

# Spangolite

# $\text{Cu}_6\text{Al}(\text{SO}_4)\text{Cl}(\text{OH})_{12} \cdot 3\text{H}_2\text{O}$

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**Crystal Data:** Hexagonal. *Point Group:*  $3m$ . Crystals equant, flattened, or elongated along  $[0001]$ , to 2 cm, with prominent  $\{000\bar{1}\}$ , equally developed  $\{10\bar{1}0\}$ ,  $\{01\bar{1}0\}$ ,  $\{10\bar{1}1\}$ ,  $\{01\bar{1}1\}$ , deeply striated parallel  $\{0001\}$ , with additional  $\{h0\bar{h}l\}$  forms, small  $\{0001\}$ , in parallel aggregates; may exhibit hemimorphic pyramidal development; cleavable massive. *Twining:* On  $\{0001\}$ , the acute forms about opposite antilogous poles joined to give an hourglasslike shape.

**Physical Properties:** *Cleavage:* On  $\{0001\}$ , perfect; distinct on  $\{10\bar{1}1\}$ ,  $\{01\bar{1}1\}$ . *Fracture:* Conchoidal. *Tenacity:* Brittle. Hardness = 2 on  $\{0001\}$ , 3 on inclined faces.  $D(\text{meas.}) = 3.135\text{--}3.141$   $D(\text{calc.}) = 3.14$  Pyroelectric.

**Optical Properties:** Transparent. *Color:* Dark green, emerald-green, bluish green; pale green in transmitted light. *Streak:* Pale green. *Luster:* Vitreous. *Optical Class:* Uniaxial (-). *Pleochroism:* Weak;  $O = \text{green}$ ;  $E = \text{bluish green}$ .  $\omega = 1.680\text{--}1.687$   $\epsilon = 1.627\text{--}1.641$

**Cell Data:** *Space Group:*  $P31c$ .  $a = 8.245\text{--}8.278$   $c = 14.32\text{--}14.54$   $Z = 2$

**X-ray Powder Pattern:** Tintic district, Utah, USA. 7.07 (10), 3.59 (8), 2.54 (7), 1.80 (7), 1.98 (6), 2.36 (5), 2.66 (4)

Chemistry:	(1)	(2)	(1)	(2)	
$\text{SO}_3$	10.11	10.03	$\text{H}_2\text{O}$	20.41	20.32
$\text{Al}_2\text{O}_3$	6.60	6.39	$-\text{O} = \text{Cl}_2$	0.92	1.00
$\text{CuO}$	59.51	59.82	Total	99.82	100.00
$\text{Cl}$	4.11	4.44			

(1) Region of Tombstone, Arizona, USA; average of four analyses, three partial; corresponds to  $\text{Cu}_{5.97}\text{Al}_{1.04}(\text{SO}_4)_{1.00}\text{Cl}_{0.92}(\text{OH})_{12.14} \cdot 2.97\text{H}_2\text{O}$ . (2)  $\text{Cu}_6\text{Al}(\text{SO}_4)\text{Cl}(\text{OH})_{12} \cdot 3\text{H}_2\text{O}$ .

**Occurrence:** A rare secondary mineral in the oxidization zone of hydrothermal copper deposits.

**Association:** Cuprite, connellite, brochantite, chalcophyllite, cyanotrichite, linarite, caledonite, clinoclase, azurite, malachite, aurichalcite, chrysocolla.

**Distribution:** Found in many localities in minor amounts. In the USA, in Arizona, the original specimen found "within a radius of 200 miles of Tombstone" [almost certainly from Bisbee]; large crystals in the Copper Queen, Czar, and Southwest mines, Bisbee; in the Maid of Sunshine mine, Courtland, Turquoise district, Cochise Co.; at Metcalf, Clifton-Morenci district, Greenlee Co.; from the Mex-Tex, Blanchard, and Portales mines, near Bingham, Hansonburg district, Socorro Co., and elsewhere in New Mexico; at the Grand Central mine, Tintic district, Juab Co., Utah; in the Majuba Hill mine, Antelope district, Pershing Co., and elsewhere in Nevada. From Wheal Gorland, Gwennap, and the West Caradon mine, St. Cleer, Cornwall, England. At Trébas, Tarn, and Fontana Rossa, Corsica, France. From the Arenas mine, south of Iglesias, Sardinia, Italy. In the Kamariza mine, Laurium, Greece. From Brixlegg, Tirol, Austria. At the Kabasaka and Nyukaku mines, Kyogo Prefecture, Japan. Additional localities are known.

**Name:** Honors Norman Spang (1842–1922), Etna, Pennsylvania, USA, American mineral collector, who provided the original specimen.

**Type Material:** The Natural History Museum, London, England, 74198; Yale University, New Haven, Connecticut, 3.3482; National Museum of Natural History, Washington, D.C., USA, 83512.

**References:** (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 556–558. (2) Merlino, S., M. Pasero, C. Sabelli, R. Trosti-Ferroni (1992) Crystal structure refinements of spangolite, a hydrated basic sulphate of copper and aluminum, from three different occurrences. *Neues Jahrb. Mineral., Monatsh.*, 349–357. (3) Hawthorne, F.C., M. Kimata, and R.K. Erby (1993) The crystal structure of spangolite, a complex copper sulfate sheet mineral. *Amer. Mineral.*, 78, 649–652. (4) Frondel, C. (1949) Crystallography of spangolite. *Amer. Mineral.*, 34, 181–187.

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