

NOTES AND NEWS

NOTES ON ARCANITE, AMMONIAN APHTHALITE AND OXAMMITE

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The name arcanite, originally proposed by Haidinger, has been held in a reserve status for natural K_2SO_4 . This substance has not hitherto been identified with certainty in nature although it was at one time erroneously supposed to be represented by the apththalite, $(K,Na)_3Na(SO_4)_2$, of Racalmuto, Sicily. The only claimant to the name is the so-called arcanite of Eakle from the Santa Ana tin mine in Trabuco Cañon, Orange County, California. This substance occurred as thin, pseudo-hexagonal tablets which were interpreted as cyclic twins on (110) of orthorhombic individuals bounded by {001}, {101} and {112}. The angles, for which only approximate measures were obtained, are close to those of both K_2SO_4 and apththalite. Chemical and physical data were not given for the mineral. The occurrence has not found general acceptance and the mineral was placed with apththalite by Hintze on geometrical grounds. Through the courtesy of Professor Adolf Pabst of the University of California the writer was enabled to examine the original specimen. The optical characters and the *x*-ray powder diffraction pattern proved to be identical with those of artificial K_2SO_4 . Chemical tests indicated the presence of only K and (SO_4) as major constituents, and the mineral may hence be accepted as the first authentic natural example of arcanite.

The mineral taylorite was briefly described by Taylor in 1859 as a sulfate of potassium and ammonium from the guano deposits of the Chincha Islands off the coast of Peru. No further data have been published thereon. Chemical analysis indicated the formula to be $(K,NH_4)_2SO_4$ with $K:NH_4 \sim 5:1$. A small amount of Na_2O (1.68 per cent) also was reported. Crystallographic and optical data are lacking. The formula suggests that taylorite might be an ammonian variety of arcanite, especially since $(NH_4)_2SO_4$ and K_2SO_4 are isostructural and are known from studies of synthetic material to form a complete isomorphous series. Unfortunately, this question may never be settled since authentic specimens of taylorite from the Chincha Islands do not appear to be extant. The only specimen that could be located, in the collection of the U. S. National Museum (No. R5905), proved on examination to be a nodular mass of fibrous calcite. A number of reputed specimens of taylorite from a second, hitherto undescribed locality on the Guañape Islands—a group of guano islands off the coast of Peru about 400 miles

northwest of the Chincha Islands—were found in the Harvard collection. This material comprised coarsely fibrous crusts and differs in this respect from the original taylorite which was said to occur as compact lumps or concretions with a crystalline structure. *X*-ray powder patterns of this material were virtually identical with that of apthitalite (glaserite), $(\text{K},\text{Na})_3\text{Na}(\text{SO}_4)_2$. A chemical analysis of the mineral by F. A. Gonyer is cited below. The analysis yields

K_2O	$(\text{NH}_4)_2\text{O}$	Na_2O	SO_3	P_2O_5	$\text{H}_2\text{O at } 95^\circ$	Organic present	Total
33.87	5.68	9.65	48.62	0.70	0.21		98.73

the formula $(\text{K},\text{NH}_4)_3\text{Na}(\text{SO}_4)_2$ with $(\text{K},\text{NH}_4):\text{Na}=3.0:1$ and $\text{K}:\text{NH}_4=3.3:1$. The mineral thus is an ammonian variety of apthitalite. The color is yellowish white and there is a distinct cleavage, presumably on $\{10\bar{1}0\}$. Fracture surfaces have a silky luster. Hardness $2\frac{1}{2}$. Specific gravity 2.51 (measured), 2.56 (calculated). Optically uniaxial positive with $n\text{O}=1.498\pm 0.002$ and $n\text{E}=1.503\pm 0.002$. The powder pattern was indexed in terms of a hexagonal cell with $a_0=5.67$ *kX* and $c_0=7.34$ ($a_0:c_0=1:1.290$). These values are close to those of apthitalite, which is hexagonal $-P$, scalenohedral ($\bar{3} 2/m$), with $a_0=5.65$ *kX* and $c_0=7.29$ ($a_0:c_0=1:1.294$) for material of unstated $\text{K}:\text{Na}$ ratio, according to Gossner. Ammonian apthitalite is soluble in water and has a saline and bitter taste. The material contains a small amount of organic matter and on heating turns brown or black and finally white. In these respects, and also in chemical composition, the present mineral resembles taylorite, and the two substances may perhaps be identical.

