HÜBNERITE FROM KENDALL, MONTANA.*

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Specimens of what appear to be a somewhat altered light-colored porphyry or breccia sent to Mr. L. S. Ries of the University of Chicago by Mr. Frank B. Bryant, E. M., of Kendall (Hilger), Montana, were turned over to the writer for determination. They contain sharp-walled veinlets of hübnerite, which also lines small cavities in the rock. Mr. Bryant kindly furnished the following description:

"This mineral (hübnerite) is from the Gold Queen group operated by Wunderlin Brothers. The property is in Fergus County, about 18 miles north of Lewistown, in sec. 29, T. 18 N., R. 18 E., practically in the center of the North Moccasin Mountains of Montana. These mountains are a small laccolithic uplift about 4 (E-W) by 5 (N-S) miles in size. A mass of dacite (or rhyolite) porphyry, intruded into the upper shales of the Cambrian, is now exposed in a roughly circular area about two miles in diameter. The gold ores of the Kendall district occur in the topmost member of the Madison limestone (Mississippian; 1200 feet thick). The Devonian is missing, only a thin stratum of Silurian is known, and the maximum exposed thickness of the Cambrian is 200 feet.

The mineral (hübnerite) comes from a breccia dike at least 200 feet wide and 1500 feet long (NW-SE). It is composed principally of fragments of the intrusive rock, but some are of quartzite and Cambrian limestone. They average one to two inches across, but range up to four inches, and are cemented by some lime mineral. Pyrite cubes are abundant in the fragments of the intrusive, and later "amorphous" pyrite is plentiful in cavities and small fissures. Very subordinate amounts of galena and sphalerite are found; this is especially true of the better ore. The dark mineral (hübnerite) is evidently congenital with the ore-bearing solutions, as its relative abundance is indicative of the gold content. It (the hübnerite) is scattered heterogeneously through a width of 12 feet of the ore body, but shows its greatest concentration along an indistinct line of fissuring

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near the foot wall. The gold values are erratic, varying from $2.00 to $9.00 per ton."[1]

As the habit of the hübnerite crystals is different from any shown by Goldschmidt,[2] they were examined on the two-circle reflecting goniometer in conjunction with other tests made on the material. The crystals are wedge-shaped and in general appear similar to some of those shown by Hess and Schaller[3] from Nederland, Colorado, except the latter are about twice as large. Detailed examination, however, shows the presence of three new prism forms, as well as a rare form recorded by but two other writers.[4]

The following table gives the results of the goniometrical study on one crystal. Only two crystals suitable for measurements were obtained, and unfortunately both of these were lost during examination by students; one crystal was not measured before its loss, while the other was studied when it was thought to be a pseudomorph after manganite with a peculiar facial development. Since the prism faces are so badly striated, the crystal was mounted on the goniometer with *c*(001) normal to the pin. When later work demonstrated that the material was monoclinic, it was necessary to compute the observed readings as if rotated 28′ about the *b*-axis, as shown in the following table.

Figure 1 gives a somewhat diagrammatic conception of the crystal habit, though the crystals are rather thinner or more

[1] The Judith Mountains, some six miles east of and geologically very similar to the two Moccasin Mountains, have been described by W. H. Weed and L. V. Pirsson in the *U. S. Geol. Survey 18th. Ann. Rept.*, Pt. **III**, pp. 437–616, 1898. *Mineral Resources of the U. S.* (*U. S. Geol. Survey*), annual volumes for **1905** and later years, covers the gold production from this area (Fergus County). See also Freeman, O. W., The North Moccasin Mountains of Montana, *Mining and Engineering World*, vol. **42**, pp. 947–49, 1915.

[2] Goldschmidt, V., *Atlas der Krystallformen*, **IX**, 1923.

[3] Hess, F. L., and Schaller, W. T., Colorado Ferberite and the Wolframite Series, *U. S. Geol. Survey, Bull.* **583**, Plate VIIB, 1914. In this paper Schaller has described 12 new forms, but through oversight Goldschmidt has not recorded these in the reference cited above.

