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FERVANITE, A HYDROUS FERRIC VANADATE

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SUMMARY

A hydrous ferric vanadate from the carnotite region of Colorado and Utah is described. The formula is $2Fe_2O_3 \cdot 2V_2O_5 \cdot 5H_2O$ and the mineral has been named fervanite from the metallic elements contained, iron (ferrum) and vanadium.

OCCURRENCE (F.L.H.)

The area covered by southwestern Colorado and southeastern Utah, in which the largest known deposits of carnotite and accompanying minerals are found, is semi-arid, and as in most such regions veinlets and crystals of gypsum are common. The gypsum is often found containing inclusions of carnotite.

Practically all of the uranium and vanadium minerals of these deposits, like the gypsum, have been formed from cool meteoric water circulating through the comparatively soft porous McElmo sandstones. The original uranium and vanadium minerals, whatever they may have been, all have been re-worked and moved a greater or less distance from their original positions. This re-working of the minerals, which is plainly still in process, has led to a number of new combinations, owing to the very complex chemical affinities of vanadium. The carnotite ores are never simple but are a confused mixture of minerals. However, segregation takes place in certain localities so that here and there comparatively pure specimens of one or more of the various minerals can be obtained.

While working with these mineral aggregates a nearly transparent fibrous brownish to yellow mineral was frequently noticed. This resembled satinspar colored by a little carnotite, and as selenite is found containing distinctly visible inclusions of carnotite it seemed probable that the yellowish or brown fibers were satinspar colored by carnotite.

[1] Published by permission of the Secretary of the Smithsonian Institution.

However, a few years ago better material was collected (by F.L.H.) on Polar Mesa on the north side of the La Sal Mountains, Grand Co., Utah, and later Mr. H. H. Christy of Grand Junction, Colorado, sent in a specimen of this material which was so evidently free from carnotite that it could no longer be supposed to be discolored gypsum. Material was also collected (by F.L.H.) in Gypsum Valley, San Miguel Co., Colorado, and it was from this material that the sample was taken for analysis.

Like the other uranium and vanadium minerals of the carnotite region this mineral is one which has evidently formed in place from meteoric water solutions. It occurs with selenite, carnotite, hewettite (or meta-hewettite) and the black vanadium minerals of the carnotite beds. Since having determined it as a mineral we find it in many specimens from the region, and it can undoubtedly be found in many localities from which we have not yet seen it. At certain places it will no doubt form a ponderable part of the vanadium-bearing minerals.

Physical Properties. (E.P.H.)

All the specimens of fervanite so far examined have a uniform golden-brown color and possess a brilliant luster. The fibers are parallel and generally about half a centimeter long. No cleavage is apparent. The specific gravity was not determined because there was not enough material available to use the pycnometer method and a shredded fibrous mass of this type would in all probability retain air which would make the use of heavy solutions impractical.

The optical properties as determined by C. S. Ross are: Indices, $\alpha=2.186$; $\beta=2.222$; $\gamma=2.224$; all ± 0.005, birefringence $=0.038$; extinction slightly inclined to the length of the fiber; optical character, $-$; 2V very small. The mineral is probably monoclinic.

The X-ray photograph was taken by E. Posnjak, and Fig. 1 shows the spacings and estimated relative intensities of the lines observed on the film.

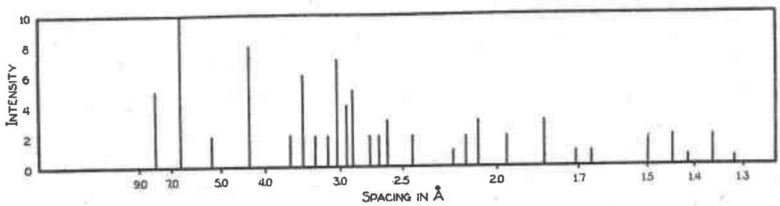

Fig. 1. X-ray Powder Diffraction Pattern.

Chemistry

Fervanite is apparently insoluble in water but no solubility determinations were made because of the limited quantity of material available.

The chemical analysis was made upon a very small, but carefully hand-picked sample obtained from several specimens, and in most cases it was so intimately mixed with other vanadium minerals that only a few milligrams of fervanite could be secured from each specimen. Less than 0.3 gram of suitable material was obtained and the following analysis was made upon a 0.15 gram sample.

