

only Fe-oxide phase present in the mineral assemblage of most of the deposits. In the gondite, the assemblage of braunite, jacobsite, and hematite, in the complete absence of magnetite, was obviously stabilized above the Fe_2O_3 - Fe_3O_4 buffer. The hematite-pyrophanite pair, therefore, must have equilibrated at high f_{O_2} . The appearance of ilmenite, the generally common associate of hematite in metamorphosed rocks, was therefore inhibited.

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Grimaldiite, CrOOH , a second occurrence, from the Hiaca Mine, Colquechaca, Bolivia

GRIMALDIITE, rhombohedral CrOOH , was first reported by Milton *et al.* (1967, 1976) from gravels in a small tributary of the Merume River, Guyana. It is there intergrown with eskolaite, Cr_2O_3 , and two other CrOOH polymorphs, guyanaite and bracewellite, both orthorhombic (a synthetic orthorhombic fourth CrOOH polymorph is also known). These water-worn grains and pebble-sized aggregates were first described by Bracewell (1946) as a hydrous chromium (aluminium) oxide 'merumite'; the largest concentration of merumite was in a strip 3-4.5 m wide and 3 km long. Almost all the Guyana grimaldiite is further interleaved with isostructural mcconnellite (CrOOCu); rarely, deep-red pure grimaldiite is seen in crushed fragments of merumite. Grimaldiite and mcconnellite are members of the delafossite (FeOOCu) structural group.

A recently purchased small specimen* ($5 \times 3 \times$

2 cm, 79 g) stated to be from the Hiaca Mine some 30 km ENE of Colquechaca, Bolivia (a well-known locality for penroseite (Ni,Co,Cu) Se_2 and cobaltomenite, $\text{CoSeO}_3 \cdot 2\text{H}_2\text{O}$), contained about 60% penroseite with 40% baryte by volume. An electron-probe microanalysis (three separate spots) of the penroseite gave an average composition Ni 16.1, Co 6.0, Cu 5.7, and Se 72.0, total 99.8%.

The penroseite contains small cracks and cavities, partially coated with a pinkish-brown mineral, at first thought to be cobaltomenite but which X-ray diffraction showed to be grimaldiite, rhombohedral CrOOH ; the patterns were identical with that of synthetic rhombohedral CrOOH (Thamer *et al.*, 1957). This is the second discovery of grimaldiite to be reported (M. Fleischer, pers. comm.). It forms radially bladed aggregates of small (0.25 mm) partial spheres or scallop-shaped platy aggregates

* RSM GY 1984-60-1.

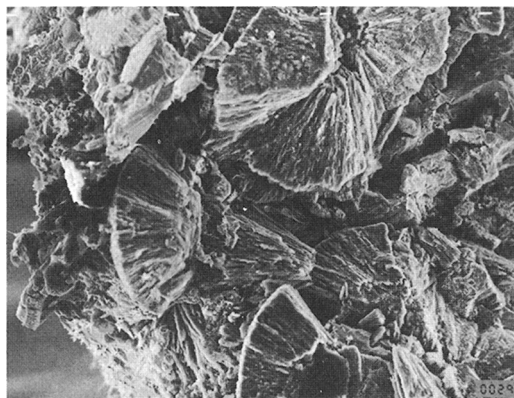


FIG. 1. Scanning electron microscope photograph of scallop-shaped clusters of grimaldiite plates ($\times 210$).

up to 5 mm across (fig. 1). Under the scanning electron microscope the tips of the blades show partial hexagonal outlines. The infra-red spectrum (fig. 2) is identical to that of synthetic rhombohedral (α) CrOOH published by Schwarzmann (1969). Table I gives the electron microprobe analysis of seven spots from five different grains. The Bolivian grimaldiite with 7.9% Al_2O_3 compares with the Guyana grimaldiite-mcconnellite with 4.3% Al_2O_3 .

Within the Hiaca Mine grimaldiite occur minute inclusions of an unidentified lead selenide (Pb 69.4, Bi 0.3, Se 27.9, total 97.6%) and a mercury selenide (Hg 69.8, Se 26.4, Si 0.1, total 96.3%).

The paragenesis (as well as its provenance) of the Guyana merumite remains an enigma; the paragenetic relations of the Bolivian grimaldiite are unlike any known in Guyana. Equally dissimilar is the paragenesis of eskolaite in merumite from the

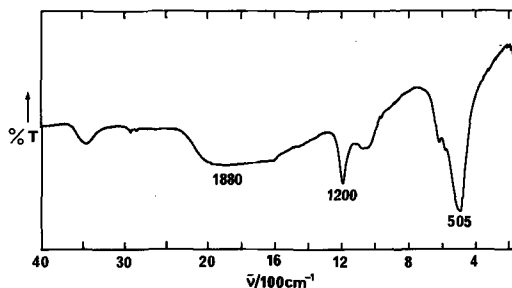


FIG. 2. Infra-red spectrum of Hiaca Mine grimaldiite.

eskolaite of the Outokumpu copper mine in Finland (Vuorelainen *et al.*, 1968).

