge of this department of mineralogy, all I have aimed at in this little brochure being simply a monograph of the Carrick Geods.

We have a few notable papers on agates, such as that by Ruskin, with coloured illustrations; and that by Heddle.

In this monograph I have admitted no loose shore specimens, and none but what I have collected myself from the lava flows.

Figures and descriptions of agates, etc., are sometimes far from being nature-perfect, as the specimens are often obtained from the gravel banks of shores and rivers, dealers' stores, or in any way.

J. SMITH.

DYKES,
DALRY,
AYRSHIRE.

14th February, 1910.

SEMI-PRECIOUS STONES OF CARRICK.

Semi-Precious Stones of Carrick.

THE Agate-bearing rocks of Carrick have been long known to geologists, and the collectors of "pebbles" have furnished beautiful examples of Carnelians, Jaspers, Opals, Agates, Onyxes, Sards, etc., and are well exposed on the Brown Carrick range of Hills, in several quarries, Lagg, Dunduff, Fort, etc.; and especially along the shore for a distance of three and a half miles from near the Heads of Ayr to beyond Dunure Castle; outliers of them occurring on the coast near Turnberry and Culzean Castles.

The recently made cuttings for the coast railway from Ayr to Girvan through the Amygdaloidal traps have given us a series of sections of the Old Red Sandstone Lava Flows where the contents of the gas cavities can be studied to advantage; the principal cuttings being those opposite Lagg; near Fisherton; at the road leading down to Dunure (Port Rorie), now where Dunure Station is situated; and Linkentoms cutting to the south of Dunure Castle.

To the casual observer the agates and other "fancy stones" of these rocks are of course the great attraction, but to the geological student the general contents of the gas cavities are equally so, and the dissection of the lavas made during the progress of the railway construction laid open a field for research—especially in the material extracted—which may never occur again.

The details given of the different varieties of amygdules from the gas cavities will best shew the peculiar nature of their contents, but I may here state that some of them are almost completely filled with calcite (crystallized carbonate of lime), others equally so with siliceous materials ; the bulk of them containing a mixture of substances, there being few *Zeolites*, and this feature has placed a marked distinction on these Old Red Sandstone Lavas compared with those of early carboniferous age and later date of the West of Scotland.

Another feature well enough seen in the shore sections, but particularly emphasised in those of the railway, is that since the infilling of the gas cavities of the traps very little tilting of the rocks has taken place, at most 20°. This is demonstrated by the banding of the level-agates, which shew only a dip of a few degrees towards the coast.

At what period the semi-precious stones were deposited in the gas cavities it may be idle speculation to enquire, but so soon as water commenced to pass through the rocks into them, deposition very likely began, and this may have been before the flows had cooled to what may be called the normal temperature of the rock ; in fact, I don't see anything that was to hinder *all the cavities to have received their contents before that temperature was reached*, and the varying temperature (for we can't imagine the heat to have been quite uniform) may have had a good deal to do with the different qualities of material deposited as geods.

Area of the Lava Flows.

The Lava Flows of Old Red Sandstone age in the north-west part of Carrick occupy an area of twelve square miles, there being a few small outliers shewing that the flows covered a much greater surface originally, a large part of them having been removed by denudation, and as the flows are seen to dip under the sea, a considerable portion may be hid below the waves.

As to whether the Lavas were poured out under water or on land will best be discussed after the evidence shewn by their associated strata has been taken.

Volcanic Vents.

In the north-west corner of Carrick no volcanic "Neck," or "Vent," through which the materials composing the flows may have come has yet been discovered in the area covered by the flows, but a short distance from the Old Red Volcanic Area we have the great Volcanic Vent of the Heads of Ayr, and it might be thought, at a first glance, that from it had flowed the lava beds of this part of Carrick, but a study of this "neck," its contents and the strata from which it rises, soon convince us that it is of much more recent origin than the flows of Old Red age, so that the neck (or necks) from which the lava came still remains to be discovered. It might be suggested that the flows had taken place from "fissure eruptions," but the exceeding scarcity of Trap Dykes through them does not favour this theory, and the thick bed of Volcanic agglomerate which had been well sorted out in water to be seen interbedded between two flows in the old coast cliff near Dunure Village, and the upper part of a similar one at Culzean Castle, and another at Maidens Bay rather favour the theory that the flows had come up through a volcanic vent or vents.

To the south of the principal volcanic area is Mochrum Hill; it can't be clearly made out whether or not it was the site of a neck, but if not, there must have been one near it, as it is composed largely of volcanic ash; in fact, if this was not the site of the volcano from which the flows took place, it was, in all likelihood, one of them.

Description of the Lava Flows.

The geological surveyors have classed all the lava flows of Old Red Sandstone age in the north-west corner of Carrick under the generic name of *Porphyrite*, and for field work the following specific terms for the different flows are very convenient: hard, fine-grained flows weathering to a lighter colour are *Felstones;* those with conspicuous crystals, Felston-porphyries; those with gas cavities, Amygdaloidal-felstones; those with both amygdules and conspicuous crystals, Amygdaloidal-felstone-porphyries.

The agate-bearing rocks extend well up the hills, and the denser and harder flows, with only an occasional amygdule, form the summits of knolls and the top of the highest of the Volcanic Hills, Brown Carrick, some of the flows where weathered shewing hard kernels of rock with a few thin felspars. Hard flows also occur at intervals down to sea level.

The solid, hard, close-grained felston flows, generally of a dark-purple, or dark-grey colour, sometimes shew a rhyolitic or flow-structure, the lava having been drawn out into thin laminate by its own differential movement when flowing and cooling. Parts of these flows also take a globular form on a large scale, and just now (January, 1906) in the Trees (or Fort) quarry two immense globes may be seen, the larger one being about 30 feet in diameter. This is probably a form of jointing which took place during cooling, and the question is, did this structure form from the outside or inside ? One would think naturally from the outside. Between the two large globes the jointing is vertical, Fig. 1.

Fig. 1. Globular structure in a fine-grained lava flow, large globe 30 feet in diameter.

As the lava flowed along it would be hindered in progress in its lower part coming in contact with the colder rock. In the more fluid flows the part above it would probably assume a rolling movement, and at places might take a globular form, and this may have been the origin of the large spherical masses seen in parts of some of the hard close-grained flows. If it was not something of this kind it is difficult to understand how these great globular masses came to get differentiated out from the liquid lava during cooling. Another structure in the same quality of flows is in support of a rolling movement of the lava, and that is elongated, irregular masses in some of them have got a lithy, concentric structure.

Along the south-eastern side of the Volcanic Area the flows are often close-grained, the fine escarpment of Craig Skean being of this description, the under and upper parts of these flows—in fact, of most of the flows—being slaggy and amygdaloidal. The first flow of all, so far as can be seen, has been a fine-grained one, and has indurated a bed of sandstone on which it rests.

Some of the harder flows have decomposed exceedingly little since the glacial period, and present on the hills bosses of rock; the greater part of the hill-area being characterised by abundance of heather and moss plants, grass being a scarce commodity. On some of the lowlands grass grows well, especially where the flows are soft, or amygdaloidal, and the stones on some cultivated bits have amongst them a considerable proportion of agates, etc.

The Old Red Sandstone strata passes under the hill-flows on the south-east side of the area. The best place, near the traps, where these beds can be examined is in Sauchie Glen, a flower and fern gorge, clothed with garlic, with steep and sometimes perpendicular sides, closed at its north-west end by a waterfall, the footboard of which is formed by the first lava flow in this part.

In the railway cuttings a variety of flows, from very fine grained to coarsely crystalline, and from sheets with only an occasional amygdule to others crowded with them, are to be seen, some of them being crowded with both crystals and amygdules intimately mixed. Commencing at the north cutting, opposite Lagg, we have beds with abundance of agates, some of the flows appearing quite green from the quantity of *Celadonite* they contain. Here siliceous geods may be found rotted to powder at a distance of 20 feet from the surface of the rock.

In the next cutting, near Drumbane, there is a flow crowded with felspar crystals and another one with both felspars and amygdules in abundance. Here there is a soft reddish flow, with very few geods.

In the cutting near Fisherton there is a remnant of a flow, much decomposed, with crystals; and a soft, purple one with abundance of amygdules, all apparently of calcite. In this cutting a micaceous *Tuff* has got a band of nodular limestone which also contains abundance of mica.

In the cutting at the road bridge (where Dunure Station now is) there are flows of various qualities, one close-grained and hard, with few amygdules—all siliceous, and some thin agate veins. An amygdaloidal flow here is conspicuous from the number of *level-agates* it contains, the original *horizontal banding* of the agate being now *inclined* at a few degrees towards the north north-west. In this cutting several short limestone beds, interposed between flows, were cut through, one of them being 5 feet thick.

Linkentoms cutting, south of Dunure (Dun Aire) Castle, shews a variety of flows, and many fine geods have been got from it, one flow being conspicuous from the number of *Carnelians* it contains. This cutting exhibits some volcanic ash beds at its south end, faulted against a lava flow.

In most of the cuttings lenticular patches of limestone are exposed, mostly fine-grained, brownish, greenish, or greyish in colour, and without fossils. They range from mere lines of nodules up to solid beds several yards in thickness, are sometimes quite crystalline, and contain patches of bright-red *Jasper* and brownish flinty-looking silica ; evidently owing their crystalline structure to the heat derived from flows of lava which took place subsequent to their deposition. The jasper and other siliceous masses in the limestone evidently resulted from the heat communicated to the limestone by the flows of lava, this having allowed molecular movement to take place, the iron in the brown limestone having combined, as oxide, with the silica to form the particularly *bright red jasper*, this substance being often set in a halo of pure white statuary marble ; the rest of the limestone from which the iron and silica had not been removed remaining as dingy-purple blotched patches. The jasper ranges from minute specks up to masses six inches in size, the white crystalline limestone surrounding each being in proportion to the size of the enclosed lumps of jasper ; indices of the amount of iron and silica that had segregated out from the surrounding limestone. This *heat-formed jasper* is quite different in structure to that deposited from a watery solution, being minutely granular.

The Lava Flows along the shore being kept fresh by constant denudation, always present an open " field " for study and are much the same as those exposed in the railway cuttings. The soft, purple beds contain a large proportion of calcite amygdules and sometimes all the cavities in these flows appear to be filled with nothing but that substance. The siliceous flows contain the most agate, or crystallized silica, and as one proceeds along the shore he is constantly passing cliffs where calcareous or siliceous material predominates in the gas cavities.

Some of those large globular masses of trap, such as have been already noted as occurring at the Fort, are also to be observed in the coast sections, the most conspicuous I have seen being more than half a mile north of Port Rorie. Here they are larger than in the Fort quarry, and where weathering has broken them up a little, the concentric plates of trap present a very jagged appearance. In some of the sea-stacks, sections of them may be seen in *plan*, and they reach to about 80 feet in diameter.

Flows crowded with conspicuous crystals are not common, but about a mile to the north of Dunure there is plenty of this quality of trap. It is often quite free from amygdules, but sometimes contains lots of them. They have also got some sandstone patches, like those already referred to, shewing that they are not sills and that this quality of flow took place under conditions quite similar to those of the other flows.

In the Carrick Old Red Lava-flows exceedingly few *dykes* are to be seen, and as to *sills* it would be hazardous to pass an opinion and difficult to distinguish between a *sill* and a *flow* where all the rocks are of igneous origin ; a dolerite sill might easily be distinguished, but I have seen none.

Besides the water-deposited veins in the lavas already referred to, there is another set, mother-liquor segregation, or *aphlite* veins, always harder and closer grained than the rocks through which they pass—they shew no banding and are coeval with the cooling of the flows.

As to columnar structure, it is almost absent from the lava flows. Occasionally we see a rude vertical jointing, but no well-formed columns have been observed anywhere.

Lava Channels.—The Lava has sometimes flowed in channels, both open and enclosed, and a fine example of the latter is to be seen in a part of the lava bed half a mile south of Dunure Castle. From the face of the sea cliff here there projects a gargoyle-like bit of compact trap surrounded by scoriaceous material, and it looks as if the former were part of an elongated mass which had plugged up a channel through which liquid trap had flowed for a time, Fig. 2.

Fig. 2. Trap filling on enclosed channel in a lava flow.

Another end of a plug 8 ft. by 6 ft., irregular in outline and composed of reddish purple amygdaloidal lava, is seen in a slaggy part of a flow.

The Pillow-structure, so beautifully seen in the *Arenig Lavas* of the south Ayrshire coast, appears to be entirely absent from the flows of Old Red Sandstone age in Carrick, so far as exposed.

As to the total thickness of the Lavas, they are probably not more than 400 feet, but have evidently suffered a large amount of denudation both in area and thickness, much of it having taken place *before* the Calciferous Series, of the Carboniferous Formation, was all deposited. The proof of this is to be seen in a railway section of calciferous conglomerate opposite Bowerhill, where many pebbles of the conglomerate are *agates* and *carnelians* derived from the denudation of some of the Lava Flows.

I have referred to the tilting the flows have undergone since the infilling of the amygdules, and will give a detail of the most striking instance of this I know. It occurs in the old quarry on the moor exactly opposite Dunduff Castle. Here a large gas cavity has had a deposit of level-agate filled into it, the flow having now an inclination of about 40°, the level-agate being inclined *in the same direction* at an angle of 20° to the N.N.W., *since* the amygdule was formed. Whether or not the lava beds had been tilted before the infilling of the gas cavity is a point which can't be determined—perhaps 20° was the angle of dip of the original surface of the flow, and if so, this one must have flowed from the S.S.E., Fig. 3.

Fig. 3. Shewing dips of lava and level-agate.

Shapes of the Gas Cavities in which the Semi-Precious Stones were Deposited.

The shapes of the gas cavities vary much, all-but globular ones occur, and where the flows are of hard trap and fine-grained we find cavities, though few of this description, indicating that the lava had been pretty fluid when it ceased to flow ; cavities sometimes nearly semi-globular in general outline have a raised boss in the bottom ; others are flat-bottomed, some are similar, with a lot of knobs projecting downwards from the flat part ; pear-shaped ones often pretty squat in outline occur ; and all these may have been formed under similar conditions to the globular ones. Other shapes probably owed their origin to the flow of the lava while it was assuming a viscous state. Occasionally, cavities have taken a nearly cylindrical shape ; several have often run together, the materials filled into them forming geods of whimsical outline. Long finger-like cavities, often compressed, and sometimes with a sharp knife-edge ; axe-shaped ones, with the edge wider than the blunt end, occur ; plumb-shaped ones are frequently seen, and long flat ones bent to one side are occasionally got. Cavities of any shape may have projecting knobs, and sharp-edged ones serrations, but many of the walls of the cavities have been pretty smooth. The almond-shaped cavities, sometimes abundant and close together, which have given the names of *amygdaloidal traps* to so many lava flows, are often to be observed in the Carrick rocks.

Axe-shaped Amygdules.—When axe-shaped cavities have had level agate, or opal deposited in them, we get to know the position in which they lay in the rock. I have two specimens which shew that the sharp edges were turned downwards, as in Fig. 4., but this

Fig. 4. Axe-shaped cavity with level agate deposited first at sharp end.

has not always been the case, as in fig. 5, where delessite curls have fallen on to the broad side of an axe-shaped cavity.

In Fig 4 we see that a layer of chalcedony has gone all round the cavity, then level-opal has begun to be formed at the sharp-edge

Fig. 5. Delessite curls sealed by calcite.

(lower part in the rock), and has continued to be deposited till more than half of the cavity was filled ; crystallized quartz fills nearly the whole of the remaining space, a small part being plugged with cachalong.

The gas cavities in the lava flows of Carrick reach from the minutest pin-head sizes to the incredible dimensions of several yards in length, a cavity in the tide-way, about half a mile north of Dunure Harbour, being nearly four yards long and over a yard at widest part.* This cavity has a nearly straight side from near the middle of which lines radiate to the opposite curved side, the material with which it is filled being white calcite, contrasting strongly with the dark trap in which it is enclosed. One in Lagg quarry was 7 feet long, with a thick layer of agate all round.

Deposits in the Gas Cavities.

Only one material deposited at a time.—In Linkentoms cutting I saw two amygdules, each about three inches in diameter and one inch apart ; one being filled with *calcite*, the other with *agate*. The solution which entered these two cavities was very likely of the same consistency in each, but why the one should have been filled by crystallized carbonate of lime and the other with crypto-crystalline silica is difficult to understand. This instance, however, offers a support to a theory I have formulated that *only one kind of substance* was deposited,† or formed in a gas cavity *at a time*, or

*For a figure of this cavity, see Author's paper in *Trans. Geological Soc. of Glasgow*, Vol. X., Plate I.

†The word *deposited* conveys the idea of being *laid down*, but some of the material in gas cavities has been *laid up*, or placed in a vertical position.

conversely, two or more substances *never were formed in a gas cavity simultaneously*. I will refer to this again.

Some Peculiarities of Structure in the Geods, or Amygdules.