Analysis of Fervanite
E. P. Henderson, Analyst

	Analysis	Insoluble and gypsum	Fervanite		Molecular ratios
			Remainder	Recalculated to 100 per cent	
Insol.	9.40	9.40			
Fe_2O_3	34.46		34.46	41.89	.2597 or 2×.1298
V_2O_5	37.92		37.92	46.10	.2534 or 2×.1267
H_2O-	11.40	1.52	9.88	12.01	.6687 or 5×.1337
CaO	2.40	2.40			
SO_3	3.42[a]	3.42			
	99.00	16.74	82.26	100.00	

[a] Qualitative tests showed SO_3 to be present, and 3.42 per cent is the calculated quantity necessary to combine with the 2.40 per cent CaO present to form gypsum.

The molecular ratios indicate that the chemical formula is $2Fe_2O_3 \cdot 2V_2O_5 \cdot 5H_2O$ and the theoretical percentage composition is 41.30% Fe_2O_3, 47.04% V_2O_5 and 11.64% H_2O.

More than twenty years ago Hewett[2] described a dark greenish black vanadium mineral which laid below a brownish-red to red surface deposit of vanadium oxide in the Quisque District, Peru. He describes this material as "having a greenish black color . . . . The mineral is generally amorphous, though along openings or water-courses it appears velvety, which appearance under the microscope is resolved into aggregates of acicular crystals . . . .

[2] Hewett, D. F., Vanadium Deposits in Peru: *Trans. A. I. M. E.*, vol. **40**, p. 274, 1909.

Specific gravity is 2.52." Hillebrand[3] analyzed the material, obtaining the following result:

A VANADIUM BEARING MATERIAL FROM QUISQUE DISTRICT, PERU
W. F. HILLEBRAND, Analyst

V_2O_5	57.33
V_2O_4	4.76
MoO_3	3.28
SiO_2	0.57
TiO_2	0.07
Fe_2O_3	19.53
CaO	0.70
MgO	trace
H_2O	13.89
	100.13

In a later article[4] Hillebrand refers to the material as a mixture, but says that "some of the specimens are characterized by high

A DARK BROWN TO BLACK VANADIUM MINERAL FROM GYPSUM VALLEY, COLORADO
W. T. SCHALLER, Analyst

	Analysis	Recalculated, Insol. and sol. SiO_2 and Al_2O_3 deducted	Ratios	
Insol. SiO_2	9.93			
Sol. SiO_2	2.13			
MoO_3	Not det.			
CaO	0.06	0.07	.0013	
UO_3	0.30	0.35	.0012	
Al_2O_3	1.26			
Fe_2O_3	12.97	15.09	.0944	1
V_2O_4	3.73	V_2O_5 69.46	.3818	4.04
V_2O_5	55.63			
H_2O	12.92	15.03	.8350	8.84
Alkalies	Not det.			
SO_3	Not det.	100.00		
	98.93			

[3] Hewett, *loc. cit.*, p. 294.

[4] Hillebrand, W. F., Merwin, H. E. and Wright, F. E., Hewettite, metahewettite and pascoeite, hydrous calcium vanadates: *Proc. Am. Phil. Soc.*, vol. **53**, p. 33, 1914.

iron content and relative freedom from lime . . . which seems to represent essentially a ferric vanadate."

W. T. Schaller, in 1926, made several analyses of vanadium minerals (collected by F.L.H.) from Gypsum Valley, Colorado. The above analysis made by him on a dark brown to black substance has not hitherto been published. If the V_2O_4 is not considered as reduced V_2O_5 the ratios are slightly different but not sufficient to make significant change in the molecular ratios.

The material which Schaller analyzed is very fine grained and almost opaque, but when examined microscopically it appears to be uniform. Nevertheless the nature of the material would hardly justify its being classified as a distinct mineral. The analysis, as shown above, reduces approximately to the following formula: $Fe_2O_3 \cdot 4V_2O_5 \cdot 9H_2O$, but this fact alone is not sufficient to prove the existence of such a chemical compound.

The two above listed analyses contain the highest percentages of iron that have been found in any of the analyzed vanadium minerals, but from the descriptions of the substances and their analyses it is unlikely that either Hillebrand or Schaller had fervanite.