

**Crystal Data:** Cubic. *Point Group:*  $4/m\bar{3}2/m$ . Octahedral crystals, to 10 cm; commonly massive, disseminated granular to compact. *Twining:* On {111}; may show polysynthetic twin lamellae.

**Physical Properties:** *Cleavage:* {001}, imperfect. *Fracture:* Uneven to subconchoidal. Hardness = 4.5–5.5 VHN = 507–586 (100 g load). D(meas.) = 4.5–4.8 D(calc.) = 4.83

**Optical Properties:** Opaque. *Color:* Pale gray to steel-gray, tarnishing easily to copper-red or violet-gray. *Luster:* Metallic.

R: (400) 41.4, (420) 41.5, (440) 41.6, (460) 41.8, (480) 42.0, (500) 42.3, (520) 42.6, (540) 42.9, (560) 43.1, (580) 43.3, (600) 43.5, (620) 43.9, (640) 44.3, (660) 44.7, (680) 45.0, (700) 45.3

**Cell Data:** *Space Group:*  $Fd\bar{3}m$ .  $a = 9.458$   $Z = 8$

**X-ray Powder Pattern:** N'Kana, Zambia.

2.86 (100), 1.674 (80), 1.825 (60), 2.37 (50), 0.994 (50), 3.35 (40), 1.234 (30)

Chemistry:	(1)	(2)	(3)	(4)
Cu	20.2	13.90	18.98	9.98
Co	38.6	35.15	35.79	36.08
Ni	0.3	7.01	3.66	7.65
Fe	0.6	0.93	2.25	
S	41.2	40.74	40.64	41.89
insol.		0.27		0.50
Total	100.9	99.25	100.00	98.35

(1) Zaire; by electron microprobe, corresponds to  $\text{Cu}_{0.99}\text{Co}_{2.04}\text{Ni}_{0.02}\text{Fe}_{0.03}\text{S}_{4.00}$ . (2) Gladhammar, Sweden; corresponds to  $\text{Cu}_{0.69}\text{Co}_{1.88}\text{Ni}_{0.38}\text{Fe}_{0.12}\text{S}_{4.00}$ . (3) Siegen, Germany; recalculated to 100% after deduction of quartz 1.25%; corresponds to  $\text{Cu}_{0.94}\text{Co}_{1.92}\text{Ni}_{0.20}\text{Fe}_{0.05}\text{S}_{4.00}$ . (4) Mineral Hill mine, Maryland, USA; corresponds to  $\text{Cu}_{0.48}\text{Co}_{1.88}\text{Ni}_{0.40}\text{Fe}_{0.12}\text{S}_{4.00}$ .

**Mineral Group:** Linnaeite group.

**Occurrence:** In hydrothermal vein deposits.

**Association:** Tetrahedrite, linnaeite, siegenite, polydymite, chalcopyrite, bornite, digenite, djurleite, chacocite, pyrrhotite, pyrite, sphalerite, millerite, gersdorffite, ullmannite, cobaltoan calcite.

**Distribution:** In the USA, from Carroll Co., Maryland, in the Patapsco mine, Finksburg [TL], and the Mineral Hill mine, Sykesville. At Boleo, Baja California, Mexico. In the Carrizal Alto copper district, Atacama, Chile. From near Chernomorets, Burgas, Bulgaria. At Vysna Boca, Nizke Tatry Mountains, Slovakia. In the Kohlenbach mine, near Eiserfeld, and throughout the Siegerland district, North Rhine-Westphalia, Germany. From Gladhammar, Kalmar, Sweden. At Tsumeb, Namibia. Large crystals from Kambove, and in the Kamoto and Musonoi mines, near Kolwezi, Katanga Province, Congo (Shaba Province, Zaire). From the Rokana mine, Kitwe, Zambia. At the Madziwa (Dry Nickel) mine, Bindura, and Shamva, Zimbabwe. In the Sazare mine, Ehime Prefecture, and the Shirataki mine, Kochi Prefecture, Japan. At the Hol Kol Au–Cu mine, about 75 km southeast of Pyongyang, Suan Co., North Korea. From Kambalda, 56 km south of Kalgoorlie, Western Australia. A substantial number of other minor occurrences are known.

**Name:** For its occurrence in Carroll Co., Maryland, USA.

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**References:** (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 262–264. (2) Riley, J. (1980) Ferroan carrollites, cobaltian violarites, and other members of the linnaeite group:  $(\text{Co, Ni, Fe, Cu})_3\text{S}_4$ . *Mineral. Mag.*, 43, 733–739. (3) Wagner, T. and N.J. Cook (1999) Carrollite and related minerals of the linnaeite group: solid solutions and nomenclature in light of new data from the Siegerland district, Germany. *Can. Mineral.*, 37, 545–558. (4) Berry, L.G. and R.M. Thompson (1962) X-ray powder data for the ore minerals. *Geol. Soc. Amer. Mem.* 85, 77. (5) Criddle, A.J. and C.J. Stanley, Eds. (1993) Quantitative data file for ore minerals, 3rd ed. Chapman & Hall, London, 74.