

XIX.—*On the occurrence of Agates in Dolomitic Strata of the New Red Sandstone Formation in the Mendip Hills.*

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HAVING had occasion to visit the cliffs of Cheddar in November 1827, I found in the collections of geodes and calcareous spar which are there exposed to sale, a number of curiously figured agates, such as I had never before seen during my numerous geological investigations of the Mendip Hills, nor in any of the cabinets at Bristol which abound in the products of this district. I was informed that they were ploughed out of the surface of some fields at the base of the Mendips, and collected from holes dug for this purpose to a slight depth where the plough indicated their abundance. I had then no leisure to examine the spot whence they came, but wrote to a geological friend (the Rev. D. Williams of Bleadon, to whom we owe the discovery of vestiges of another hyena's den at Uphill), requesting him to ascertain the exact place whence these agates were taken, and on being informed that it was in the village of Sandford, about two miles east of Banwell, I visited the spot with him in November 1828, and found their matrix to be the dolomitic strata of the new red sandstone formation.

As they are the first examples I have ever met with, of the occurrence of perfect agates in this formation, I send specimens to the Geological Society, in illustration of the present communication.

In external form and size, these agates resemble the ordinary varieties of a common potatoe; they are, in fact, very nearly allied to those geodes, to which the name of potatoe-stones has been generally applied, and which have been long known to abound in the dolomitic beds of the new red sandstone formation around the Mendip Hills. Their exterior is rugged, like that of a truffle, and opaque; but on being broken they present internally, on a larger scale, the same structure and arrangement as the compound agates known in jewelry by the name of bird's-eye agates, being made up of alternating bands of chalcedony, jasper, and hornstone, disposed in irregular and concentric

curves : the outermost of these curved bands are conformable to the irregularities of the external surface, whilst a number of minor agates nearly spherical in form, and composed of the same materials as the external case, are dispersed throughout an amorphous mass of chalcedony and hornstone, which occupies the interior of the entire or mother agate.

The prevailing colours of these bands of chalcedony and hornstone are various shades of gray ; some are opaque and white, approaching to cacholong ; others are red, and pass into red jasper ; some of the white bands are filled with minute specks of red oxide of iron, like the specks in bloodstone. The central part is either a cavity lined with crystals of quartz, or a solid mass of semitransparent chalcedony, or of hornstone variously coloured by iron. The chalcedony is sometimes opaque and hydrophanous.

Thus far, considered mineralogically, our specimens differ but little from the common agates of the trap rocks, but their geological relations are entirely different, and the circumstance of their matrix being a dolomitic bed of the new red sandstone formation, presents a novelty worthy our attention, and of which I now proceed to the details.

It has been mentioned in the account of the south-west coal district of England, by Mr. Conybeare and myself, that the Mendip Hills are composed of inclined strata of mountain limestone, and old red sandstone ; and that on the sloping sides, and basset edges, and around the base of these inclined strata, we find horizontal beds of dolomitic conglomerate, dolomite, red sandstone, and red marl, which together make up our new red sandstone formation\*.

The geodes which are found in many parts of this last formation have been long familiar to mineralogists under the name of potatoe-stones, and are mentioned in the memoir now alluded to (p. 292) ; these rarely contain pure chalcedony, but are mostly composed of a case or shell of hornstone or quartz, of variable thickness, lined internally, and often very prettily, with crystals of quartz and carbonate of lime, being almost always hollow at the centre ; they vary from an inch to a foot in diameter, and have evidently been produced by infiltration into cavities of the matrix, in the same manner as agates are infiltrated into cavities of the trap rocks : these potatoe-stones abound near Wells, and also in the villages adjacent to the agate bed at Sandford, viz., at Hutton, Banwell, Churchill, Winscombe, Burrington, Compton Bishop, &c. Near Cheddar and Burrington they assume the character of coarse jasper-agate : nearly pure red jasper-agates occur also in the dolomitic rocks, on the left bank of the Severn, in the villages of Worle and Clevedon.

\* Geological Transactions, Second Series, vol. i. pp. 214, 225.