Lining or "skin" of the Gas Cavities.—Generally speaking, although there are exceptions, and sometimes no lining at all, *Celadonite*, or green earth, was the first substance to be formed within a gas cavity of an amygdaloidal trap. It sometimes accumulated to the thickness of an eighth part of an inch all round the cavity, and forms the "skin" to the substance afterwards deposited inside. It is often a mere "wash," but where thick it is made up of a number of thin laminæ which, curving round all the asperities of the inside of the cavity, simulate closely, both in "pattern" and colour, the intricate structure seen in *Malachite*. After the deposition of this first layer it appears often to have shrunk and split, the tattered and curled fragments of it having hung down in the cavity, or fallen to the bottom, and were afterwards surrounded or covered up by some of the different substances deposited therein. Celadonite also assumes a branching and anastomosing form, difficult to account for, and will be referred to in the descriptions of some of the geods. It also occurs as stalactites and forms the cores of the pendicles, as well as giving different shades of green to some of the contents of the amygdules. As the Celadonite layer occurs so frequently I will not again refer to it, unless to note its absence, or mention some peculiarity connected with it.

Reddish Layer.—Inside of the Celanonite skin there is sometimes a reddish layer, soft and shrubby looking, and when specimens of this description are rubbed down with water on either sandstone or Water o' Ayr whetstone, the *green* (Celadonite) adheres to the stone and the red floats off. In some cases this layer may be composed of *red stilbite*, but in the Carrick geods it is too thin to enable one to determine the point.

Chalcedony Layer.—Generally speaking, a layer of *chalcedony* follows the Celadonite all round the interior of a gas cavity and is sometimes represented by one moderately thick band, but often made up of a very few very thin laminæ, the position of the chalcedony layer being sometimes represented by cachalong.

Surface Tension.—It has been supposed by some mineralogists that the deposits of Celadonite and chalcedony inside of a gas cavity had taken place by a peculiar adhesion of the materials to the walls and roof of the cavity, this clinging of these substances all round the interior having been explained by the term " surface tension " At one time I made a pretty extensive microscopical examination of agates from thin slices cut at right angles to the layers and in every case found that the deposition of chalcedony was always *due to crystalline growth*, the crystals (tridymite) being of course microscopic and always standing at right angles, or nearly so, to the surfaces they commenced to grow on. Amongst my Carrick specimens I have some where the aggregate bundles of crystals can be seen by the naked eye.

Opal has often been entangled amongst tridymite crystals in the chalcedony layers.

It is clear, I think, from the above remarks that the growth of the chalcedonic layers (forming agate) was simply a matter of crystallization, a fact well known to those mineralogists who have studied the matter microscopically and with polarized light.

The Crypto-crystalline structure of the banded siliceous geods is sometimes beautifully brought out by weathering, the microscopic needle-shaped crystals closely packed together and always vertical to the banding having been clearly differentiated by that slow, natural process may be washed out and mounted in Canada balsalin. How these minute crystals have come to be

Fig. 6. Kernel of quartz.

lined by distinct laminæ or bands is a matter to theorize on. Was it by the drying up of a cavity, the entrance of a more watery solution or the reverse, the quality of the solution itself often producing various colours in the laminæ ; the effect of galvanic currents passing through the rocks, or how the dickens was it ?

Quartz following Opal.—In the Lagg and Dunure road railway cuttings there were many examples of this, and when the opal-layers (sometimes interbanded with chalcedony ones) had been decomposed, they are easily peeled off, leaving kernels of quartz, one side of which is *flat* (the underside in the rock), often smooth, sometimes "ornamented" with various patterns; often pure white and exceedingly beautiful. Fig. 6.

Hemi-Agates.—These occur in various parts of an amygdule, being sometimes the first deposits to form inside of a gas cavity. They often occur in great numbers (26,000 to a square inch) on the inside of the outer chalcedony layer, being sparingly seen on subsequent bands, and may be sealed over by celadonite, opal, cachalong, chalcedony, or crystallized quartz. They always begin to form from points (probably a single "molecule" was first laid down under the gaffership of the spirit of the druse) and have frequently remained "self-contained," but often they have coalesced (grown up to one another) into clusters, forming "fortification agate" and occasionally little parasitical Hemi Agates have grown on the larger ones.*

Occasionally a Hemi-Agate is seen to fill nearly the entire space inside of the outer layer of Chalcedony, but this is of exceedingly rare occurrence.

Agate.—Thickness of the Layers.—From a number of microscopic sections I made, it was seen that the layers of chalcedony forming agate vary very much in thickness. Some of them are quite visible to the naked eye, or with a lens; others are extremely thin, those of the Hemi-Agates being the thinnest of all, some of them only measuring the ten-thousandth part of an inch in thickness.

It has been suggested by mineralogists that the substance forming the "eyes" in agates differs from ordinary chalcedony, and the exceeding thinness of the layers of growth seem to support this view. It must be remarked, however, that they shew a cryptocrystalline structure like the ordinary agates, but on a very much smaller scale.

Cachalong.—This substance often gives a very beautiful and striking effect to geods when shewn in section, its pure white bands contrasting strongly with the differently coloured ones with which it may be interlaminated. As we have seen, it may take

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* Hemi-Agates are only perfectly hemispherical when they have grown on a *flat* surface, such as that afforded by an opal plate. The larger ones have been called "eyes" by lapidaries, but as they are only half-spheres that is rather a poor term, so that I have introduced the above one.

the place of the outer chalcedony layer, or it may fill nearly the entire space within that band, being either laminated or massive. When opal and chalcedony are decomposed to a certain extent, they sometimes take a form closely resembling cachalong—the beautiful—but never so fine as the real "stingo."

Stalactites in Gas Cavities.—These are composed of various substances. I have seen them, but rarely, of Celadonite, and these are easily distinguished from the included shreds of skin of that substance which are often surrounded by chalcedony—simulating stalactites—by the round or oval sections which they give when specimens are cut at right angles to their length, as well as by their lines of growth.

Stalactites in banded Opal.—In this example white stalactites have apparently grown down from the chalcedony layer, but this can't be clearly made out, and some of them probably reached the

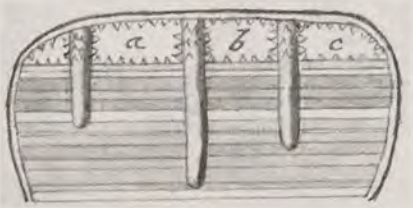

Fig. 7. Stalactites partly sealed by opal and partly encrusted by quartz crystals.

bottom, but others do not do so. Opal had then been deposited in level layers, sealing up the stalactites, more or less. In fig. 7, *a*, *b*, *c*, is an empty space or druse, with quartz crystals, which substance also encrusts the stalactites.

A stalactite over one inch in diameter has got a little brown centre. Then follows a ring of chalcedony, followed by a ring of crystallized quartz; outside of this there is a band of agate during the growth of which it had impinged on a ring of similar material of a neighbouring stalactite, the outside portion of the agate going round both of the stalactites. This stalactite—now double—has been completed by a ring of quartz, the apices of the crystals all pointing *outwards*.

A geod has got 300 to 400 siliceous stalactites to the square inch, and these can't possibly have been formed by *drops of water* (drops would have been immensely too big for the job), but likely have originated by the oozing of a siliceous solution into a gas cavity just sufficient to keep up a sort of sweating of the roof of the cavity, and possibly the solution went down through *hollow interiors* of the stalactites* until their formation was completed, after which they were sealed up by other substances.

A geod 2½ inches in diameter has got several hundreds of siliceous stalactites to a square inch; their original length can't now be ascertained, but it was more than 1½ inch. They are all more or less parallel to one another, although a few lie at various angles. Hornstone and crystallized quartz has accumulated round them till all have been sealed up, some of the former substance shewing concentric banding. These stalactites are of a pink colour, some of them with hollow centres a ⅓ of a mm., or less, in diameter. The centre of this amygdule is filled with crystallized quartz.

In some geods the stalactites are composed of numerous little globes attached to one another and sealed up in unbanded carnelian form exceedingly pretty specimens.

Fig. 8. Chalcedony Stalactites enlarged two diameters.

I got an amygdule in Linkentoms cutting with stalactites of a comparatively large size, some of them being half an inch in diameter and 1½ inch long. Some have smooth surfaces and others are covered with hemi-agates.

A moderately sized amygdule has got an immense number of stalactites of chalcedony hanging from its dome. These have been sealed by both quartz and calcite, and where the calcite has been dissolved out (naturally) the long cylindrical stalactites are beautifully exposed, as in the small bit represented in fig. 8.

In the same amygdule, after the quartz had filled the cavity a bit, stalactites of an entirely different kind had grown here and there on it. These are curved and twisted and point in every direction as shewn in fig. 9.

We are sometimes told that twisted and curved stalactites in

*Young stalactites in Limestone Caverns are generally *hollow*. See the Author's Monograph on the Stalactites and Stalagmites of the Cleaves Cove.

limestone caverns have taken their peculiar shapes by having grown on spiders' threads, rootlets, or sometimes have had their shapes determined by currents of air. This, doubtless, is often so,

Fig. 9. Twisted Stalactites, enlarged.

but one would think that inside of a quartz-sealed druse neither of these agents could have affected the shapes of the stalactites, but that their remarkable forms were derived from some inherent quality of the substance from which they were formed; or was it from the "play" of electric currents?

In the agates formed in the rocks of the future will it be too much to expect that electrograms will be found written which had been imprinted by wireless telegraphic messages? If this is correct, then some of the peculiarities of structure of agates, etc., may have been caused by electric storms of the past; but who can read!

In a geod rather irregular in shape, stalactites have depended in great numbers from a layer of chalcedony. In a corner in the

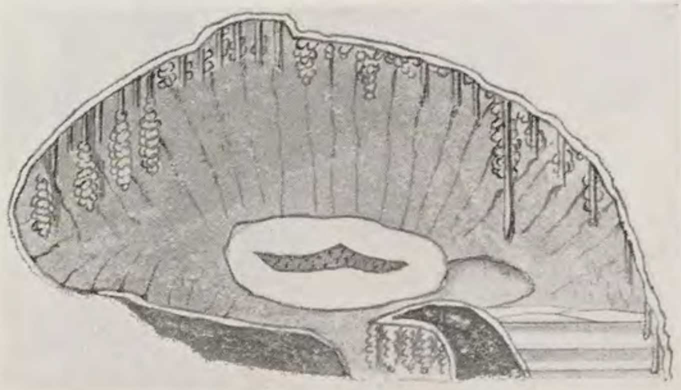

Fig. 10. Stalactites with Mammilated Chalcedony, enlarged.

bottom of the cavity there is a small deposit of opal, which seals up a few of the stalactites. Mammilated chalcedony has now formed on the remaining stalactites which hang from the roof like bunches of grapes (Fig. 10). Quartz now sealed up the mammilated stalactites, and then a deposit of cachalong took place, leaving a small hollow which was plugged with quartz. It will be seen in this example that the stalactites are at right angles to the layers of opal, a proof, if any were needed, that both were formed under the law of gravity.

In a fragment of an amygdule there are stalactites one and three-quarters of an inch long (but have been longer), remarkable on account of their exceeding slenderness, as the originals have been only a 1-10th of a mm. in thickness, a hole up through them is the 1-30th of a mm. in diameter, so that they look like little pipes. They are not quite uniform, but this may be taken as the average size. Subsequent incrustation has increased the diameter of a lot of them to half a mm., and as this has taken place by deposits of mammilated chalcedony, many now look like strings of beads, a lot of them touching one another. To the naked eye the *tout ensemble* is a parallel bundle of rods, but microscopic examination shews that many lie at various angles. All of them have been sealed by fine crystallized quartz.

A geod is remarkable on account of the whimsical shapes of its stalactites, which seem to exhibit a passage from the ordinary stalactites to the "coralline structure." Fig. 11 shews a bit of

Fig. 11. Stalactite with "coralline structure," enlarged two diameters.

one of them, twice enlarged, exhibiting a number of branches, the bottom ones sweeping away towards the side. All the stalactites are sealed by quartz, and as the one illustrated was exposed by a blow of the hammer, it is, consequently, a mere fragment, and probably the straight part extended for half-an-inch further up.

A gas cavity has had, first, a thin mass of calcite, irregular at one end, which has extended across the interior in an oblique direction, forming a diaphragm. This plate of calcite is covered with a thin crust, the surface of which is crowded with microscopic vermicular markings and bosses. From the *roof* of the cavity extend downwards numerous long slender stalactites, generally with smooth surfaces, or with faint beading; and from the *under side* of the calcite equally numerous stalactites, having a strongly-bedded structure, some of them reaching to the bottom of the cavity. Fig. 12. The stalactites which hang from the roof offer

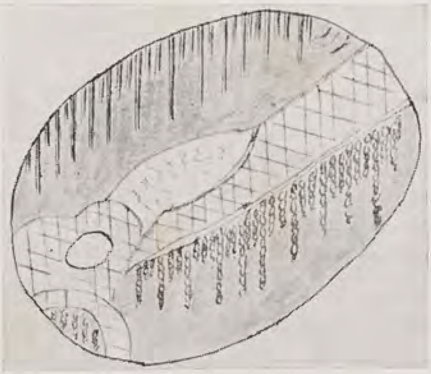

Fig. 12. Geod, natural size, stalactites shewn enlarged two diameters—diagramatic.

no difficulty as to how they have been formed, but those which depend from the encrusted calcite present us with a new feature in geod structure, and we naturally ask, in what way have they received their siliceous pabulum; did it soak through the calcite, or come along the siliceous crust? The skin of this geod is composed of celadonite *none* of which has *fallen in* to the cavity, and all the stalactites are sealed by quartz.

Cachalong Globules.—Minute globules having every appearance of being composed of cachalong are not unfrequently seen in layers of opal, but I will only describe one specimen. In this geod a number of level opal layers are followed by a few of chalcedony; the opal layer carrying the globules lies on a chalcedony layer, and is overlain by a dark-blue opal layer a little thicker than itself. The globule-bearing layer is 1.3 mm. in thickness, and the little globes are .06 of a mm. in diameter, and give to the layer a fine light grey, mirly appearance, like a scrap of the milky way, turned into stone.

"The hyaline the glassy sea
With stars numerous."

More frequently we see a curdled structure in some layers, the material not having been able (under natural "law") to differentiate itself into globules.

Microscopic Hemi-Agates.—An amygdule has a thick band of several layers of cachalong going all round, the last layer being a very thin one, and on this layer hundreds of microscopic Hemi Agates are seen in a single section (about 26,000 to a square inch). The bulk of the remaining interior is filled with a light-coloured siliceous substance crowded with microscopic red spots, their arrangement indicating that this part had been deposited in thick bands of various sizes. The last cavity, which is angular, is plugged with quartz, and is very eccentric. The celadonite skin of this specimen is pretty thick, and this, combined with the thickness of the cachalong, may have had something to do with the Hemi-Agates being so uniformly minute, although it is possible the outside skin had nothing to do with it, but after all the *thin cachalong layer* on which they grew was, perhaps, the real secret of their microscopic dimensions.

Moss Agate.—A small geod is largely filled with *celadonite,* branching and anastomosing in a remarkable manner, many of the detached patches resembling little sprays of moss, at parts assuming a beaded structure. At one time formations of this sort

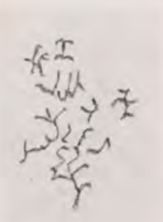

Fig. 13. Part of a Moss-agate, enlarged.

in vapour cavities were thought to be plants of "petrified moss," but mineralogists now consider this structure to be entirely of inorganic origin. This amygdule is crowded with minute agates many of them microscopic, the celadonite sprays and agates being set in a groundwork of cachalong. This geod has no bounding chalcedony band, but a thin layer of that substance surrounds the celadonite sprays. Moss Agates are rather rare in Carrick. Fig. 13.

Coralline-looking Structure.—A geod of this description has had no chalcedony layer, the coralline structure being sealed by pale pink silica which also encloses a few agates.

Another geod is largely composed of Calcite which seals innumerable minute structures "by all the world" like little white branching corallines. When we see things of this sort in geods, we "swither" whither to accept of them as inorganic, or to speculate (like the old mineralogists) on the possibility of "spores" finding their way into geods from which these very organic-looking bodies were produced.

Lustre Mottling.—This form of structure (also called ophi-calcite) has been produced by calcite crystallizing round substances which had settled or grown on it, sometimes round brecciated material, and still preserving its cleavages in uniform directions. *Celadonite* and *Delessite* are substances which have occasionally grown on Calcite in the Carrick geods, and little bunches of an undetermined very minute mineral also occur, as well as *goethite*.

A vapour cavity has been filled with minute crystals of *quartz* and *calcite* the latter having uniform cleavages and shewing lustre-mottling.

In cases of lustre mottling from the growth of foreign substances on calcite, the question is, was the growth of one of the minerals suspended whilst that of the other went on ?

Prismatic Structure in Cachalong.—A little geod has had the bulk of the chalcedony layer weathered off, exhibiting a structure not unlike that seen on some kinds of sea urchins, the "plates" being of various sizes, generally hexagonal, sometimes slightly hollow, the largest ones about 2 mm. across, the prismatic structure extending right through a layer of cachalong, the prisms being firmly bound together and shewing no tendency to separate. The interior is filled with quartz, and I think this gives us the key to this peculiar structure of the celadonite layer, the boundaries of the "plates" being just a continuation, so to speak, of the sides of the quartz crystals through that substance, the plates representing the ends of the quartz crystals. The cachalong layer has got a number of minute rents which pass through the "plates" and have been filled up with siliceous material. So far as I have seen, this little geod is unique as to the prismatic structure of the cachalong layer.

