**Schwertmannite** $\mathbf{Fe^{3+}_{16}O_{16}(SO_4)_2(OH)_{12}\cdot nH_2O}$ (n ~ 10 to 12)



**Crystal Data:** Tetragonal. *Point Group:* $4/m$ (probable). As fibrous aggregates of poorly-crystalline needles, to 100 $\mu$m, in films and thin to thick crusts.

**Physical Properties:** Hardness = n.d. D(meas.) = n.d. D(calc.) = 3.77–3.99

**Optical Properties:** Semitransparent. *Color:* Brownish yellow. *Streak:* Ocher-yellow. *Optical Class:* Uniaxial. $\omega$ = n.d. $\epsilon$ = n.d.

**Cell Data:** *Space Group:* $P4/m$ (probable). a = 10.66(4) $c$ = 6.04(1) Z = 1

**X-ray Powder Pattern:** Pyhäsalmi mine, Finland; consists of broad bands.
2.55 (100), 3.39 (46), 4.86 (37), 1.51 (24), 2.28 (23), 1.66 (21), 1.46 (18)

**Chemistry:**

| | (1) | (2) | (3) |
|---|---|---|---|
| $Fe_2O_3$ | 62.6 | 71.0 | 74.01 |
| $H_2O^+$ | 12.9 | | |
| $H_2O^-$ | 10.2 | | |
| $H_2O$ | | 14.6 | 16.71 |
| $CO_2$ | 1.5 | | |
| $SO_3$ | 12.7 | 14.4 | 9.28 |
| Total | 99.9 | [100.0] | 100.00 |

(1) Pyhäsalmi mine, Finland; Fe and S by ICP, $CO_2$ by gas analyzer, $H_2O$ by TGA. (2) Analysis (1) after deduction of $CO_2$ and adsorbed $H_2O^-$, recalculated to 100.0%; corresponds to $Fe_{16}O_{16}(OH)_{9.6}(SO_4)_{3.2}\cdot 10H_2O$. (3) $Fe_{16}O_{16}(SO_4)_2(OH)_{12}\cdot 10H_2O$.

**Occurrence:** A secondary mineral precipitated by waters of pH 3–4.5 and high in iron sulfate content from the surface oxidation of metal sulfides.

**Association:** Goethite, jarosite, natrojarosite, ferrihydrite, sulfides.

**Distribution:** From the Pyhäsalmi mine, Oulu, Finland. At over 40 unspecified localities in Europe, North America, and Australia.

**Name:** For Udo Schwertmann (1927– ), Professor of Soil Science, Technical University of Munich, Munich, Germany, who has worked on poorly crystalline products of weathering.

**Type Material:** Museum of Natural History, University of Helsinki, Helsinki, Finland, B8659.

**References:** (1) Bigham, J.M., L. Carlson, and E. Murad (1994) Schwertmannite, a new iron oxyhydroxysulphate from Pyhäsalmi, Finland, and other localities. Mineral. Mag., 58, 641–648. (2) (1995) Amer. Mineral., 80, 847 (abs. ref. 1).