able than [$Ca_2B_4O_8(OH)_3$]. Nevertheless, a discrepancy in the density measurement coupled with a smaller error in the chemical analysis could satisfactorily produce the ideal formula [$Ca_2[B_5O_8(OH)_2]OH$] for tyretskite.

The presence of 6.64 percent halite seems curious in a water insoluble mineral, and it may be that in tyretskite, as in heidornite, NaCl is present as a part of the structure and not as halite impurity. The similarity in the cell dimensions of tyretskite and strontiohilgardite-1Tc suggests, however, that this is unlikely and that the error lies in the experimentally determined specific gravity.

References

Braitsch, O. (1959) Strontiohilgardite-1Tc and its position in the hilgardite group. *Beitr. Mineral. Petrog.*, **6**, 233–47.

Burzlaff, Hans (1967) Die structur des Heidornit, $Ca_3Na_2Cl(SO_4)_2B_5O_8)(OH)_2$. *Neues Jahrb. Mineral., Monatsh.*, **6**, 157–169.

Englehardt, Wolf von, Hans Füchtbauer, and Josef Zemann (1956) Heidornit, $Na_2Ca_3[Cl.(SO_4)_2.B_5O_8(OH)_2]$—ein neues Bormineral aus dem Zechstein—anhydrite. *Heidelberger Beitr. Mineral. Petrogr.*, **5**, 177–186.

Ivanov, A. A., and Ya. Ya. Yarzhemskii (1954) Boron manifestations in the saline strata of the Leno-Angar basin. *Trudy Vses. Nauchn.-Issled. Inst. Galurgii*, **29**, 210–214.

Kondrat'eva, V. V. (1964) X-ray diffraction studies of some minerals of the hilgardite group. *Rentgenogr. Mineral'n. Syr'ya. Vses. Nauchn. Issled. Inst., Akad. Nauk S.S.S.R.*, **4**, 10–18.

THE AMERICAN MINERALOGIST, VOL. 53, NOVEMBER–DECEMBER, 1968

MORE DATA ON GREIGITE

Sidney A. Williams, *Phelps Dodge Corporation, Western Exploration Office, Douglas, Arizona.*

It seems likely that many more occurrences of greigite (Fe_3S_4) will be found until the species is quite well known. A specimen of the mineral of superior quality was recently obtained from a mineral dealer in Agua Prieta, Sonora, and the information obtained from the sample is the subject of this brief note. The locality of the specimen was given only as Zacatecas.

The paragenesis in this specimen is as follows: early pyritohedral pyrite gradually becoming more cubic in habit is followed by marcasite and then greigite. The early pyrite is associated with sphalerite and galena in a gangue of creamy dolomite. Pyrite in the gangue is partly replaced by very fine grained marcasite whereas pyrite euhedrons on the dolomite are partly replaced by well crystallized marcasite. Calcite

was deposited on the dolomite during the crystallization of marcasite. Greigite coats and embays both pyrite and marcasite; it also may be perched directly upon the carbonates. Calcite coated with greigite is deeply corroded whereas dolomite is unaffected.

Greigite occurs as balls of intergrown octahedra with curved faces averaging 0.3 mm on an edge. The luster is metallic with a decidedly pink color; locally the crystals are tarnished a metallic blue. Hardness is 4 on the Mohs' scale; Radusinovic (1966) gives $H=4.5$.

Very pure material was easily obtained by hand picking and combing the grains with a magnet. A solid piece of 17 mg gave a specific gravity of 4.049 (average of three trials on the Berman balance). A value calculated from the data in this paper is 4.08; Skinner *et al.* (1964) give a calculated value of 4.079.

Two samples were prepared for analysis. Sulfur and total iron were determined gravimetrically on a 103-mg sample. Another 90-mg sample was diluted with sodium bicarbonate and analyzed for Cu, As, Zn, Ni, and Cr by X-ray fluorescence with a tungsten target tube. The results of the analysis are as follows: Fe, 56.5%, S, 42.2%; Cu, 0.08%; As, 0.38%; Zn, 0.007%; Ni, 0.10%; Cr, 0.14%; Total, 99.407%. E. C. Thompson, Chief Chemist, Phelps Dodge Reduction Works, was the analyst for Fe and S; all other elements were analyzed by X-ray fluorescence.

The Fe:S ratio is 3:3.903 and, if all elements are considered, the Fe+Cu+Zn+Ni+Cr:S+As ratio is 3:3.892. Polyushkina and Sidorenko (1962) report a variation of Fe:S from 3:4.240 to 3:3.858 with a corresponding variation in cell edge.

The cell edge for the Zacatecas material was obtained as a simple average of 12 values from the powder data (using a 114.59 mm camera and vanadium-filtered CrKa radiation). The value $a=9.875$ Å compares favorably with 9.876 Å (Skinner *et al.*) and 9.878 Å (Radusinovic). Kramm and Sukhitskaya report $a=9.84$ Å. One could also calculate a value of $a=9.91\pm0.01$ Å from the data of Polyushkina and Sidorenko, but their sample with a composition most similar to the Zacatecas material has $a=9.86$ Å.

References

Kramm, T. P., and N. Ya. Sukhitskaya (1965) Melnikovite from the Kimmerian sediments of the Kerch Penninsula. *Mineral Sborn. Lvov. Univ.* 19, p. 520–523.

Polyushkina, A. P., and G. A. Sidorenka (1963) Melnikovite as a mineral species. *Zap. Vses. Mineral. Obschch.* **92**, 547–554.

Radusinovic, D. R. (1966) Greigite from the Lojane chromium deposit, Macedonia. *Amer. Mineral.*, **51**, 209–215.

Skinner, B. J., R. C. Erd, and F. S. Grimaldi (1964) Greigite, the thio-spinel of iron; a new mineral. *Amer. Mineral.*, **49**, 543–555.