

**Crystal Data:** Orthorhombic. *Point Group:*  $2/m\ 2/m\ 2/m$ . Crystals typically short, prismatic, to 4 cm, or anhedral, equidimensional. Commonly in disseminated grains, compact, or massive. *Twining:* {011}, not common.

**Physical Properties:** *Cleavage:* {010}, distinct; {001}, imperfect. *Fracture:* Uneven to conchoidal. *Tenacity:* Brittle. Hardness = 6 D(meas.) = 3.87–4.12 D(calc.) = 4.15

**Optical Properties:** Transparent to translucent. *Color:* Olive-green, bluish green, gray, flesh-red, reddish brown; pale green in thin section, may be colorless. *Streak:* Pale gray.

*Luster:* Vitreous to greasy.

*Optical Class:* Biaxial (-). *Pleochroism:* None or weak; X = brownish red; Y = reddish; Z = greenish blue. *Orientation:* X = b; Y = c; Z = a. *Dispersion:*  $r > v$ .  $\alpha = 1.770\text{--}1.788$   
 $\beta = 1.807\text{--}1.810$   $\gamma = 1.817\text{--}1.825$   $2V(\text{meas.}) = 60^\circ\text{--}70^\circ$

**Cell Data:** *Space Group:*  $Pbnm$ .  $a = 4.86\text{--}4.90$   $b = 10.59\text{--}10.62$   $c = 6.22\text{--}6.25$   $Z = 4$

**X-ray Powder Pattern:** Synthetic. (ICDD 35-748).

2.560 (100), 2.867 (90), 1.814 (72), 2.607 (67), 3.627 (50), 1.565 (33), 2.695 (30)

**Chemistry:**

	(1)	(2)
SiO <sub>2</sub>	29.27	29.75
FeO	1.20	
MnO	65.23	70.25
MgO	1.98	
CaO	2.32	
Total	100.00	100.00

(1) Benallt mine, Wales; corresponds to  $(\text{Mn}_{1.84}^{2+}\text{Mg}_{0.10}\text{Ca}_{0.08}\text{Fe}_{0.03}^{2+})_{\Sigma=2.05}\text{Si}_{0.97}\text{O}_4$ . (2) Mn<sub>2</sub>SiO<sub>4</sub>.

**Polymorphism & Series:** Forms two series, with fayalite, and with forsterite.

**Mineral Group:** Olivine group.

**Occurrence:** In Fe–Mn ore deposits, related skarns, and metamorphosed manganese-rich sediments.

**Association:** Zincite, willemite, franklinite, rhodonite, jacobsonite, diopside, gageite, bustamite, manganocalcite, glaucochroite, calcite, banalsite, alleghanyite.

**Distribution:** In the USA, from Franklin and Sterling Hill, Ogdensburg, Sussex Co., New Jersey; at Bald Knob, near Sparta, Alleghany Co., North Carolina; and in the Sunnyside mine, San Juan Co., Colorado. From Buritirama, Piaui, Brazil. In the Harstigen mine, near Persberg; at Långban, Värmland; and in the Sjö mine, near Grythyttan, Örebro, Sweden. From the Benallt mine, near Rhiw, Lleyn Peninsula, Gwynedd, Wales. In the Meldon quarry, Okehampton, Devon, and the Treburland mine, Altarnun, Cornwall, England. At Val Malenco, Lombardy, Italy. From Bonneval-sur-Arc, Haute-Maurienne, Isère, France. Large crystals from the Wessels mine, near Kuruman, Cape Province, South Africa. In the Kaso mine, Totigi Prefecture, and the Noda-Tamagawa mine, Iwate Prefecture, Japan. From Broken Hill and Tamworth, New South Wales, Australia. On the Clark Peninsula, Wilkes Land, Antarctica.

**Name:** From the Greek for *ash-colored*.

**Type Material:** Mining Academy, Freiberg, Germany, 23653.

**References:** (1) Dana, E.S. (1892) Dana's system of mineralogy, (6th edition), 457–459.

(2) Deer, W.A., R.A. Howie, and J. Zussman (1982) Rock-forming minerals, (2nd edition), v. 1A, orthosilicates, 337–357. (3) Francis, C.A. and P.H. Ribbe (1980) The forsterite-tephroite series. I. Crystal structure refinements. Amer. Mineral., 65, 1263–1269. (4) (1984) NBS Mono. 25, 21, 92.

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