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CUBANITE: IDENTITY WITH CHALMERSITE; MAGNETIC PROPERTIES.

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The original cuban(ite), from southeastern Cuba, was characterized by Breithaupt[1] in 1843 as a massive, light yellow opaque mineral with distinct cubical cleavage, hardness 5, density 4.026-4.042 and containing about 19 per cent copper. When later analyzed (1845) by Scheidhauer the formula $CuFe_2S_3$ was obtained.[2] For density determination, and presumably for analysis, carefully selected fragments were used. Color differences were recognized between the cubanite and associated pyrite, pyrrhotite and chalcopyrite. About 1854, analyses of specimens from Barracanao, Cuba, supposedly the locality of the cubanite, were made,[3] but no descriptions which definitely identify the material with cubanite are recorded. The analyses and densities are not closely those of cubanite.

Several years later material similar to cubanite in cleavage (or parting), color, hardness (about 4), density, composition and association was described from two localities in Sweden.[4] Still later (1895) a specimen resembling cubanite, in the Berlin University collection, agreed in composition with cubanite.[5]

Recently several museum specimens which were labeled cubanite, but which were not definitely tested by the above criteria, were found to be inhomogeneous when examined microscopically on polished surfaces.[6] These observations tended to discredit the previous work on cubanite.

[1] *Pogg. Ann.*, **59**, 325, 1843.
[2] *Pogg. Ann.*, **64**, 280, 1845.
[3] Reported in Dana's System of Mineralogy, and *Am. J. Sci.*, **18**, 381, 1854.
[4] P. T. Cleve, *Geol. För. Förh.*, **1**, 105, 1873; H. Sjögren, *Z. Kryst.*, **7**, 116, 1883.
[5] Robert Schneider, *J. prakt. Chem.*, **52**, 555, 1895.
[6] Joseph Murdock, Microscopic Determination of Opaque Minerals, *New York*, 1916, p. 37. Murdock, p. 8, cites opinion of M. Leo that cubanite is a mixture.

In 1902 Hussak[7] proposed the name chalmersite for some small, well-defined, opaque, light yellow, strongly magnetic crystals from Brazil. Unsatisfactory determinations of density and composition were made. A later analysis[8] gave the cubanite formula, but the agreement was not noticed. More complete measurements were made by Palache,[9] and some of the same crystals were polished and studied by Murdock, who reported lighter color and greater hardness than chalcopyrite.[10]

During work in Alaska in 1912 on some fine-grained copper ores Johnson[11] was able to distinguish a mineral which could not then be identified. His later studies[12] including comparisons of the material with the Brazilian crystals with respect to composition, density, hardness, magnetic power and behavior of polished surfaces led to the conclusion that the two were identical. However, no cleavage had been observed in the Brazilian mineral corresponding to the decided cleavage in the mineral from Alaska.

In all the several respects in which comparison of the Alaskan mineral with cubanite can now be made they are identical. In the same respects (with the possible exception of cleavage) and in magnetic power the Alaskan mineral is identical with the Brazilian chalmersite. Thus the identity of chalmersite with the previously described cubanite may be considered established.

One other point of similarity between the Brazilian crystals and cubanite has just been found. During a magnetic test one of the Brazilian crystals broke squarely along the base, thus indicating at least one good cleavage. Also in the following paragraphs some more definite relationships between the Alaskan mineral and chalmersite are shown.

Discussion. Both Breithaupt and Sjögren[4] state that massive cubanite breaks into cubical pieces. This, however, does not necessitate the inference that cubanite is isometric. The Brazilian crystals are orthorhombic; if they were not so small and rare two other pinacoidal cleavages might be looked for in them. Breithaupt gives the hardness of cubanite as that of feldspar, 5, Sjögren says it is about 4, while Hussak[7] gives 3.5 for chalmersite.

[7] *Centr. Min. Geol.*, 69, 1902.
[8] *Centr. Min. Geol.*, 332, 1906.
[9] *Am. J. Sci.*, **24**, 255, 1907.
[10] Joseph Murdock, Microscopic Determination of Opaque Minerals, p. 72.
[11] *U. S. Geol. Survey, Bull.* **542**, 101-3, 110, 112, 120, 1913.
[12] *Econ. Geol.*, **12**, 519, 1917.