Cryptocrystalline Structure.—The cryptocrystalline formation of the chalcedonic layers, so well seen in sections prepared for the microscope, is sometimes visible to the naked eye, and the individual crystallites (tridymite) may be seen with a lens. Let the description of one specimen suffice. A little geod $\frac{7}{8}$ of an inch in diameter has got some bands of chalcedony which have sealed up

Fig. 14. A geod with two bands of cryptocrystalline structure visible to the naked eye—diagramatic.

some Hemi-agates and mammilated structure. Then follows a thick band with cryptocrystalline structure visible to the naked eye. This is sealed by cachalong all round, and inside of the latter the cryptocrystalline structure again continues for a short distance, in both cases its colour being pale blue. The last formed layer fades into hornstone of a pale pink colour, the centre being plugged with quartz. Fig. 14.

Ripple Opal.—Banded opal is sometimes rendered beautifully rippled in structure by layers of water-clear opal alternating with bands of cachalong, both minerals having the layers of unequal thickness. The reason for this is probably owing to this opal having some slight chemical difference from the usual level-banded material. The ripple opal is exceedingly rare in the Carrick amygdules. See fig. 59, page 62.

Ripple Agate.—The finest specimens of the ripple agate I have seen appear to have been formed in the following manner. Certain bands have had their surfaces roughened by "molecular creep," "segregation," or by a quasi-crystallization; the band of chalcedony which followed having gone in and out through all the sinuosities, took the wavy form of the roughened band and so, with those which followed, till a beautiful ripple-structure was produced; occasional development of some form of the roughening of a layer sometimes taking place during the subsequent building up (in) of the geod.

Ripple Fracture.—The surfaces of some of the dark-red agates —when broken at right angles to the layers—present beautiful ripple patterns ; a sort of minute, extended, conchoidal fracture. This is not an inherent structure of any agate, but is a result (on a fractured surface) of the internal structure.

Structure on Opal.—On a fragment of a level opal plate about a square inch in area, there are numerous lines crossing it in a curving manner. On closer examination the lines look like the basset edges

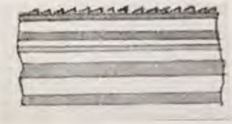

Fig. 15. Section, flounces on opal—diagramatic.

of outcropping strata, but as they occur on a perfectly level plate I don't understand how they have been formed, so won't attempt an explanation. Fig. 15 shews a diagramatic section much exaggerated in size, the lines (flounces) on the bit of opal numbering 52.

Another specimen has got a beautifully netted structure, the imprints being on some layers of chalcedony which had got fractured and fell into the interior when the geod was forming.

Fire Opal ?—This occurs in very small quantity in the Carrick amygdules, polarizing light and shewing rainbow colours. I am not quite satisfied that this is real fire opal, or only a peculiar kind of quartz.

Rainbow Calcite.—Calcite shewing prismatic colours when the cleavages are held at a certain angle to the light, is sometimes got in the geods. This property has probably been superinduced by a slight strain to which the mineral had been subjected by earth movements.

Partial Agates.—This is a term I have introduced for those agates the layers of which do not go completely round the interior of a gas cavity, but finish off either against the outside of the cavity, the celadonite skin, the first chalcedonic layer, or, as it frequently happens, against one another ; in fact, all the layers formed after the first one often finish off in the latter way. All those agates having a " tube of escape " are partial agates, and there may be several tubes of escape in a single geod.

Netted Geod.—In the Dunduff old agate quarry I got a partial agate the surface of which is all covered over with a minute network of raised ridges. It appears to have been formed in this way. A rather thickish layer of fine green Celadonite had first been formed all round the inside of the gas cavity; the inner surface of this layer had shrunk, forming a series of minute cracks taking the form of a net with irregular meshes. When the chalcedony layer was formed all round, part of that material had entered the cracks in the celadonite layer, taking a cast of them. As the specimen had lain for a long time to the "weather" the comparatively soft celadonite layer has mostly been worn off, exposing the netted structure on the surface of the chalcedony layer. This formation, which appears to be very rare, raises the question, did the cavity dry up before the cracking of the celadonite layer took place, or did it form when the cavity was filled with fluid? One would think, from what we know as to the formation of suncracks, that the cavity had run dry; but who can tell? It is the only specimen I have seen of this kind.

Amygdules within an Amygdule.—This amygdule is about 1½ inch in diameter and is bounded by a delessite skin. The interior has been crowded with gas cavities (at least they look so) in a ground mass of soft purplish material, the bulk of the cavities being of microscopic size. The larger ones are oblong, but irregular in shape and have a tendency to lie with their long axes in one direction. The great bulk of the cavities are filled with celadonite, but some of the larger ones have only a "skin" of that material with a white infilling. In some of them there is a celadonite skin or white layer and a celadonite nucleus. In this geod there is no chalcedonic nor opaline material, and I can make no suggestion as to how it has been formed.

Torrified Geods.—It is quite conceivable that certain gas cavities may have had their contents filled into them *before* a subsequent lava flow, or sill, took place, in which case the heat communicated by the molten rock may have allowed of some alteration to take place amongst the materials of the cavities, and the globular structure occasionally seen in geods and other anomalous peculiarities may have taken place in that way. Amygdules which have been so treated may be called *Torrified Geods*.

A siliceous geod has got an entirely curdled structure, microscopic, filamentous, dirty-white silica mixed in a very intricate manner with semi-translucent material, filling it. Unless on the supposition that this is a Torrified Geod, I can't understand how this structure has been brought about. There is a small white agate in it which may have been formed in the usual watery-way *after* the structure formed by the heating process had been completed.

In the descriptions of the different varieties I will have opportunities of occasionally referring to what appear to be torrified geods.

Amygdules of One Material.*

Calcite.—This substance is often seen to fill entirely a gas cavity, and in some of the lava flows, especially those of a soft nature and dull purplish colour, few other substances occur. The railway section, a short distance to the north of the one in which Dunure Station is situated has got a flow of this description, and others occur in the shore cliffs. The Calcite is sometimes very pure (Iceland Spar) but is often mixed with *ferite*, *celadonite*, etc., some of it being of fine yellow or reddish colours and these will be more particularly referred to in the descriptions which follow. Except in the case of *yellow calcite*, this substance appears never to have commenced to form *all round simultaneously* in a cavity, but only from one or several points. When acidulated water has etched the surfaces of calcite rhombs they shew numerous lines, close together in two sets, but no cleavages take place along these lines.

Limestone Amygdules.—Limestone, fine grained in quality, and of a greyish or greenish colour does undoubtedly *fill enclosed gas cavities* in the lava flows and these amygdules do not shew the celadonite layer, but as a substitute for it have got a thin reddish "skin." I have never seen any of these limestone amygdules shew a banded structure, they are always massive or amorphous. A polished specimen has got shreds of the lining of the cavity *in it*, all collected to one side (the lower one in the rock), a good proof, I think, that it is an amygdule and not a nodule ; although the skin covering it is quite as good a proof.

Quartz.—Quartz frequently fills the entire space in a cavity, the crystals having commenced to grow *all round*, so that each one stands at right angles to the part of the wall (top, sides, bottom) it is attached to. The crystals are closely packed together, do not form

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*This is over and above the " skin " or celadonite layer, and in the descriptions of the varieties which follow I will only mention this layer when it presents some extraordinary peculiarity, or have occasion to note its absence.

regular hexagons, but present a rather "congested" appearance, as if they had been pinched for room to grow in—elbowing one another in their little world they have crushed in each other's sides.

Hornstone.—Silica in a granular form, and also as hornstone, sometimes entirely fills gas cavities. In this state it is variously coloured, greyish, greenish, reddish ; but in Carrick I have seen no hornstone taking the form of heliotrope.

A small geod is entirely composed of hornstone of a light green colour, with a few white blotches.

Delessite.—This substance often fills up a cavity, especially when the lava flows are of a dark-green colour, and when pure it appears always to have shrunk considerably, the shrinkage cracks being filled with secondary calcite, or arragonite (fig. 16). When impure, the

Fig. 16. Delessite geod, with shrinkage cracks filled up.

delessite has not shrunk, and in this state it contains calcite intimately mixed with it in microscopic specks. It often shews a curdled appearance, and contains irregular patches of white saponite and labyrinthine mazes of a yellowish substance.

An amygdule one and a half inches in diameter is apparently entirely composed of delessite. It is anything but homogeneous, however, in structure, the ground-mass being of a livid purple colour, part of the saponite having "segregated" out into innumerable blebs of various shades of green, most of them being microscopic. There is no banding, and the same material extends from the centre to the boundary.

Agate.—This form of silica very seldom entirely fills a cavity, but in Linkentoms cutting a few complete specimens occurred. Light-coloured agates may be said to be the commonest kinds in Carrick, but red and amethystine ones also occur. The layers may be water-clear (chalcedony), white (cachalong), purple (amethystine), red (cornelian), opalescent (opal) ; and of various other tints : yellow layers (composed of innumerable microscopic yellow specks in a clear ground mass) being seldom seen.

Opal.—I have never seen this substance entirely fill a vapour cavity, there being always a thin layer of chalcedony, or agate, which has preceded it, and bounds it below and around the sides, and sometimes a layer of these substances seals it over the top, but not always. It occurs in two forms (1) level, horizontal, or banded opal ; (2) and massive opal. The level opal is sometimes inter-banded with other substances—quartz and cachalong—but oftenest with chalcedony, and, when with the last two, their layers *always leave the opal layers* and go up the sides and often round the dome of the cavity ; the cachalong layers—which also do this—being generally much *thicker on top of the opal layers* than at any other part, as if the opal had had some attraction for the cachalong.

Banded Opal.—On a surface of banded or horizontal opal there is an intricate series of " carvings " resembling pointed leaves of a twisted form laid out in various " patterns," with intricate tracery between them and little nodular masses, as if " nature " had anticipated some of the " designs " of man. This structure is probably the result of " molecular creep " in the substance of one of the layers. Another specimen has got on one of the surfaces a series of oval, hummocky ridges, quite apparent to the naked eye. On some of the layers of banded opal there are short dark lines. I have traced these through various stages, and find that they have resulted from the filling-in of minute shrinkage cracks with *pyrite.* Some of the cracks cross one another and others branch. Where the pyrite is decomposed the part is surrounded by a yellowish stain. Some of the level layers occasionally assume a curdled appearance, and when these layers are separated by natural weathering, their surfaces are seen to present an irregularly pitted structure like that exhibited on the armour plates of some kinds of ancient fishes.

Porous Siliceous Substance.—A vapour cavity about four inches in diameter has been filled with a light grey, porous, siliceous material, without banding, which adheres slightly to the tongue.

Another smaller one, white and chalky-looking, is easily crumbled between the fingers, and appears to have been made up of innumerable minute globular masses. Both of the above are evidently decomposition products as they now exist, but have probably been torrified siliceous geods before being touched by the " elements " of rot.

Chalcedony and Sinter of Same.—Some specimens show that a sinter of chalcedony had trickled down the sides of gas cavities forming wall-stalactites, the cavities having been afterwards filled with massive chalcedony. This would appear to point to the cavity having been empty of water—*and the first ingoing of water*—when the sinter accumulated on its sides, a rare occurrence in the Carrick amygdules.

Unbanded Chalcedony.—In the fine-grained, harder and more siliceous flows, vapour cavities are not often seen, but when they do occur they are often filled with unbanded chalcedony and microscopic sections of this massive form of chalcedony, shew—by polarized light—that it has got the crypto-crystalline structure in common with the banded form ; however, it is difficult to account for its being massive. The entering solution appears to have been constant and unaltered in quality during its whole formation.

Nodular Chalcedony.—Chalcedony sometimes occurs in gas cavities as if made up of a number of small nodules which look as if they had "segregated" out when the chalcedony was in a plastic state. It is possible, however, that this structure may have resulted from the heat derived from a lava flow, or sill, producing a Torrified Geod. This is all the more likely, I think, as it is not easy to understand how a gas cavity could be filled with a gelatinous mass of silica which afterwards hardened (taking a globular structure) without shrinking.

Carnelian.—This substance seldom fills a gas cavity, occurs both in massive and banded forms, and is not often seen free from cracks, being the most brittle of all the siliceous geods. It is, generally speaking, rare in Carrick, but a flow in Linkentoms Cutting contains abundance of specimens ; and they are equally common (and more easily got) in a conglomerate of Calciferous Sandstone age in the railway cutting opposite Bower Hill, and also in a gravel bed derived from this conglomerate.

Agates rendered red by innumerable minute red spots simulate the Carnelians, and red spots also occur in the latter, both disseminated and in bands, the individual spots being sometimes *elongated*, or as *circles* with opposite fin-like projections. The dark-red Carnelians are much tougher and freer from fractures than the brighter coloured ones, and they endure weathering much better than any other of the Carrick geods, being often obtained in the cultivated fields.

Massive Siliceous Geod.—This geod has been filled to about three-quarters of its cubic content with brownish-red silica, fading to white, this deposit being exceedingly thick. There has then been a break in the growth of the geod represented by a bright red line

Fig. 17. Massive Siliceous Geod.

of dots, after which siliceous material of a dark brown colour was packed away, and in this substance—at its other end—there is a minute white agate, indicating that towards this end of the geod there had been a weak, or porous, part in the rock. The usual outer chalcedony layer is absent in this specimen. Fig. 17.

Amygdules of Two Constituents.

Agate and Quartz.—This is a frequent combination, the quartz generally having formed all round on a thin layer of agate. Some-

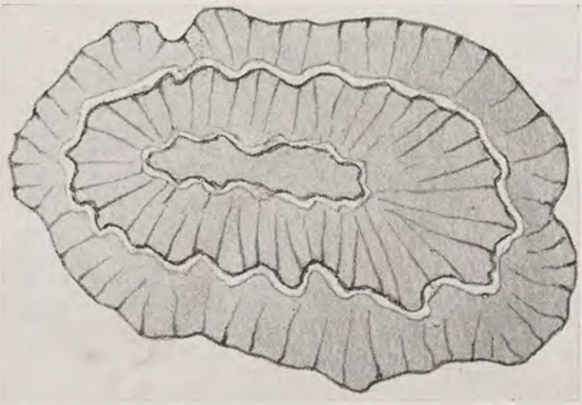

Fig. 18. Quartz with interposed agate layers—reduced.

times the agate is thick, followed by a quartz centre. I have a specimen where, after a thick band of quartz had been formed, the centre was plugged with agate. Another one shews a thin band of quartz enclosed in agate, but only going three-quarters round the cavity, this being one of those kinds which has got a "tube of escape."

A pretty large specimen is filled almost entirely with crystallized quartz. During the growth of the crystals there had been two breaks, the first taking place about five-eighths of an inch from the side, the second at more than an inch. These breaks are represented by thin bands of white agate going all round the inside of the cavity—for the time being—and sealing up the pyramidal ends of the quartz crystals, so that the white layers are exceedingly irregular in outline. Fig. 18.

In another specimen a layer of white agate has been first formed, then follows a thick growth of quartz, the ends of the crystals having been sealed over by a layer of white agate, the centre being hollow.

Another variety has got, first a thick band of pale pink, unbanded silica, the *inside* of which is spotted with red oxide of iron, the interior being filled with quaitz.

In this connection I will give a description of two cavities each about 3 inches in diameter and placed one inch apart in the rock in Linkentoms cutting. Both had begun with a few thin laminæ of chalcedony going all round. Within this thin band one of the geods contains nothing but *crystallised quartz* which fills it to the centre. The other is filled almost entirely with *agate* in concentric layers, there being a small tick of crystallized silica in the centre of the geod. These two cavities very likely began to be filled at the very same time and evidently from the *same quality of solution*, a similar solution having continued to enter the cavities till they were filled up ; at least it is difficult to understand how the solutions in the two cavities (so near one another) could be of different qualities, but by some mysterious process of *nature, crystallized silica* accumulated in one cavity, whilst *cryptocrystalline silica* (tridymite) was being deposited in the other.

Agate (chalcedony) and *Opal*.—There are some interesting combinations of these substances. When *opal* is *banded* it always occurs in *level layers*, some of them exceedingly thin, others pretty thick, and these are always confined to the lower part of the cavity during their deposition, but occasionally bands of chalcedony were formed alternately with those of the opal, and *they go all round, or sometimes partly so*. Fig. 19 will illustrate this, first a band of agate was formed all round the cavity, then opal (level) and chalcedony (both level and going all round) alternating with the opal in the bottom of the cavity, was laid down. There may

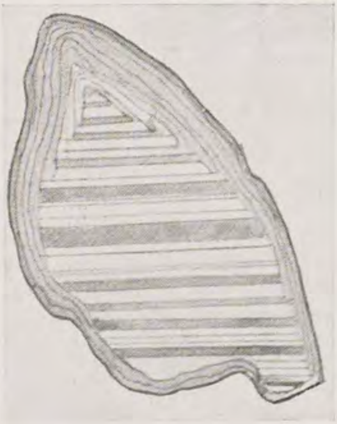

Fig. 19. Opal alternating with chalcedony, the latter going round the dome of the cavity.

have been one or several bands of opal, then one or several bands of chalcedony, and so on till the space was partly or completely filled up ; completely in the geod under consideration.

Fig. 20 is another example of chalcedony and opal filling a gas

Fig. 20. Chalcedony and opal. (From a photo by Mr. A. Shanks).

cavity, the chalcedony interbanded with the level opal and also going round the dome of the cavity.

In some cases, after the opal began to form it kept the cavity entirely to itself, there being no layers of chalcedony alternating with it, and going up (by itself) round the dome.

