On the "Skin" of Agates.

By Professor HEDDLE and J. STUART THOMSON.

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"I BELIEVE that the green 'Skin' of Agates will prove to be celadonite and not delessite, as has been generally supposed." This is an extract from a paper by one of us, which was published in 1879 in the *Transactions of the Royal Society of Edinburgh.*

Quarrying for agates upon a large scale having been carried out for several weeks during a succession of years on the shore of Forfarshire, an unusual supply of the soft coating which frequently invests them was obtained.

It is by no means insisted that this coating is invariably one and the same substance. At several, if not at many localities there is indeed no investing layer whatever. At others it is zeolitic-natrolite or crockalite; then it penetrates into the outer layers of the agate itself, and is not merely adherent, like the skin of a potato. The substance treated of in this communication is of a vivid green colour, is glossy upon its outer surface, and is disposed in layers, assuming occasionally internally a distinct, though minute mamillated structure. It is well seen on the agates of Scurr Hill in Fife, of the Path of Condy in the Ochils, and at the locality whence our supply was obtained,—the so-called "Blue Hole," near Usan, in Forfarshire.

The circumstances under which agates were formed, and also the minerals whose decomposition led to their formation, must vary much; and this they do irrespective of proximity of locality.

The agates of Scurdy Ness, which is not over three miles north of the Blue Hole, have no skin; while the skin of agates taken from a bed overlying that which yields the green-coated agates of the "Blue Hole," is russet brown, earthy, and may be removed by washing.

Again, the form of the agates of that upper bed is most irregular, even *hackly*, while that of the lower or true bed is ovoidal and smooth surfaced. The colours of the upper bed agates are reds, pinks and wax yellows; of the lower bed inky blues, with rarely outer layers of a rich

brown jaspery character. The substance of the upper bed stones, is in its outer layers at least, more or less opaque, from that incipient water loss which produces "quartz-nectique." The lower bed stones are pellucid, sound, unaltered; but that which best characterises them is their brilliant smooth green coat, called in the district their "paint." It is this "paint" which was analysed.

Its specific gravity, taken on 43·5 grains, was found to be 2·605.

It yielded on analysis—

		Formula.
Silica	51·742	54·05
Alumina	4·443	3·88
Ferric Oxide ...	11·911	11·94
Ferrous Oxide ...	4·195	5·4
Manganous Oxide ...	trace	
Lime	0·535	
Magnesia	8·288	6·76
Potash	7·399	7·88
Soda	0·552	
Water	11·491	10·14
	100·556	

Of the above 11·491 per cent. water, 6·13 per cent. is lost at 212° Fah.; and 5·716 is lost when the powder is exposed over H_2SO_4, all being recovered on re-exposure to a normally moist atmosphere.

The figures in the second column give the numbers required by the formula already given in the *Edinburgh Royal Society Transactions*.

$$(\dot{Fe}^{\frac{1}{4}}\dot{Mg}^{\frac{1}{2}}\dot{K}_2^{\frac{1}{4}})^3\ddot{Si}^6 + (\ddot{Al}_2^{\frac{1}{3}}\ddot{Fe}_2^{\frac{2}{3}})\ddot{Si}^2 + 5\dot{H}_2.$$

Celadonite is insoluble in acids. Now a small proportion of this substance in powder is soluble in acids. This, along with the slight departure in its composition from that of normal celadonite, warrants the supposition that there may be some little admixture with saponite or delessite, both of which are decomposed by acids.

All the substances which by analysis have been shown to be celadonite are decomposition products of transference,—not remaining within either the rents or the bounding walls of the decomposed or altered mineral, as a pseudomorphic plug. Hence we have no physical aid in conjecturing what that mineral had been. Olivine, where present in the rock, yields serpentine or a more or less serpentine-like pseudomorph; and also presumably yields the veins which cut both these pseudomorphs and such portions of the rock as are closely adjacent; but evidence that the de-

composition of olivine has yielded products which have been transferred into druses or interstial spaces, has not been forthcoming.

Augite can be seen with its own rents filled with fibrous saponite, and also throwing out into drusy cavities plumose arrangements of piles of hexagonal crystals of saponite.[1]

Hence, it is little more than the vaguest chemical speculation which would assign the formation of delessite, chlorophæite and celadonite also to the destruction of augite. In fact no mere degradation,—no mere new arrangement of the ingredients pre-existent in any one of the minerals concerned—that is being altered—*rotted*, let us call it,—could form certain of these new compounds;—a re-combination of certain of the ingredients of several, or at least of more than one of these minerals, is necessary.

Olivine or enstatite could not supply the alumina,—augite could not supply the potash of celadonite; felspars must have been giving way; and when celadonite results, the presence of a potash felspar is almost vouched for.

It is at least clear that the changes which have taken place during the "alteration" of a rock,—the kaolinisation of its felspars—the serpentinisation of its enstatites and olivines—the lining of its cavities with zeolites, and plugging them with agates—the details of the work in Nature's laboratory, in short—are not confined to the mere sundering of old combinations and their degradation through the loosening of the bricks, but are engaged also in the *elaboration* of new compounds and the building up of new structures,—in these cases more complex and more enduring than the originals which supplied their components.

To some small extent the rationale of the loosening of the bricks, and the consideration of the processes engaged in the sundering of the former structures has been entered upon; but those connected with the rearrangement of the materials, and the building up of the newer structures are still altogether beyond our ken.

It is, however, the first step towards knowledge to see clearly—to recognise what are the things which we do not understand.

[1] Usually set down as *serpentine* by petrologists.