Villamanínite $(Cu, Ni, Co, Fe)S_2$

Crystal Data: Triclinic, pseudocubic. *Point Group:* $\overline{1}$ or 1; pseudo $2/m\ \overline{3}$. As pseudocubes, pseudo-octahedra, and pseudocubo-octahedra, with rounded faces, to 5 mm; also as nodules with radial fibrous structure. *Twinning:* Noted, but not described.

Physical Properties: *Cleavage:* Perfect pseudocubic. *Fracture:* Uneven. Hardness = 4.5 VHN = 535–710 (spherical aggregates); 440–520 (euhedral crystals) (20 g load).
D(meas.) = 4.4–4.5 D(calc.) = 4.408–4.604

Optical Properties: Opaque. *Color:* Iron-black; pale blue-gray to violet-gray in reflected light. *Streak:* Sooty black. *Luster:* Dull metallic.
R: (400) 30.1, (420) 29.7, (440) 29.2, (460) 28.7, (480) 28.1, (500) 27.4, (520) 26.8, (540) 26.3, (560) 26.0, (580) 25.9, (600) 26.1, (620) 26.5, (640) 27.2, (660) 28.1, (680) 29.0, (700) 30.1

Cell Data: *Space Group:* $P\overline{1}$ or $P1$. $a = 5.7030$–5.7087 $b = 5.7041$–5.7070 $c = 5.7051$–5.7086 $\alpha = 90.0089°$–$90.0250°$ $\beta = 90.0091°$–$90.0573°$ $\gamma = 90.0112°$–$90.0301°$
Z = 4

X-ray Powder Pattern: Providencia mine, Spain.
2.852 (100), 1.7174 (40), 2.548 (30), 2.325 (25), 2.014 (25), 3.289 (15), 1.0959 (15)

Chemistry:

	(1)	(2)
Cu	24.0	24.1
Ni	11.8	17.3
Co	4.0	5.7
Fe	5.3	2.2
Se	0.06	1.5
S	54.0	50.2
Total	99.2	101.0

(1) Providencia mine, Spain; corresponds to $(Cu_{0.47}Ni_{0.25}Fe_{0.12}Co_{0.08})_{\Sigma=0.92}S_{2.08}$. (2) Do.; by electron microprobe; corresponds to $(Cu_{0.48}Ni_{0.37}Co_{0.12}Fe_{0.05})_{\Sigma=1.02}(S_{1.96}Se_{0.02})_{\Sigma=1.98}$.

Occurrence: As subhedral disseminated grains in black bituminous dolostone; in white coarse-grained recrystallized dolostone; as nodular aggregates in vuggy dolomite veinlets (Providencia mine, Spain).

Association: Pyrite, chalcopyrite, dolomite, quartz (Providencia mine, Spain).

Distribution: From the Providencia mine, six km east-northeast of Villamanín, Cármenes district, León Province, Spain [TL]. In Poland, in the Lubin copper mine, near Legnica, Zechstein copper district, Lower Silesia, and at Karniowice. From Rum Jungle, Alligator River district, Northern Territory, Australia.

Name: For the town of Villamanín, Spain.

Type Material: The Natural History Museum, London, England, 1919,309; 1920,7.

References: (1) Schoeller, W.R. and A.R. Powell (1920) Villamaninite, a new mineral. Mineral. Mag., 19, 14–18. (2) (1920) Amer. Mineral., 5, 168 (abs. ref. 1). (3) Hey, M.H. (1962) A new analysis of villamaninite. Mineral. Mag., 33, 169–170. (4) Ypma, P.J.M., H.J. Evers, and C.F. Woensdregt (1968) Mineralogy and geology of the Providencia mine (León, Spain), type-locality of villamaninite. Neues Jahrb. Mineral., Monatsh., 174–191. (5) Moreiras, D., C. Marcos, A. Panaiagua, M.R. Diaz-Fernandez, and S. Garcia-Granda (1991) Preliminary data about symmetry and structure of villamaninite. Neues Jahrb. Mineral., Abh., 163, 254–256. (6) Marcos, ?? (1996) ??title?? Acta Cryst., 899–?? str??; [order-may replace 5??] (7) Bayliss, P. (1977) X-ray powder data for villamaninite. Mineral. Mag., 41, 545. (8) Criddle, A.J. and C.J. Stanley, Eds. (1993) Quantitative data file for ore minerals, 3rd ed. Chapman & Hall, London, 606.