Level Agates are called by lapidaries, *Onyx*, and I have seen very good lapidaries onyx (black and white bands) in the Carrick lava flows ; the bands are often variously tinted.

No definitions of natural objects appear ever to work out exactly, and the level agates sometimes shew an occasional layer of quartz, as well as of cachalong, this substance going up the sides and sometimes round the dome, but being generally thinner at these places than it is on the opal layers, as already remarked, and sometimes a *single layer* is made up of different substances placed *end to end*.

In the Lagg, Fisherton, and Linkentoms cuttings, *level agates* are rather rare, but in the railway station cutting at Dunure they are common, as also in some parts of the shore and hill sections. In the station cutting, they shew that since their formation a slight tilting of the rocks to the N.N.W. has taken place ; in fact this is always seen wherever they occur. Some of the level layers of Chalcedony, alternating with opal layers, are granular in structure, whilst the continuation of the *same layers round* the sides and dome of the cavity do not exhibit the granulation. This, I think, shews that the opal layers had occasionally some *chemical*, or perhaps more properly speaking, *molecular* effect on the chalcedony ones.

Agate and Calcite.—This combination is of frequent occurrence, the agate generally forming a thin layer round the calcite and sometimes sealing up hemi-agates which had grown on the green earth layer. The calcite appears always to have begun to crystallize at a *point*, or several points ; perhaps a singular molecule (a mineral seed or spore) was laid down here and there, but never all round a cavity. Exception to this definition must be made in the case of yellow calcite which sometimes occurs *all round* a cavity, and of which I have seen several examples in Carrick, and evidently (from its mode of growth) it had begun to form from a great number of points like the quartz and tridymite, and the cleavage planes crop out against the sides of the cavity at different angles In some cases the calcite had formed its crystals which have been subsequently sealed up by later deposits of agate, but *during* the growth of the calcite *no agate was formed.*

Calcite and Silica.—In Linkentoms cutting I obtained a very peculiar specimen which appears to have been formed in the following manner :—A moderately large gas cavity had first contained a tapering six-sided crystal of calcite. The rest of the cavity had then been filled up with cryptocrystalline, granular quartz. After this the calcite had begun to get dissolved *throughout its substance*, except a small portion in the centre of the crystal, the portions removed being replaced by reddish silica. The principal quantity of silica has been deposited in the cleavage planes (or spaces dissolved out along these planes) of the calcite, but these deposits of silica are bound together by a microscopic *network* of reddish siliceous fibres of the same material, which never assume straight courses, but

Fig. 21. Silica replacing calcite, *a* a bit enlarged.

curve and twist about in every direction, the silica in the cleavages being also mostly of this description. It might be argued that the deposition of calcite and silica had gone on alternately, but the reason I have adopted the above view is that the silica in the cleavages does sometimes stop suddenly, then run to the right or left along other cleavages, shewing, I think, that the silica had *replaced calcite* in the cleavages. Another argument in favour of the view taken is that when silica is deposited as an original layer, or layers, it never shews the very intricate structure (in the great number of specimens I have examined) exhibited by this geod. Fig. 21.

Calcite and Hornstone.—A gas cavity has got a large irregular rhomb of *calcite*, filling three-quarters of its cubic contents, the rest of it being made up with reddish unbanded *Hornstone*. In this instance the calcite crystal had clearly been formed first, the hornstone filling up all the remaining space, there being no inter-banding,

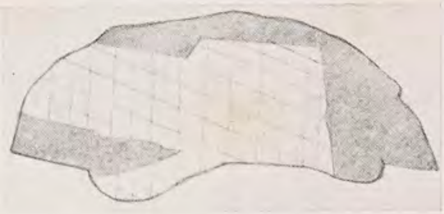

Fig. 22. Calcite and Hornstone.

or bedding, of the hornstone with the calcite. Fig. 22.

Another cavity filled with hornstone and calcite has got the latter as occasional rhombs through the substance of the former, the hornstone being of a light grey colour and shewing banding. In this instance it looks as if the rhombs of calcite had formed whilst the hornstone was in a semi-fluid or viscous state. Fig. 23. [In a

Fig. 23. Hornstone with Calcite rhombs.

number of sections I made of the chert taken from the *White Limestone* (the one above the Hurlet Limestone) of Ayrshire, numerous microscopic rhombs of calcite are seen to be dispersed through it.]

Hornstone and Agates.—A pale rose-coloured hornstone has apparently been pretty much crowded with cavernous hollows, with small, light-coloured agates. Fig. 24. How the hornstone had come to have such a number of little irregular hollows in it is what I won't attempt to explain.

Hornstone with Hydrated Oxide of Iron.—A vapour cavity is filled with hornstone, in which particles of hydrated oxide of iron are disseminated. The iron salt looks to have grown from points (places) on the hornstone as it was being deposited in the cavity.

Ophi-calcite with Ferite.—This gas cavity is filled with calcite, but during its formation particles of ferite had grown on the calcite,

Fig. 24. Hornstone with Agates, a fragment.

the latter having crystallized round them, producing what is known as "lustre-mottling," the cleavages of the calcite always preserving the *same direction*. There is no green earth on this amygdule, its place being taken by a thin siliceous band which is firmly attached to the porphyrite, this layer also containing particles of the ferite.

Another example (*Calcite* with *Ferite*) has got each particle of ferite surrounded by a pale green band, as if some of the iron had combined with a little silica in the solution to form *silicate of iron*.

Ophi-calcite with Delessite.—The remarks given in the first paragraph of the above will equally well describe this combination.

In some of the cavities the combination Ophi-calcite and ferite, or ophi-calcite and delessite, occupy about three-quarters of the cavity, the rest of the space containing pure calcite, its crystallization being continuous with the *first* or lustre-mottling crystallization.

Delessite and Chalcedony.—An oblong geod over three inches in length has been filled with delessite and chalcedony, the latter occurring in an indescribable arrangement in labyrinthine patches and strings, and is mostly of the red or carnelian variety, especially towards the centre. Towards the sides it is lighter in colour. Perhaps the delessite first filled the cavity, then shrinkage of its substance took place, after which the chalcedony was deposited in the shrinkage spaces, but there is such a large quantity of chalcedony to delessite that I am afraid this explanation is not the correct one. Of course some of the delessite may have been dissolved and carried out of the cavity before the deposition of

Fig. 25. Delessite and Chalcedony.

the chalcedony began. In some of the spaces the chalcedony has taken the form of small agates. Fig. 25.

Delessite and Calcite.—An axe-shaped gas cavity has had a thick layer of delessite all round the interior of the cavity. This layer has shrivelled and curled up, probably from the drying of the cavity, and, with the exception of some small fragments the delessite from the upper part has fallen and the curled-up mineral now occupies about half of the lower part of the cavity like so many shavings of green heart. Calcite has crystallized amongst the curls, as well as filled the rest of the cavity. The delessite layer in the bottom of the cavity has also curled up, but, of course, remains there. See fig. 5, page .

Brownish Fragments and Jasp-agate.—The interior of an amygdule

Fig. 26. Brownish fragments and jasp-agate.

is crowded with soft brownish *angular* fragments, evidently representing the breaking up of a layer. There are also some bits of green earth "skin." Round each of the brown particles there is a thin green layer. The rest of the inter-spaces are filled with greyish, brownish and yellowish jasper and agate. Fig. 26.

It is strange to see a cavity in which one would think there could have been no commotion, with so many broken fragments in it. This breaking up of certain layers has been ascribed by mineralogists to "the force of the incoming fluid," but I think this is not the correct explanation. It is only *occasionally* that the celadonite (a very tender layer) and other outer layers have been broken up, and it appears to me that this took place from *shrinkage* of the layer, or layers, when a cavity had got dried up for a short time.

Celadonite-stalactites Sealed by Agate.—It has been suggested by mineralogists that "stalactite agates" had been formed round patches of the "skin," green earth, or celadonite layer, which had been ruptured and forced in by ingoing fluid and hung down from the roof of the cavity, agate (chalcedony) having been subsequently deposited round them. Agate has undoubtedly been deposited round hanging shreds of skin—and I have seen examples in the Carrick geods—but I have specimens from the Carrick flows which shew clearly that *stalactites of celadonite* had been formed *before* any deposition of agate, etc., had taken place round them, *the stalactites having grown down from the roofs of cavities.* Bits of skin can't be mistaken for these stalactites as the former occur as mere shreds, often curled up.

Cachalong Stalactites Sealed up by Quartz.—I have a specimen which puts the occurrence of celadonite stalactites in gas cavities completely at rest. It contains several dozens of small cachalong

Fig. 27. Cachalong-stalactites and Quartz.

stalactites suspended from an *unbroken* celadonite layer and a few of them have got (in part sometimes) a celadonite centre. After the stalactites had formed, a bit of the celadonite layer had split off and fallen down a little, carrying a lot of the stalactites with it. Quartz had then been deposited *around* those that had remained sticking to the dome, but *above* those which had fallen down. Fig. 27.

Cachalong and Calcite.—A moderately large geod has got a strong layer of cachalong all round, the interior being filled with calcite. Before the calcite had begun to be deposited a part of the cachalong layer had split, carrying a bit of the celadonite skin along with it, the broken pieces being now enclosed in the calcite.

Quartz and Calcite.—An irregular, curving cavity, $3\frac{1}{2}$ inches long by $1\frac{1}{2}$ inches wide, has been filled in a peculiar manner by quartz

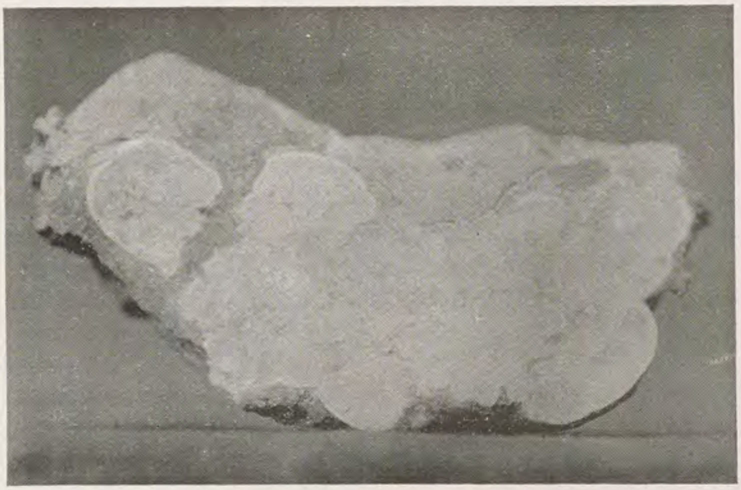

Fig. 28. Quartz and Calcite.
(From a photo by Mr. A. Shanks).

Fig. 28 *a* ; a large bleb of same enlarged two diameters.

having a dull semi-vitreous fracture, there being a little calcite mixed with it. The quartz occurs in irregular blebs from less than a mm. up to half an inch in size, the larger ones arranged round the outside, the smaller crowding the interior. Some of them appear isolated (in section), but many of them are connected together in a labyrinthine manner—and perhaps all are so. With the exception of a faint banding towards the outside of some of the larger blebs there is no structure. Surrounding each bleb, or cluster of blebs, there is a white shell. It is difficult to understand how this structure has been brought about, and I will only suggest the following explanation. This cavity was first nearly filled with a siliceous deposit before the outpouring of the next lava flow took place. When that occurred the siliceous deposit was heated sufficiently to allow molecular movement to take place, when it got formed into blebs all more or less connected together, so that at this stage it was a torrified geod; by and by calcite was deposited from a watery solution (fig. 28).

Barite and Agate.—As already remarked, barite occurs very sparingly in the gas cavities of the Carrick flows. An amygdule is composed largely of crystallized barite, the centre being filled with an ordinary agate.

Quartz and Black Crystals.—Quartz crystals line a gas cavity, and the free ends of some of them have got small holes on their surfaces, sunk rings surrounding some of the holes. In the hollows there is a dark mineral, and the same substance is attached to other crystals which have got no holes. From this it would appear that some of the quartz crystals had continued to grow a little after the mineral got attached to them, whilst others had ceased to increase in size before the mineral settled on them.

Quartz and Opal.—A skeleton amygdule has got a large quantity of quartz mostly all to one side, and a small patch of banded opal. No opaline deposit had taken place during the growth of the quartz, the opal having been deposited in the remaining space. Quartz *following* banded opal and level agate is of frequent occurrence in Carrick, forming kernels with *flat bases.*

Keel and Hard Particles.—A geod is composed of a dark-red keel with minute hard particles which render its polishing impossible, as the particles become detached, and getting dragged between the keel and the polishing stone leave scratches.

Cachalong and Grey Material.—In this variety there is first a layer of cachalong going all round. Mostly in the interior, and seldom towards the sides, there are innumerable grains of irregular size, grey in colour and with a dark border, mostly all touching one another, but a few of them widely detached. Then there is another deposit of cachalong subsequent in date to the granular part, as it

Fig. 29. Grey material and cacholong (agates).

has filled up all the interspaces and has often taken the shape of small agates, especially towards the outside (fig. 29). It looks in this case as if the grey material (not limestone) had shrunk after it had filled the cavity, the shrinkage apparently having been caused by heat so that this is perhaps a torrified geod, the cachalong agates having been deposited in the watery way after torrification had taken place.

Delessite and Jasp-agate.—A geod 1½ inch in diameter is composed of delessite and jasp-agate, the latter being mostly of a dark green

Fig. 30. Delassite and Jasp-agate.

and dark red colour. There appears to be about ¾ of the siliceous material to ¼ of the delessite, and they are "fankled" together in an indescribable manner. If the jasp-agate fills shrinkage spaces in the delessite the latter must have shrunk to a great extent, and there can be no doubt of its having filled spaces as all the little irregular masses of it have grown from the outside inwards. This geod has no boundary layer of chalcedony which gives it a rather naked appearance. Fig. 30.

Chalcedony and Opal.—Many layers of Chalcedony have grown all round a gas cavity, some of them carrying dots and lines of red oxide of iron. After the chalcedony had ceased to grow an oblong cavity was left in which level opal was laid down in many thin courses and varying shades of colour. The result has been a very pretty little "peeble" enclosed within its coat of bright green—a fairy from the nether world.

Agate and Quartz of two qualities.—A cylindrical geod about two inches long has a thin layer of agate going all round, the rest of the space being tightly packed with quartz crystals. The peculiarity of this geod is that rather more than half of the cylinder has got quartz of the ordinary quality, the rest being amethystine in colour.

Delessite and Calcite.—A dome shaped geod with a flat base, is composed mostly of granular calcite, the cleavages of the particles pointing in all directions as they do in crystalline limestone. It has got a delessite skin, and particles of that substance are scattered through it, but no lustre mottling is observable anywhere. It is possibly a torrified geod, the cavity having originally been filled with ordinary calcite, as so many of the Carrick vapour spaces have been.

Amygdules of Three Substances.

Level-agate (Onyx), *Hornstone and Calcite.*—In one amygdule dark grey hornstone follows level agate, and is followed by calcite. The Hornstone has not kept to a uniform thickness, but has got heaped up towards the sides, so that the calcite does not rest on a level platform. The hornstone contains angular bits of the agate, shewing that the latter had consolidated and got broken up before the deposition of the hornstone had taken place. Perhaps a fault (earthquake) had fractured the agate, as it is difficult to see how such a hard and tough substance as agate could otherwise have been broken in bits. Fig. 31.

Celadonite, Agates and Ophi-calcite.—This variety contains small irregular deposits and specks of celadonite interspersed with small agates. Round about these ophi-calcite has accumulated. The small agates are commonish near the outside, the calcite often extending to the wall.

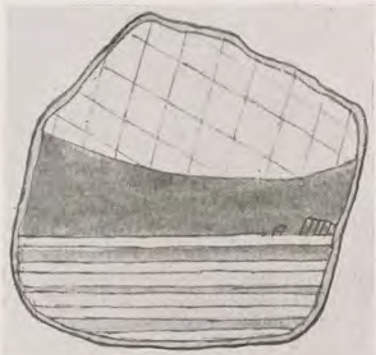

Fig. 31. Onyx, Hornstone and Calcite.

Agate, Hemi-agates and Chalcedony.—A thin layer of agate going all round a gas cavity has got occasional hemi-agates attached to it, followed by a much thicker layer of agate sealing up the hemi-agates and fading away into a bandless form of Chalcedony which fills up the centre of the geod.

Agate, Quartz, and Calcite.—The filling in of this cavity has begun with a thin band of agate which goes all round, then there are some isolated hemi-agates followed by agate *which does not go all round.* Inside of the partial agate and the remaining bit of the agate carrying the hemi-agates, there is a band, irregular in thickness, of crystallized quartz, the interior being filled with calcite.

Cachalong, Level-opal and Calcite.—Another example mostly of opal was got in the Dunure Station cutting. First there is a thin layer of Cachalong going all round the interior of the cavity. Then follows two inches of level agate (in this case *all of opal*) some of the bands being faintly reddish, others white. After this, the rest of the cavity (top part) has been filled with calcite, one of the cleavages of which has been placed obliquely to the last layer (top one) of the opal. This specimen shews that *opal* can be deposited in a cavity without any interbanding of *chalcedony* which, had it been present, would have gone up the sides and probably also round the dome of the cavity. Fig. 32.

