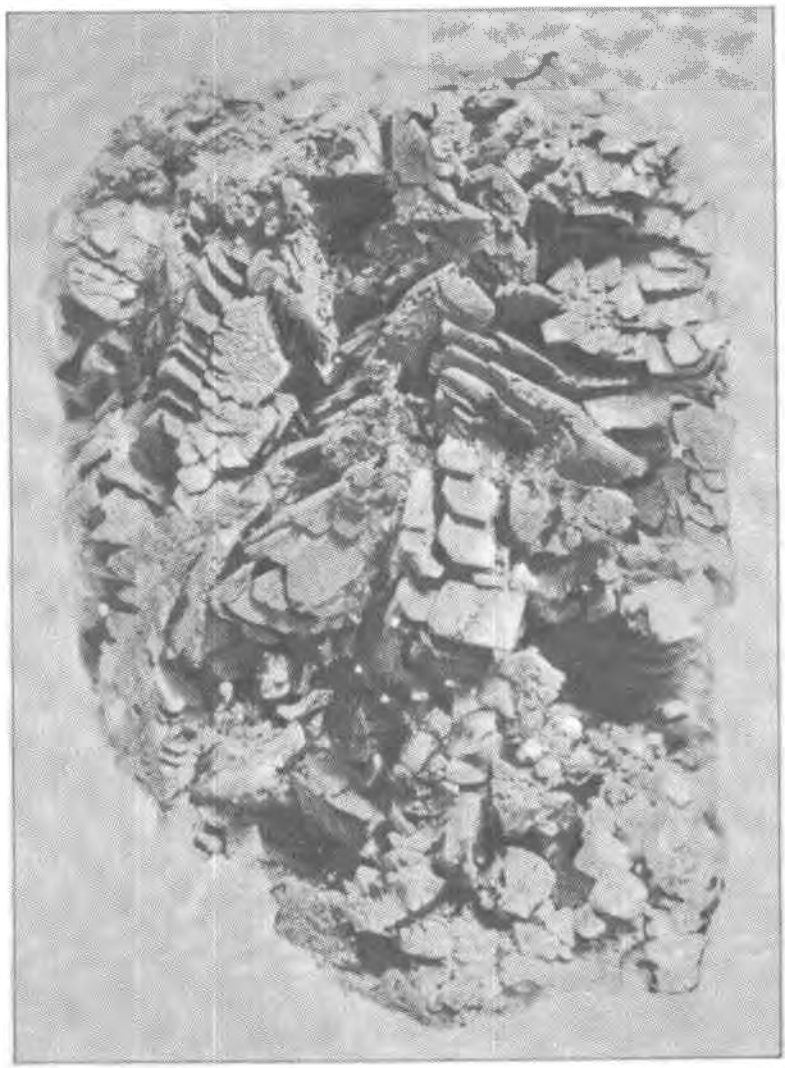

Photograph by Samuel G. Gordon

CHALCOPYRITE, FALLS OF FRENCH CREEK, CHESTER CO., PA.

PLATE VI

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A NEW OCCURRENCE OF CRYSTALLIZED WILLEMITE

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WHILE willemite is not an uncommon mineral, its occurrence in distinct crystals has not been frequently noted in the literature and it seems advisable to record a new locality for this mineral. The specimens described below were collected by Mr. W. H. Parker in the Star District, Beaver County, Utah, and were sent to this laboratory for determination by Ward's Natural Science Establishment. Details as to the field occurrence are not at hand.

The specimens, seven in number, vary in size from 1 x 1 x 2 inches up to about the size of a fist. They are very drusy in character and the cavities are lined with small crystals of willemite and of several less abundant minerals. The associates are small colorless crystals of hemimorphite (calamine) with a tabular development parallel to the brachypinacoid, well defined rhombohedrons of milky calcite and rounded colorless crystals of calcite, small mushroom or pestle shaped aggregates of yellow mimetite, frosted crystals of quartz with the prism and unit rhombohedrons, and long columnar crystals of cerussite with a yellow to greenish coating.