The more perfect agates I am now considering are found in the dolomitic beds of the new red sandstone formation. The spot on which I saw them, lies between the villages of Banwell and Churchill, at the north base of a hill called Sandford Hill, where the junction of the wood with the cultivated land marks the geological junction of the inclined mountain limestone with the horizontal beds of dolomite. Here a shallow pit, which has been opened for the express purpose of digging agates, presents the following section :

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| 1. Yellow clay, mixed with carbonate of magnesia and carbonate of lime . . . . .  | 6 inches.   |
| 2. Yellow dolomite, used as firestone in lime kilns ; it crumbles readily to a soft powder, and is filled with specks of manganese, and contains small veins and minute nodules of chalcedony . . . . .   | } 6 inches. |
| 3. Yellow clay, falling to powder in water, like fuller's earth, and containing much carbonate of lime and magnesia. In this clay the agates are dispersed irregularly, like nodules of flint in chalk, but not like them in horizontal lines . . |             |
| 4. Yellow clay and earthy dolomite, to the bottom of the pit . . . . .  | 12 inches.  |

In the adjacent field is an open well, about twelve feet deep, showing the continuation downwards of the same argillaceous, earthy dolomite which forms the bottom of the agate pit.

These beds of dolomitic clay seem to be decomposed strata of dolomite, in the cavities of which, before its decomposition, the agates may have been formed. The soft, arenaceous, yellow dolomite, No. 2., would, by a very little decomposition, be reduced to a state much resembling the yellow clay of No. 3. In the more solid and crystalline slabs of the stratum No. 2. I found siliceous concretions, which, on being broken, proved to be coarse potatoe-stones ; whilst the softer and yellow portions of the same stratum contained thin veins of opaque and white chalcedony, and minute insulated nodules of agate. The substance of these veins and agates is precisely like that of the large agates in the clay immediately subjacent.

This union of potatoe-stones with veins of chalcedony, and with small agates, in the solid dolomite immediately reposing on the clay containing the larger agates, shows that their common origin may be due to an infiltration of siliceous matter into cavities. I do not, however, contend that all these agates and potatoe-shaped concretions have been formed by infiltration into cavities of consolidated rocks : some may have been formed contemporaneously, whilst their matrix was yet plastic, and unconsolidated, and admitted the separation of its siliceous from its calcareous ingredients, in the same manner as contemporaneous concretions of flint have been formed in chalk, and nodules of chert in various limestones, and as *Septaria* have been formed in beds of clay.

The theory of the formation of agates in trap rocks by infiltration of silex into their cavities is now generally admitted; similar infiltrations of chalcedony occur occasionally in other rocks, and in the cracks and cavities of silicified organic remains. The finest examples of organic remains containing agates are the silicified woods and corals from the tertiary strata of Antigua; in a less perfect state they occur in silicified wood of other formations. The conversion of fossil shells to chalcedony and jasper is due to this same process of infiltration. Remarkable examples occur in the green-sand formation of Devonshire, in shells from the Whetstone pits at Blackdown\*, which are turned to limpid chalcedony; and in the shells of the same green-sand at Little Haldon Hill, near Dawlish, which are converted to red jasper†.

I possess two agates from cavities of chert in the green-sand formation at Lyme Regis, one having the structure of a box agate, the other of a fortification agate; and from the same green-sand I have an Echinus, the interior of which is nearly filled with bluish chalcedony. Chalcedony also occasionally assumes the form of agates, in veins and small cavities of primitive and transition rocks; and, indeed, wherever silex is present in a state of sufficiently minute division to be filtrated into any small cavity, there the formation of agates may proceed.

The occurrence of entire beds, as well as nodules of jasper and jasper-agate in the mountains of dolomite near Palermo, which I agree with Dr. Daubeny in referring to our magnesian limestone formation, affords a parallel example of silex assuming the form of agates, jasper, and chalcedony in a formation of the same age with that containing agates in the Mendip Hills.

\* In the collection of the present Dean of Bristol there is a specimen from Blackdown, in which a small pond of stratified chalcedony occupies the cavity of one valve of a large Venus; this chalcedony is disposed in parallel and horizontal plates, like the plates at the bottom of a box agate. The shell itself is converted to chalcedony, and must have laid horizontally, when its cavity received in a fluid form the silex, which is become an onyx composed of thin horizontal layers of differently coloured chalcedony.

† The fossils at this place afford the only example I ever saw, of shells converted into red jasper: they are of the same species with those in the not far distant Whetstone Pits of Blackdown, between Honiton and Cullompton, which are usually in the state of light grey coloured chalcedony.