Cachalong, Hornstone and Quartz.—Even the tough Cachalong has sometimes been broken up and the fragments enclosed inside of a cavity. A specimen has got Cachalong *in situ* and attached to the green earth skin for three-quarters of the perimeter. The rest of it had got broken up and found its way inward for more than

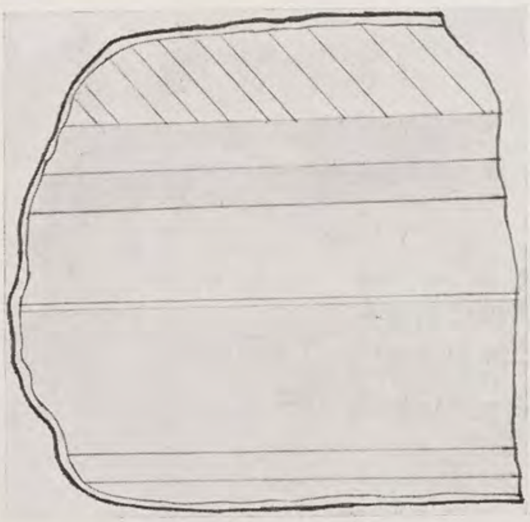

Fig. 32. Cachalong, Level Opal and Calcite.

half-an-inch, each bit carrying the green earth skin attached to it. Following the cachalong, and also sealing up the detached portions of same, there is reddish hornstone fading into quartz of the small crystallized variety, the centre of the geod having detached druses with quartz crystals.

Cachalong, Opal (with stalactites) and Quartz.—In this example (the only one I have seen) it is a question whether the opal or stalactites

Fig. 33. Cachalong (stalactites), Opal and Quartz.

were first formed. The stalactites are white, and apparently all composed of cachalong. Quartz seals up the stalactites, and has filled the rest of the cavity. Fig. 33.

Quartz, Calcite and Black Crystals.—In a large cavity, crystallized quartz has been deposited in patches of irregular shape and size of a dirty white colour with brown bands, one of the patches containing a bit of calcite. On top of these patches an irregular layer of ordinary quartz, the crystals closely packed together, has grown, the free pyramidal ends pointing to an empty cavity, this layer being $\frac{3}{8}$ of an inch thick, the ends of the crystals having got some minute black crystals attached to them.

Celadonite, Saponite and Agates.—In this geod the celadonite occurs in irregular patches and curving scales, which *send off branches* in the most whimsical manner. The saponite is very much connected together, and envelopes the celadonite. The agates are *always embedded in the saponite :* in no case have I seen them touch the celadonite. These pet-lambs of the mineral kingdom appear always to have been taken special care of, till the Lapidary comes with his ruthless knife and cuts them up, or the geologist knocks them on the head with his " mell."

Calcite, Silica and Agates.—I got part of an amygdule, perhaps originally 10 or 12 inches in diameter, which is composed of a mass of roundish blebs of calcite set in a meshwork of silica ; the specimen shews this beautifully where it has been " etched " by the weather. The calcite particles run in size from mere microscopic points up to blebs about 1-16th of an inch in diameter, the smaller ones having a tendency to occur in clusters. Occasional agates, generally of a reddish tint, are sparingly scattered through this amygdule. This amygdule had originally probably been a calcite geod which suffered torrification, the agates and siliceous mesh having filled up (in the watery way) all the interspaces between the calcite blebs, the siliceous mesh being of a dull white shade.

Carnelian, Cachalong and Quartz.—Carnelian has been deposited all round this gas cavity ; then cachalong, all round ; Carnelian again all round ; cachalong again all round ; carnelian once more

Fig. 34. Carnelian, Cachalong and Quartz.

all round, and quartz plugs the centre. The peculiarity of this specimen, and which I have seen in no other, is that there is a sharply-toothed line between the carnelian and cachalong in both cases, but only on the *inside* of the carnelian layers. Was this an attempt of the carnelian to crystallize? All the bands of both carnelian and cachalong shew no laminæ. Fig. 34.

Chalcedony (*massive*), *Cachalong* (*massive*), *Quartz* (plug).—In this geod a thick irregular band of pretty translucent chalcedony goes all round and encloses a few delessite curls. Massive cachalong

Fig. 35. Chalcedony, Cachalong and Quartz.

fills nearly the whole of the remaining cavity and contains numerous red spots, but shews no banding. A minute " tick " of quartz plugs the remaining space. Fig. 35.

Calcite, Delessite, Coralline-looking structure.—A fair-sized amygdule is composed of calcite mixed with particles of delessite and a white branching substance " by all the world " like a microscopic coralline, the rounded branches being 1-10th of a mm. in diameter. When one sees a structure like this in an amygdule he " swithers " whether to excuse the older mineralogists for thinking that these things were just minute vegetable growths, or to speculate himself on the possibility of *spores* of some of the humbler plants having found their way into gas cavities in Lava Flows, and giving rise to such structures as we see crowding the calcite of this amygdule.

Delessite, Cachalong, Carnelian.—An oblong-compressed geod has got nearly half of its area filled with delessite in very irregular masses, a few stalactites of the same material depending from it. A snow-white deposit of Cachalong of an irregular thickness and intricate outline seals up the delessite and its stalactites, the rest of the very irregular space being filled with Carnelian. The strong contrast of colours in this geod, dark-green, pure white, and pink, has formed a very beautiful little " sed." This amygdule has no chalcedony layer, the celadonite skin being very thin (fig. 36).

Agate, Hemi-Agates, Carnelian.—A small amygdule has got a thin band of agate all round, on which a few hemi-agates of exceptional size have grown, one of them being three-eighths of an inch in

Fig. 36. Delassite, Cachalong, Carnelian.

diameter. They are built up of layers of various shades of white, red, and water-clear material, and, if cut in the proper direction, would form a very fine "ringle-éet" agate. The rest of the geod is filled in with pale mauve carnelian.

AMYGDULES WITH FOUR SUBSTANCES.

Chalcedony, Opal, Calcite, and Quartz.—A geod six inches in diameter

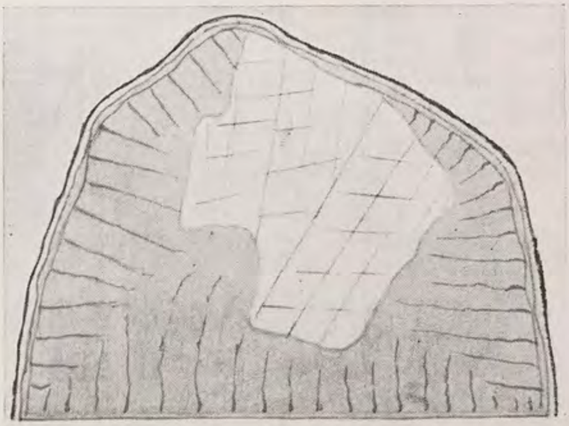

Fig. 37. Chalcedony, Opal (removed) Calcite—reduced in size.

has had, first, a thin deposit of chalcedony all round, then a deposit of opal in horizontal laminæ in the bottom of the cavity, succeeded by a thin band of agate, all round. From the roof of the cavity (as now formed) there has grown down a large twin-crystal of calcite more than two inches in size, the remainder of the space being closely filled with crystals of quartz, which, having commenced to grow on the last agate layer (but not on the calcite), have joined one another at different angles, sometimes at a right angle, and have grown up close to the calcite (fig. 37).

Opal (banded), Agate, Quartz, and Calcite.—A layer of banded opal has first been deposited in horizontal laminæ in the bottom of a gas cavity. This has been followed by a thin layer of agate which

Fig. 38. Banded Opal, Agate, Quartz and Calcite.

goes all round the interior, sealing up the opal; then follows a thick band of crystallized quartz of unequal thickness, but going all round; the interior being filled with calcite (fig. 38).

Cachalong, Chalcedony, Opal (massive) and Quartz.—Opal has not always been deposited in level plates, although this is by far the most common form in Carrick. A specimen has got cachalong, all round; chalcedony, all round; cachalong again all round; then opal fills three-quarters of the remaining space; it is a little clouded (milk opal), but has got no bands. The remainder of the cavity—top part—is filled with quartz.

Chalcedony, Cachalong, Quartz and Calcite.—A gas cavity has chalcedony all round, cachalong all round, crystallized quartz all round, and calcite fills the centre; the above being the order of formation.

Hemi-Agates, Cachalong, Opal and Chalcedony.—After growths of hemi-agates had taken place here and there, cachalong had been deposited all round, sealing them up; then alternating layers of opal and chalcedony have been formed, the opal always level, the chalcedony layers *level on top of the opal,* but also going all round the sides and dome of the cavity. The result has been that the agate at the upper part—where no opal was deposited—is three times as thin as it is at the lower part. In this geod the hemi-agates have grown upon the *celadonite skin*, a circumstance of rare occurrence in the Carrick amygdules.

Cachalong, Chalcedony, Opal, Calcite.—A fair-sized geod has had first a deposit of cachalong going all round, then chalcedony about three-quarters round the cavity; level opal was now deposited; afterwards a band of calcite of unequal thickness, followed by level opal which filled up the remaining space in the cavity.

Note.—The opal on each side of the cavity differs much in thickness, the thickest opal having two of the bands, rather unequal. In this case it cannot be determined which of the opal bands was laid

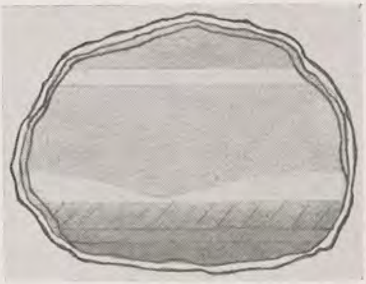

Fig. 39. Cachalong, Chalcedony, Opal and Calcite.

down first. It will be noticed from the figure that the calcite abuts on one side against the cachalong, and on the other against the chalcedony, but this has not affected its regularity of growth (Fig. 39).

Cachalong, Green Chalcedony, Green Opal, and Quartz.—In this little oblong geod there is a layer of snow-white Cachalong going all round. Inside of this there are four laminæ, two of green

Fig. 40. Cachalong, Green Chalcedony, Green Opal and Quartz.

chalcedony and two of cachalong. In the bottom of the cavity as now formed, there are a few layers of green opal. The rest is composed of quartz which has grown all round simultaneously leaving a small narrow druse. It is an odd and very pretty little sed, the green colouring matter is delessite, and the skin of this example is formed of that material. Fig. 40.

Chalcedony, Calcite, Cachalong and Quartz.—A Sard.—Brown Chalcedony goes all round this geod and a large mass of Calcite has grown on the Chalcedony layer the base of which does not take up much space ; then a thicker layer of beautifully white cachalong with red spots,

"Like a dish of strawberries
Smothered in cream,"

goes all round the greater part of the cavity, tapering off as it approaches both sides of the calcite, not touching it. A bright

Fig. 41. Chalcedony, Calcite, Cachalong and Quartz.

red layer bounds and seals up the cachalong. Quartz has grown on the red band and has sealed up part of the calcite. Fig. 41.

Note.—It looks, from this example, as if the cachalong had been *repelled* by the calcite as it approached it, and although the quartz has not been repelled by the calcite it has not grown on it, which is a common feature in the Carrick geods. This is what Lapidaries call a *Sard*, as to its siliceous constituents.

Calcedony, Hemi-agates, Partial-agate, and Level-agate.—A little siliceous geod is remarkable, owing to the thinness of the layers of which it is built up. There has first been chalcedony all round in thin laminæ. A few hemi-agates have grown on the chalcedony and are sealed by a partial agate of many thin laminæ. Level-agate has now been deposited in innumerable very thin layers, and consists of plates of opal which have *remained level* and of chalcedony which, as well as being level on top of the opal, *go up the sides* and form a partial agate of peculiar construction. In this geod the great bulk of the layers are of some shade of red, some of them white. A few of the *level* layers have taken a concretionary structure, but none of those that go up the sides have done so. Many reddish microliths are present in this specimen. Fig. 42.

Fig. 42. Chalcedony, Hemi-agates, Partial-agate, and Level-agate.

Dolomite, Ferite, Light-pink material and Saponite.—A geologist knows at a glance when a rock has been altered from a *Limestone* (carbonates of lime) to a *Dolomite* (carbonite of lime and magnesia), as it is all crowded with cavernous hollows which may be either empty, or filled by some exfiltration product. So it has been in a few of the Carrick amygdules which at first were filled with limestone but became cavernous dolomite by the introduction of magnesia.

Fig. 43. Shrinkage spaces in Dolomite filled with Ferite, Pink material and Saponite.

In an amygdule of this sort the shrinkage spaces have been filled by three substances: ferite, which is scarce; a pale pink stuff, abundant; and white saponite, rare. In this geod there is no bounding layer either of celadonite or chalcedony, but the dolomite is, at parts, tinged of a greenish colour, especially round the sides. The alteration of limestone into dolomite is a subject which has exercised the theroretical imaginations of geologists to a considerable extent, but can't be entered into here. Fig. 43.

Delessite plus Calcite, Calcite, Quartz and Cachalong.—In this geod there is an irregular layer of delessite and calcite which appears to represent the " skin," but is at parts half an inch thick, these materials being intricately mixed together. Then there is a thick layer of yellow calcite which is followed by quartz, and cachalong plugs the centre.

Note.—This specimen has the yellow calcite *all round* and so differs from the usual sporadic manner in which calcite has grown in a gas cavity, but in this case it may be owing to its having followed the first layer of calcite plus delessite, which does not shew lustre-mottling. The cleavages of the yellow calcite run in all directions as if it had commenced to grow from a great many independent points situated not far from one another, round the inside of the spherical hollow on which it grew.

Chalcedony, Level-agate, Cachalong, and Quartz.—The peculiarity of this specimen is that thin microscopic layers of quartz alternate with similar ones of cachalong and go all round ; one of the quartz layers *in the upper side* widening out to a quarter of an inch in thickness, so that the remaining part of the geod is very eccentric. The whole structure (after the minute quartz layers began to form) is zig-zag, somewhat resembling a ripple-agate, but with the crests of the "ripples" sharp instead of rounded, owing to the opal and cachalong layers having begun to form over the sharp ends of microscopic quartz crystals.

Delessite, Chalcedony, Siliceous Concretions, and *Mica* (white).—There is some difficulty in understanding how this geod has been formed. The interior siliceous concretionary structure is intimately mixed with minute particles of mica, looks as if it had resulted from the torrification of a geod and the chalcedony layer, which is very mammillated, is soldered to it, so that this is probably a torrified geod ; the mica being a product " manufactured " within this gas cavity by metamorphism.*

Chalcedony, Opal, Hornstone, Quartz, and *Amethyst.*—A moderately large geod has chalcedony all round, followed by a considerable deposit of plated-opal in the lower part of the cavity. A band of light-coloured hornstone goes all round, seals up the opal, and fades away into granular quartz. Amethyst in large crystals of

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*Perhaps the greater quantity of the Mica in the Carrick Lava Flows owed its existence to Metamorphic action.

both dark and light tints, fills the rest of the cavity, having formed all round on the quartz layer.

Amygdules of Five Substances.

Cachalong, Hemi-agates, Opal, Calcite, and Delessite.—In this specimen the opal is *level*, but unbanded, and the above has been the order of formation of the different substances in this geod. It is worth remarking to see the delissite so far within a geod, but it is a substance which has formed both *first* and *last* in gas cavities: very rarely last.

Chalcedony (all round), Hemi-agates (all round), Chalcedony (again all round), Agate (partial), Quartz (partial), Calcite (plug).—In this amygdule the agate, pink in colour, is nearly all round, the quartz

Fig. 44. Chalcedony, Hemi-agates, Agate, Quartz and Calcite.

about three-quarters round; the calcite has filled up the remaining space and touches the second chalcedony layer. Fig. 44.

Celadonite, Reddish Layer, Calcite, Greenish Particles and Needle-shaped Crystals.—An irregularly-shaped geod has got an outside layer of Celadonite, inside of which there is a reddish layer of fine needle-shaped crystals of an undetermined substance surrounded by calcite, minute particles of a greenish substance being dispersed throughout the calcite, the latter filling the cavity inside of the red layer.

Hemi-agates, Chalcedony, Level-opal, Calcite and Quartz.—A pretty large cavity has had a great number of Hemi-agates all round; 2nd, Chalcedony was deposited all round and sealed the Hemi-agates; 3rd, Banded opal was deposited in the bottom of the cavity as formed; 4th, Three masses of calcite with cleavages all in different directions from one another, grew in different parts of the cavity, one entirely on the chalcedony layer, another party on the chalcedony and partly on the last opal layer, the third grew on the last opal layer; 5th, Quartz then grew on the remaining parts of the chalcedony and opal layers—*but not on the calcite*—and continued to grow till it sealed up all the remaining space—growing up *close to* the calcite. Fig. 45.

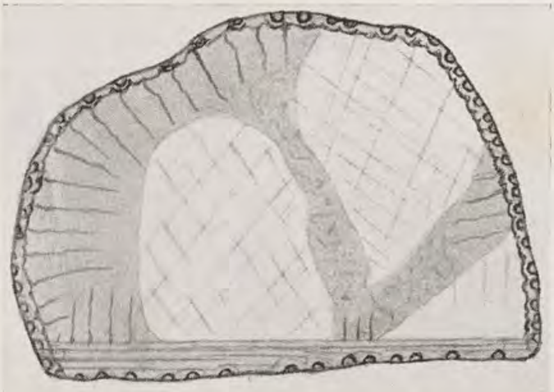

Fig. 45. Hemi-agates, Chalcedony, Level-opal, Calcite and Quartz.