[4] *U. S. Geol. Survey, Bull.* **624**, p. 183, 1917, lists hübnerite from the following four Montana localities: Philipsburg, Potosi District (Madison County), Sugarloaf Mountain (Powell County), and Butte. A. N. Winchell has described the optical properties of the Butte hübnerite (*Econ. Geol.*, vol. **5**, pp. 163–65, 1910). J. T. Pardee (*U. S. Geol. Survey, Bull.* **725**, pp. 141–179, 1922) has briefly described the manganese deposits of Montana.

Table I. Goniometrical Study of Hubnerite

Forms	Face: Symbol: Gdt.	Face: Symbol: Miller	Face: No.	Quality[5]	Readings Observed: Phi	Readings Observed: Rho	Observed Readings Rotated 28′ on *b*-axis: Phi	Observed Readings Rotated 28′ on *b*-axis: Rho	Goldschmidt Calculated Readings: Phi	Goldschmidt Calculated Readings: Rho
c	*o*	001	10	*d*	——	0° 00′	90° 00′	0° 28′	90° 00′	0° 28′
j	$\bar{6}\bar{\infty}$	$\bar{6}\bar{1}0$	8	*d*	262° 45′	90° 13′	262° 45′	89° 45′	262° 10′	90° 00′
	$\bar{6}\infty$	$\bar{6}10$	6	*v*	276° 26′±	91° 25′	276° 26′±	90° 57′	277° 50′	90° 00′
*J**	$^3/_2\infty$	320	2	*v*	61° 2′±	87° 46′	61° 3′±	88° 13′	61° 10′	90° 00′
	$\overline{^3/_2}\,\overline{\infty}$	$\bar{3}\bar{2}0$	7	*e*	242° 11′	87° 46′	242° 10′	87° 19′	241° 10′	90° 00′
	$\overline{^3/_2}\infty$	$\bar{3}20$	5	*d*	297° 57′	90° 44′	297° 58′	90° 17′	298° 50′	90° 00′
*P**	$\infty\bar{4}$	$1\bar{4}0$	11	*d*	164° 56′±	87° 8′	164° 46′±	87° 34′	165° 6′	90° 00′
*T**	$\infty\bar{5}$	$1\bar{5}0$	12	*e*	167° 56′	87° 26′	168° 6′	87° 52′	167° 59′	90° 00′
t	$^1/_2 0$	102	9	*m*	{88° 16′ to 89° 9′	{26° 36′ to 28′ 48′	{88° 16′ to 89° 9′	{27° 4′ to 29° 16′	90° 00′	28° 3′

[5] *d*, dim, but definite; *e*, very dim; *m*, multiple; *v*, multiple for phi but single value for rho.

* New forms.

tabular ∥ to *a* than here shown. The zone parallel the *c*-axis is gently double convex lens-shaped in cross-section, with numerous vertical striations due to oscillatory combination of prism forms. The basal pinacoid is very narrow, and generally appears curved (in a vertical plane including the *b*-axis) due to the presence of many small irregular sub-parallel faces, but a fairly good signal is given by the central portion of the face. The hemi-orthodome *t*(102) is badly curved and only multiple images were obtainable; however, these fall within such limits as to leave no doubt about the symbol for the face. It is possible that a front hemi-bipyramid is present on some crystals, but a satisfactory signal could not be obtained. Neither of these upper faces is striated, but both show irregularities as described for *c*.

The form *j* (610), first described by Bøggild,[6] was also noted by Schaller.[7] On the Montana specimen this form is represented by two faces, one of which is quite wide (0.2 mm.) and smooth, though it did not give a strong reflection of light; one other face of this form furnished a signal, but elsewhere the striations are too close to permit sufficient light to be reflected.

[6] Bøggild, O. B., *Mineralogia Grönlandica; Meddelelser om Grönland*, No. **32**, p. 179, 1905. Bøggild used *p* for this form, but *p* had previously been used by Moses for (214). Goldschmidt uses *α*, but Schaller's letter *j* has priority.

[7] Hess, F. L., and Schaller, W. T., *op. cit.*, p. 53.

