SKUTTERUDITE FROM COBALT, ONTARIO[1]

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On some specimens recently obtained from the Temiskaming mine, Cobalt, Ontario, small brilliant crystals resembling smaltite were observed, imbedded in fragments of soft chloritic or micaceous country rock included in the vein. As is well known, smaltite and chloanthite closely resemble one another and are commonly intergrown in the same crystal. It was with a view to determining the relative purity of the supposed smaltite that this examination was undertaken.

The principal ore in the vein is smaltite, usually massive, but occasionally forming rough crystals up to 5 or 6 millimeters in diameter. The rest of the vein matter is either calcite or fragments of country rock. The small crystals under investigation seem to represent the latest mineral to form; they are tin white, and very lustrous. The specific gravity, determined on 0.62 gram of carefully selected crystals, is 6.79, which is closer to the value usually given for skutterudite ($CoAs_3$) than to that for smaltite ($CoAs_2$).

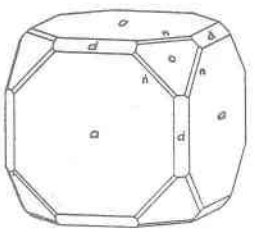

FIG. 1.

The crystals, which seldom exceed a millimeter in diameter, were measured on a Goldschmidt goniometer. The following forms were observed on each crystal: $a(100)$, $o(111)$, $d(110)$, and $n(211)$. The relative development of the forms is shown in figure 1. Nothing observed suggests that the crystals are hemihedral — the faces of the last two forms were not always present in full, but the omissions appeared to be quite irregular. These four forms have all been observed on both smaltite and skutterudite.

An analysis made on the powdered mineral is shown in I.

[1] Presented at the first annual meeting of the Mineralogical Society of America, December 28, 1920. [That crystallinity is not necessarily a criterion of homogeneity has been demonstrated repeatedly in recent mineralogical work. In this paper fractional solution of the material, a method which is not used as often as it should be, is applied successfully to demonstrating the non-homogeneity of what might otherwise have been announced as a new species. ED.]

The molecular ratio for (Co, Ni, Fe) to (As, S) appears to be nearly 2:5, so that from this analysis the composition would be well represented by the formula $(Co, Ni, Fe)_2(As, S)_5$. Remembering the work of Volkhardt[1] with reference to intergrowths of smaltite and skutterudite an attempt was made to determine, by dissolving part of the powder, whether it could be demonstrated that the soluble part had a different composition from the less soluble portion. Some of the same powder was treated with hot 50% nitric acid for three minutes, and water was then added to interrupt the action. About half the powder was dissolved. The insoluble part was weighed and the weight of the dissolved part was obtained by difference. The analysis of the soluble part is shown in II, the composition of the insoluble part (obtained by calculation) in III.

	I			II			III		
	%	Mol. Ratios		%	Mol. Ratios		%	Mol. Ratios	
Co...	20.57	.3506	.4149	20.89	.3558	.4504	20.18	.3437	.3784
Ni...	1.31	.0223		2.54	.0433		0.11	.0018	
Fe...	2.35	.0420		2.87	.0513		1.84	.0329	
S....	1.25	.0391	1.0367	.99	.0309	1.0017	1.50	.0469	1.0667
As...	74.72	.9976		72.71	.9708		76.38	1.0198	
Total.	100.20			100.00			100.01		

From the above molecular ratios it may be observed that the soluble part is most basic, and the insoluble part most acidic, thus:

Soluble portion	(Co, Ni, Fe):	(As, S)	:: 1:2.22
Original mixture	"	"	" 1:2.49
Insoluble portion	"	"	" 1:2.82

In Hintze's Mineralogie only one of the 55 analyses of smaltite-chloanthite contains as high a percentage of cobalt as the material here analyzed. In most of the cases, Hintze's analyses correspond to complex intergrowths of smaltite-chloanthite with a mineral containing a considerable excess of arsenic. In 39 of the 55 analyses the excess of arsenic (and sulfur) beyond the ratio required for a smaltite-chloanthite mixture is so great, that there must also be present some mineral more acid than those usually assumed. The most reasonable explanation is

[1] *Z. Kryst. Min.* **14**, 407–8, 1888. Also Beutell and others, *Centr. Min. Geol.* **1915**, 359–373; **1916**, 10–22, 49–56, 180–5, 206–21.

found in regarding such samples as composed of smaltite-chloanthite and skutterudite. The general distribution of the last named mineral in what has often been regarded as smaltite-chloanthite can scarcely be doubted.

Analyses of massive or nodular smaltite-chloanthite from the veins of Cobalt usually conform to the general formula RS_2, as brought out by the analyses reported by Miller,[1] which show: Co 16.7–19.8, Ni 4.5–7.0, Fe 6.2–8.9, As 60.3–63.5, S 4.1–7.0, insoluble, etc. 0–4.4%. The present case thus represents the peculiar situation of massive material having a composition nearer to the theoretical than crystallized material.

The results here brought forward confirm those of Volkhardt and of Beutell, that skutterudite and smaltite-chloanthite are capable of forming isomorphous intergrowths in all proportions, and the theoretically pure individual minerals are almost unknown. These minerals resemble one another so closely in physical properties as to be nearly indistinguishable, while crystallographically they show the same dominant forms, $a(100)$, $o(111)$, $d(110)$, and $n(211)$. They are probably all pyritohedral, altho in the case of skutterudite the hemihedral character is not so well established. The isomorphism of smaltite-chloanthite and skutterudite, minerals which do not possess similar chemical formulas, suggests in some respects the striking isomorphism of the minerals of the feldspar group.

THE MINERALS OF ROCKPORT, MASSACHUSETTS

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More than fifty years ago attention was called to the unusual mineral occurrences at Rockport, on Cape Ann, by J. P. Cooke's description of danalite, a new beryllium mineral, and subsequently of cryophyllite, a new lithium mica. Besides being the type locality for these species, the Rockport quarries have afforded an interesting list of rare-earth minerals, and, perhaps most unusual of all, large tabular crystals of fayalite, normally an utter stranger to granitic rocks.

Geology.—The country rock of Cape Ann is an alkali granite which forms a batholith having an exposure of some 25 kilometers in greatest diameter, and is cut by numerous dikes of diabase

[1] Miller, W. G., *Report, Bureau of Mines*, **19**, pt. II, 17, 1913.