

Note on some Specimens of Glaucophane-rock from the Ile de Groix.

By Prof. T. G. BONNEY, D.Sc., LL.D., F.R.S., F.G.S.

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IN my description of a Glaucophane-eclogite¹ from the Val d' Aoste, I alluded to the occurrence of a rather similar rock in the Ile de Groix (off the south coast of Brittany) in the following words:—"In the Ile de Groix the glaucophane occurs in no great abundance, with greenish mica, epidote, garnet, hornblende, and but little quartz." My knowledge of the rock, as then stated, was from one or two specimens only; but in the autumn of 1886 I paid a short visit to the Ile de Groix in order to see the rock in the field. I then found that in the above phrase I had unwittingly done an injustice to this locality for glaucophane, for I obtained specimens in which that mineral is even more abundant and almost as well developed as in the rock from the Val d' Aoste. On this account, and as the locality is rarely visited,² I venture to think that a few notes may be interesting to the Society, although the rock has been already excellently discussed by Dr. Charles Barrois,³ to whom I am much indebted for information about this and other interesting localities in Brittany.

The Ile de Groix chiefly consists of mica-schists. These are fairly coarsely crystalline, contain much silvery mica in pretty large flakes, with quartz, and not seldom garnet. Chloritoid is frequently present, the flakes being sometimes nearly .5" in diameter. Hence Dr. Barrois names the group *schistes à chloritoïde*. Occasionally the schist is anthracitic, and at the eastern end of the Island there is a felspathic gneiss. The whole group has evidently been much modified by intense pressure subsequent to the general crystallisation, which has produced what I have termed 'cleavage-foliation' as contrasted with 'stratification foliation.'⁴ In mineral composition and general aspect it has a considerable resemblance

¹ *Min. Mag.* Vol. VII., p. 1.

² It can be reached by a steamer from Lorient. As this starts about 6 a.m. it would be possible to visit some of the localities and get back the same evening to Lorient, but it is better to pass the night in the Island. Near the landing place is an auberge; the entertainment is homely but the people are kindly.

³ *Annales de la Soc. Géol. du Nord.* Vol. XI. p. 18.

⁴ *Presidential Address to the Geol. Soc.* 1886. See *Proceedings*, Vol. XLII.

to the schists which occur towards the middle, as it seems, of the Alpine series.¹

The glaucophane-rock, termed by Dr. Barrois, whose name I will adopt for convenience in this paper, glaucophane-amphibolite,² occurs in the neighbourhood of Locmaria, about the middle of the south side of the Island, and at the eastern end around Fort de la Croix, intercalated in the *schistes à chloritoïde* in masses, generally several yards, occasionally (according to Dr. Barrois) as much as fifty metres thick. I paid particular attention to the relations of the amphibolite to the *schiste à chloritoïde*, a point on which Dr. Barrois hesitates to decide. As my own examination was comparatively cursory, I do not like to speak at all positively, but the evidence appeared to me as in favour of the amphibolite being intrusive in the schist. The one rock did not seem to graduate into the other; the line of parting was not only sharp but also occasionally suggested an intrusive junction. In one place, it is true, I observed that the mica-schist was interbanded with the outer part of the amphibolite, but this might be explained by a crushing out of some fragment of the mica-schist caught up in an intrusive mass of amphibolite.³ The latter rock always exhibits some schistosity, and at the east end of the Island is occasionally distinctly foliated. This structure is parallel with the cleavage foliation in the *schistes à chloritoïde*. About Locmaria its dip is slightly to the east of south, but nearer the eastern end of the Island it becomes about south-west, which appears to be the dominant direction; the angle varies from about 15° to 20° or a little more. The amphibolites, as mapped by Dr. Barrois, appear to cut obliquely across this structure, as we should expect intrusive dykes or sheets to do; moreover the amphibolite of the Ile de Groix (except for the glaucophane and the garnets) resembles in its general structures, mode of weathering, &c. the amphibolites which I saw on the Breton Coast about the embouchure of the Pouldu, and at Roscoff, which I have no doubt are intrusive rocks, modified by subsequent pressures and consequent mineral change.

The glaucophane-amphibolite in the bay south of Locmaria is less schistose than that in the east of the Island, and it bears a remarkable resemblance to the rock from the Val d' Aoste. True, it is in places fairly

¹ *e.g.* Apparently above the rather friable banded gneisses, as on the south side of the St. Gothard group.

² Otherwise I should have retained the name *eclogite*, used in my last paper; for in all the specimens noticed in this garnet is present abundantly.

