

THOROTUNGSTITE. A MINERAL CONTAINING
TUNGSTEN AND THORIUM FROM THE
FEDERATED MALAY STATES.

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In 1921 Mr. B. W. Thunder, the Manager of Kramat Pulai Ltd. Mine, at Pulai in the Kinta District of Perak, found a yellow mineral that appeared to agree with the hydrated oxide of tungsten described by T. L. Walker in this Journal¹ for which the author suggested the use of the name Tungstite as the supposed anhydrous tungstite² had never been analyzed. In examining the mineral from the Kramat Pulai mine it was found difficult to obtain pure material, but later, in 1926, better material was found with numerous druses lined with honey-yellow crystals which it was possible to collect in sufficient quantity for an analysis, carried out by J. C. Shenton, Chemist in the Geological Department, Federated Malay States.

The mineral occurs in shapeless blocks of a few pounds in weight at the base of an eluvial deposit overlying granite on a hillside. The eluvial deposit is worked for tin-ore. The blocks are stated by Mr. Thunder to occur always immediately above the granite. They are of rare occurrence. A coarse concentrate from the workings was found to contain a little of the mineral; in a finer concentrate none was found.

The block that afforded the material analyzed has some quartz-sand coating its surface. Quartz is also found in the druses. A fracture-surface shows a pale yellow to almost white mass, in which are the druses, lined with the yellow crystals. Examination under the microscope points to the mass of the block consisting of minute crystals of the same mineral.

The crystals are transparent and acicular in habit. The longest measured are 0.8 of a millimeter. The greatest breadth measured is 0.06 of a millimeter. The crystals show a transverse cleavage, and a longitudinal cleavage not so well marked. If they are examined under the microscope *in situ* in the druses terminal faces can be seen, shown in Fig. 1; Fig. 2 shows detached and broken crystals under the micro-

¹A review of the Minerals Tungstite and Meymacite, vol. 25, pp. 305-308.

²Dana's System of Mineralogy, 6th Ed., p. 202.

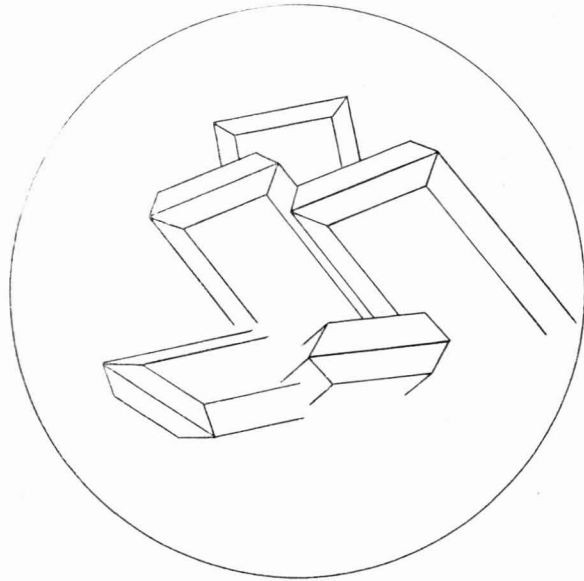


Fig. 1. Thorotungstite. x 400.

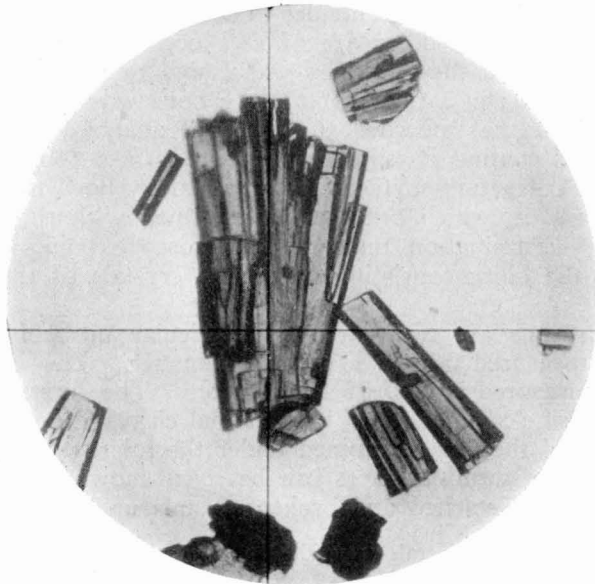


Fig. 2. Thorotungstite. x 100.

scope. A microphotograph was taken showing the terminal faces but is not clear enough for reproduction.