In this geod the Hemi-agates grew on the celadonite skin— a rare occurrence in the Carrick geods.

Chalcedony, Level-opal, Quartz with Delessite (in part), *and Calcite.* —In this gas cavity there is chalcedony all round, then level-opal with a quartz layer of unequal thickness on top of it, which goes also round the dome of the cavity, the part *on top of the opal* being mixed with particles of delessite. Calcite plugs the remaining space, and as is the case with that substance *on top of opal*, so it is here *on top of the quartz*, one of the cleavages is obliquely set to the upper part of the quartz.

This example shews us that delessite can be deposited in a cavity after several substances have been formed in it, but it is strange to see it confined to the part of the quartz on top of the opal as if the latter had some attraction for it. The quartz layer in this geod has got the crystals exceedingly small, the well formed pyramidal ends all pointing inwards and sealed by calcite.

Note.—Although I have seen no instance in the Carrick geods of quartz growing on calcite, but numerous cases in which it *avoided growing on it*, still calcite grows freely on quartz, as in this specimen.

Delessite, Chalcedony, Hemi-agates, Level-agate and Quartz.—The skin of this geod is composed of a pretty thick layer of dark-green delessite, following which there is a layer of chalcedony all round.

On this there is a thin layer with a few hemi-agates. Level-agate now fills ¾ of the cavity and is composed of opal of various tints, streaks of sparkling, granular quartz, and cachalong interlaminated

Fig. 46. Amygdule of five constituents.

with wavy bands of pale-blue opal, giving it the appearance of a "machral-sky." The remaining cavity has been filled with quartz mixed with a little cachalong. Fig. 46.

Chalcedony (all round), Hemi-agates, Opal (level), Quartz, and Amethyst.—Amethyst is not rare in the Carrick Amygdules, but it is generally of a pale colour, although dark-purple coloured ones are also got. It generally lines the remaining druse in a cavity, and in a specimen I have the materials have followed each other in the order named.

Agate, Level-opal, Quartz, Delessite plus Calcite.—In this geod there has first been a layer of agate all round, followed by level-opal. Quartz has then filled a large part of the remaining cavity, being very thin on top of the opal. A central space about an inch in diameter is filled with delessite and calcite intimately mixed, in miscroscopic particles, forming lustre-mottling. This is another instance in which delessite occurs pretty far in, in a geod.

Amygdules of Six Constituents.

Calcite, Chalcedony, Hemi-agates, Banded Opal, Partial-agate, and Crystallized Quartz.—This is a remarkable geod. First of all there grew on the side of a 3-inch cavity a small mass of calcite; (2) then all round the cavity and sealing up the calcite, a strong band of chalcedony; (3) after this there grew on the chalcedony an innumerable number of hemi-agates; (4) in a depression of the bottom of the cavity there was deposited a few layers of opal;

(5) afterwards there was attached to the top of the cavity and attaining a thickness at that part of 3-16ths of an inch, numerous very thin layers of agate, red and water colour, these layers cropping out successively *as they go down* the sides of the cavity, a few of them covering up part of the opal, but *none occur on the bottom* of the cavity half an inch in length. This is a striking instance of the fact that *agate* has been formed in a vapour cavity quite independent of the force of gravity. The large centre of this geod is filled with crystallized silica.

Hornstone, Hemi-agates, Chalcedony, Carnelian, Quartz, and Calcite.—In this geod light green hornstone occupies the bottom of the cavity and goes up the sides a short distance. On it hemi-agates have grown, as well as all round the dome of the cavity where they are attached to the *celadonite or skin*, and where I have washed off that comparatively soft substance their bases are seen--rings within rings—this being a rare feature, as the hemi-

Fig. 47. Hornstone, Hemi-agates, Chalcedony, Carnelian, Quartz, and Calcite.

agates, generally speaking, have accumulated most abundantly on the *first* chalcedony layer. The hemi-agates are sealed by some bands which go all round the cavity and form fortification agate. This is followed by a partial carnelian of various tints. Quartz then partly seals up the carnelian and calcite plugs the top part of the cavity touching the quartz and chalcedony layers. Fig. 47.

Reddish Layer, Hornstone, Chalcedony, Calcite, Cachalong and Quartz.—In this specimen a reddish layer has taken the place of the usual *celadonite* layer. A hornstone band of unequal thickness has then been deposited all round. A thin band of chalcedony has sealed up the hornstone. Yellow calcite of unequal thickness goes all round, and although it does so it has not commenced to grow from every part of the perimeter (as quartz usually does), but from points here and there, and the cleavages are laid in many directions.

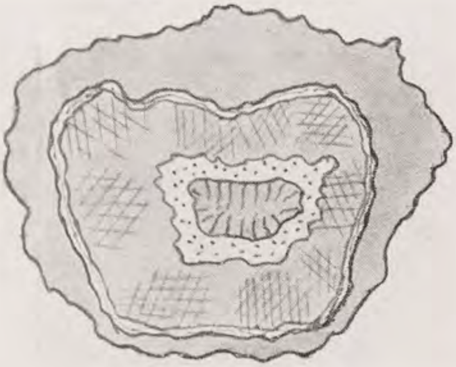

Fig. 48. Geod of six constituents.

A beautiful thick band of snow-white cachalong, with red spots, seals up the calcite and quartz fills the remaining space. Fig. 48.

Note.—Some particles amongst the quartz of this geod shew sparkling colours like fire-opal, and is probably that substance, a feature rarely seen in the Carrick geods. The initial reddish layer may be stilbite.

Geods of Seven Constituents.

Calcite, Chalcedony, Arragonite, Hemi-agates, Level-opal, Partial-agate, and Quartz.—In this geod a small mass of calcite has grown on the celadonite layer and has been sealed by a thick layer of pale blue chalcedony, which goes all round. On this layer a branching mass of arragonite has grown in the *bottom* of the cavity as formed, and hemi-agates all round. In one corner there is a small depcsit of level-opal which enables us to fix the position of this geod in the rock when it (the geod) was forming. A partial agate of many laminæ, and several colours goes round the dome and down the sides, but it tapers off before reaching either the arragonite, or level-agate. Quartz fills the rest of the cavity, sealing the arragonite, opal, first chalcedony layer, and partial-agate. In the quartz there is a small druse, strange to say not far above the bottom of the cavity, so that the bulk of the material in this geod has accumulated independent of the force of gravity. Fig. 49.

Note.—From this geod it is impossible to know in what turn the arragonite, level-opal, and partial-agate were introduced; they may have all grown simultaneously. This can't be known, but I

Fig. 49. Amygdule of seven constituents.

don't think it is likely, as so far as I have seen, *only one constituent* was deposited in a vapour cavity at a time, as I have already remarked.

COMPOUND AMYGDULES.

Calcite, Chalcedony, Opal, Hemi-agates, Agate, Opal, Agate

Fig. 50. Compound Geod.

(*partial*), *and Quartz.*—In this compound geod there is *first* of all a mass of calcite occurring in the bottom of the cavity. *Second,* chalcedony goes all round, sealing up the calcite. *Third*, numerous hemi-agates have grown on the chalcedony. *Fourth*, a band of agate seals up all the hemi-agates. *Fifth*, after this there was a deposit of level-opal in the bottom of the space as now formed. Now comes an arrangement difficult to understand. *Sixth*, for about a quarter of an inch there is level-agate of many laminæ which *abut* against layer four, go round the greater part of the cavity, and taper off at the right side of the dome. *Seventh*, then a *band* of agate of many faint laminæ go partly round and abuts twice against layer four. *Eighth*, on this there is a thin deposit of level-opal. *Ninth*, the remainder of this vapour cavity is filled with crystallized quartz, part of which touches band four. Fig. 50.

Note.—In this geod, as in many others, chalcedony has grown on calcite, but in no case have I seen crystallized quartz grow on calcite : it always avoids *growing on it*, but may *grow up close to it*. This shews us that although chemically closely related, there must be some considerable difference in the " molecules " of these two substances, and in their " likes and dislikes."

Calcite, Chalcedony, Hemi-agates, Opal in level plates, Chalcedony, Partial-agate, Opal and Quartz.—An amygdule 1⅝ inch in its long diameter has got a very peculiar structure. First of all a mass of calcite has crystallized in the bottom of a gas or vapour cavity, its

Fig. 51. Compound Geod.

surface being all but horizontal, which is not a little strange. (2) Then a deposit of chalcedony has sealed up the calcite and gone all round the sides and top of the cavity. (3) Upon this hemi-agates have grown. (4) Next, opal in level courses has formed in the bottom of the cavity, sealing up the hemi-agates at that part. (5) Now some bands of chalcedony of irregular thickness have sealed up the rest of the hemi-agates and partly covered the opal at one side. (6) A partial-agate of many thin laminæ now filled up a large part of the remaining space, leaving a " tube of escape " on one side, the layers in the upper part all tapering off at different places, but in the lower they abut " square " against the chalcedony bands which sealed up the hemi-agates on the left of the cavity. This is a point of structure difficult to understand, of which I have only seen one example before. (7) The " tube of escape " has first had a few thin bands of opal deposited in its lower part. (8) The rest of it being plugged with crystallized quartz. Fig. 51.

The geod illustrated in fig. 52, has commenced to be formed by a lot of very narrow stalactites depending from the roof. The ends of these have been sealed by chalcedony which also goes all round the cavity, and is thick where it has sealed up the stalactites as if they had had some attraction for it. Banded opal has then formed in a large part of the bottom of the cavity and a thin agate has been interbanded with the opal for a bit, and goes round the upper part of the cavity. Banded opal had again resumed to be deposited

Fig. 52. Compound Geod.

for some time. Quartz had then grown on the most of the agate layer and on part of the opal. A thin band of cachalong seals the lower part of the quartz (which had remained uncovered) and then level opal filled the remaining cavity. In this geod the level-opal has had its growth suspended three times, *first* when the partial-agate was being formed, *second* when quartz was " growing," and *third* when the cachalong layer was sealing up part of the quartz. Fig. 52.

Cachalong, Delessite with agates: Cachalong, Opal, banded*: Opal, unbanded: and Opal, banded.*—This geod had commenced to be formed by a layer of cachalong, all round. In the right corner of the geod there is a mass of delessite with a few agates in it, the delessite being dark in shade and sealed by a band of cachalong.

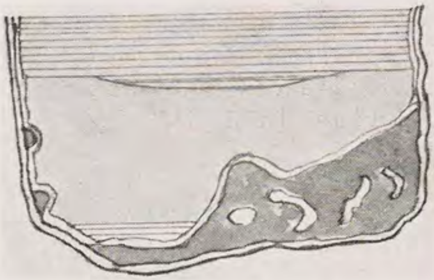

Fig. 53. Compound Amygdule.

A few layers of banded opal had now been laid down in the bottom of the cavity towards the left side. Then follows unbanded opal $\frac{7}{8}$ of an inch thick, and it has probably shrunk a little, at least, there are a few layers of opal levelling up a hollow in its surface, followed by banded opal. (The upper part of this amygdule is lost). Fig. 53.

Note.—At what period the agates in the delessite of this geod were formed can't be made out.

Purple layer, Chalcedony, Hemi-agates, Level-opal, Quartz, Level-agate, and Quartz.—In this specimen a thin dark-purple layer has

Fig. 54. Compound Geod.

followed the bright green celadonite skin. It is sealed by a layer of chalcedony on which a few hemi-agates have grown. In the bottom of the cavity there is some level-opal sealing up a bit of fortification-agate. On top of it there is a thick band of quartz which goes up one side of the cavity (as a thinner layer) and over the dome, sealing up some of the hemi-agates. Level-agate follows, composed of cachalong bands and opal, the former going round the cavity, *but reduced in thickness* after they leave the opal. Quartz fills the remaining space, some of it decomposing light and

"Sparkling like a swarm of fireflies,
Tangled in a silver braid."

Fig. 54.

Hornstone, Chalcedony, Quartz, Chalcedony Quartz and Calcite.—A pale green hornstone, granular in structure, fills about half of the cavity, but does not go all round. Pale-blue chalcedony

Fig. 55. Compound Geod.

seals the hornstone and goes round the cavity. A very thin layer of quartz goes all round. Milky chalcedony goes nearly all round. Quartz goes completely round and calcite fills the remaining space. Fig. 55.

Delessite, Chalcedony, Agate, Quartz, Cachalong and Quartz.—In this geod an irregularly shaped mass of delessite has accumulated

Fig. 56. Compound Geod.

(probably in the bottom of the gas cavity), a thick layer of bluish chalcedony going all round seals up the delessite and also *mixes* with it. Agate occupies the whole of the circumference, but is exceeding thin at one part. Quartz has been deposited irregularly, mostly to one side, leaving a space which is lined with a thick layer of cachalong, spotted with red which almost touches the first chalcedony layer at each end. Quartz plugs the remaining narrow space. Fig. 56.

This is one of the dark-green skinned geods, which, besides delessite, seldom contain anything but siliceous deposits, mostly coloidal, although largely crystalline in this one.

Chalcedony, Level-agate, Quartz, Chalcedony, Level-agate and Quartz.—In this compound geod there has first been a layer of chalcedony all round; then level-agate, composed of numerous thin layers of chalcedony and opal, the various chalcedony layers going round the dome. A patch of quartz has grown on the level-agate and another on the dome, and are sealed by layers of

Fig. 57. Compound Geod.

chalcedony, which are very wavy where they cover up the ends of the quartz crystals, but become flat on the level-agate, and are there interlaminated with opal plates. Two isolated spaces have a few layers of level-agate, composed of opal and chalcedony, the remainder of them being plugged with quartz. The complicated structure of this geod has arisen from the manner in which the two first quartz masses have grown. Fig. 57.

Chalcedony (all round), Level-agate, Quartz, Level-agate and Chalcedony.—In this form the quartz kernel has occupied more than half of the cavity, there having been a space through it subsequently filled with level-agate, composed of layers of opal, cachalong and chalcedony. The opening through this quartz kernel corresponds to the "tube of escape" in agates and is a feature seldom seen in the Carrick geods. From the quartz kernel all the chalcedony layers have been dissolved off by the "weather," but one of the opal layers is still firmly attached, this being of frequent occurrence in the Carrick amygdules. Fig. 58.

In this connection I may remark that opal, although a more "watery" substance than chalcedony, is immensely more durable, and it is quite a common feature in the upper (decomposed) surfaces

Fig. 58. Compound Geod. A Quartz Kernel with an opening plugged by level-agate. Opal layer at base.

of flows to find the plates of opal quite *entire*, whilst the interbanded chalcedony layers have been reduced to powder. The opal has, of course, been altered to a considerable extent by loosing some of its "constitutional water." In the "long-run" all goes to powder —*alles irdishe verhalt.*

Ripple Opal.

This is rarely seen, but one specimen I have shews it in great perfection. The cavity has had first a thick layer of chalcedony going all round. It has then been filled with level-opal, the central

Fig. 59. Geod with Ripple Opal.

part of which has taken a ripple form; all the layers abutting against the chalcedony. The whole geod has been so affected by weathering that both the chalcedony and opal, with the exception of alternating bands of the latter, now exist as cachalong, and this is strongly in favour of the notion that the latter is sometimes a decomposition product after both opal and chalcedony, although I am convinced that it is often an original mineral in the Carrick geods ; and perhaps quartz nectique would be the better term to apply to the altered substances. Fig. 59.

ANGLE-LINE IN AGATES.

When chalcedony was deposited in a sharp-edged or ended gas cavity, an *angle* was formed in each layer corresponding to the sharp corner of the cavity, and it is astonishing how sharp this angle has sometimes kept as innumerable successive layers were laid down (*up*, some of them), and, owing to the growth of the

Fig. 60. Angle-line *a b* at the corners of agate layers, highly magnified.

microscopic tridymite crystals forming the chalcedony layers, what looks like a *line, in section*, but actually the angles of plates, has been formed, this being caused by the ends of the crystals where they touch one another and terminate, fig. 60. Even under high powers of the microscope this line is seen to be *continuous*.

PARTIAL AGATES.

Partial agates have been often referred to in the descriptions of the varieties of geods, and I will now make a few observations on them. Sometimes the material being deposited in a gas cavity has been of such a consistency as neither to be laid down in *level plates*, nor go *round* the cavity. In a specimen, 32 layers have been deposited in the bottom of the cavity, and every one of them tapers off before it goes half-way up the sides. They are followed by a band of milky chalcedony which goes *right round the cavity*, followed by unbanded carnelian.

In another example, after a layer of cachalong and another of chalcedony going all round, some of the following deposits have gone *partly round* and some *right round*, the remaining space, which is, of course, eccentric, being filled with crystallized quartz. In this example there are a great many very minute red spots, some of them in lines concentric with the banding. Two rows of them are conspicuous, as the spots are elongated. They give an exceedingly fine appearance to the specimen.

I suspect that it was only when the above quality of material (that which goes only partially round a cavity) was being deposited, *and then only* that an agate was furnished with a " tube of escape," and since there are sometimes three or four of these in a geod, solutions may have entered more freely at certain points than uniformly all round, which certainly suggests the idea that "tubes of escape" were only formed opposite weak parts in the rock, bounding amygdules, admitting *more-watery* solutions into the cavity where these occur, but I will refer to this again.

CARNELIAN.

