Digenite Cu_9S_5

Crystal Data: Hexagonal, pseudocubic. *Point Group:* $\overline{3}\,2/m$ most likely. Rarely in pseudocubic crystals, to 3 cm; more commonly as intergrowths with other copper sulfides.

Physical Properties: *Cleavage:* {111} (synthetic). *Fracture:* Conchoidal. *Tenacity:* Brittle. Hardness = 2.5–3 VHN = 86–106 (100 g load). D(meas.) = 5.546 D(calc.) = 5.706

Optical Properties: Opaque. *Color:* Blue to black; distinctly blue in polished section. *Anisotropism:* Mostly isotropic.
R: (400) 29.6, (420) 28.8, (440) 28.0, (460) 27.0, (480) 25.9, (500) 24.8, (520) 23.5, (540) 22.2, (560) 21.0, (580) 19.9, (600) 18.9, (620) 18.0, (640) 17.2, (660) 16.3, (680) 15.5, (700) 14.8

Cell Data: *Space Group:* $Fm3m$ $a = 5.57$ $Z = 4$, below 73 °C becoming *Space Group:* $R\overline{3}m$ (pseudocubic). $a = 3.92$ $c = 48.00$ $Z = 15$

X-ray Powder Pattern: Leonard mine, Butte, Montana, USA. Anilite transforms to digenite during grinding.
1.973 (100), 3.21 (40), 2.79 (40), 1.686 (30), 1.139 (20), 3.05 (10), 2.17 (10)

Chemistry:

	(1)	(2)	(3)
Cu	78.11	77.9	78.10
Fe		0.1	
S	21.85	22.4	21.90
Total	99.96	100.4	100.00

(1) Jerome, Arizona, USA. (2) Seathwaite Tarn, England; by electron microprobe. (3) Cu_9S_5.

Occurrence: In hydrothermal copper deposits of primary and secondary origin. Formed under a wide range of conditions; reported from mafic intrusives, as a volcanic exhalation product, and in pegmatites.

Association: Chalcocite, djurleite, bornite, chalcopyrite, other copper minerals, pyrite.

Distribution: From Sangerhausen, Thuringia, Germany [TL]. In the Botallack mine, St. Just, Cornwall, and from Seathwaite Tarn, near Coniston, Cumbria, England. At Listulli, Norway. From Kiruna, Sweden. In the USA, crystallized at Butte, Silver Bow Co., Montana; in Arizona, from the United Verde mine, Jerome, Yavapai Co., the Magma mine, Superior, Pinal Co., and at Bisbee, Cochise Co. Abundant at Kennicott, Alaska. From Cananea, Sonora, Mexico. In Namibia, at Tsumeb. At Dongxiang, Jiangxi Province, China. Probably not yet recognized at many other localities.

Name: From the Greek for *two kinds* or *sexes*, in reference to the presumed presence of both cuprous and cupric ions.

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 180–182. (2) Buerger, N.W. (1942) X-ray evidence of the existence of the mineral digenite, Cu_9S_5. Amer. Mineral., 27, 712–716. (3) Donnay, G., J.D.H. Donnay, and G. Kullerud (1958) Crystal and twin structure of digenite, Cu_9S_5. Amer. Mineral., 43, 230–242. (4) Morimoto, N. and G. Kullerud (1963) Polymorphism in digenite. Amer. Mineral., 48, 110–123. (5) Morimoto, N. and A. Gyobu (1971) The composition and stability of digenite. Amer. Mineral., 56, 1889–1909. (6) Will, G., E. Hinze, and A.R.M. Abdelrahman (2002) Crystal structure analysis and refinement of digenite, $Cu_{1.8}S$, in the temperature range 20 to 500 °C under controlled sulfur partial pressure. Eur. J. Mineral., 14, 591–598. (7) Berry, L.G. and R.M. Thompson (1962) X-ray powder data for the ore minerals. Geol. Soc. Amer. Mem. 85, 40. (8) Criddle, A.J. and C.J. Stanley, Eds. (1993) Quantitative data file for ore minerals, 3rd ed. Chapman & Hall, London, 141.