On banded and brecciated concretions / by John Ruskin.

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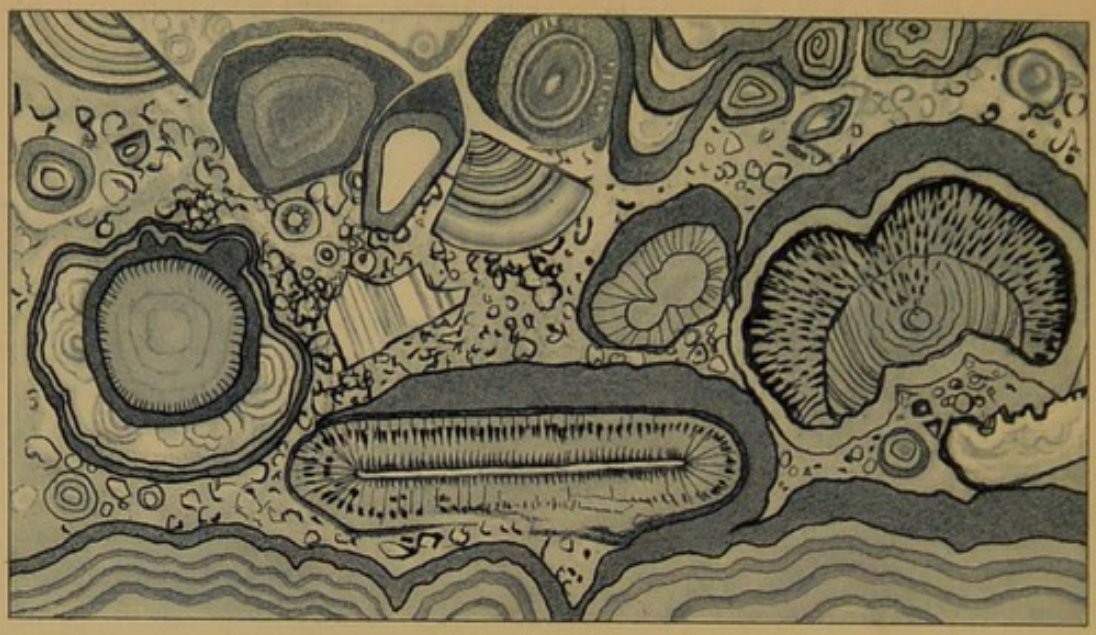

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BANDED AND BRECCIATED CONCRETIONS.

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ON BANDED AND BRECCIATED CONCRETIONS.

By John Ruskin, Esq., F.G.S.,

(PLATE XV.)

AMONG the metamorphic phenomena which seem to me deserving of more attention than they have yet received, I have been especially interested by those existing in the brecciate formations. They are, of course, in the main, two-fold; namely, the changes of fragmentary or rolled-pebble deposits into solid rocks, and of solid rocks, *vice versa*, into brecciate or gravel-like conditions. It is certainly difficult, in some cases, to discern by which of these processes a given breccia has been produced; and it is difficult, in many cases, to explain how certain conditions of breccia can have been produced either way. Even the pudding-stones of simplest aspect (as the common Molasse-nagelfluhe of north Switzerland) present most singular conditions of cleavage and secretion, under metamorphic action; the more altered transitional breccias, such as those of Valorsine, conceal their modes of change in a deep obscurity: but the greatest mystery of all attaches to the alterations of massive limestone which have produced the brecciated, or apparently brecciated, marbles: and to the parallel changes, on a smaller scale, exhibited by brecciated agate and flint.

The transformations of solid into fragmentary rocks may, in the main, be arranged under the five following heads:—

1. Division into fragments by contraction or expansion, and filling of the intervals with a secreted, injected, or infused paste, the degree of change in the relative position of the fragments depending both on their own rate and degree of division, and on the manner of the introduction of the cement.

2. Division into fragments by violence, with subsequent injection or secretion of cement. The walls of most veins supply notable instances of such action, modified by the influence of pure contraction or expansion.

3. Homogeneous segregation, as in oolite and pisolite.

4. Segregation of distinct substances from a homogeneous paste, as of chert out of calcareous beds. My impression is that many so-called siliceous "breccias" are segregations of knotted silex from a semi-siliceous paste; and many so-called brecciated marbles are segregations of proportioned mixtures of iron, alumina, and lime, from an impure calcareous paste.

5. Segregation accompanied by crystalline action, passing into granitic and porphyritic formations.

Of these the fourth mode of change is one of peculiar and varied interest. I have endeavoured to represent three distinct and progressive conditions of it in the plate annexed; but before describing these, let us observe the structure of a piece of common pisolite from the Carlsbad Springs.

