On some Rocks from the Saas-Grat, compared with Erratic Blocks from the neighbourhood of Lake Leman.

By Captain MARSHALL-HALL, J.P., F.G.S., &c.

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The following are chiefly notes of a longer paper read April 5th, 1882, before the Société Vaudoise des Sciences Naturelles.

For some years familiar with the valleys of Anniviers, St. Nicklaus, Zermatt and Saas, the author has made a study of comparison between the above rocks *in situ* and erratic specimens of the same nature. The want of a laboratory and of more than a travelling microscope with polarising apparatus render his researches so imperfect that a more complete report upon these rocks must be deferred.

In the neighbourhood of Geneva, amongst other glacially transported rocks, are specimens of Euphotides, Serpentines, Eklogites, &c. found *in situ* in but few localities in Switzerland: the Euphotides especially from the mountains above the valleys of Erin and Saas; the Serpentines, on the other hand, from several other valleys on the same (the south) side of the Rhone.

Also, on the shores of Lake Leman, up to an altitude of not *less* than 2,500 feet above the sea, or 1,300 feet above the lake, the author has found numerous specimens of the rocks in question left by retreat of the great glaciers.

About Montreux and the lateral valleys, for instance, Serpentines and Euphotides are common, as also in the neighbourhood of Evian on the French side. After careful examination and comparison, the author is confirmed in the opinion generally held, that the origin of the Euphotides near Montreux is the Saas-thal; while those about Evian are from the Val d'Erin. Euphotides and some Serpentines are also found near Geneva; a fertile field is the corner of land at the junction of the rivers Arve and Rhone, a mile below the town.

Professor Alphonse Favre has given a description of these erratics in his geology of the canton of Geneva. On the other hand, Professor Bonney has described the microscopical appearance of some "gabbro" from the Evvolena district (Val d'Erin). The author has made sundry

analyses of rocks from the Saas, the Anniviers and the Gremenz localities, as also from the erratic rocks about Montreux, Evian and Geneva; all these he has likewise examined under the microscope, together with many others. He owes to the kindness of Professor Bonney the notes of that gentleman's microscopical examination of rocks sent him by the author, giving results more complete than were possible with the author's limited appliances.

Before entering upon the description of these rocks, the author relates how he traced the Euphotides and Serpentines up the valley of Saas to a point marked 3150 *m* (= 10,390 feet approximately) in the excellent map of the Swiss Alpine Club. Monsieur Alphonse Favre had very kindly given him directions, results of his experience on a visit some years since, which enabled him to find his way direct to its foot, forming the last eminence of an *arête* descending from the Allalinhorn, and dividing the vast glaciers of Hochlaub and Allalin, the latter of which must be crossed in order to reach the base of the rocks, which took some three-quarters of an hour of slow and careful climbing to ascend. From this point, so far as had been ascertained, come the whole of the Euphotides found in connection with the Saas district. The steep sides are covered with characteristically angular blocks of nearly anhydrous rocks, passing in some places into altered hydrous and serpentinous masses. So far as could be ascertained in the time available without risk of being benighted, the mass is rightly supposed by Mons. A. Favre to be Euphotide. The next neighbouring rock masses were serpentinous. The whole ridge requires a clear day of exploration, which would involve the necessity of camping out an elevation of not far from 10,000 feet the previous night.

Amongst the specimens obtained from the solid rock, the following, selected by the author, possess interest, as bearing upon the degree of the metamorphism:—

1. Shows some schistosity. 2. More schistosity. 3. No schistosity, but evidence of metamorphism, in the opinion of Professor Bonney, in which the author joins, who observes that there are but few cases in which the beginning of alteration is not visible under the microscope. He attempted the approximate estimation of amount of change in various specimens, and there appeared to be a distinct relation between what could be detected by eye or with the microscope, and the amount of water expellable by ignition and *weighed* (as water) after previous long continued desication at ordinary temperatures, and finally at 100° C. Even the most characteristic Euphotides gave a small per centage of H_2O.

