Danalite from Cornwall.

By H. A. Miers, M.A., and G. T. Prior, M.A.

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THE specimen which is the subject of the present note consists of a group of large rude, reddish crystals of tetrahedral aspect, which in colour, lustre, and general appearance, resemble garnet; they were formerly supposed to be garnet pseudomorphous after some tetrahedral mineral, and the original mineral was presumed to have been fahlerz, on account of the size of the crystals, which measure as much as 3 to 5 centimetres across.

The specimen was purchased from the late Mr. Richard Talling in 1864, two years before the first discovery of danalite in America, and is from Redruth.

On a fractured surface the mineral is seen to consist of a substance of vitreous or resinous lustre, varying in colour from columbine-red (the colour of almandine) to a brick-red (like that of essonite); throughout the mass are dispersed granules of quartz, and near the surface, where it is slightly altered, it also contains small crystals of mispickel, minute specks of a black mineral, and in some places calcite. These impurities give it somewhat the appearance of a mineral of secondary origin.

On the other hand the tetrahedra do not display the characteristic twinning of fahlerz, nor that of copper pyrites.

If they are not pseudomorphs, the only tetrahedral silicate to which they could be referred is helvite, but it seemed highly improbable that such gigantic crystals of so rare a mineral could occur in Cornwall, where it was entirely unknown. The minerals of the Helvite group (helvite and danalite) for many years were only represented by the small yellow tetrahedra found at Schwarzenberg in Saxony, but have subsequently been found in many places where they attain considerable dimensions. At Lupiko in Finland, for instance, tetrahedra of helvite measure 1½ inches across (Kokscharow, *Mat. z. Min. Russl.* 5, 320), and the large trigonal tetrahedra of achtaragdite, from R. Achtaragda, in Siberia, are now usually regarded as pseudomorphs after helvite.

A closer examination of the Cornish mineral shows that it is in reality no pseudomorph; for small crevices and cavities in the large crystals and in the massive material contain occasionally minute, but very perfect, tetrahedra of a reddish brown or yellow colour, with glistening faces; these are capable of exact measurement, and are found to have the tetrahedron angle 109°28′; moreover, they are translucent, and remain dark between crossed Nicols; hence there can be no doubt that the form of the mineral is not due to any pseudomorphous replacement, but that it really crystallises in tetrahedra belonging to the cubic system.

The present specimen, as will be seen from the following description, resembles both in appearance and composition the danalite found in granite at Rockport and Gloucester in Massachusetts (J. P. Cooke, *Amer. Journ. Sci.*, 42 (1866), 73), and probably also at Bartlett in New Hampshire, in granite (M. E. Wadsworth, *Proc. Boston Soc. Nat. His.*, 20 (1879), 284), but the mode of occurrence of the Cornish danalite is peculiar and in composition it differs in some respects from the variety previously analysed.

The large tetrahedra are here associated with imperfectly crystallised prisms of quartz of later growth, and with small crystals of mispickel, which were apparently contemporaneous with the danalite; the tetrahedra project from a layer of massive danalite from a quarter to half-an-inch thick, which passes into a matrix consisting of a compact mixture of chlorite and mispickel, traversed by threads of quartz; associated with the mispickel are a very few small crystals of blende.

The large tetrahedra of danalite, where exposed, have a shining but uneven surface, but they are partially covered with a layer of platy irregular quartz prisms; upon their surface are also to be noticed occasional minute crystals of copper pyrites.

Material taken from the interior has the following characters:—Crystalline; lustre vitreous to resinous, the darker portions in particular are resinous; colour columbine-red; translucent; streak light pink; cleavage parallel to the faces of the tetrahedron; H = 5½; G = 3.350.

In thin section the mineral resembles a dark-coloured isotropic garnet.

The minute crystals found in the small cavities are brilliant tetrahedra with smooth plane faces and without modifications, measuring about 0·5mm across. They are mostly of the same colour as the main mass of the material, but some are yellowish, and one was found which, while red at one end, was a clear greyish-yellow at the other. This association seems to indicate the presence in a single crystal of two minerals, the red danalite and the yellow helvite, the colour of the latter resembling that

of the helvite from Brüder Lorenz mine at Breitenbrunn. Hence t is not surprising to find that this specimen yields on analysis a composition intermediate between that of danalite and that of helvite.

