ART. XXXII.—*A Review of the Minerals Tungstite and Meymacite;* by T. L. WALKER, University of Toronto.

EARLY in the last century Silliman* described a mineral rich in tungstic acid from Huntington, Connecticut, and although no analysis had been made of this mineral it was agreed to regard it as anhydrous tungstic acid, WO_3. Many years later Nordenskiöld described the crystal form of artificially prepared anhydrous tungstic acid, and this description has been incorporated in the general description of Silliman's mineral. Finally in 1874 Carnot studied and described an occurrence of a massive mineral greenish to yellowish in color, very impure from the presence of foreign substances and, concluding that it was hydrated tungstic acid of the formula $WO_3.2H_2O$, named it Meymacite and regarded it as a distinct species. The uncertainty as to the proportion of water in the case of Carnot's analyses is shown by the fact that in his three analyses the water percentage varied from 6·85 to 12·93. Meymacite has usually been regarded as a variety of tungstite. Recently, while examining some specimens from British Columbia, the writer had occasion to review the relationship of these minerals. Material from the vicinity of Salmo occurring in small masses in gold quartz veins, and at times containing small particles of native gold, appeared on examination with the blowpipe to agree fairly well with the standard description of tungstite. This was followed by a detailed examination, which leads to the conclusion that it is at once the same as the material of Silliman and of Carnot and that the chemical composition is $WO_3.H_2O$. In the following description the main characteristics of the British Columbia mineral are recorded.

General Description.—The material here considered reached the Mineralogical Museum of the University of Toronto through the kindness of Mr. R. B. Thomson, lecturer in botany in the University of Toronto. Later, on visiting British Columbia in 1907, more specimens were obtained, but as the vein from which the specimens came was not being worked at the time of my visit no considerable quantity was obtainable. The specimens are made up of a heavy golden-yellow mineral streaked and netted with dark strings exhibiting a structure common to serpentines. In the centers of the yellow areas small druses of minute crystals may be observed on examination with the microscope. Quartz, wolframite, scheelite and specks of native gold make up a considerable portion of the whole. The grain is too fine to make it possible to secure a sample of pure yellow material for analysis. The yellow min-

* This Journal (1), iv, pp. 52 and 187.

eral apparently results from the alteration of wolframite. Having determined by the aid of the pycnometer the specific gravity of the aggregate as a whole and later of the part insoluble in ammonia and knowing the relative proportions of the soluble and insoluble constituents, it is simple to calculate the specific gravity of the yellow soluble constituent. In this way the density has been found to be 5·517, hardness 2·5, luster resinous, pearly on the one perfect cleavage. In thin section the mineral is seen to be golden yellow, in transmitted light, but not perceptibly pleochroic. The index of refraction is less than that of Canada balsam since the mineral in thin section is smooth-surfaced. Examined between crossed nicols the polarization colors are brilliant, indicating fairly low double refraction. As the mineral is very cleavable in one direction numerous cleavage plates are torn loose in the mounting, and these being oriented so that their cleavage plane is that of the mount, give in convergent light biaxial interference figures.

Although there are numerous druses lined with tiny crystals none of them was large enough for study on the goniometer. All that we know of the crystallography of this mineral depends upon two observations: the mineral possesses one perfect cleavage and these cleavage plates exhibit biaxial interference figures. Since in this case the acute bisectrix is at right angles to the cleavage we may conclude that the mineral may be rhombic and the cleavage pinacoidal, or it may be monoclinic with the cleavage parallel to the plane of symmetry. Later it may be possible to secure crystals large enough to settle this question definitely.

Chemical characters.—Since both tungstite and meymacite are said to be soluble in ammonia and sodic hydroxide, the powdered mineral was treated with warm caustic soda, and the residue washed and dried at 110° was found to make up only 13·52 per cent of the whole. In this way it was possible to consider (from a chemical point of view) the specimens as made up of two parts—one soluble in alkali corresponding to tungstite or meymacite, and an insoluble portion made up, according to physical and chemical examination, of wolframite, limonite and scheelite.

The result of a complete analysis was as follows:

WO_3	86·20%
CaO	·54
FeO*	1·21
Fe_2O_3	4·14
H_2O	7·72
Total	99·81%

* The condition of the iron was not determined—that portion necessary to form wolframite with the balance of the tungstic acid has here been expressed as FeO.

On analysis of that portion soluble in ammonia it was found to yield 80·08 per cent WO_3, the balance not accounted for by the insoluble dried at 110° C. being apparently water. This amount agrees very closely with the difference between the percentage of water contained in the powder sample as a whole and that contained by the insoluble portion. As scheelite, wolframite and limonite appear to make up the insoluble part of the sample, we may indicate the approximate mineralogical composition of our aggregate as follows:

		$WO_3.H_2O$	$FeO.WO_3$	$CaO.WO_3$	$2Fe_2O_3.3H_2O$	Excess
WO_3	86·20%	80·08	3·88	2·24	---	
CaO	·54	---	---	·54	---	
FeO	1·21	---	1·21	--	---	
Fe_2O_3	4·14	---	---	--	4·14	
H_2O	7·72	6·21	---	--	·69	·82
		86·29%	5·09%	2·78%	5·83%	
		Tungstite	Wolframite	Scheelite	Limonite	

The material soluble in alkali is therefore hydrated tungstic acid, $WO_3.H_2O$. Since the mineral of Silliman has never been analyzed and that of Carnot was so impure that nearly half of the constituents found had to be rejected in calculating his formula $WO_3.2H_2O$, it seems very probable that all three of these occurrences have really the same chemical composition.

This mineral is probably widely distributed as indicated by the following extract from the "Economic Resources of the Northern Black Hills."* The reference is to the formation of secondary products by the alteration of wolframite.

"Despite the decomposed and gouge-like character of the country rock, alteration has not generally taken place to any noticeable degree. Where the ore has been long exposed to atmospheric conditions, however, a mineral of gold-yellow color, in glistening druses of extremely minute crystals, very often coats the surface. This has been considered by Forsyth as suggestive of tungstite or tungsten trioxide, but none of that collected by the writer gave satisfactory results to tests for tungsten and its true character has not yet been determined."

Some of the gold quartz mines in Southern British Columbia in the vicinity of Salmo have, according to report, produced considerable amounts of this mineral, but as nobody suspected the presence of any valuable substance other than the gold, it does not appear to have been utilized.

*Irving, Emmons and Jagger, U. S. Geol. Survey. Professional Papers No. 26, p. 166.

Conclusion.—In British Columbia and possibly in the Black Hills, S. D., a yellow crystalline mineral occurs having the formula $WO_3.H_2O$. This appears to be the substance which under various conditions has been called tungstite and meymacite. It occurs along with gold and other tungsten minerals and may be of industrial importance. The author suggests that the name tungstite be used for this well established hydrated oxide since the supposed anhydrous material had never been analyzed.

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