Another specimen of so-called taylorite from the Guañape Islands, contained in the collection of the American Museum of Natural History, has been described optically by Larsen. He found the mineral to be biaxial positive with $2V$ about 36° , $r > v$, and $n\text{X}=1.447$, $n\text{Y}=1.448$, $n\text{Z}=1.459$. These values differ significantly from those for arcanite, ammonian arcanite or mascagnite, and doubtless refer to some other species, perhaps stercorite.

In the course of the above work specimens labeled guanapite, guanoxalate, and oxammite from the Guañape Islands were examined. One of the minerals present on the specimens was identified by optical and *x*-ray comparison with artificial material as ammonium oxalate monohydrate $(\text{NH}_4)_4\text{C}_2\text{O}_4\cdot\text{H}_2\text{O}$. This substance doubtless is oxammite, for which the formula $(\text{NH}_4)_4\text{C}_2\text{O}_4\cdot 2\text{H}_2\text{O}$ was originally given. The mineral formed opaque, yellowish, lamellar masses with a perfect cleavage on $\{001\}$. Optically biaxial negative with *X* perpendicular to the cleavage and $n\text{X}=1.440$, $n\text{Z}=1.593$, $2V$ medium large. The mineral was somewhat altered on the surface to a fibrous, unidentified substance.

REFERENCES

- HÄIDINGER, W., *Handbuch der Mineralogie*, Vienna, 492 (1845).
 EAKLE, A. S., *Bull. Dept. Geol. Univ. California*, 5, 232 (1908).
 HINTZE, C., *Handbuch der Mineralogie*, 1, Pt. 3B, 3695 (1929).
 GOSSNER, B., *Jb. Min., Beil.-Bd.* 57, 89 (1928).
 LARSEN, E. S., *U. S. Geol. Surv., Bull.* 679, 142 (1921).
 TAYLOR, W. J., *Proc. Acad. Nat. Sci. Philadelphia*, 309 (1859).

DEMONSTRATION OF THE DOUBLE REFRACTION OF ARAGONITE
 FOR RAYS TRAVELING IN THE NEIGHBORHOOD
 OF AN OPTIC AXIS

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The purpose of this note is to call attention to the fact that the demonstration of "internal conical refraction" is facilitated by the use of the universal stage and that an unusually accurate axial angle determination can be made for both the primary and secondary optic axes.

The microscope has previously been used for demonstrating the behavior of rays of light passing through aragonite near an optic axis direction.¹

With the aid of the universal stage, which today is available in most mineralogical laboratories, the demonstration of so-called internal conical refraction is greatly facilitated.

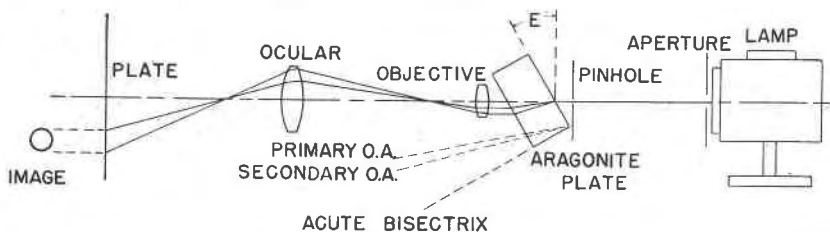


FIG. 1. Schematic diagram of the demonstration of "internal conical refraction".

Figure 1 shows schematically the essential features of the apparatus. The microscope, focused for projection of the pinhole image, is drawn as though made up of thin lenses. The plane of the drawing is taken as the axial plane of the crystal. To avoid confusion, only two rays, whose wave normals coincide with the primary optic axis, are shown. Rays traveling in such directions form a cone within the crystal and, because

¹ Clay, R. S., *Treatise on Light*, pp. 480-483, Macmillan & Co., Ltd. (1911).