

STEIGERITE, A NEW VANADIUM MINERAL*

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SUMMARY

A new yellow, hydrous aluminum vanadate, $\text{Al}_2\text{O}_3 \cdot \text{V}_2\text{O}_5 \cdot 6.5 \text{H}_2\text{O}$, which has been named steigerite, is here described. It is similar to, but is not a true analogue of the iron vanadate, fermanite, and like fermanite is from the uranium-vanadium claims along the north wall of Gypsum Valley, San Miguel County, Colorado.

OCCURRENCE

On a visit in 1932 to the uranium and vanadium claims owned by Sullivan Brothers of Nucla, Colorado, and located along the north wall of Gypsum Valley, the author collected several specimens of a bright yellow, more or less pulverulent mineral that coated cracks in the uranium- and vanadium-bearing sandstone. At the time of collection they were considered to be pascoite but later when found to be insoluble in water it was evident that the yellow mineral was not pascoite. Samples of this mineral collected by Frank L. Hess in 1921 and labelled pascoite with a question mark, had been held by him during this time awaiting analysis. He collected his material from the Ponto No. 3 claim which at that time was owned by the W. L. Cummings Chemical Company, and adjoins the Sullivan claims on the east.

To this new mineral the name steigerite is given in honor of Dr. George Steiger formerly chief chemist of the U. S. Geological Survey, whose chemical analyses are widely known and quoted.

The country rock, the Morrison (McElmo) sandstone, is heavily impregnated with oxidized vanadium minerals and has a mottled brownish to purplish black color. No individual segregations of the vanadium minerals were found that would yield suitable material for a definite determination of the mineral sequence, but using color as a basis and comparing the material with the type specimens of corvusite that were described from the Ponto No. 3 outcrop, it seems certain that the principal vanadium mineral in the sandstone at this place is corvusite.

A number of concentrations of vanadium minerals are some-

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what nodular in form. In the sandstone near the marginal limits of these nodules small fractures have developed, which in general are curved nearly parallel to the nodular body and pass through the sandstone independent of the bedding. Towards the outer edges of some of the vanadium-rich concentrations the fractures are more closely spaced than near the centers. It seems logical to conclude that these cracks are the result of some change of volume in the minerals. The best specimens of corvusite were slickensided with a fibrous appearing structure produced by the swelling of the mineral as it formed in the sandstone.

Steigerite, fervanite and gypsum fill the minute fractures in the corvusite concentrations and are the last vanadium minerals deposited. Thus it appears that the change which takes place in the vanadium minerals are probably due to oxidation and hydration. These changes have made necessary certain volume adjustments. The primary vanadium minerals of the sandstone are still unknown but the following sequence of vanadium minerals seems to be consistent with both occurrence and chemical reasoning.

| | |
|------------|---------------------------------------|
| Vanoxite | $2V_2O_4 \cdot V_2O_5 \cdot 8 + H_2O$ |
| Corvusite | $V_2O_4 \cdot 6V_2O_5 \cdot ?H_2O$ |
| Steigerite | $Al_2O_3 \cdot V_2O_5 \cdot 6.5H_2O$ |
| Fervanite | $2Fe_2O_3 \cdot 2V_2O_5 \cdot 5H_2O$ |

In other places the solutions have apparently migrated farther than the limits of the vanadium-rich concentrations as occasional seams of the minerals steigerite and fervanite are found in the sandstone. These seams in general have the appearance of being the channels along which the most recent movements of vanadium solutions have taken place.

PHYSICAL PROPERTIES OF STEIGERITE

Steigerite has a bright canary yellow color. No crystallized specimens have been found, but in all the specimens so far examined the mineral has, to the unaided eye, a powdery appearance. Closer examination reveals a rather waxy luster and small fractures which resemble shrinkage cracks. With the aid of the microscope a slightly different texture is noticeable, including some flat plates, a crypto-crystalline fibrous type resembling chalcedony and again a nondescript gummy mass. Some of the properties indicate that this mineral may have been deposited as a colloidal precipitate.

Selecting the best of the yellow material and being careful to exclude any other vanadium minerals contained in the sandstone, a 0.75 gram sample was prepared. The chemical analysis, x-ray examination and index of refraction, were all determined upon this same sample.

The texture is such that only a mean index of refraction could be determined and although there is some variation in the values all were confined within the range of 1.700 and 1.715, so that until better material is available the mean index is given as $1.71 \pm .005$.

ANALYSIS OF STEIGERITE

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| | Percentages | Molecular ratios | |
|--------------------------------|-------------|------------------|--------|
| V ₂ O ₅ | 44.44 | 1 | .2448 |
| Al ₂ O ₃ | 25.14 | 1 | .2460 |
| Fe ₂ O ₃ | 1.50 | | .0094 |
| H ₂ O-110° | 8.08 | | |
| H ₂ O+110° | 21.04 | | |
| | 100.20 | 6.5 | 1.6110 |

Separate portions were tested qualitatively for silica, uranium and sulphates but none were found. Steigerite is easily decomposed by mineral acids and produces a solution with a deep cherry-red color. Steigerite was placed in a tightly stoppered flask filled with water and after three months time showed no appreciable solubility.

ARTIFICIAL STEIGERITE

Although the natural mineral is amorphous it was hoped that the synthetic steigerite could be prepared in the crystalline form. However, the artificial steigerite was amorphous and similar to the natural material in all its physical properties.

A soluble calcium vanadate was made by boiling hewettite or metahewettite, in saturated lime water. An aluminum sulphate solution was prepared by adding an excess of freshly precipitated aluminum hydroxide to sulphuric acid. These two solutions were then slowly siphoned off into a larger dish simultaneously. For details of the apparatus and procedure, see Johnston's¹ description of the diffusion processes in the preparation of pure substances.

The precipitate, steigerite, prepared in this manner was then

¹ Johnston, John, *Jour. Amer. Chem. Soc.*, vol. 36, p. 16, 1914.

transferred to a tall cylinder and repeatedly washed with water until the washings were free from sulphates.

The artificial steigerite was found to contain V_2O_5 44.89% and the loss on ignition at red heat was 31.83%. The V_2O_5 content agrees nicely with that of the natural mineral; however, the water content is slightly higher.

The following table permits a comparison of the loss of water for the natural and the artificial steigerite.

DEHYDRATION OF STEIGERITE

| Temp. | Percentage loss of water | | |
|------------------|--------------------------|-------|-------|
| | (1) | (2) | (3) |
| -110° | 8.08 | 7.43 | 8.74 |
| +110° | 21.04 | 21.23 | 23.09 |
| Molecular Ratios | 1.616 | 1.59 | 1.76 |

(1) From sample analyzed.

(2) Determinations from another specimen.

(3) Artificial steigerite.

Comparing the total loss of water on the artificial material with the two natural mineral specimens, a rather close agreement is noticed. The degree of hydration is not, however, definitely settled. If the average ratio is taken of the total loss of water at red heat on the two natural samples, which had been exposed to the atmosphere in the Museum for over a year, the ratio of water to bases is 1:1:6.5.

In the artificial preparation the ratio between V_2O_5 and H_2O is 1:7.1. This suggests that the stable hydrate contains either 6.5 or 7 molecules of water. However, until a new locality for steigerite is found which will yield additional specimens for study the water content is being tentatively assigned as 6.5 molecules.

The *x*-ray examination made by Dr. E. Posnjak² shows that the natural steigerite is crystalline with a pattern which is distinctly different from fervanite. The artificial aluminum vanadate gave no distinct pattern, only faint, broad bands, which would indicate that the primary particles are exceedingly small, and that this material may be largely amorphous.

² Personal communication.