Smythite $Fe_{3+x}S_4$ (x = 0 to 0.3)

Crystal Data: Hexagonal. *Point Group:* $\overline{3}\ 2/m$. As very thin hexagonal flakes, to 2 mm.

Physical Properties: *Cleavage:* Perfect basal. *Fracture:* Subconchoidal. *Tenacity:* Flexible and elastic lamellae. Hardness = n.d. VHN = 388 D(meas.) = ∼4.32 D(calc.) = ∼4.32 Strongly ferromagnetic, crystals attracted edge-on.

Optical Properties: Opaque. *Color:* Jet-black with a brown tinge against a white background, pale bronze-yellow viewed on the mirrorlike base; in polished section, pinkish cream. *Streak:* Dark gray. *Luster:* Metallic; splendent on basal section. *Pleochroism:* Strong; grayish yellow to reddish brown. *Anisotropism:* Strong; yellow and blue-gray.
R_1–R_2: n.d.

Cell Data: *Space Group:* $R\overline{3}m$. a = 3.4651(5) c = 34.34(2) Z = 3

X-ray Powder Pattern: Bloomington, Indiana, USA.
1.732 (100), 1.897 (80), 1.979 (70), 11.5 (60), 3.00 (60), 2.56 (60), 2.26 (60)

Chemistry:

	(1)	(2)	(3)
Fe	56.98	57.81	56.64
Ni	1.04	0.07	
Cu		0.03	
Co		0.03	
S	40.92	41.33	43.36
Total	98.94	99.27	100.00

(1) Bloomington, Indiana, USA; by electron microprobe, average of seven analyses; corresponds to $(Fe_{3.20}Ni_{0.06})_{\Sigma=3.26}S_{4.00}$. (2) Landsberg, Germany; by electron microprobe, corresponds to $Fe_{3.21}S_{4.00}$. (3) Fe_3S_4.

Occurrence: Formed as a low-temperature oxidation product of the strongly magnetic monoclinic phase of pyrrhotite, as inclusions in calcite crystals in quartz geodes; also in hydrothermal veins.

Association: Pyrite, greigite, mackinawite, pyrrhotite, marcasite, magnetite, sphalerite, galena, chalcopyrite, calcite.

Distribution: In the USA, in Monroe Co., Indiana, from a road cut about 3 km north of Bloomington [TL], and near Unionville; at the Kramer borate deposit, Boron, Kern Co., California; and from near Helena, Lewis and Clark Co., Montana. In Canada, from the Silverfields mine, at Cobalt, and the Nicopor mine, north of Schreiber, Ontario; in the Bird River mines, Lac du Bonnet area, Manitoba; and elsewhere. In Ukraine, from the Kimmerian sedimentary iron ores of the Kerch Peninsula. In the Kamaishi mine, Iwate Prefecture, Japan. In the Lengenbach quarry, Binntal, Valais, and Trimbach, near Olten, Switzerland. In Germany, from Hartenstein, Saxony; in the Clara mine, near Oberwolfach, Black Forest; and at Landsberg, near Obermoschel, Rhineland-Palatinate. From the Ceragiola quarry, near Seravezza, Tuscany, Italy. At Wadi Kamal, Saudi Arabia.

Name: Honors Professor Charles Henry Smyth, Jr. (1866–1937), economic geologist and petrologist, Princeton University, Princeton, New Jersey, USA.

Type Material: Harvard University, Cambridge, Massachusetts, 106149; National Museum of Natural History, Washington, D.C., USA, 112704.

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