All the crystals show straight extinction. The refractive index is higher than that of methylene iodide (1.74). The double refraction is high, the interference colors being of the fourth order in a crystal lying on the larger face parallel to the long axis (Fig. 1). The optical character is negative. No axial figure good enough for diagnostic purposes was obtained. In finely crushed material a few fragments suggested that an optic axis of a biaxial figure emerged close to, but not in the field. No isotropic fragment was found such as one would get in a uniaxial mineral. The mineral appears to be orthorhombic, with pinacoid, prism, and dome faces. The crystals are too minute for measurement on a goniometer.

The specific gravity is 5.55.

The mineral is attacked by acids and on treatment with hot caustic soda solution is partly dissolved, leaving a heavy white flocculent precipitate containing thoria, iron, and rare earths.

Mr. Shenton's analysis is as follows:

	Per cent.
Loss on ignition (H ₂ O)	4.18
Tungstic oxide (WO ₃)	69.69
Ferric oxide	1.35
Alumina	4.31
Silica .....	.48
Thoria	16.00
Rare earths (nearly all cerium)	1.77
Zirconia	1.96
Lime	1.02
Magnesia	trace
	100.76

The alumina may be slightly on the high side and contain a little thoria and zirconia owing to the difficulty of complete separation. The separation was made by the ammonium carbonate method of R. Lessing³ the alumina precipitate dissolved in hydrochloric acid and reprecipitated three times.

The powdered mineral used for this analysis was examined under the microscope, and a small amount of quartz was the only impurity recognized. This evidently accounts for the silica in the analysis, so we are dealing with a mineral containing water, tungstic oxide, thoria, rare earths (zirconia), alumina, ferric oxide, and a trace of magnesia.

³ Zeitschr. Anal. Chem., 67, pp. 341-352, 1925.

The molecular ratios are:

Water .....	.2322
Tungstic oxide .....	.3004
Ferric oxide .....	.0084
Alumina .....	.0421
Thoria .....	.0605
Rare earths calculated as Ce_2O_3 .....	.0053
Zirconia .....	.0159
Lime .....	.0181

The only approach to a formula that can be deduced from these is obtained by dividing the water between the tungstic oxide, and the thoria, rare earths and zirconia taken together, thus:

Tungstic oxide . . . . .	.3004	Water . . . . .	.1502
ThO_2, Ce_2O_3, ZrO_2 . . . . .	.0817	Water . . . . .	.0820

or $2WO_3 \cdot H_2O + (ThO_2 \cdot Ce_2O_3 \cdot ZrO_2) \cdot H_2O$.

The ratios of the thoria, etc., are nearly $12ThO_2 \cdot Ce_2O_3 \cdot 3ZrO_2$. This formula is certainly not satisfactory and leaves the ferric oxide, alumina, lime, and magnesia unaccounted for, while microscopic examination of the material does not indicate that these are impurities.

However, it does appear to be beyond doubt that the mineral is hydrated oxide of tungsten and thorium and we suggest for it the name "*Thorotungstite*," thus describing the main constituents and the resemblance to Walker's tungstite.

We believe the mineral to have been formed at the base of the eluvial deposit as the result of the decomposition of scheelite or wolfram, probably the latter, seeing that it occurs above granite, and some mineral containing thorium and cerium. Scheelite is abundant on the Kramat Pulau Ltd. mine in limestone country, and wolfram occurs. Monazite is found in the tin-ore concentrates and in this hot moist tropical country is generally cloudy owing to hydration. The thorium and cerium may have come from monazite, but an obvious objection is that the cerium should be in excess of the thorium, which is not the case. Zircon is abundant in the granite, and may have become hydrated and supplied the zirconia.

If the mineral were simply hydrated tungstic oxide it would be easy to account for its existence. The thorium, cerium, and zirconium, however, are not easy to account for.

We are indebted to Dr. G. T. Prior, F. R. S., for examining some of the mineral found in 1921.

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