It consists of a calcareous paste which arranges itself, as it dries, in imperfect spheres, formed of concentric coats which separate clearly from each other, exposing delicately smooth surfaces of contact: this deposit being formed in layers, alternating with others more or less amorphous. Now it is easy to put beside any specimen of this pisolite, a parallel example of stratified jasper, in which some of the beds arrange themselves in pisolitic concretions, while others remain amorphous. And I believe it will be found that the bands of agate, when most distinct and beautiful, are not successive coats, but pisolitic concretions of amorphous silica.

Of course, however, the two conditions must be often united. In all minerals of chalcedonic or reniform structure, stalactitic additions may be manifestly made at various periods to the original mass, while in the substance of the whole accumulation, a structural separation takes place,—separation (if the substance be siliceous) into bands, spots, dendritic nuclei, and flame-like tracts of colour. But the separation into any of these states is not so simple a matter as might at first be supposed.

On looking more closely at the Carlsbad pisolite, we may discern here and there hemispherical concretions, of which the structure seems not easily to be accounted for;—much less when it takes place to the extent shown in Fig. 1, Plate XV., which represents, about one-third magnified, a piece of concretionary ferruginous limestone, in which I presume that the tendency of the iron-oxide to form reniform concretions has acted in aid of the pisolitic disposition of the calcareous matter. But there is now introduced a feature of notable difference. In common pisolite, the substance is homogeneous; here, every concretion is varied in substance from band to band, as in agates; and more varied still in degree of crystalline or radiant structure; while also *sharp-angled* fragments, traversed in one case by straight bands, are mingled among the spherical concretions: and series of brown bands, of varying thickness, connect, on the upper surfaces only, the irregular concretions together, in a manner not unusual in marbles, but nevertheless (to me) inexplicable.

Next to this specimen, let us take an example of what is usually

called "brecciated" malachite (Fig. 2, in the same plate). I think very little attention will show, in ordinary specimens of banded malachite, that the bands are concretionary, not successive; and in the specimen of which the section is represented in the plate, and in all like it, I believe the apparently brecciated structure is concretionary also. This brecciation, it will be observed, results from two distinct processes: the rending asunder of the zoned concretions by unequal contraction, which bends the zones into conditions like the twisted fibres of a tree; and the filling up of the intervals with angular fragments, mixed with an ochreous dust (represented in the plate by the white ground), while the larger concretions of malachite are abruptly terminated only at right angles to the course of their zones, not broken raggedly across: a circumstance to be carefully noted as forbidding the idea of ordinary accidental fracture.

Whether concurrently with, or subsequent to, the brecciation (I believe concurrently), various series of narrow bands have been formed in some parts of the mass, binding the apparent fragments together, and connecting themselves strangely with the unruptured malachite, like the brown bands in example No. 1.

Now, if we compare this condition of the ore of copper with such a form of common brecciated agate as that represented in Plate XV., Fig. 3, it will, I think, be manifest that the laws concerned in the production of this last—though more subtle and decisive in operation, are *essentially* the same as those under which the malachite breccia was formed,—complicated, however, by the energetically crystalline power of the (amethystine) quartz, which exerts itself concurrently with the force of segregation, and compels the zones developed by the latter to follow, through a great part of their course, the angular line of the extremities of the quartz crystals *cotemporaneously formed*, while, in other parts of the stone, a brecciate segregation, exactly similar to that of the malachite, and only the fine ultimate perfectness of the condition of fragmentary separation which is seen incipiently in the pisolite (Fig. 1), interrupts the continuity both of the agate and quartz.

And finally, a narrow band, correspondent to the connecting zones of the malachite, surrounds the brecciated fragments in many places, while in others it loses itself in the general substance of the massive quartz.

I cannot, however, satisfy myself whether, in this last example, some conditions of violent rupture do not mingle with those of agatescent segregation; and I am sincerely desirous to know the opinions of better mineralogists than myself on these points of doubt: and this the more, because in proceeding to real and unquestionable states of brecciate rock, such as the fractured quartz and chalcedony of Cornwall, I cannot discern the line of separation, or fix upon any test by which a fragment truly broken and cemented by a siliceous paste which has modified or partly dissolved its edges, may be distinguished from a secretion contemporaneous with the paste, like the so frequent state of metalliferous ores dispersed in quartz.

Hoping for some help therefore, I will not add anything further in this paper; but if no one else will take up the subject, I shall proceed next month into some further particulars.

EXPLANATION OF PLATE XV.

Fig. 1. Section of a piece of concretionary ferruginous limestone, magnified about one-third.
Fig. 2. Section of a (so-called) "Brecciated" Malachite.
Fig. 3. Section of a Brecciated Agate.

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