On a cupriferous Lewisian para-gneiss.

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THE writer has recently been engaged in the investigation of a 'Lewisian' inlier within the Moine series of Glen Dessarry, at the head of Loch Arkaig, Inverness-shire. The inlier is largely composed of a series of hornblendic and felspathic gneisses but includes small lenses of marble and calc-silicate rocks. All these are to be reported later in two separate communications. There are in addition, however, some steeply inclined and impersistent ribs of mica-schist, granulite, and diopside-epidote-rocks, which will only be incidentally mentioned in those accounts in so far as they bear upon certain specific problems. In themselves they are apparently of little petrographic interest except for the occurrence of an unusual copper-bearing meta-sediment. This it seems convenient to record in a separate note.

The exposures of this rock occur in the lower slopes of the hill on the south side of Glen Dessarry, and near the head of the glen. The precise locality lies about 250 yards SSW. of the shepherd's cottage Cuil (pronounced 'cool'; on some maps A' Chùil) and about 100 yards west of the Allt Coire a' Bhoganaich. Here, within ultra-basic and basic hornblendic-felspathic gneisses there occur several thin, almost uncontorted impersistent sheets of foliated meta-sediments. These ribs, a few feet thick and sporadically exposed, extend for about 100 yards uphill to the south along the strike. The dip is westerly, almost vertical. The meta-sediments are chiefly semi-pelitic schists and granulites with thin pelitic-seams and with interbanded green diopside-rock also containing biotitic layers. The diopside-rock may contain scattered crystals of diopsidic augite by accession of which it gradually passes into bodies composed of such crystals. These are usually partly replaced by deep-green hornblende to form rock types from which felspathic gneisses are seen to derive by a process of pegmatitization.

In this rock association certain semi-pelitic ribs (unfortunately poorly exposed) carry small grains of a green mineral with the general appearance of malachite. These measure up to the size of a pin's head and are dis-

seminated throughout the rock. Perhaps about a dozen grains may be seen with the naked eye in one square inch of rock. Under a pocket-lens they show ragged margins interlocking with the parent rock. One or two grains contain cores of a dark opaque mineral resembling bornite. A secondary origin is therefore indicated for the green mineral.

A thin section of the rock shows a medium- to fine-grained granoblastic ground of potash-felspar and oligoclase. Biotite is abundant as straight plates and almost black in the position of maximum absorption. There are no signs of crushing. Sphene, quartz, magnetite, and apatite are accessory, together with a translucent grass-green mineral in irregular-shaped patches about 0·1–0·5 mm. across, or occasionally forming straight-sided laths within, and along the cleavage of, biotite. These forms are all cryptocrystalline, sometimes with fibrous habit. The green mineral shows aggregate polarization. Absorption masks the interference tints. It is not pleochroic. In reflected light it is of apple-green colour with a dull, earthy lustre.

The green mineral was carefully picked out of the rock and a clean sample separated under the binocular microscope. By kind permission of Professor W. Q. Kennedy an X-ray powder photograph of the sample was taken in the Geology Department, Leeds University. The film matched a standard powder photograph for malachite.

A copper estimation performed on the parent gneiss gave the following result: copper 0·24 % (analyst Herdsman).

It may here be of interest to compare this figure with estimations by Steiger, quoted by Siebenthal,[1] carried out on a composite of 235 samples of Mississippi delta mud. This composite material is shown by Pettijohn[2] to be about $\frac{1}{3}$ sand, $\frac{2}{3}$ silt and clay. Steiger's analysis, amongst other values totalling 100·62, gave SiO_2 69·96, Al_2O_3 10·52, CuO 0·0043 %.

The problem of the origin of the Glen Dessarry copper arises. There appears to be no vein mineralization and the copper-bearing gneiss is not smashed to provide easy passage for hydrothermal solutions. It has also resisted mechanical penetration by pegmatite, a penetration greatly affecting the associated ultra-basics. However, both from its intimate association with the last, and from its petrography, it seems to have been metasomatically modified by pegmatite. Perhaps then the copper was concomitantly introduced. One fact in opposition to this, however, is that pegmatitization dominates the whole inlier, whilst the copper-

[1] C. E. Siebenthal, Bull. U.S. Geol. Surv., 1915, no. 606, p. 72.

[2] F. J. Pettijohn, Sedimentary rocks. New York, 1949, p. 271.

bearing rock seems to be extremely localized, no other cupriferous material having yet been detected within the inlier.

In view of the complex history of the district, the poor exposures of the cupriferous rock, and the unknown role of meteoric waters, no definite conclusions are advanced regarding the origin of the copper. Nevertheless it is tentatively suggested that a syngenetic, sedimentary origin may be worthy of consideration.

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