II.—*Note on the Serpentine of Duporth, in St. Austell Bay, Cornwall.*—By J. H. Collins, F.G.S.

THE Geological Survey Map of Cornwall shews, to the south of the town of St. Austell, several patches of "greenstone," extending from near the ancient earthwork called Trethullan Castle, on the west, to the sea at St. Austell Bay in the east; a distance of over four miles.

The western end of the most extensive of these patches swells ont on the top of the hill to the north-east of St. Mewan Church, so as to cover several hundred acres (including some of the best land in the parish). This was described by Mr. J. Arthur Phillips some years since in the Philosophical Magazine.* Mr. Phillips speaks of the rock as being distinctly crystalline, consisting of felspar (sometimes triclinic); semi-transparent yellowish-brown crystals, probably hornblende; a green fibrous mineral also believed to be a variety of hornblende; many black grains of oxide of iron and a few hexagonal crystals, probably apatite; and he says the rock exhibits unmistakeable evidence of extensive alteration. Speaking of its extension eastward, he says "it extends in diminished proportions in a south-easterly direction to the sea at Duporth."

An examination of this intrusive mass in different parts of its course, shews that it becomes more coarsely crystalline and porphyritic as it approaches the cliffs, and that the chemical composition is also changed, until, finally, the hornblendic rock of St. Mewan becomes a serpentine at Duporth.

The clay-slate in the cliffs is soft and yellowish, and dips about 20°, to the W. N. W. Apparently interbedded with this is the serpentine, in a mass from 40 to 50 feet thick, of a general greenish-grey color, mostly soft, often somewhat schistose, and considerably decomposed near the surface.

* Phil. Mag. Feb., 1871.

The less decomposed portions near the sea-level are seen to consist of serpentine of a darker green colour, full of grayish-white spots of a substance resembling kaolin, which on examination appear to be pseudomorphs of hornblende and perhaps felspar, varying from 1-20 to 1-4th of an inch in length. The crystals have not quite lost their power of depolarizing polarized light, but the difference between the crystals and the green base in this respect, is not extremely great.

The green serpentine base is often somewhat fibrous, the fibres curving round the larger crystals and exhibiting brilliant colours with polarized light; it is sprinkledwith very small prisms of scarcely altered felspar. The base and the altered included crystals are both sprinkled pretty thickly with crystals and grains of oxide of iron, and the whole rock is in places stained yellow or brown with peroxide of iron.

Fig. 3 Plate VII shews the appearance of a polished specimen unmagnified; fig 4 a rather thick section magnified twelve diameters. Fig. 5 illustrates the internal structure of one of the large altered hornblende crystals, and fig. 6 the characters of the serpentine part magnified 200 diameters.

Proceeding inland, the rock soon becomes harder, but is still full of imbedded crystals, mostly of hornblende with some felspar, until at St. Mewan it is so fine-grained that the ingredients mentioned by Mr. J. A. Phillips can rarely be distinguished without using a lens. I have spoken of the serpentine as being *apparently* interbedded with the killas at Duporth. This is how it appears at that place, but at Gewans, about a mile inland, where the rock is very hard, and is extensively wrought for road stone, it distinctly cuts through the slates and appears as a great east and west dyke at least 60 feet wide and nearly perpendicular, the killas there dipping to the N.W. It is also distinctly intrusive at St. Mewan, as pointed out by Mr. Phillips.

The following analyses shew the interesting changes of chemical composition exhibited in this mass in different parts of its course. (*a*) is the mean of three analyses of the rock at St. Mewan made by Mr. Phillips,* (*b*) is my own analysis of the rock from the quarry

* Phil. Mag., Feb., 1871.

near Gewans, (*c*) my analysis of the rock at Duporth, and (*d*) a recent analysis of the same rock made by Mr. J. Arthur Phillips.†

	a.	*b.*	*c.*	*d.*
Sp. Gr.	2·97	2·86	2·64	2·86
Water	·80‡	·80§	8·65‖	·72 9·29
Silica	47·57	50·24	37·09	35·74
Titanic acid	trace	trace	trace	——
Phosphoric acid ..	·12	·20	·21	·18
Alumina	17·16	19·19	19.90	12·23
Ferric oxide ..	13·04	15·30	15·54	4·68
Ferrous oxide ..	9·30		2·02	13·84
Oxide of manganese,	trace	trace	trace	·98
Sulphur	trace	trace	——	——
Lime	4·11	5·02	trace	trace
Magnesia	trace	·93	15·90	22·13
Potash	2·30	7·21	trace	trace
Soda	5·45			·25
	99·85	98·89	99·31	100·04

From these analyses it appears that the change is not great at Gewans as compared with St. Mewan, a distance of a mile and a half, and that it consists chiefly in a lessening of the proportions of iron oxides and a slight increase in the silica. Within the next mile, however, a very notable change takes place, the silica being reduced by upwards of 12 per cent. and the alkalies entirely carried off, while the proportion of water increases from less than 1 to over 8 per cent, and the magnesia from less than 1 to nearly 16 per cent. or in Mr. Phillips's specimen over 22 per cent. Chemically and mineralogically the rock now consists essentially of a base something over 30 per cent. of serpentine, containing in crystals and grains, nearly 50 per cent. of kaolin, and nearly 20 per cent. of peroxide and magnetic oxide of iron.

†For this analysis I am indebted to Mr. Phillips, who has courteously sent me his results since the reading of the above paper. He remarks "I find more magnesia than you do, but my specimens have undergone more extensive change than yours, as you will see from the fragment which I enclose." He also observes "My recent analysis of some remarkably fresh rock from the Sanctuaries gave 1·75 per cent. of magnesia.

‡ ·33 lost in water bath. § ·5 lost at 120° C. ‖ 2·73 lost at 120° C.

As to the cause of this remarkable change of a hornblendic into a serpentinous rock, there is little at present to guide us; but the district is one of very extensive disturbance, traversed in all directions by mineral lodes and elvan courses; and it is not more than 2 miles from the St. Austell granite. I have, in a paper read before the Royal Geological Society of Cornwall in 1876, given my reasons in detail for believing that the extensive alteration of the felspar of that granite into kaolin has been produced by mineral solutions acting through fissures from below, and I have little doubt that this production of serpentine is due to a similar action, but the proof of this speculation is, I think, still wanting. If I were to guess, I should say fluoride of magnesia was the principal cause of the alteration.