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TABLE I. *Electron microprobe analysis of grimaldiite from Bolivia in wt. %*

	1	2	3	4	5	6	7	Ave.
Cr_2O_3	68.5	71.5	65.9	67.3	62.9	63.3	63.8	66.2
Al_2O_3	8.6	9.2	8.3	8.5	6.9	6.8	7.3	7.9
FeO	0.9	0.9	0.7	0.8	0.8	0.8	0.8	0.8
MnO	0.7	0.7	0.6	0.7	0.6	0.6	0.6	0.65
SiO_2	0.6	0.7	0.6	0.6	0.9	0.8	0.8	0.7
Wt. loss*	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
Total	95.6	99.3	92.4	94.2	88.4	88.6	89.6	92.55

* Thermogravimetric on a 0.98 mg sample.

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Barian muscovite from Franklin, New Jersey

A BARIUM-RICH muscovite was reported from Franklin, New Jersey, by Bauer and Berman (1933), who noted its similarity in composition to the barian variety of muscovite which had previously been known as 'oellacherite'. They reported a BaO content of 9.89 wt. % which, being one of the highest reported in muscovite, has been reported in subsequent compendia (Deer *et al.*, 1962). This Franklin mica was subsequently studied by Heinrich and Levinson (1955), who noted that the X-ray powder diffraction data were consistent with the 1M polymorph of muscovite. This muscovite is unlike common micas in appearance. It is fine-grained and thus cleavage is not evident. It has a microgranular texture, a dull lustre, and a deep pink-violet colour. It is associated with hendricksite, euhedral andradite, and native copper. In thin-section, the sample studied by Bauer and Berman (1933) is seen to be an exceedingly fine-grained mixture of many phases: muscovite is predominant and baryte is very abundant, forming lath-shaped crystals which are rimmed by hyalophane; native copper is randomly distributed as microscopic, flattened, skeletal crystals.

Preliminary microprobe analyses of several samples of such material indicated that the previously reported BaO content was in error. Several samples have BaO values varying from 4.8 to 6.3 wt. %. Accordingly, the samples were subjected to additional analyses by microprobe using as standards; hornblende (Si, Al, Fe, Mg, Ca, Na), microcline (K), manganite (Mn), benitoite (Ba), and rhodonite (Zn). Wavelength-dispersive microprobe scans indicated no other elements with atomic number greater than 8. Water was determined using the Penfield method. The samples studied were from the Smithsonian collection (NMNH 105848 and

C6258), the latter being Bauer's sample, and they had very similar compositions. The resultant analysis yielded SiO₂ 43.5, Al₂O₃ 34.1, MgO 0.7, K₂O 9.7, BaO 6.3, Na₂O 0.2, MnO 0.8, ZnO 0.2, H₂O 4.47, sum = 100.0 wt. %. This yields a chemical formula, calculated on the basis of 24 (O + OH), of:

$$(\text{K}_{1.63}\text{Ba}_{0.34}\text{Na}_{0.05})_{\Sigma 2.02}(\text{Al}_{3.64}\text{Mg}_{0.14}\text{Mn}_{0.09}\text{Zn}_{0.02})_{\Sigma 3.89}(\text{Si}_{6.05}\text{Al}_{1.95})_{\Sigma 8.00}\text{O}_{19.85}(\text{OH})_{4.14}$$

or ideally,



a barian muscovite.

The present analysis, when compared with that of Bauer and Berman (1933), shows a near reversal in the given BaO and K₂O values (they gave 6.33% K₂O and 9.89% BaO), suggesting at first reading that the figures might have been switched by accident. However, this is mere conjecture and the abundance of baryte inclusions in the muscovite provides a ready source for excess Ba. In either case, the Ba content of this muscovite is lower than was originally reported and is thus presented here for the record. Ba is present in other Franklin micas; Frondel and Ito (1966) reported it as occurring in hendricksite in amounts varying from 0.6 to 1.5 wt. %. The extent of Ba substitution in other layer silicates at Franklin has also been noted. It has been found in amounts less than 1.0 wt. % in ganophyllite, a mineral with a composition similar to that of a hydrated manganese mica (Dunn *et al.*, 1983), and in amounts up to 1.3 wt. % in lennilenapeite (the Mg analogue of stilpnomelane) and in a Mn-dominant stilpnomelane (Dunn *et al.*, 1984). Recently, Mansker *et al.* (1979) have described high Ba-biotite which, when fully characterized, will be a new species, the Ba analogue of biotite.