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CHARLES D. WALCOTT
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CHEMICAL COMPOSITION OF CALAVERITE FROM CRIPPLE CREEK, COLORADO.

By W. F. HILLEBRAND.

The occurrence of tellurium in the ores of the mining district of Cripple Creek, Colorado, has been known from an early day in the brief industrial history of that region. That it was, in part at least, associated with gold was likewise known from the observance of a crystallized gold-tellurium mineral. Although the ores of the district are chiefly gold carriers, they contain also a little silver, and since recognized silver minerals had not been observed, or at most only in minute amount, it seemed probable that the silver was associated with the gold in the tellurium compound. Indeed, Mr. R. Pearce,[1] of Denver, came to the conclusion, from analyses of oxidized and unoxidized ores, that this mineral was sylvanite, and he says, "Sylvanite itself appeared in little silver-white specks disseminated through a mass of greenish rhyolite, accompanied by amethystine fluorite." Notwithstanding that F. C. Knight[2] has identified calaverite by analysis and that sylvanite has not been identified by positive chemical or crystallographical tests, the evidence of Mr. Pearce as to its presence, in some portions of the district at least, is entitled to consideration. The telluride or tellurides are, however, of very sparing occurrence, so that it was only by dint of much effort that material in sufficient purity for decisive tests was obtained by Prof. R. A. F. Penrose, jr., who transferred it to me for chemical examination. The material was procured from three different mines in order to ascertain whether it was of constant or varying composition, or, in fact, whether there might not be more than one specific telluride. That the composition does vary within narrow limits the analyses show, but there is no reason apparent for assuming more than one existing species in the ores of these particular mines.

The material from the Prince Albert mine, the first received, was with little trouble brought into an almost ideal condition of purity. It was in part fairly well crystallized, and the most perfect crystals have been examined by Prof. S. L. Penfield, of New Haven. The specific gravity of this material was 8.91 at 24° C., which becomes 9 when corrected for a small admixture of silico-ferruginous gangue of assumed specific gravity 2.70 (probably low). The other samples were imperfectly crystallized and held too much foreign matter of uncertain composition to make specific gravity determinations of any value.

[1] Proc. Colo. Sci. Soc., Jan. 8 and Apr. 5, 1894.
[2] Ibid., Oct. 1, 1894.

Analyses of calaverite from the Cripple Creek district.

	I. Prince Albert mine.	II. Raven mine.	III. C. O. D. mine.
Tellurium (Te)	57.27	47.69	53.89
Gold (Au)	38.95	33.93	39.31
Silver (Ag)	3.21	1.47	.85
Insoluble matter	.33	5.80	.91
Ferric oxide (Fe_2O_3)	*a* .12		
Iron (Fe)		5.41	1.67
Sulphur (S)		*b* 6.17	1.58 (2.96 FeS_2)
Manganese (Mn)			*c* .23
Calcium (Ca)			.51
Magnesium (Mg)			.10
Oxygen, fluorine, and soluble silica by difference			*d* .95
Total	99.88	100.47	100.00

a This was included with the insoluble matter in arriving at the corrected density.
b Calculated from the Fe to make FeS_2.
c As MnO, ?
d A part of the calcium found in solution was derived from fluorite, which likewise constituted some of the insoluble matter in this instance.

Selenium has been reported by Mr. Knight (loc. cit.) to occur in oxidized ores of the district, but it could not be detected in the amount of mineral taken for the above analyses.

Excluding everything but gold, silver, and tellurium, and recalculating to 100, the following comparison is obtained:

	I.		II.		III.	
	Per cent.	Ratio.	Per cent.	Ratio.	Per cent.	Ratio.
Te	57.60	2.01	57.40	2.05	57.30	2.09
Au	39.17	1.00	40.83	1.00	41.80	1.00
Ag	3.23		1.77		.90	
	100		100		100	

The ratio here obtaining is that for sylvanite and calaverite, but the very low percentage of silver shows that the mineral is calaverite. Indeed the first analysis agrees almost exactly with Genth's analyses of the species. Interesting is the slight variation in the ratio between gold and silver and the very low percentage of silver in the mineral from the C. O. D. and Raven mines. Calaverite, the lowest silver carrier of the gold-silver tellurides, has not heretofore been known to carry less than 3 per cent of silver.

The pyrognostic characteristics of the mineral from the Prince Albert mine were essentially those ascribed to calaverite. In the closed tube it fuses, giving a white coating near the assay and a globular gray coating just above, which latter by strong heat can be in part driven higher up, leaving the glass covered with the same white fused coating as lower down. This latter is yellow while hot. On charcoal the mineral fuses with a green flame, giving a white coating and similar fumes and leaving a yellow bead. The color is pale bronze-yellow, in powder greenish-gray. The hardness is not less than and perhaps a little over 3. Specific gravity, as given above, 9.

The identity of the telluride occurring at Cripple Creek, which in oxidizing gives free gold and oxidized tellurium compounds,[1] seems thus satisfactorily established, but unless there is another richer in silver, as believed by Pearce, the mode of occurrence of the silver in some of the ores is still in large part unaccounted for. It may be derived from a very rich argentiferous tetrahedrite, a small specimen of which Professor Penrose submitted for identification. This carries over 11 per cent of silver, but is said to be excessively scarce, and, therefore, hardly to be considered in this connection, unless, indeed, this should have been the original source of most of the silver and later have suffered oxidation to a great extent, whereby the silver has become more evenly distributed throughout the ore.

W. F. H.

PARTIAL REPORT ON CALAVERITE CRYSTALS FROM CRIPPLE CREEK, COLORADO.

By S. L. PENFIELD.

The crystals of calaverite which were examined were developed with prismatic habit, but the prismatic zone was striated to such an extent that it was impossible to identify a single face in the zone, and on the reflecting goniometer almost an unbroken band of signals was obtained in a revolution of 360°. Owing to oscillatory combinations the crystals were also much distorted, so that they did not present regular cross-sections. The prisms were attached, so that doubly terminated ones were not observed, while the faces at the free end were small and developed with so little symmetry that after a study of a number of crystals it was found impossible to determine with certainty the system of crystallization.

The crystals do not exhibit the perfect cleavage ascribed to sylvanite and krennerite, but are similar to the former in some of their angles. When placed in position to show their relation to sylvanite they have their prismatic development parallel to the *b* axis. One crystal which, owing to its development, was more carefully measured than any of the others, was apparently a twin about 101, and showed at the end the forms 111 and 110. The measurements, compared with the corresponding ones of sylvanite, are as follows:

	Calaverite.	Sylvanite.
	° ′	° ′
111 ∧ (111) over twinning plane	93 35	94 30
110 ∧ (110) over twinning plane	35 2	34 43
110 ∧ 111	36 35	37 3
110 ∧ 111 in the twin crystal	36 33	37 3

[1] From tests made by myself on a number of specimens collected by Professor Penrose the combination seems to be chiefly, if not altogether, with iron, but whether as tellurite or tellurate could not be ascertained. Knight (loc. cit.), however, has shown that the combination, in some cases at least, is a tellurite approximating to the formula $2(Fe_2O_3, 2TeO_2) + H_2O$.