The primary metallic minerals observed in the deeper levels of the Champion mine are chalcopyrite, bornite, sphalerite, pyrite, a local occurrence of stibnite, and very sporadic molybdenite. The accessible workings in the adjacent Anderson mine were all in the oxide zone. In these upper levels drusy hemimorphite frequently lines seams in the copper ore and associated with this hemimorphite the crystals described below were found.

Among a number of specimens of the drusy hemimorphite, three were found which showed tiny pyramidal crystals of tetragonal habit implanted upon the hemimorphite crystals. A few square tabular crystals were also found. A few of the crystals, apparently unaltered, were nearly colorless and translucent. Most of the crystals were an opaque white due to partial replacement by hydrozincite which is also present as late crusts on the hemimorphite. A few other crystals of both tabular and prismatic development show partial to complete replacement by chrysocolla. Since both tabular and pyramidal wulfenite crystals had been found in some of the Champion workings, that mineral was suspected here, but both triple nitrite and iodide microchemical tests failed to show any lead. Calcium was proved by precipitating microchemical gypsum and cesium chloride showed the absence of bismuth. Molybdenum was proved by semi-micro reduction to molybdenum blue and confirmation with xanthate. No tungsten reaction was obtained by using reduction tests of both stannous chloride and tin. Thus a calcium molybdate conformable with powellite is indicated. The age sequence in relation to the hemimorphite suggests a relatively low temperature of formation.

Chrysocolla, in addition to replacing the powellite, was observed in various stages up to complete replacement of both hemimorphite and acicular to capillary malachite crystals.

TRICLINIC CALCULATIONS

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To simplify triclinic calculations it may be well to point out certain relations implicit in my recent paper[1] which were not explicitly stated. Here the rectangular coordinate parallel to the $\phi = 0°$ direction of the orthographic projection of unit distance on the axial trace out towards the "right" was expressed as n_0, n_1 or n_2 in the three orientations.[2]

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[1] Fisher, D. Jerome (1952), Triclinic gnomonostereograms: *Am. Mineral.*, **37**, 83–94. On p. 91 the denominator of (13) should be cot β.*

[2] Since the m-coordinates (parallel the $\phi = 90°$ direction) are readily derived from the n-values, it would seem that one could dispense with the former. It is stated (*op. cit.*, base p. 88) that the denominator of (9) is n_0.

From (4) and (19) get: $\cos \rho_0 = n_1$ (4′)
From (12) and (28) get: $\cos \rho_1 = n_2$ (12′)
From (21) and (9) get: $\cos \rho_2 = n_0$ (21′)
From (9) and (21) get: $q_0' = c/n_0$ (9′)
From (10) and (28) get: $p_0' = c/(a\ n_2)$ (10′)
From (17) and (21) get: $q_1' = a/n_0$ (17′)
From (18) and (19) get: $r_1' = a/(c\ n_1)$ (18′)
From (26) and (28) get: $p_2' = 1/(a\ n_2)$ (26′)
From (27) and (19) get: $r_2' = 1/(c\ n_1)$ (27′)

Since $\rho_0 = [c] \wedge [c^*]$, it is clear that $\cos \rho_0 = n_1$ is one of the direction cosines of $[c^*]$; another one is $\cos \alpha^* = n_1 y_0'$. Similarly $\rho_1 = [a] \wedge [a^*]$, and so $\cos \rho_1 = n_2$ is one of the direction cosines of $[a^*]$; another is $\cos \beta^* = n_2 z_1'$. And finally $\rho_2 = [b] \wedge [b^*]$, so $\cos \rho_2 = n_0$ is one of the direction cosines of $[b^*]$; another is $\cos \gamma^* = n_0 x_2'$. The last six of the above formulae furnish simple relations between axial units and certain Goldschmidt projection constants, given n_1, n_2, and n_0 [which can be calculated readily from (4), (12), and (21)]. It might be well to include these three values in triclinic angle tables.[3] Of course n_0 becomes unity in the monoclinic (where $n_1 = n_2 = \sin \beta$), and all three are unity in the orthorhombic.