This substance seldom fills a vapour cavity in the Carrick Lavas. It occurs both in the massive and banded forms, and is rarely seen free from cracks, being the most brittle of all the siliceous geods. It is, generally speaking, rare in Carrick, but a flow in Linkentoms cutting contains abundance of specimens, and they are equally common and more easily got in a conglomerate and a drift bed in the railway cutting opposite Bower Hill. The dark carnelians are much tougher and freer from cracks than the brighter-coloured ones, fine specimens of them being sometimes found in the fields—good for the Lapidary, but of little use to the Geologist, as they are imperfect.

Agates rendered red by innumerable minute red spots simulate the carnelians, and red spots also occur in the carnelians, both disseminated and in bands, the individual spots being occasionally elongated, or as circles in section (globes) sometimes with two opposite fin-like projections.

" TUBE OF ESCAPE."

I have already frequently mentioned this " opening," and will now give a few illustrations of it, remarking that all the specimens in which I have seen it are wholly siliceous, the silica being either completely crypto-crystalline, or with just a mere " tick " of crystallized silica in the plug of the tube. In Fig. 61 the tube lies to the broad side of an oval geod, the whole of the specimen shewing banding, reddish in colour, narrow, deep-coloured bands alternating with broad, faintly-reddish ones; the final small

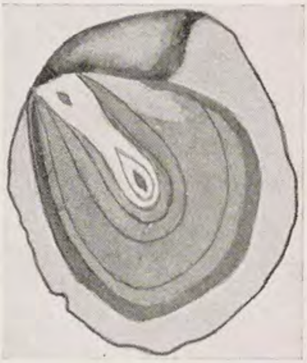

Fig. 61. Tube of Escape.

deposit of quartz being not far removed from the centre of the geod. In one specimen the "tube" is *entirely through crystallized quartz.*

Fig. 62 shews a more strongly banded example than the last, the minute crystallized spot being more eccentric.

Fig. 62. Tube of Escape.

In Fig. 63 the outside thick layer shews no banding, and the inner one a few faint lines.

Fig. 64 shews three "tubes of escape" with strong banding, confined for the most part to the interior.

Fig. 65 has two tubes, and, perhaps, had three, but part of one appears to be wanting.

Plug of the Tube of Escape.—It will be observed that in all the examples illustrating "the tube of escape" the plug of each tube is simply a *tubeless agate*, which could not have been formed in any other way than by "endosmotic" and "exosmotic" action, and

Fig. 63. Tube of Escape.

Fig. 64. Geod with three Tubes of Escape.

Fig. 65. Has two Tubes and perhaps had three.

thus clearly bearing out my contention that it was only when material of a certain quality was being deposited that a "tube of escape " was formed, connected, I think, with a weak part—a place where fluid entered most readily—existed opposite it in the rock.

" Tubes of escape " are rarely seen, and it is only after breaking up, it may be hundreds of specimens, that one is to be found shewing this peculiarity.

The above facts, I think, are strongly against the theory of a " tube of escape " *for each agate*. A great many layers are often terminated it may be an inch or more from that opening, which favours the notion that where " tubes of escape " occur, they are simply opposite weak points in the surrounding rock, and we can easily imagine that when the " gas " or " vapour " was streaming into some of the expanding cavities—from the liquid rock—during their formation, that it would, in some cases, do so more freely along certain parts than in a general manner through the liquid substance of the rock, and, continuing to do so as the rock cooled, would leave these parts more porous and consequently more readily traversable by the water which was to convey the substances that were to form the agates.

I may say that in any specimens I have seen shewing the tube of escape, none of them shew it going through the outer chalcedony layer, a peculiarity not easily accounted for on any theory we may formulate regarding tubes of escape—they stop abruptly when they come (from the inside) to that " shell."

Further and completely demonstrative evidence against the necessity for a " tube of escape " was obtained from specimens collected from the railway cuttings. No geods were more commonly got than those with quartz kernels. I put scores of these through my hands which had been so " etched " by weathering that the agate layers could be peeled off by the fingers till the quartz kernels were reached, and the great bulk of them did not shew a single vestige of a " tube of escape " ; demonstrating in the clearest manner that the silica from which both the agate layers and the quartz centre had been derived had—in a state of solution—not only gone in *through* the layers previously deposited, but the remaining liquid (freed from its silica, or part of it) had gone out, as it came in, through the substance of the previously deposited material, or materials.

Some Peculiarities of Structure.

Globules.—I have one little amygdule three-quarters of an inch in diameter which looks like a series of globules all closely packed together. It is mostly clear, unbanded chalcedony, and scattered through it there are a number of minute white globules, sometimes tinged with red and all apparently composed of masses of minute crystals, the needle-shaped ends of them pointing outwards, each of them being surrounded by chalcedony of a clearer consistency than the rest of the amygdule.

"*Eyes.*"—I may, in this connection, again remark that the so-called "eyes" in agates are not *globes*, and, according to the manner in which they have been formed, they can't possibly be globular. They are half-globes, sometimes a little larger or smaller than that, according to the position in which they have grown. If they grew on a salient angle or bulging surface, they are larger; if on a re-entrant angle, or concave surface, they are smaller. It was only when they grew on a perfectly-flat surface, like that presented by an opal-plate, that they became complete half-globes. They look to have been formed from a point; perhaps one molceule was first laid down—the "seed" from which this peculiar structure grew.

I have seen hemi-pectolites, but not in the Carrick flows; they occur in the dolerite rock forming the Castle Hill at Howrat, near Dalry.

Microliths.—I have already several times remarked on the microliths occurring in the amygdules and have now only to add that many of them are exceedingly small, some I have measured being only the 30,000th part of an inch in diameter. They are generally globular, but oval ones and other shapes occur. Sometimes we find them as aggregates which, when red, resemble little raspberries. They are oftenest red, sometimes yellow, and of other tints.

Minute bodies in Calcite.—In some of the finely-crystallized calcite which occurs in the gas cavities there are minute microscopic specks which, in the aggregate, give a peculiar appearance to the calcite. It is quite easy to split (along the cleavage plains) bits of the calcite thin enough to be examined microscopically by transmitted light, and when so examined it is seen that they are clear, slender and very delicate needle-shaped bodies occurring in great abundance; and when bits of the calcite are digested in acid these disappear, but specks are left behind and shew under the microscope, as globular, radiating bundles of very minute crystals.

Red Egg-shaped Mass.—In the centre of a green hornstone amygdule there is an egg-shaped mass an inch long, the boundary between it and the hornstone being very regular and quite sharp. It is much softer than the hornstone, of a vermilion colour, and its formation difficult to account for. If it has been deposited in a remaining hollow of the hornstone there are no bands in either of these substances to support this theory. It looks very like a decomposition product of the hornstone, and I am strongly inclined to think that this is the proper explanation of its origin, although one would naturally expect that decomposition ought to have commenced at the outside of the hornstone: but regarding the decomposition of geods, I may here remark that it is quite a common feature *to see inside layers* much further gone in decay than ones *outside* of them, this probably resulting from slight chemical, or possibly structural, difference. The hornstone also contains some agates and crystallized calcite.

Heliotrope.—Green hornstone of a granular nature, with dispersed calcite and small agates, some of them *red*, is the nearest approach to heliotrope I have seen in the Carrick geods.

Black Globes.—Minute, black globes crowd the inner surface of an outer mammillated layer of chalcedony of an agate, which has been separated from the layer on which they grew by weathering, and the greater number of them have stuck to the last-named layer. Round each of them there is a pure-white ring, probably a shell of the chalcedony that has got more weathered than the rest.

Quartz Plate.—A band of quartz a quarter of an inch deep, and of equal thickness throughout, occurs as a *plate* in a level-opal; its *upper* and *under* surfaces are finely *granular*. When quartz has grown on opal and been sealed by that substance, or by chalcedony, its pyramidal ends are well seen in section, but that is not the case in this specimen. The quartz-plate abuts "square" against the first chalcedony layer of the geod, none of the quartz having gone up the sides, a feature not commonly seen.

Rings on Opal Plates.—These are preserved on parts of three plates, which follow one another. The smallest ones on the lowest plate are about half a mm. in size, on the next ·8 of a mm., and on the third 1·2 mm., the largest ones on that plate being 1·6 mm. On the first plate they all stand apart, on the second they are nearer together but don't touch, and on the third they all touch, some of them indenting their neighbours slightly. On the second and third plates, with the exception of those that are indented, all the rings appear to be perfect geometrical figures and of a beaded structure. On the first plate they were probably like the rest, originally, but are now rather decomposed. Perhaps the rings on one plate are *exactly above* those on another, and the relative positions of some of them appear to bear this out. As to how these "fairy rings" of the mineral kingdom have originated I can form no idea.

Accessory Minerals.

Galena.—I have only twice seen small specks of galena in the Carrick geods. They each occurred in the interior of agates embedded between the layers and were evidently formed during the deposition of the agate.

Pyrite.—Iron Pyrites is occasionally seen in the Carrick amygdules, and sometimes a speck of it may be detected embedded in an agate, and in some cases it has been the first substance to form as small particles on the walls of a vapour cavity. It occasionally *crosses* layers in opal, chalcedony, and cachalong as if it had filled minute shrinkage cracks. In one instance I saw it filling cracks in crystallized calcite from an amygdule.

We learn from the paucity of sulphides in the geods that the Carrick Volcano, or Volcanoes, sent forth very little *sulphur*, and this observation is borne out by the lithology of the flows.

Dendritic Manganese.—This substance has probably always been quite a recent deposit, growing in little tree-like forms in cracks and on agate layers slightly parted by decomposition. In the latter position it may, of course, have been coeval with the deposition of the agate, but on this point I can't speak with certainty.

Agates with manganese have been called Mocha Stones. *Red Spots* (oxide of iron ?) had formed in *cracks* after some of the amygdules had consolidated and got fractured. They are often very beautiful when viewed under the microscope, occurring as small *flat*, ringed discs, which, by their growth, have often coalesced and form clusters. The reason for their occurring as thin discs is that, having been formed in cracks, they had only room to expand sideways. As already remarked, they also occur *in the substance* of agate layers, in cacholong, in both banded and massive opal, and in carnelian, and are evidently coeval with the formation of these substances. They are sometimes seen abundantly on the surface layers when parted asunder, but whether they were formed originally on the layers, or are of recent growth, is a question.

Barite.—Heavy Spar but seldom occurs in the Carrick flows. I have seen it associated with Kilpatrick Quartz, and, in the instance given on page 38, it was the first substance to form in a gas cavity.

Kilpatrick Quartz.—Quartz, generally speaking, can't be called an accessory mineral, as it sometimes forms the principal part of geods, but in the form of Kilpatrick Quartz it occurs, crusting with its minute sparkling rosettes, the surfaces of other minerals in vapour cavities. It is also found in veins in the porphyrites.

Dark Crusts. — Little, dark, velvety, pancakey-looking crusts sometimes occur on the surfaces of both quartz and calcite crystals in the gas cavities. They sometimes grow up to one another, forming clusters, the largest individuals measuring only about ·5 of a mm.

Introduction of the Minerals into the Gas Cavities.

The question to be considered now is, in what manner were the different materials introduced into the gas cavities? In the first place, the acidulated and alkaline water carrying the substance has undoubtedly percolated *through the solid rock,* as the cavities in which the amygdules or geods are contained are *sealed all round,* and, in doing so, has dissolved out the materials which now form the geods. This, I think, is the generally received opinion of mineralogists as to the formation of agates, etc.; so that *the outside layer* of a geod or amygdule is the oldest or first formed.

I think there can be little doubt that before their introduction, and immediately after it, all the different substances were in a state of solution. Opal is the only mineral which, when in level courses, looks like a sedimentary deposit, but from its structure it does not appear to have been so. This raises rather a moot question, viz., did the substances, Quartz, Tridymite, Chalcedony, Hemi-agate, Cachalong, Carnelian and Opal, all so closely chemically allied, exist in the solution, or solutions, *as these substances,* or were they differentiated from a solution of *uniform quality* just immediately before, or during their transformation into these substances?

It is held by some mineralogists that during the deposition of *siliceous solutions* a hole, ultimately growing into a pipe or funnel-shaped avenue, kept up a communication with the interior of the geod, and that the solution, or solutions, came in by "endosmotic action" *all round the cavity,* and through every layer as it was formed the exhausted solution (water, mostly) going out by the pipe mentioned. Holes and wide openings do exist through the layers of *some* agates, but in the cuttings for the railway I have obtained sufficient evidence to shew, I think, that it was only in certain cases that those holes were formed, and that in the great majority of instances the solutions *came in* and the water (probably *in all cases* containing certain materials in solution) *went out* through the gradually thickening wall of agate, etc., by what has been called " endosmotic " and " exosmotic " action. I use these terms out of deference to some mineralogists, but, for my part, I think it was simply a matter of *percolation*. Water certainly soaked through the rocks by percolation, " picking up " certain substances in its course, and as a more or less saturated solution entered the gas cavities. After some layers had been laid down it continued to enter and leave the cavities *through* these layers, but why different terms (with a different meaning) should be employed is what I don't see any use for ; in fact, I will go the length of saying that they are quite meaningless as applied to the filling of gas cavities by mineral substances, for when these actions take place through the skin of a bladder, the bladder has *first to be filled* by water, so that the initial filling of a gas cavity by a watery solution must necessarily have been simply a matter of percolation. If a solution could come through the solid rock, as it must have done, and through the layers of introduced substances in the gas cavities, as it is supposed to have done, what was to hinder the solution (now thinner, so to speak) from going back in the same way, and I am convinced that this was the manner in which the great bulk of the agate and some of the other substances composing the amygdules were formed, but as I have discussed this matter under the heading " Tube of Escape " I need say no more about it.

An anecdote told of Sir Isaac Newton will help us in this matter. Sir Isaac had two cats (a big one and a small one). He was constantly troubled by requiring to open his room door to allow the cats to get in and out at their sweet will. He pondered over the subject, thinking how he would get quit of this bother. A bright idea occurred to him, and he had two holes cut in the door—a big one for the big cat and a small one for the little cat—but to his astonishment and confusion he was grieved to see that when the big cat went out through the big hole the small cat followed it, and took no notice of the wee hole.

In the case of solutions entering and leaving gas cavities, it appears to me that they did so by the larger openings *found so* *sparingly* through the layers of the substances deposited therein, as well as through the walls of the deposits, and as I have already shewn, not one agate perhaps in a thousand has got a single one of the larger openings.

That solutions *carried out* part of the materials they had brought into the gas cavities is perfectly evident—in fact,demonstrated—from a study of the Carrick amygdules. We have already seen (page 29) that two contiguous geods may contain very different substances, but it is difficult to understand how the solutions entering these cavities could be other than of the *same quality*, so that *part of the materials* brought in was certainly carried out again.

Did the Original Steam or Gas which formed the Cavities leave any Deposit therein ?

In the first place, as to what this substance actually was we have no means now of knowing, but in all likelihood it was water vapour or steam, and that it would be perfectly pure is not at all likely, so that it probably carried in some mineral substances and also gases. As we have seen, *Celadonite* has in at least 999 cases out of a 1,000 been the first mineral to form in a gas cavity, and as it usually occurs as an exceedingly thin skin to the geods, and differs so entirely from the substance following it, it in all likelihood was formed from the original vapour which swelled out the cavity in the molten rock. The original watery vapour may have been contained in the molten rock in a diffused state and under the pressure of a great mass of " crust," probably many miles in thickness, so that when the molten material reached the earth's surface the pressure would be greatly lessened, the vapour would swell up and form what are now the geod-filled cavities in the flows. If not in a diffused state, then as *solid nodules* of water or gas, generally of small size, but odd ones must have been comparatively large to form cavities four yards long by a yard wide.

How many Substances were deposited at a time in a Gas Cavity ?

The next question is, was more than *one* mineral substance formed or deposited in a cavity at a time ? From the examination of the Carrick amygdules, I think the answer to this question is that *only one mineral or material was formed or deposited at a time in a gas cavity.* When opal was being laid down in level plates there was apparently no chalcedony deposit taking place. When quartz crystals were growing generally all round and closely packed together, probably no other minerals were forming. When calcite was crystallizing, it appears to have had the cavity all to itself, and when a cavity is entirely filled with it, certainly all to itself, and when the outer " skin " first formed, undoubtedly the cavities contained no other solid substances. Even with the beautiful little hemi-agates, whilst they were being built up dome upon dome in the fairy palace of the geod, all other work was suspended ; so that there is no confusion, no hurly-burly, no jerry-building, but everything perfect in its kind, and done in a very leisurely manner, a small *cosmos* constructed within a large one.

We have seen that cavities may be entirely filled (including the skin, but not always) with crystallized quartz, calcite, delessite, unbanded chalcedony, agate, banded opal, silica in various states of hornstone, etc., and limestone. I have not seen one filled with white saponite, arragonite, massive opal, or celadonite, and the agate ones are extremely rare.

Why opal should occur *in level courses* is a great mystery. It looks more like a sedimentary deposit than one formed from a solution, but for all that it gives grandeur and variety to a geod, like the level bars of cloud in a quiet sky. Evidently the molecules of opal were not capable of sticking to the walls or dome of a gas cavity, the water they contained probably (acting as a lubricant) preventing them from doing so.

Quartz crystals have commenced simultaneously (as a rule, but not always) to grow all round a gas cavity, either on the celadonite layer, on chalcedony, or on that substance and banded opal, forming kernels with a *flat base*, but if the cavity had previously contained a crystal of calcite, they don't grow *on the calcite*, but have continued to increase, in many cases, till they have sealed up that substance.