However, Murdock says that chalmersite is harder than chalcopyrite, which he gives as 3.5-4.0. Hardness is so indefinite a property even when determined under conditions that are as nearly as possible comparable, that different values may be expected by different methods. On polished sections near the boundaries between harder and softer grains, the harder grains are convex and the softer concave. Thus, with vertical illumination and not too high magnification, when the objective is raised from sharp focus the borders of softer grains are more strongly illuminated. The reverse effect obtains when the objective is lowered.[13] By this means chalcopyrite was found to be softer than the Alaskan cubanite.

MAGNETIC OBSERVATIONS.[14] In separating, magnetically and with heavy solutions, the Alaskan cubanite from the associated ore minerals, pyrrhotite was found to contaminate slightly the most magnetic, and chalcopyrite the least magnetic portions of the concentrate, but there was a surprisingly large range of fractions which were alike in density and composition but different magnetically. This behavior could be accounted for by assuming that the cubanite has a very elongate magnetic ellipsoid, and that only those grains which jumped farthest were parts of single crystals, the others being aggregates of variously oriented crystals.

Two tests of this hypothesis were made: (1) one of the least magnetic portions was more finely powdered. Much of this then jumped from considerably greater distances. (2) Portions of the most magnetic material and of the least were made into disc shaped aggregates of the same size with equal amounts of paraffine, then the distances the discs would move were found to be approximately equal. Both tests thus support the theory in a substantially quantitative way.

One of the Brazilian crystals measured by Professor Palache and kindly loaned to us was suitable for magnetic investigation. Tests showed conclusively that it possessed one axis, *a*, of high magnetic susceptibility, and that along the other two crystallographic axes its susceptibility was very weak. Also it jumped toward the magnet from practically the same distance as the most magnetic of the grains of Alaskan cubanite. All other known strongly magnetic substances possess at least two axes of high susceptibility.

[13] Murdock used a method of inclined illumination. Ref. 6, p. 30.

[14] Details of the magnetic tests are not suitable for publication here.

SUMMARY. Cubanite as described from such typical localities as southeastern Cuba, also Tunaberg and Kafveltorp in Sweden, is compared with chalmersite from Brazil and Alaska. In all respects in which these minerals have been adequately described they are identical. Cubanite is the older name. Cubanite is unique among known strongly magnetic substances in having only one axis of high magnetic susceptibility.

EUHEDRAL MAGNESITE CRYSTALS FROM SAN JOSE, CALIFORNIA

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In this country magnesite has been found in two fairly distinct varieties: (1) the compact white or so-called amorphous variety, which is really microcrystalline, a fairly common mineral in the serpentines of California, and (2) the distinctly crystalline or cleavable variety, which occurs in abundance in Stevens County, Washington, as a replacement of dolomitic limestone.

A somewhat different cleavable variety occurs in the San Juan quicksilver mine (now abandoned), five miles south of the city of San Jose, Santa Clara County, California. Here the magnesite occurs in veins in an alteration product of serpentine, which consists largely of opal and magnesite with small amounts of cinnabar and pyrite and a little residual antigorite. A microscopic examination of a thin section shows that the magnesite had replaced the opal and the opal in turn had replaced the antigorite of serpentine. The serpentine is doubtless an alteration product of peridotite.

The veins of magnesite are from 1 to 10 cm. in width and show a more or less banded structure. The magnesite is colorless to pale amber-colored with cleavage surfaces up to 5 mm. in size. In appearance it resembles dolomite, but chemical tests show only a small amount of calcium. The specific gravity determined on about 4 g. of carefully selected material is 3.052. Quartz, chalcedony, and occasionally a little bitumen are found directly associated with the magnesite.

In cavities the magnesite is found in distinct euhedral crystals. The exceeding rarity of crystallized magnesite accounts for the present note. As far as can be ascertained, magnesite crystals have never been described from the United States before; in fact, there are records of only seven or eight occurrences taken the world over.