Form *J* (320) is new, but there is no doubt of its identity, as it is represented by three faces which gave signals; one of these faces, the largest prismatic face on the crystal, is 0.3 mm. wide. Faces of this form also seem to be present on many crystals as very shiny but narrow rectangles in the position of *P* or *T* of Figure 1.

The new forms *P* (140) and *T* (150) are each represented by a single narrow face, about as shown in Figure 1, except that they extend only part way along the edge of the crystal. Each of these faces gave a definite signal, and the agreement between observed

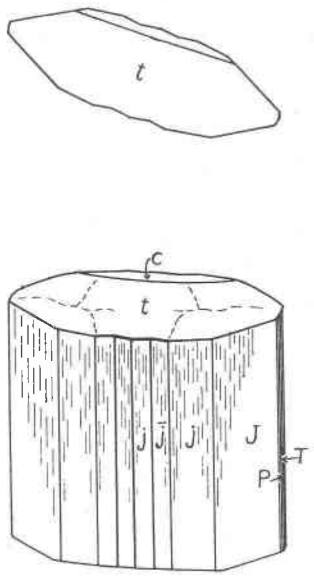

FIG. 1. Orthographic and clinographic projections of hübnerite from Montana The crystal is about 1 mm. wide.

and recorded values seems as good as could be expected from such a small highly striated crystal.

Very few specimens of this Montana hübnerite show any cleavage, though a few grains had the typical (010) cleavage. Under the binoculars the fracture is semi-conchoidal, and the fractured surfaces have a splendent sub-adamantine, luster resembling the shiny portions of anthracite. Macroscopically the luster is sub-metallic, the color shiny gray-black (rutile red in certain lights), and the streak like ground coffee. The hardness of the crystals appears to be 4, or very slightly less; this is distinctly lower than is given in the textbooks. Under the microscope the finer grains are amber brown with faint pleochroism to slightly reddish brown.

Warming in HCl after fusion with soda furnishes a yellow residue of WO_3, as shown by the tin test. The mineral fuses at about 3 to a dull black, non-magnetic globule.[8] The qualitative ammonia test for iron resulted in such a small precipitate that it is believed safe to regard the mineral as a hübnerite (not over 20% $FeWO_4$[9]) rather low in iron. It gave a typical manganese reaction in the Na_2CO_3 bead and (for the oxidizing flame) in the borax bead; for the latter in the reducing flame, however, the yellow due to tungsten masked the normal colorless manganese bead. The salt of phosphorus bead tests[10] were unsatisfactory from the point of view of indicating any known element present; the results follow:

Oxidizing flame { Hot—rich, amber brown.
Cold—same, but slightly paler.

Reducing flame { Hot—rich brown.
Cold—same, but deeper; nearly black in center.

Other properties are in conformity with the textbook descriptions.

Dr. P. M. Harris of the Department of Chemistry kindly made an X-ray spectrograph (24-hour exposure) of the finely ground powder of the mineral mounted between celluloid films.

Measurements of the spacings of the atomic planes in Ångstrom units follow:

Spacing	Est. Int.	Spacing	Est. Int.	Spacing	Est. Int.
5.75	1	1.72	5	1.14^0	1
4.75	5	1.67	0.5	1.12^0	0.5+
3.75	6	1.59	1−	1.10^0	0.5+
3.35	0.5	1.51^5	3+	1.08	0.5
2.95	10	1.47^0	3−	1.04	0.5
2.48	5	1.44^0	3−	1.02	1.5
2.38	2−	1.38^0	2−	0.99	0.5
2.22	4	1.33^0	2−	0.96	0.5
2.05	2−	1.28^0	0.5	0.93	0.5
2.01	2	1.25^0	0.5	0.91	0.5
1.88	1+	1.23^0	0.5	0.88	0.5
1.83	1+	1.19^5	1	0.83	0.5
1.77	2				

[8] This might be taken by some to indicate absence of iron, but Hess (*op. cit.*, p. 8) has shown that many ferberites fuse to a non-magnetic globule.

[9] Hess, F. L., *op. cit.*, p. 37.

[10] These results differ somewhat from Dana, *System*, p. 984, 1892.