

II.—*On some specimens of Gabbro from the Pennine Alps.*

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SOME time since Capt. Marshall Hall called our attention to Arolla, in the Pennine Alps, as a locality interesting to mineralogists.* I venture, then, to offer you a brief note on one of its rocks, collected during a visit in the summer of 1875.

At the head of the Combe d' Arolla rises the grand mass of the Mount Colon, a truncate cone of precipitous rock, dominating the glaciers of Vuibez and Arolla, which, after sweeping down from the watershed of the Pennine chain, unite into one stream at its base. The highest point of its snowy cap is 12,264 feet above the sea. In the Swiss geological map the greater part of the mountain is coloured as gabbro, and the same rock forms a small peak near the head of the Otemma glacier on the S.W., and the S.W. flank of the Dents de Bertol to the N.E. The persistent bad weather prevented me from attempting the ascent of Mount Colon, or crossing the Col de Bertol, but I visited the only readily accessible place (on the N. bank of the Arolla glacier) where, according to the map, the gabbro can be seen *in situ*, in contact with the gneissoid rock, but here is either an error in the map, or (what is more probable) some change in the level of the glacier has covered up the junction. Hence my examination of the gabbro has been confined to the specimens which are brought down in great quantities by the Arolla glacier. Among these we find two types which we may call normal; one, a rather finely crystalline rock of a mottled dull bluish or brownish-grey colour, which consists of an apparently not very distinctly crystalline groundmass of felspar and rather altered olivine, in which are scattered numerous crystals, generally about $\frac{1}{5}$ " long, of a pyroxenic mineral, augite or diallage, of rather dull non-metallic lustre. The other variety is a coarsely crystalline rock, consisting of a dead-white or slightly greenish saussuritic mineral, and dark-green hornblende in prisms, often about $\frac{1}{2}$ " by $\frac{1}{8}$ ". Still coarser varieties of the latter rock sometimes occur: and in these may be seen diallage crystals, an inch or so in diameter, which are in part converted into hornblende. Some-

* Min. Mag., vol. 1., p. 61, Feb., 1877.

times one of the diallage crystals is almost intact, sometimes it has an irregular border of hornblende, sometimes no trace of the diallage remains, the whole crystal consisting of the other mineral. The latter gabbro then illustrates the replacement of diallage by hornblende, so well shewn in some of the gabbros of the Lizard (Cornwall).* I have examined microscopically the two normal varieties noticed above. The first consists of plagioclase felspar in rather "stumpy" crystals or crystalline grains, fairly well preserved though in parts kaolinized,—probably labradorite; olivine generally well preserved, but here and there partly converted into serpentine; diallage with perhaps a little ordinary augite; and a few grains of iron peroxide. Besides these we notice an occasional brownish mineral, which generally occurs in irregular strips, often bordering a grain of olivine or diallage. It has an imperfect prismatic cleavage, a rather "satiny" aspect, is dichroic (pale yellowish-brown to darkish-brown), and closely resembles the mineral which I have described as occurring in a mass of rock included in serpentine north of Kynance Cove, Cornwall.† The cleavage is not characteristic, but I believe the mineral to be a variety of hornblende. Its occasional association with clotted ferruginous dust leads one to suspect it may be a secondary product, and its mode of occurrence suggests sometimes that it may be the result of an alteration of the diallage, in other places, however, it seems as if it were either wholly a separate mineral or formed from a separate crystal.‡ Possibly the composition of the original pyroxenic constituent of the rock may have varied slightly, so that one part would change more readily than another.

In the coarse variety of the Mount Colon gabbro the plagioclase is almost wholly converted into an aggregate of irregular microliths (bright coloured with crossing prisms) and dusky earthy clots. It is apparently identical with the mineral occurring in the altered gabbros of the Lizard district, being a kind of saussurite,|| the result of the alteration of lab-

* See my paper, *Quart. Journ. Geol. Soc.*, xxxiii, p. 895.

† *Ibid.*, p. 889.

‡ The boundary between it and the diallage being sharply defined, or its being enclosed by grains of olivine or felspar.

|| Analysed by Mr. Hudleston:—

Water (with traces of carbonic acid)	...	...	...	4.80
Silica	...	...	...	45.70
Alumina	...	...	...	23.00
Oxides of iron	...	...	...	5.50
Lime...	...	...	...	19.30
Magnesia...	...	...	...	4.75
Alkali and loss	...	...	...	1.95

100.00

Some of this magnesia may be due to minute fibrous hornblende which is probably present, but, as Mr. Hudleston observes, the result looks as if the original mineral had been anorthite.

radorite or anorthite. The hornblende occurs generally in groups of crystalline grains, sometimes shewing very characteristic cleavage, but being occasionally rather platy. Minute ferruginous microliths are not unfrequent. This mineral also closely resembles the hornblende described in a gabbro from the Balk (Cornwall).* I have not been able to detect any olivine or any considerable grains of serpentine; here and there, however, a grain seems to be composed of fibrous hornblende, mingled with ill-defined rather prismatic transparent microliths and an isotropic mineral, like some serpentines. This marked deficiency (even if the absence be not complete) of olivine or serpentine is to be observed in some of the Lizard gabbros, and there I could only conclude that in certain cases the olivine originally present had not been converted into serpentine but had been replaced by hornblende. It is, however, very singular that a rock so rich in olivine as the first described, in which, also, the formation of serpentine is begun, should have lost all distinct traces of either mineral. This, however, is not without a parallel in the Crousa Down gabbro. It will be well for future wanderers in the less accessible districts about Mount Colon to keep a sharp look out in order to discover the relations of these two rocks, lest there should be, as at Coverack Cove, two distinct masses of gabbro. Be this, however, as it may, I have no doubt that the gabbro is a true igneous rock.

On the right bank of the Zmutt glacier, a gabbro similar to the above abounds among the blocks which are strewn thickly over the ice, and of course is found frequently in the bed of the Visp lower down. Here, also, as on the Colon glacier, both varieties may be found. The coarser one (saussurite and hornblende) shews occasional traces of the diallage; the finer hardly differs from that described above, and is evidently rich in olivine. I have not had sections made of these, as their similarity to the others is so great. This gabbro obviously comes from the Matterhorn; according to Sig. Giordano† it occurs *in situ* among the cliffs above, a little below the level of the Col de Lion, viz., about 11,000 feet above the sea. On the other side of this gap it is yet more largely developed, "Questo banco di roccia cristallina ha qui l' enorme potenza di 500 metri e soltanto cessa a 3580 metri d' altitudine." No trace, however, of gabbro, as I know myself, is seen on the opposite (eastern) flank of the mountain during the ascent from Zermatt. Sig. Giordano says of this "sul fianco orientale del picco a vece dell' eufotide non si trove che un gneis verdognolo-talcoso. . . Si ha qui pertanto il curiosissimo fatto del passaggio della eufotide allo gneis in un medesimo banco assai regolare." As, however,

* Quart. Journ. Geol. Soc., xxxiii, p. 895.

† Bulletino del Club Alpino Italiano 1868, p. 299.

there is no proof of this asserted passage beyond what can be seen from the Zmutt glacier more than 2000 feet below, and the rock is practically identical with that of Mont Colon, I have no doubt that it is really intrusive in the talcose schist. This, however, will be hard to prove by actual inspection, for the cliffs appear hopelessly inaccessible, and are frequently swept by showers of falling stones.