Calcite seldom commenced to grow *simultaneously all round* a gas cavity. It looks to have begun to form from a point (perhaps from a single molecule), and may occur as one or several masses, sometimes forming twins. When it has grown on the surface of a layer of level opal, one of the cleavages *is always set obliquely* to the opal platform, *never parallel to it*. We see from this that a " molecule" (so called) of calcite is neither a cube, a "brick," a globule, nor a wedge, and if we carry the process of reasoning a stage further in the direction of the infinitely minute, we must come to the conclusion that the " atoms " of Dalton, or rather Democritus 2,000 years before his time, have no geometrical form, if, indeed, there are such things. I had abundant opportunities of observing this peculiarity of calcite on opal from specimens I collected from the gas cavities of the Carrick Lava Flows. See Fig. 32.

Yellow calcite is the only form of that substance which I have seen go round a gas cavity, and of this I have observed a number of instances. It appears to have begun to grow from numerous points situated not far from one another, so that its cleavages (that is to say, of the different masses) point in many directions.

When calcite has the form of lustre—mottling or skinkle—calcite in the gas cavities, it looks as if its growth had been suspended during the time the substance—it afterwards enclosed—was growing on it.

There is only one point in answer to the above question that I am doubtful about, and that is, when a substance was forming in, say, the bottom of a gas cavity, may not a crystal or partial layer of some substance have been growing on its sides or dome? This I can't answer, but I think not: the numerous instances I have observed of hemi-agates growing *at intervals* round a cavity when no other substances could possibly be forming gives strong support to the theory I have put forward that *only one substance* was formed in a gas cavity at a time.

Crystals.—Where an open space exists in the inside of a partly filled vapour cavity the last layer to be formed (generally speaking, for there are exceptions) was one of crystallized quartz, occasionally with a few calcite crystals growing on it, or hemispherical or pancake shaped ones of a dark, velvety appearance, composed of radiating bundles. Occasionally in these small rock-bound palaces of crystalline delight we see beautiful little sparkling groups of Kilpatrick quartz—rock diamonds—the last substance to form in these dark chambers of the lava flows; but were they always dark? Probably not, in fact, all the building in of a geod may have taken place in the most brilliant light under the influence of a particle of radium.

"Hail, holy light,
Offspring of heaven."

Pseudo Geods.

This is a name I have given to an obscure class of geods, or nodules, in the Carrick Traps. They have probably not originated in the usual way by deposition from watery solutions in gas cavities, but look as if they had segregated out either from the fluid rock or from rock which had been heated by flows, dykes, or sills. One of them is an intimate mixture of small specks of quartz, calcite and dark particles. It has no " skin " and nothing to suggest deposition from a watery solution—apparently not formed in a gas cavity.

Dissolved-out Substances.

During the period of the infilling of the gas cavities, or perhaps immediately after they were filled, certain minerals may have been dissolved out, or partly so, and been replaced by other substances, but the dissolution of materials from cavities has, geologically speaking, been mostly of quite recent origin and very probably

Fig. 66. Geod, shewing bases of Hemi-agates.

since the glacial period, as during the glacier stage of that time all the old pre-glacial or rotted part of the rocks was carried away; the proofs of this being numerous where a thick protecting water-tight " till " has preserved them from post-glacial " weathering " influences, the rocks in such favoured cases being *quite fresh, solid and undecomposed*. The destruction of the geods has probably been due to the very same set of agents which formed them, viz., the soaking through them of water charged with solvent materials. Calcite has suffered most, as we often see from the remnants of crystals left. Other substances have had certain constituents removed and have often been rendered so powdery as to be easily crushed between the fingers; even the adamantine agates and opals have been reduced to this condition or certain layers and plates so softened that those on each side of them can be readily parted. Sometimes the celadonite layer has been weathered off, as in the case mentioned page (23) where a netted structure is exposed. In cavities where hemi-agates had grown on the celadonite layer, a rare occurrence, their bases have been exposed when that layer has been dissolved off as in the remarkable geod shewn in Fig. 66, which exhibits on its surface rings within rings, the bases of these pretty little structures.

In coloured agates we often see white blotches formed by "weathering," these being sometimes conspicuous where there is a "tube of escape" or wide openings as in partial-agates. These facts are also in favour of there being weak or porous parts in the rock opposite these openings, allowing the readier entrance of primed destructive solvents at these places, although in the great majority of cases they have come in all round the geods when destroying them, as the building-in-solutions did when forming them. Amygdules which have suffered partial weathering not conspicuously visible are often more easily cut than solid ones. On the other hand, first-formed layers of chalcedony and sometimes even inside ones have often become *exceedingly hard* by a small amount of weathering, owing to their having parted with their "water of constitution."

Opals are much more easily cut than agates, evidently owing to the comparatively large quantity of constitutional water they contain, and when they have lost that water they have been converted into a substance called quartz nectique.

Cavities rarely contain a little dark-brown powder, probably what remains where some compound of iron or manganese has been decomposed.

Geod with Tesselated Structure.

A geod 3 by 2¼ inches has had first a layer of siliceous matter forming the "shell" on which at one part some calcite had grown. In the interior there are at least three plates of granulated quartz separated by soft green layers which had all got broken up into figures resembling the spaces between sun cracks, the interspaces having been filled with a whitish amorphous, siliceous substance.

The specimen had been broken through the middle and considerably weathered before I found it, the soft layer wasted mostly away, leaving the infilling material in relief. The specimen is unique,

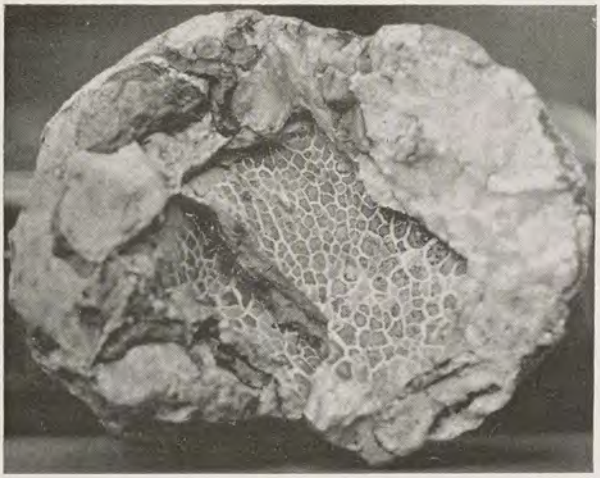

Fig. 67.

and during its formation it would appear that the cavity in which it was being formed had got dried up several times so as to allow of the shrinkage and breaking up of the green layers. Another explanation would be the torrification of the geod by heat breaking up the green layer and subsequently infiltration, but the former seems the most likely as the green layer is quite soft, Fig. 67.

Empty Gas Cavities.

It is quite possible that some of the gas cavities never contained any amygdules at all, but I think that is very unlikely, although their fresh appearances are much in favour of it, sometimes there being in the cavities a mere skin, with perhaps a thin crusting of minute crystals. However, some of them are now quite empty; in fact, whole clusters are in that condition.

Besides a general weathering of the rock from the surface, downwards to more than 20 feet, affecting the amygdules more or less, there has been a more intense alteration on each side of the master-joints, there being in such places bands, generally of a light-brown colour, where the Lava Flows have had their more soluble colouring matters dissolved out of them, these features being particularly noticeable in the railway cuttings and along the shore sections, the rock assuming in such places a "fossy" yet often tough quality, and these bands at a first glance might readily be mistaken for *dykes*, passing up through the rocks, of a different quality of material from the flows.

In front of Craig Skean, at a lower level and just above the cultivated land, there is a natural exposure of an amygdaloidal flow, from which weathering has removed all the materials of the gas cavities, except crystallized quartz and hornstone, these minerals being still remarkably fresh ; these remarks, of course, applying to such cavities as are open to "day."

Did the Lavas flow out on Land or under Water?

The question to be considered now is, were the Lava Flows, many of which are crowded with amygdules, and few, or perhaps none—entirely destitute of them—thrown out *on land* or *under water?* Some of the tuff and ashbeds in connection with the flows show a very decidedly stratified arrangement, as if they had been sorted out in water, but this is not sufficient evidence one way or another, as pools of water or mere surface wash might do this.

Another feature which I have already mentioned is that irregular hollows and cavities in the upper parts of flows caused probably by shrinkage and the breaking up of surface crusts as the flows began to cool, have been filled in with sandstone—sometimes micaceous and very fine-grained, and in thin leafy layers as well as with thin bands of shale. In these beds I have discovered more than fifty species of fossils, a number of them being footprints, accompanied by trailing marks of tails or spines of small animals, U-shaded tubes, spiculæ or spines, thread-worm-looking fossil trails, egg-clusters, worm, trail-and-burrow markings, etc., a number of the fossils being microscopic, but none of them can be said, with certainty, to have belonged to or been made by marine creatures ; and these inter-lava-flow sedimentary rocks being very limited in thickness and area—often only a few inches and a few square feet or yards—it looks as if they had been deposited in pools of water and consequently that the Lava Flows took place on land.*

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*See Author's work on Upland Fauna of the Old Red Sandstone of Carrick, Ayrshire, printed by Mr. Cross, Kilwinning.

Limestone Beds between the Flows.

The sporadic deposits of limestone already referred to are in favour of origin in pools of water, and that they have hitherto yielded no fossils is no argument against such a mode of formation. I have come to the conclusion that these limestones were deposited as *quicklime* washed from the surfaces of lava flows, and by its absorption of Carbonic Acid became carbonate of lime. On the contents of a blast furnace being drawn out, water was thrown on the material, when quicklime was washed out and got deposited in little pools here and there. This gave me the clue to the idea that limestone beds may sometimes have originated as deposits of quicklime washed by rainwater from the surfaces of lava beds, and this would effectually account for the absence of "life" in these limestones. I may say that in a long series of microscopic sections I made, the material having been taken from many parts of the limestone beds, I saw no minute fossils in any of them.

Zeolites.

The rarity of zeolites in the lava flows of Old Red Sandstone age in Carrick is more of a chemical question than a geological one.

In the great series of lava flows of Lower Carboniferous age which cross the centre of Scotland, zeolites are confined to certain flows and appear to be totally absent from others; and in the south-west part of the series agates are extremely rare.

Veins in the Flows.

Agate.—Veins of agate, narrow in width, sometimes occur in the harder and more siliceous flows, some of the thinner ones holding very beautiful ripple agate, and others red agate and jasper.

Cracks sometimes pass through amygdules, and have been filled by siliceous or calcareous deposits: so do minute faults shifting the layers a bit.

Calcite.—Calcite Veins are frequent in the flows, and often attain to several inches in width, filling the spaces and rents made during violent commotions in the rocks, and may, by a little stretch of fancy, be called fossilized earthquakes.

Veins containing a mixture of substances, especially calcite and quartz, are common.

Hematite.—Dull-red veins resembling a very siliceous hematite are occasionally seen.

Limestone.—As already remarked, limestone undoubtedly occurs as *amygdules*, and in such cases it must be an exfiltration product, that is dissolved out of the rocks and re-deposited. It also occurs as vein-like strings, and some of these may be veins, but I am strongly inclined to think that others are not veins in the usual sense of the term, but simply deposits originating in the same manner as the short beds of limestone already noticed did; the lime having found its way into narrow cracks in the upper parts of flows.

In all ages the semi-precious stones appear to have had a particular attraction for humanity, and in the West of Scotland I have occasionally found articles of antiquity fashioned from agates and jaspers.

The Babylonians and Egyptians used them in making cylinders and seals, and carved them into the forms of various animals. They are referred to in the various Holy Writs of the world, and at the present time immense quantities are cut into ornaments and useful articles.

Poets have gloated over them: one of the happiest flights of fancy in that respect I here reproduce—

Thence will I go
To undermine the treasure fertile womb
Of the huge Pyrenean, to detect
The agate, the deep-entrenched gem
Of kindred jasper—Nature in them
Delights to play the mimic on herself,
And in their views she oft portrays the ferns
Of leaping hills, of trees erect and streams
Now stealing softly or now thundering down
In desperate cascade, with flowers and beasts
And all the living landscape of the vale.
In vain thy pencil Claudio or Pousin,
Or thine immortal Guide, would essay
Such skill to imitate—it is the hand
Of God himself.

By way of tail-piece, I introduce a Carrick Geod composed mostly of Stalactites. Fig. 68 (from a photo. by Mr. A. Shanks).

This figure is in its proper position, but owing to some optical peculiarity the stalactites do not show "solid" unless the figure is turned upside down.

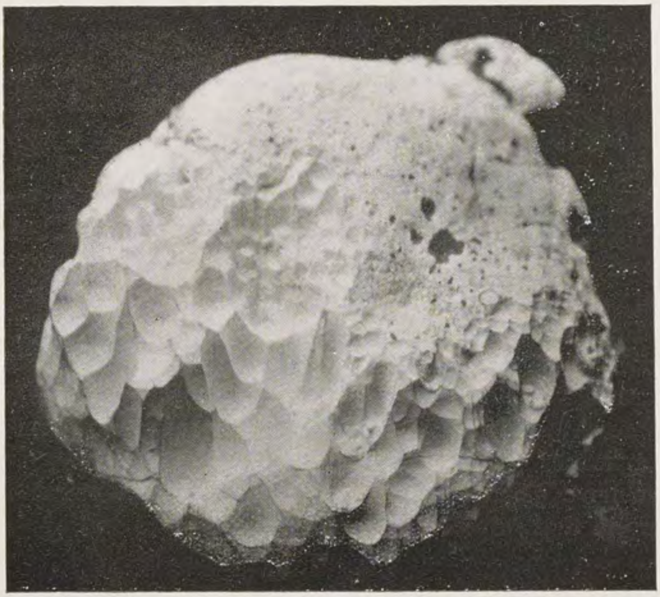

Fig. 68. Stalactites.

PLATE I.

(*Frontispiece*)

This plate illustrates a number of the Carrick geods cut and polished. Some regularly-shaped agates will be seen; others with the material deposited more or less to one side; two shew level-banded opal, with surrounding layers of agate; one has got massive opal with a few thin layers of chalcedony going all round; one has a very irregular intermixture of agate; and another one shews white spots of cachalong in a ground mass of chalcedony.

PLATE II.

This plate illustrates a number of the Carrick geods as taken from the rock. There are some pretty oval ones; one axe-shaped with a cutting edge at one end, the opposite end being blunt and somewhat pointed; another has a rounded blunt end, the opposite one being sharp and almost brought to a point; two are contracted towards the middle, the hollow of each passing all round, the ends blunt, one of them almost flat; one geod shews where two steam cavities have run together, the smaller one indenting the larger.

PLATE III.

This plate illustrates a number of the more regularly-shaped quartz kernels, the outer layers having been peeled off by natural weathering of geods, which, having been near the surface of the rock, were exposed to the action of acidulated water. When dug out the outer layers were more or less in the condition of a siliceous scaly powder, which was easily washed off.

PLATE II.

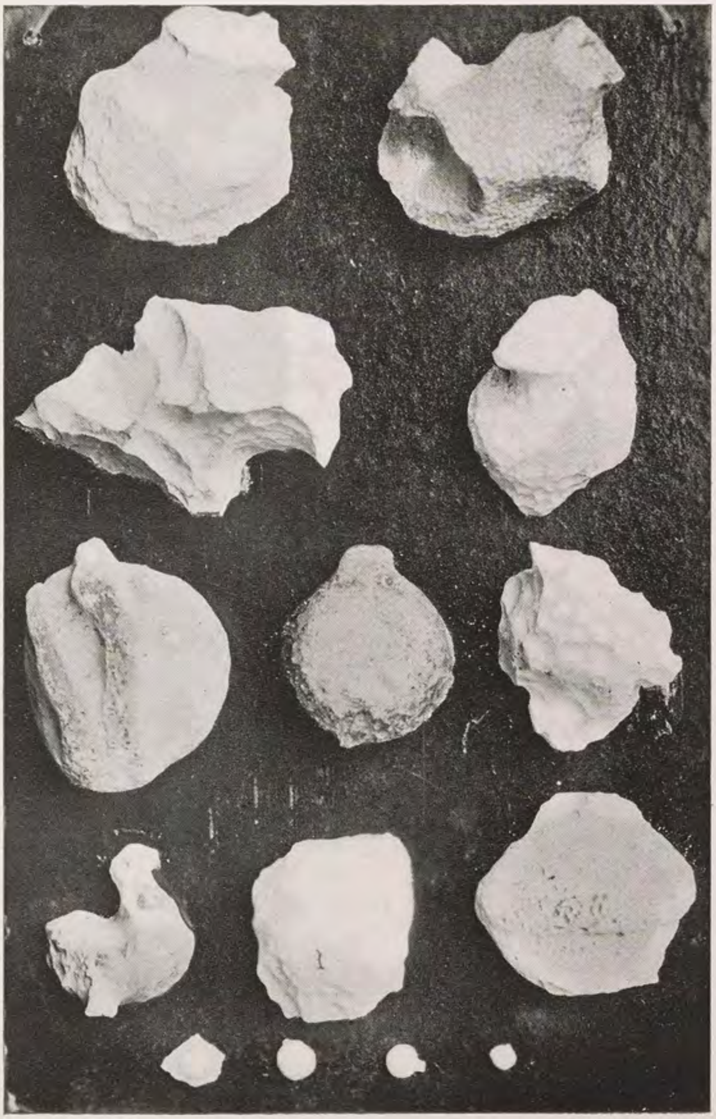

PLATE III.