Canadian Mineralogist,
Vol. 12, p. 229 (1973)

FERROAN STARKEYITE FROM DEL NORTE COUNTY, CALIFORNIA

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The starkeyite-bearing specimen was collected by the writer in a dump area at the now-defunct Alta troilite mine, Del Norte County, California. Starkeyite ($MgSO_4 \cdot 4H_2O$) occurs mainly as a cream-colored fine-grained efflorescence on the troilite, but also forms veins in it. A combination of gravimetric and electron probe methods was used in the analysis, which is MgO 17.5, FeO 4.5, SO_3 41.0 and H_2O 36.0, summation 99.0 weight per cent. Qualitative tests give a strong reaction for Fe^{2+}, and all iron is assumed ferrous in calculating the formula, which, on the basis of 4.00 H_2O (one-quarter the unit cell) is: $Mg_{0.86}Fe_{0.12}(SO_4)_{1.02}(H_2O)_{4.00}$. Physical data are intermediate to the pure iron and magnesium compounds, but closer to magnesium sulphate. X-ray data are *a* 5.93(2), *b* 13.62(2), *c* 7.91(1)Å and β 90°51′ ± 10′. Intensities of lines are similar to the pattern given for synthetic starkeyite by Hodenberg & Kühn (1967), the *d*-spacings being somewhat enlarged compared to the iron-free compound.

The Del Norte starkeyite, when collected, may have contained more or less than $4(H_2O)$, depending on the conditions of temperature and humidity then applying. The mineral as analyzed is, however, stable under the laboratory conditions in which the specimen was stored for several years: temperature 21 ± 1°C and relative humidity 45 ± 5%. The electron probe data and the *x*-ray powder diffraction results both indicate the mineral is a true intermediate member of the Fe-Mg sulphate tetrahydrate series, and not just a mechanical mixture of iron and magnesium sulphates.

This mineral is essentially $MgSO_4 \cdot 4H_2O$. The writer has recently obtained approval from the IMA Commission to use starkeyite for this composition because another name (leonhardtite) was also available, a situation which came about as follows. Starkeyite was named by Grawe (1945, pp. 209-210) who, on the basis of *x*-ray data and qualitative tests for iron,, thought the mineral was $FeSO_4 \cdot 4H_2O$. Subsequent partial analysis of the type material at the U.S. Geological Survey, however, showed minor FeO and abundant MgO, suggesting starkeyite was a magnesium instead of an iron sulphate. Accordingly, some years later, Grawe (1956) transferred the name to $MgSO_4 \cdot 4H_2O$, allowing that his initial error was due to association of the new mineral with pyrite, and similarity of its *x*-ray pattern to $FeSO_4 : 4H_2O$. Meanwhile Berdesinski (1952) had identified, apparently by *x*-ray data alone, a natural occurrence of $MgSO_4 \cdot 4H_2O$, naming it leonhardtite. Fleischer (1957) later pointed out, however, that to avoid confusion with the zeolite leonhardite, starkeyite should be used for $MgSO_4 \cdot 4H_2O$, and this usage has now been approved.

Some other occurrences of starkeyite are noted by Garavelli (1957), Proshchenko (1959), and Calleri *et al.* (1968). Hodenberg & Kühn (1967) found that, of eleven natural efflorescences on kieserite ($MgSO_4 \cdot H_2O$) from Stassfurt salt, eight were starkeyite.

References

Berdesinski, W. (1952): Sanderit, Leonhardtit, Allenit und Hexahydrit, neue Mineralien der marinen Kalisalzlagerstatten. *N. Jahrb. Mineral. Monatsh.* 1952, 28-29.

Calleri, M., Ferraris, G. & Scaini, G. (1968): Segnalazione de un particolare membro del gruppo de minerali $A''(SO_4) \cdot 4H_2O$. *Rend. Soc. Mineral. Ital.* **24**, 143-151.

Fleischer, M. (1957): New data: starkeyite. *Amer. Mineral.* **42**, 443.

Garavelli, C.L. (1957): Solfato di magnesio esaidrato (esaidrite) e tetraidrato fra i minerali di alterazione del giacimento elbano di Capo Calamita. *Soc. Toscana Scienze Naturali Pisa, Atti, Mem.* **64A**, 6-15.

Grawe, O.R. (1945): Pyrite deposits of Missouri. *Missouri Geol. Surv. Water Res.* **30**, 1-482.

——— (1956): Starkeyite, a correction. *Amer. Mineral.* **41**, 662.

Hodenberg, R.F.V. & Kühn, R. (1967): Zur Kenntnis der Magnesium Sulfathydrate und der Efflorescenzen des Kieserits von Hartsalzen. *Kali u. Steinsalz* **4**, 326-340 (*Chem. Abs.* **67**, 7271).

Proshchenko, E.G. (1959): [Natural magnesium sulphate tetrahydrate]. *Mineral. Sbornik L'vov Geol. Obsh.* **13**, 363-367 (*Min. Abs.* **16**, 545).

Manuscript received March 1973, emended July 1973.