

# Benjaminite

# (Ag, Cu)<sub>3</sub>(Bi, Pb)<sub>7</sub>S<sub>12</sub>

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**Crystal Data:** Monoclinic. *Point Group:* 2/m. Massive and as laths, to 6 mm, which are complex intergrowths of several closely related phases. *Twinning:* Polysynthetic, common.

**Physical Properties:** *Cleavage:* Fair, parallel to the elongation. Hardness = 3.3–3.5 VHN = 186–232 (50 g load). D(meas.) = n.d. D(calc.) = 6.68

**Optical Properties:** Opaque. *Color:* Gray on fresh fracture, tarnishing dull or yellow to coppery red; in polished section, creamy white to very pale brownish. *Luster:* Metallic, with greasy appearance. *Anisotropism:* Strong.

R<sub>1</sub>–R<sub>2</sub>: (400) 44.2–47.2, (420) 44.8–47.8, (440) 45.2–48.6, (460) 45.2–49.0, (480) 45.0–49.2, (500) 44.8–49.2, (520) 44.5–49.0, (540) 44.0–48.6, (560) 43.6–48.0, (580) 43.3–47.6, (600) 43.1–47.2, (620) 43.0–46.8, (640) 42.8–46.3, (660) 42.7–45.9, (680) 42.6–45.6, (700) 42.5–45.2

**Cell Data:** *Space Group:* C2/m.  $a = 13.25(2)$   $b = 4.05(1)$   $c = 20.25(3)$   
 $\beta = 103.14(07)^\circ$   $Z = 2$

**X-ray Powder Pattern:** Camsell River, Canada. Easily mistaken for pavonite. 2.851 (100), 3.539 (80), 3.427 (80), 2.813 (60), 2.022 (60), 2.007 (60), 3.302 (50)

<b>Chemistry:</b>	(1)	(2)	(1)	(2)	
Ag	12.6	14.2	Bi	65.1	64.8
Cu	1.4	0.0	Sb		0.0
Pb	3.7	0.6	S	16.4	18.0
			Total	99.2	97.6

(1) Round Mountain, Nevada, USA; by electron microprobe, average of four analyses; corresponding to  $(\text{Ag}_{2.74}\text{Cu}_{0.52})_{\Sigma=3.26}(\text{Bi}_{7.31}\text{Pb}_{0.42})_{\Sigma=7.73}\text{S}_{12.00}$ . (2) AW mine, Australia; by electron microprobe, corresponding to  $\text{Ag}_{2.82}(\text{Bi}_{6.62}\text{Pb}_{0.06})_{\Sigma=6.68}\text{S}_{12.00}$ .

**Occurrence:** In a quartz vein near the contact of a soda-granite and an intrusive rhyolite (Outlaw mine, Nevada); with arsenides (Camsell River, Canada); in a veinlet in calcite (Cobalt, Canada); in a molybdenite pipe deposit (AW mine, Australia).

**Association:** Aikinite, chalcopyrite, pyrite, covellite, muscovite, molybdenite, quartz (Outlaw mine, Nevada); safflorite, skutterudite, rammelsbergite, arsenopyrite, nickeline, matildite, bismuthinite, chalcopyrite, pyrite, sphalerite, galena, bismuth, silver (Camsell River, Canada); molybdenite, bismuth, bismuthinite (AW mine, Australia).

**Distribution:** In the USA, from the Outlaw mine, about 17 km north of Manhattan, Round Mountain district, Nye Co., Nevada [TL]; in the Alaska mine, Poughkeepsie Gulch, near Ouray, San Juan Co., Colorado. From the Terra Company mine, Camsell River, Northwest Territories; and in the Canadian Keely mine, Cobalt, Ontario, Canada. In the Porvenir mine, Cerro Bonete, Potosí, Bolivia. At the Pirquitas deposit, Riconada Department, Jujuy Province, Argentina. From the AW mine, south of Tenterfield, New South Wales, Australia. In the Nanten and Daimaru veins, Ikuno deposits, Hyogo Prefecture, Japan. At the Svishti Plaz gold deposit, central Balkan Mountains, Bulgaria. In the Waschgang Au–Cu deposit, Goldberg Mountains, Upper Carinthia, Austria.

**Name:** Honors Dr. Marcus Benjamin (1857–1932), U.S. National Museum, marine taxonomist and long-time editor of U.S.N.M. publications.

**Type Material:** Royal Ontario Museum, Toronto, Canada, 13805; Harvard University, Cambridge, Massachusetts, 85749; National Museum of Natural History, Washington, D.C., USA, 95058.

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