He compares these rocks, taken *in situ*, with other erratic specimens. The following are instances, the letter B indicating the opinion of Professor Bonney.

A slice from a gully of the point itself, distinctly schistose, showing under the microscope grains surrounded by metamorphism and microliths of hornblende and perhaps mica. Some earthy matter (B) which may be a product of the decomposition of a felspar. Fragments of smaragdite here and there olivine, evidently in course of alteration. Here and there a passage from Euphotide towards a hydrous rock.

Compared with two slices from Veytaux and from Geneva (junction of Arve and Rhone), the unassisted eye would almost say they were detached from the same specimen as the last. Under the microscope we see the same constituent minerals similarly grouped as in the Veytaux slice, and after the same manner in the Geneva case the iron appears more oxidised. Think of the history of these stones—one detached from its native rock, the others transported so many miles, and exposed to atmospheric and aqueous action during so long a voyage and subsequently.

Another specimen—also from a gully—evidently secondary, under the microscope showing badly defined crystals of dichroic hornblende (B) with distinct cleavage. Grains of epidote (B also) and a felted mass without colour, resembling mica, but of two kinds, both orthorhombic; one, more fibrous, mica? (B), the other, less cleavable, more homogeneous and translucent, probably talc; actinolite present and (B) uralite and possibly zircon.

Another, midway up the point, consists principally of talc, hornblende, and actinolite. Schistose, and much altered.

A specimen from the incipient moraine at the base of the rock is Saussurite, with portions of smaragdite and small crystals of a hornblende, of garnets and, I think (also B), of mica. Saussurite seems more a rock than a mineral, in strict sense. At all events the author has never met with a homogeneous specimen. The same is the case with smaragdite, which contains diallage and some other mineral, according to Haidinger, pyroxene, and amphibole.

Another slice from near the base of the point resembles the last, with less talc and more hornblende, in small prisms. This is surprisingly altered, chipped off such a rock mass, still it contains but little hydrous mineral.

Mons. Henri de Saussure sent the author a specimen from Geneva, consisting of Saussurite which contained some felspar near labradorite (B and author), but not so brilliant as usual.

Two other specimens, one from (M. H. de Saussure) Geneva, the other from (Mr. Collins) Cornwall, resemble each other so remarkably without the assistance of the microscope, that the author mentions them as an example of the imperative necessity of microscopic analysis. Under a moderate power, however, they appear quite different. The Cornish specimen consists, according to Mr. Collins, of bronzite, enstatite, and a plagioclastic felspar. The Genevese specimen is, subject to further examination, Saussurite and a hornblende, accompanied, as it seemed to the author, by diallage or some pyroxenic mineral. Both show alteration and hydration.

To pass over some descriptions, we quote the author's observations on some serpentinous rocks, not from the point of which so much has been said, and not needful to abstract here.

A Serpentinous rock from the glacier of Allalin, close under the precipices of the Inner Thurm (on its South border), compared with a specimen from Geneva (confluence of Arve and Rhone), presented both to the unassisted eye and under the microscope a most striking resemblance. The same with a specimen from the rock *in situ*, at present in England, and one from Geneva, due to the kindness of Mons. H. de Saussure.

The author, whose Paper was illustrated by the rock specimens quoted, and by slides under microscopes, as also by many other specimens, regretted that he should only be able to give so incomplete a description, and expressed a hope that on another occasion he should be able to enter upon minutiæ of the rocks described, and to discuss those from the Val d'Erin and Evian. He drew attention to the great difficulty of meeting with a quite unaltered rock, to the incipient hydration of every rock under their notice, to the difference, in some cases inappreciable even under the microscope, between rocks broken from the parent mass and stones found at so great a distance as Geneva, after so immense a lapse of time as must have passed since they were left exposed to weather by the retreating glaciers; and to the details of evidence of community of origin afforded by these beginnings of microscopical comparison between rocks from so widely separated localities as the Saas-Grat, Montreux, and Geneva.