The willemite crystals are small, being about one half of a millimeter in diameter and three quarters of a millimeter in length. Some of them are limpid but the majority have a red color. Examined under the microscope this color is seen to be due to a red pigment, probably iron oxide, unevenly disseminated in the crystals. Single or sharp images could not be obtained, especially on the prism faces, which are greatly striated vertically. For this reason it was not possible to determine the axial ratio,

but the forms present could be identified as c (0001), e ($01\bar{1}2$), a ($11\bar{2}0$), and m ($10\bar{1}0$). See figure 1.

The development of the crystals is very similar to that recorded by Penfield on some willemite crystals from the Merritt Mine in Socorro County, New Mexico.[1] The unit prism of the first order was not observed by Penfield, but appears as a very narrow face on some of the crystals from Utah. The images were very dull, but by shimmer reflections its identity could be definitely

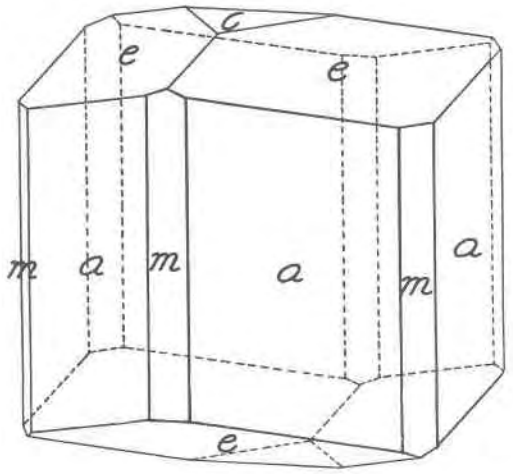

FIGURE 1. CRYSTAL OF WILLEMITE FROM BEAVER CO., UTAH

established. The following represent the average of the various observations made:

	Observed	*Calculated*
a : a′	59° 57′	60°
a : m	30° 40′	30°
c : e	20° 54′	21° 8′
e : e′	36° 17′	36° 23′

The indices of refraction were determined under the microscope by the immersion method. α-monochlornaphthalene and methylene iodide were mixed until a solution was obtained having the same index as the mineral for a given direction and then the index of the liquid for sodium light was determined on the Abbé total refractometer. This gave the following values:

[1] *Am. J. Sci.* [3], **47**, 306, 1894.

	Utah	Franklin Furnace	
	Clark	Gaubert[2]	Palache[3]
ω_{Na}	1.690±2	1.6931	1.6939
ϵ_{Na}	1.71ℓ ±2	1.7118	1.7230
$\epsilon-\omega$	0.026	0.0187	0.0291

The value of the index for the extraordinary ray and the double refraction are somewhat higher than the corresponding values given by Gaubert for willemite from Franklin Furnace and are a little lower than those assigned to willemite from the same locality by Palache. These differences may be due to molecular replacements in the chemical composition of the mineral but, since analyses are not given for the specimens on which the indices have been determined, this idea cannot be verified at present.

It is interesting to note that the index for the ordinary ray does not change materially while the variations for the index of the extraordinary ray are considerable. Penfield and Minor[4] have shown that in topaz the amounts of fluorine and hydroxyl vary widely and that with these variations come changes in the optical properties of the mineral and in the axial ratios. In willemite it seems probable that molecular replacements of the zinc by manganese or other elements cause a lengthening or shortening of the c axis and a corresponding change in the elasticity in that direction due to the separation or compression of the crystal molecules. Further work on this point is contemplated.

Manganese-free willemites from two other localities, Sedalia Mine, Colorado, and Altenberg, Germany, have identically the same indices of refraction as the Utah mineral described by Mr. Clark in the above article. These values, instead of those of Gaubert, which are usually quoted, should therefore be accepted for pure, normal willemite. [THE EDITORS.]

[2] Groth's *Chem. Kryst.*, II Teil, p. 253.
[3] *Z. Kryst. Min.*, **47**, 582, 1909.
[4] *Am. J. Sci.*, **47**, 387, 1894.