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WITH TEN PLATES.

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4. *Apatite and Hessonite in a Pegmatite from Canaan, Ct.*

South of the Canaan Valley post office and east of the small stream known as the Whiting river in the township of Canaan, Ct., the gneiss of the district is cut by veins of pegmatite in which occur several crystallized minerals. As the locality has not been described the minerals of these veins may deserve a passing mention. The most abundant of these are a white feldspar which sometimes appears in crystals having dimensions of as much as eight inches, and a green or colorless muscovite in elongated hexagonal crystals measuring several inches on an edge. These muscovite plates frequently enclose quartz in bi-pyramidal crystals in form and size much resembling the well known quartzes from Edwards, N. Y. Biotite is less abundant than the muscovite and occurs in small black plates. Crystals and aggregates of black tourmaline as large as one's fist are not rare. A cinnamon-colored garnet is found sometimes in distinct crystals as much as a half-inch in diameter, sometimes intergrown with the feldspar so as to produce a structure resembling graphic granite. One crystal of green apatite was found which was over two and a half inches in length and an inch in diameter. It was broken in removing from the rock, but the fragments show the crystal to be bounded in the prism zone by both the first and second order prisms in about equal development. A more careful examination of the locality would perhaps reveal other minerals.

ART. XV.—*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 as yet 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, of Denver, came to the conclusion, from his examination* of certain ore concentrates, that this mineral was sylvanite. It is, however, of very sparing occurrence, so that it was

* Proc. Colo. Sci. Soc., Jan. 8, and April 5, 1894.

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 derived 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 species.

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 apparently fairly well crystallized, but the measurements made by Prof. S. L. Penfield, of New Haven, are unfortunately not decisive as to the system of crystallization, as shown by his notes at the close of this paper. The specific gravity of this material was 8·91 at 24° C., which becomes 9·00 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.

ANALYSES OF CALAVERITE.

	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	·33	5·80	·91
Ferric oxide (Fe_2O_3)	·12*		
Iron (Fe)		5·41	1·67
Sulphur (S)		6·17†	1·58 (2·96 FeS_2)
Manganese (Mn)			·23‡
Calcium (Ca)			·51
Magnesium (Mg)			·10
Oxygen, Fluorine and Soluble Silica by difference			·95§
	99·88	100·47	100·00

Selenium has been reported to occur in traces in the district,‖

* This was included with the insoluble matter in arriving at the corrected density.

† Calculated from the Fe to make FeS_2.

‡ As MnO_2?

§ A part of the calcium found in solution was derived from fluorite, which likewise constituted some of the insoluble matter in this instance.

‖ F. C. Knight, Proc. Colo. Sci. Soc., Oct. 1, 1894.

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.	ratio.	II.	ratio.	III.	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	
	100·00		100·00		100·00	

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 three 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, 9·00.

The identity of the telluride occurring at Cripple Creek, which in oxidizing gives free gold and oxidized tellurium compounds* seems thus satisfactorily established, but unless there is another richer in silver 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 of which Prof. Penrose submitted a small specimen for identification. This carries over eleven 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

* From tests made by myself on a number of specimens collected by Prof. Penrose the combination seems to be chiefly if not altogether with iron, but whether as tellurite or tellurate could not be ascertained.

oxidation to a great extent whereby the silver has become more evenly distributed throughout the ore.

Professor Penfield has kindly contributed the following notes on the crystallography of the mineral:

"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:

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

Other forms which were measured could not be referred to the sylvanite axes, and it seems probable from their development and lack of symmetry that the crystals are triclinic; but no satisfaction was obtained after a long and careful study of the limited supply of material on hand.

In conclusion, therefore, it may be stated that the crystals are probably triclinic, but near sylvanite in angles and axial ratio."

Laboratory of the U. S. Geological Survey, Washington, D. C., May, 1895.