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HIGGINSITE, A NEW MINERAL OF THE OLIVENITE GROUP

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The new mineral described in this paper was found by J. B. Tenney at the Higgins Mine, Bisbee, Arizona and was sent to the Harvard Mineralogical Museum for determination in 1917. Mr. Tenney, then Chief Geologist of the Phelps-Dodge Corporation, described the occurrence of the mineral in the following words:—"The mineral occurs always with manganese ore on or near the surface. The manganese minerals are psilomelane, braunite and pyrolusite. Occasionally barite occurs with it also, and the manganese passes on the edge of the deposits into limonite (or goethite) intergrown with cherty quartz, or into crystalline limestone. The form and nature of the occurrence suggest replacement of pure limestone by manganese, iron and silica, carried in strong sulfate solutions. The green mineral appears to be of the same age, as far as can be told."

The authors take pleasure in following the suggestion of Mr. Tenney that this mineral bear the name *higginsite*, after the Higgins Mine, where it was found.

The specimens received show crystals and granular masses of higginsite interspersed thru black manganese ores with an occasional plate of white barite. The color of the crystals is a vivid malachite green; of the granular material, yellow green. The powder is distinctly yellowish green, with a brownish cast. In the coarsest material grains as much as 2 cm. in diameter were seen, but the largest crystal measured was about 5 mm. in length.

Crystallography—Higginsite is orthorhombic, with the elements:

$$p_0 = 1.272 \qquad q_0 = .7940.$$

Details are given on a later page. Its close relationship in

form to olivenite and descloizite is shown by comparison of their axial ratios:

	a : b : c
Higginsite	.6242 : 1 : .7940
Descloizite	.6368 : 1 : .8045
Olivenite ($^2/_3$a)	.6264 : 1 : .6726

Figures 1 and 2 show the prevailing habits of the crystals. The prismatic habit is most frequent in those at hand; but the domatic development, either as shown or with nearly equal extension parallel to the two horizontal axes, gives some crystals an octahedroid appearance. The lack of any pronounced cleavage makes the orientation of the crystals difficult. The faces, especially of the pyramid forms, are of good luster and gave on the whole very satisfactory reflections on the goniometer.

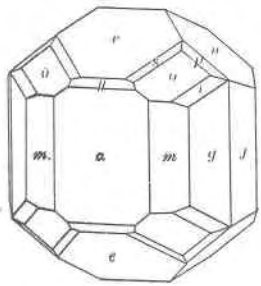

FIG. 1

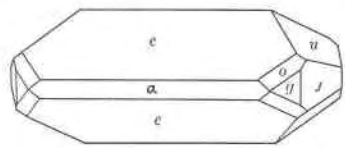

FIG. 2

Physical Characters.—Hardness about 4.5; specific gravity 4.33. The optical properties were studied by Mr. T. Matsumoto and partly determined as follows, the small size and opacity of the crystals rendering complete results unattainable:

Refractive index $\beta > \alpha > 1.745$; birefringence approx. 0.030.

Optical orientation: X || a, probably Bx_a; Y || b; Z || c; Axial plane therefore parallel to (010).

Opt. character:—(?); axial angle large; dispersion $v > \rho$ (if —).

Absorption Y > X > Z; pleochroism marked: X green; Y yellow green; Z blue green.

Chemical Composition.—The analyses (by E. V. S.) were made on carefully hand-picked grains, freed as far as possible from manganiferous gangue. Some of the latter appeared to be present as dust even in the clearest crystals and could not be wholly removed. The final analysis was made upon about 1 gram of material, the check determination of copper and calcium on a half gram of the same powder.

TABLE 1

ANALYSES OF HIGGINSITE, BY E. V. SHANNON

	1	2	Av.	Ratios		
CuO	28.51	28.82	28.67	0.3603	1.93	2
CaO	20.92	20.74	20.83	0.3712	1.99	2
V_2O_5	1.97		1.97	0.1901	1.02	1
As_2O_5	41.23		41.23			
$H_2O - 105°$ C.	0.08		0.08			
$H_2O + 105°$ C.	3.41		3.41	0.1892	1.02	1
Fe_2O_3	0.48		0.48			
MnO	2.84		2.84			
Gangue (Insoluble)	0.86		0.86			
Total	100.30		100.37			

All the iron and manganese is regarded as extraneous and derived from the gangue material. Deducting these, with the insoluble material and hygroscopic water, the average analytical figures yield the ratios in the last column.

These ratios then yield quite closely the formula:

$$2\,CuO.\ 2\,CaO.\ As_2O_5.\ H_2O \text{ or } Cu\,Ca\,(OH)\,(AsO_4)$$

Arsenic is replaced to a small extent by vanadium. This may be compared with the formulas of olivenite and descloizite: $4\,CuO.\ As_2O_5.\ H_2O$, and $2PbO.\ 2\,ZnO.\ V_2O_5.\ H_2O$, which are typical of the olivenite group.

Recalculating the essential constitutents of the mineral to 100% and comparing with these figures the composition required by the formula derived above we obtain the following figures.

	Original	Recalculated to 100 %	Theory for Cu Ca $OHAsO_4$
CuO	28.67	29.83	30.65
CaO	20.83	21.67	21.60
V_2O_5	1.97	2.05	44.28
As_2O_5	41.23	42.90	
H_2O	3.41	3.55	3.47

These figures show a very satisfactory agreement.

Pyrognostic Characters.—Higginsite fuses at about 3, coloring the flame at first pale blue (As) and then blue green (Cu). On charcoal alone it fuses to a black slag without flame coloration or coating; with soda and borax it is reduced to metallic copper, yielding a faint arsenic reaction. In the closed tube it decrepitates slightly, turns black, and at a red heat gives off a little neutral water. Gives no arsenic sublimate when heated with charcoal in the closed tube. It is readily soluble in nitric and hydrochloric acids; partially soluble in sulfuric acid; insoluble in ammonia.