Analysis.—The specimen, although of considerable size, was so impure that it was not easy to obtain sufficient material fit for analysis. The coarse material was broken into small fragments, which were then shaken up with methylene iodide of specific gravity 3·3. From the portion which sank in this liquid, the most transparent pieces were picked out under the lens. The mineral was decomposed by digestion with concentrated hydrochloric acid. The silica obtained on evaporation contained about 4 per cent. of impurities, which were separated by digestion with sodium carbonate solution. In the calculation of the analysis the weight of this impurity was deducted from the weight of material used. The iron, with a portion of the beryllium, was separated by double precipitation with sodium acetate, and the zinc precipitated in the filtrate after acidifying with acetic acid by hydrogen sulphide. The beryllium was separated from the manganese by repeated precipitation with ammonia, and finally the manganese was precipitated by ammonium sulphide, and weighed as sulphide after ignition in hydrogen. The sodium acetate precipitate containing the iron and a portion of the beryllium was dissolved in hydrochloric acid, and the bases were reprecipitated by ammonia, dried and weighed. The separation of the beryllium and iron was then effected by Deville's method, as modified by Cooke (*Am. J. Sci.* 42 (1866), 73); *i.e.* the iron was driven off as ferrous chloride from the beryllia by ignition in a platinum tube, first in a current of hydrogen and then very strongly by the blowpipe in a current of hydrochloric acid. The residue of beryllia was tested for aluminium by Penfield's method (*Am. J. Sci.* 32 (1886), 107), *i.e.* it was dissolved in hydrochloric acid, evaporated to dryness, dissolved in least possible quantity of water, treated with solution of caustic soda until the precipitate first formed just re-dissolved, and finally transferred to a beaker containing about 800 c.c. of water, which was kept boiling for an hour. A slight precipitate was obtained in the filtrate, but it gave no colour with cobalt nitrate. The analysis gave the following numbers :—

SiO_2	= 29·48
FeO	= 37·53
MnO	= 11·53
ZnO	= 4·87
BeO	= 14·17
CaO	= trace
S	5·04
	102·62

Specific gravity at 17° = 3·350

Weight of material used = 0·6728 gram; for the sulphur 0·1488 gram.

The equivalent ratios are :—

SiO_2	= 49·205
R	= 131 09
S	= 15·77

which correspond more closely to the formula $RS.7RO.3SiO_2$ than to that usually accepted $RS.6RO.3SiO_2$. The published analyses, however, of both helvite and danalite show considerable variations between these two results. Thus one of the latest analyses of helvite by Sloan (*Chem. News*, 46, 195) gives S : R : SiO_2 = 1 : 8 : 3·4 ; and one of the original analyses of danalite by Cooke gives S : R : SiO_2 = 1 : 8·4 : 3·3.

Having regard to these discrepancies, a repetition of Gmelin's analysis (which shows a loss of about 4 per cent.) of helvite from Schwarzenberg seemed desirable. The same methods of analysis were employed. The material was separated from impurities of quartz, calcite, etc., by the use of methylene iodide, but unfortunately it still retained some of the associated fluor which has a specific gravity almost the same as that of the helvite. Amongst the minerals which sank in the methylene iodide was some scheelite, which is not mentioned as an actual associate of helvite.

The analysis gave the following numbers :—

SiO_2	31·85
FeO	4·26
MnO	42·47
BeO	14·25
Al_2O_3	0·74
CaO	3·16
S	4·81
	101·54

or deducting the weight of fluor corresponding to the weight 3·16 p.c. of lime

		Atomic proportion.		
SiO_2	= 33·33	55·62	or	3·5
FeO	= 4·45	6·20		
MnO	= 44·43	62·80	131·65	8·3
BeO	= 14·92	62·65		
Al_2O_3	= 0·77			
S	= 5·03	15·74		1
	102·93			

Specific gravity at 18° = 3·202.

Weight of material used 1·1091 gram ; for sulphur 0·3988 gram.