Using these n-values also simplifies several standard formulae,[4] as follows:

$a^* = 1/(a\ n_2)$ (54) $a = 1/(a^*\ n_2)$ (54′)
$b^* = 1/(b\ n_0)$ (55) $b = 1/(b^*\ n_0)$ (55′)
$c^* = 1/(c\ n_1)$ (56) $c = 1/(c^*\ n_1)$ (56′)
$V^* = a^*b^*c^*\ n_0 \sin \beta^* = a^*b^*c^*\ n_1 \sin \gamma^* = a^*b^*c^*\ n_2 \sin \alpha^*$ (48–50)
$V = abc\ n_0 \sin \beta = abc\ n_1 \sin \gamma = abc\ n_2 \sin \alpha$ (48′–50′)

While equations (26′) & (54) seem to say that $p_2' = a^*$, and (27′) & (56) that $r_2' = c^*$, it must be remembered that a, b, & c of (54)–(56) represent unit cell edge lengths. Thus:

$a^* = p_2'/b_0 = p_0'/c_0$ (36)
$b^* = q_1'/a_0 = q_0'/c_0$ (37)
$c^* = r_2'/b_0 = r_1'/a_0$ (38)

where a_0, b_0, & c_0 are a, b, & c of (54)–(56). In short these projection constants (as well as the n_1, n_2, and n_0 direction cosine values) are also con-

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[3] For chalcanthite (see *Am. Mineral.*, **37**, 1952, 111) $n_1 = 0.9524$ and $n_2 = 0.9378$. In this table p_0 should $= 0.990$ and p_0' should $= 1.0393$. Other corrections in this paper include: p. 104, base, γ in (31′) should be α; p. 105, lines 10 and 22, *diffraction* should read *precession;* p. 109, Table 6, last line of right column, prime the G_2. The calculated density of the chalcanthite is $499.42/(.6023 \times 361.94) = 2.291$.

[4] Buerger, M. J. (1942), *X*-ray crystallography, New York, pp. 360–361. The numbers are those of Buerger.

stants which relate the lengths of the edges of the direct unit cell to those of the reciprocal unit cell.

The linear[5] elements of the triclinic system may be considered to include a^*, b^*, c^*; $a_0b_0c_0$; also a, b, c; and the six Goldschmidt projection constants listed in the first set of formulae. From the first two "sets of three" of these linear elements one may derive the n_1, n_2, n_0-values [using (54)–(56)], and these put in (9′–10′), (17′–18′), & (26′–27′) yield the listed projection constants.

The angular elements include α, β, γ; α^*, β^*, $\gamma^*(=\lambda, \mu, \nu)$; also ϕ_0, ϕ_1, ϕ_2; and ρ_0, ρ_1, ρ_2. From the last set of three one easily derives d_0', d_1', d_2' (tangent values) or n_1, n_2, n_0 (cosine values). From the first set of three one easily derives $s_0'=z_2'$, $s_1'=x_0'$, and $s_2'=y_1'$ (cotangent values).

From (8) and the value of n_1 in (4) get: $y_0'=\cos\alpha^*/n_1$ (8′)
From (16) and the value of n_2 in (12) get: $z_1'=\cos\beta^*/n_2$ (16′)
From (24) and the value of n_0 in (21) get: $x_2'=\cos\gamma^*/n_0$ (24′)
From (8) and (5) get: $\tan\phi_0=\cot\beta/y_0'$ (5′)
From (16) and (13) get: $\tan\phi_1=\cot\gamma/z_1'$ (13′)
From (24) and (22) get: $\tan\phi_2=\cot\alpha/x_2'$ (22′)

While the n_1, n_2, n_0 values may be calculated easily from either linear or angular elements, there is no way to go from the first six listed angular elements alone to the first six listed linear elements alone. This is most easily comprehended by visualizing the direct and reciprocal unit cells as representing parallelepipeds having definite angles but indefinite (though reciprocal) dimensions. It is possible to calculate the angular elements from the values of the first six listed linear elements. However, this is a tedious process by any method known to the writer; moreover, this is not recognized as being of any practical value.

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[5] Goldschmidt uses *linear* as opposed to *polar*. No such meaning is here intended. Goldschmidt's use of the word is outmoded. In his sense the proper word to use is *direct* (as opposed to *reciprocal*) or *primitive*.

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