CHEMICAL COMPOSITION OF CUPROTUNGSTITE

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The occurrence of cuprotungstite at Cave Creek, Arizona, has been described by Hess.[1] Its association with ferberite and with scheelite is shown by him in a colored plate (Pl. XVII).

Two samples were analyzed, one hard and compact and the other soft and friable. Two analyses were made of each sample, using HCl and HNO_3 as the solvents. It was not realized when the analyses were begun that so considerable a quantity of insoluble gangue was present in both samples. The role played by the calcium soluble in the acids is not known. It may belong to the cuprotungstite, to the insoluble matter, to scheelite, or to fluorite. Fluorine was not looked for in either sample. The water passes off only above 110°C.

ANALYSES OF CUPROTUNGSTITE FROM CAVE CREEK, ARIZONA

Solvent	Hard material			Soft material		
	1	2	Average	1	2	Average
	HCl	HNO_3		HCl	HNO_3	
Insoluble	71.75	71.84	71.80	33.14	34.08	33.61
WO_3	13.10	13.24	13.17	35.47	35.26	35.37
CuO	7.85	7.69	7.77	19.89	19.26	19.58
CaO	0.88	1.08	0.98	1.72	1.74	1.73
MgO	0.20	0.12	0.16	0.19	0.34	0.27
Fe_2O_3	0.61	0.68	0.65	1.52	1.03	1.28
H_2O	4.35	4.32	4.34	6.43	6.46	6.45
	98.74	98.97	98.87	98.36	98.17	98.29

The average analyses of both the hard and the soft material are given below with the insoluble gangue and the iron oxide deducted, and the remainder recalculated to 100 per cent. The insoluble gangue in both samples contained considerable clay-like material and had a considerable water content. The percentage of water in the insoluble gangue was determined on both samples, after decomposition of the cuprotungstite with HCl, solution of the sep-

[1] Hess, F. L., Tungsten minerals and deposits: *U. S. Geol. Surevy, Bull.* **652,** pp. 32–33, 1917.

arated oxide of tungsten in ammonia, washing, and air drying for a week. The insoluble gangue of the hard material contained 2.63 per cent H_2O and that of the soft material 3.49 per cent. Allocating this water to the gangue, the average analyses of the two samples can be restated in the form given in the table below which also shows the average analyses of the cuprotungstite recalculated to 100 per cent.

AVERAGE ANALYSES OF CUPROTUNGSTITE WITH INSOLUBLE GANGUE DEDUCTED

	Hard material		Soft material	
	Analysis	Recalculated	Analysis	Recalculated
WO_3	13.17	55.36	35.37	59.04
CuO	7.77	32.66	19.58	32.68
CaO	0.98	4.12	1.73	2.89
MgO	0.16	0.67	0.27	0.45
H_2O (in mineral)	1.71	7.19	2.96	4.94
	23.79	100.00	59.91	100.00
Gangue (ignited)	71.80		33.61	
Fe_2O_3	0.65		1.28	
H_2O (in gangue)	2.63		3.49	
	98.87		98.29	

The ratios obtained from the recalculated average analyses, are as follows, taking that of WO_3 as 1.00.

RATIOS OF RECALCULATED AVERAGE ANALYSES OF CUPROTUNGSTITE

	Hard material			Soft material		
WO_3	0.239		1.00	0.255		1.00
CuO	0.410			0.411		
CaO	0.073	0.500	2.10	0.052	0.474	1.86
MgO	0.017			0.011		
H_2O	0.399		1.67	0.274		1.08

In the hard sample the ratios of the bases to WO_3 is slightly over 2:1; in the soft sample, slightly under. The average is 1.98 to 1.00 or practically 2:1. In the soft sample, containing the smallest

quantity of gangue, the ratio of water to WO_3 is almost 1:1, in the hard sample it is somewhat greater. These ratios indicate clearly that the formula of cuprotungstite is $WO_3 \cdot 2CuO \cdot H_2O$.

If the CaO+MgO be considered as belonging to scheelite and the corresponding quantity of WO_3 allowed for and deducted, then the ratio of CuO to WO_3 is 2.76 in the hard sample, and 2.14 in the soft sample; insufficient evidence for doubting the 2:1 ratio of base to acid in the mineral. This ratio does not even approach the 1:1 ratio, as given by Dana and by Hess, no matter what assumption is made with reference to the role played by the calcium.

The only recorded analysis of essentially cuprotungstite is the first one listed by Dana.[2] If the 2.00 per cent CaO therein reported be ascribed to scheelite and the corresponding quantity (8.31 per cent) of WO_3, deducted, the ratios of the analytical figures representing cuprotungstite yield the same formula as deduced from the analysis of cuprotungstite from Cave Creek, namely, $WO_3 \cdot 2CuO \cdot H_2O$.

RATIOS OF DOMEYKO'S ANALYSIS OF CUPROTUNGSTITE FROM CHILE, AFTER ALLOWING FOR IMPURITIES

WO_3	48.17	.2076	1.00 or 1
CuO	30.63	.3848	1.85 or 2
H_2O	4.62	.2567	1.24 or 1
Fe_2O_3	2.53		
SiO_2	3.87		
Scheelite	10.31		
	100.13		

If it be assumed that no scheelite was present and that the CaO belongs to the cuprotungstite and its ratio be combined with that of CuO, as was done with the analysis of the mineral from Cave Creek, then the ratio of WO_3:CuO+CaO:H_2O is 1.00:1.73:1.06, yielding the same formula as before, namely $WO_3 \cdot 2CuO \cdot H_2O$.

The other three analyses listed by Dana are probably impure mixtures of cuprotungstite and scheelite, as noted by Hess. The name cuproscheelite[3] should be discarded, as it obviously was applied to a mixture, as stated by Hess.

[2] Dana, E. S., System of mineralogy, 6th ed., **1892,** 988. Analysis by Domeyko, on material from Chile.

The analyses of cuprotungstite from Arizona, supplemented by one analysis of material from Chile, has shown that its chemical composition is that expressed by the formula $WO_3 \cdot 2CuO \cdot H_2O$.

A specimen of cuproscheelite from Kern County, California, from an old collection, with a label of Henry G. Hanks, San Francisco, and probably an authentic specimen, when examined microscopically, was seen to be scheelite with admixed cuprotungstite, which colored the scheelite greenish.

[3] The name cuproscheelite would apply better to a mineral analogous to scheelite but with CuO in place of CaO. Its formula would then be $CuO \cdot WO_3$. No such mineral is known.