³ Rather large but ill-preserved crystals of andalusite are developed near the junction of the rocks, chiefly in the mica-schist; possibly this may be indicative of an intrusion.

well banded with epidote and hornblende (as is excellently seen in the pebbles so abundant on the beach), and these bands are occasionally puckered, but in some specimens the foliation is only slight. In the latter case the rock is extremely tough, and, as in the Val d' Aoste, it is difficult to break off good specimens. Macroscopically the resemblance of the two rocks is very close, even to the presence of occasional small flakes of a silvery mica. Microscopically also there is but little difference. There are reddish garnets, epidote, hornblende, glaucophane, as the chief constituents; with quartz, mica, iron-oxide,¹ sphene (?), and rutile as accidentals. The only difference which I observe is that in my slide of this variety of the Ile de Groix rock the garnets have a more definite crystalline outline, there is less green hornblende and more glaucophane; but the crystals of the latter mineral are not quite so large individually and less perfectly defined externally than in the Val d' Aoste rock. But I attach no importance to these differences, because they might not be maintained if a slice were taken from another specimen—the rocks are substantially identical, so far as I can see.

The glaucophane-amphibolites in the eastern part of the Island are generally rather coarser in texture and more definitely foliated than the last named. I brought away four varieties, one of which exhibits a very distinct foliation, the glaucophane and epidote occurring in thin but well-defined bands. The garnets, which are less numerous, are rather larger than usual, being sometimes nearly a quarter of an inch in diameter. Of the other specimens, one differs microscopically from that described above in having a slightly more definite orientation of the minerals. It is very rich in glaucophane. The second, as might be expected from its general appearance, only presents slight differences from the last named, the grains of glaucophane having a less definite orientation. Transverse sections of this mineral are commonly rather less than .02" in diameter, longitudinal about .03", sometimes less, sometimes a little more. The third specimen, however, which is extremely rich in glaucophane, has the crystals of that mineral larger, for sometimes they are almost double of the above dimensions; the garnets also often are about a quarter of an inch in diameter.

Rutile, as identified by Dr. Barrois, is rather abundant in these amphibolites, and is the sole mineral included in the glaucophane. I think that the mineral in the Val d' Aoste rock, which I suggested might be an impure sphene, is very probably a dark coloured, and so perhaps an

¹ Both magnetite and hematite occur variably.

impure rutile. In the Ile de Groix rock the rutile is lighter coloured and more translucent than in that from the Val d' Aoste, but brown grains occasionally occur; also it is more generally disseminated, so as to be almost a normal constituent. The garnet in the former is often rather full of inclusions of a filmy mineral of slightly irregular outline, bright coloured between crossed nicols and with an oblique extinction. These sometimes occur in wavy or bent lines, which may possibly indicate a structure in the rock anterior to the formation of the garnet.¹ As in the Val d' Aoste rock, I think the garnet was formed before the glaucophane. Here also the latter mineral sometimes passes at the exterior into a rather fibrous dark green mineral, whether by subsequent change or the reverse it is difficult to determine, but I incline to his former view. For a very full discussion of the minerals in the Ile de Groix rock I may refer to Dr. Barrois' elaborate memoir.

I have lately received from Prof. B. Kotō, of Japan, a copy of a Paper² describing the discovery of glaucophane in that island. It occurs in a schist, containing, together with "epidote, yellowish green crystals of garnet, quartz, some felspar, rutile, also specular iron" and other constituents, among them "piemontite or manganese epidote." The rock is found in the crystalline-schist system, which is extensively developed, especially in the central mountain chains of the island of Shikoku." He gives an analysis of the glaucophane, and, as his Paper may not be very easily consulted in England, I venture to quote it. The mineral gave, separated by the Thoulet solution:—

SiO ₂	=	56.71
Al ₂ O ₃	=	15.14
Fe ₂ O ₃	=	9.78
FeO	=	4.81
CaO	=	4.80
MgO	=	4.83
Na ₂ O	=	4.83
K ₂ O	=	0.25

100.15

S.G. 2.9912.

Prof. Kotō also notices the occasional passage of the glaucophane grains at their exterior into a fibrous mineral, which he names crocidolite,

¹ They might be of secondary origin, formed by solution of the garnet along lines of strain; but if this were so, it would be difficult to explain their being bent into S-like folds, as they are in at least two of the garnets.

² *Journal of the College of Science, Imperial Univ.* Vol. I. Part I. (1886).

regarding it as of later origin; in corroboration of this view, he states that "for microscopic examination a number of specimens had been prepared from different localities, and glaucophane in these slides in the course of some weeks totally lost its original blue colour and turned into a light green substance."¹ He also describes the occurrence of glaucophane in a serpentinous rock. Here the mineral is formed from diallage, as described by myself in the case at Pegli, near Genoa. He regards it as one generally of secondary formation. The occurrence of glaucophane in schists in California has been recently noticed by Dr. Becker (*Amer. Jour. Sci.* Ser. iii. Vol. xxxi. p. 348); but some of the theoretical conclusions in his paper will in my opinion be difficult to substantiate.

¹ I have not noticed any change in my slides; those from the Val d'Aoste are quite eighteen months old.