

**Butlerite****Fe<sup>3+</sup>(SO<sub>4</sub>)(OH)·2H<sub>2</sub>O**

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**Crystal Data:** Monoclinic. *Point Group:* 2/m. Tabular on {001} or {100}, may be pseudo-octahedral. *Twinning:* On {101}, very common.

**Physical Properties:** *Cleavage:* On {100}, perfect. Hardness = 2.5 D(meas.) = 2.55 D(calc.) = 2.53

**Optical Properties:** Semitransparent. *Color:* Deep orange; in transmitted light, pale yellow-orange. *Streak:* Pale yellow. *Luster:* Vitreous. *Optical Class:* Biaxial (-). *Pleochroism:* X = colorless; Y = very pale yellow; Z = pale yellow. *Orientation:* Z = b; X ∧ c = -18°. α = 1.593-1.604 β = 1.665-1.674 γ = 1.731-1.741 2V(meas.) = Large.

**Cell Data:** *Space Group:* P2<sub>1</sub>/m. a = 6.44-6.50 b = 7.31-7.37 c = 5.84-5.87 β = 108°23(5)'-108°28(20)' Z = 2

**X-ray Powder Pattern:** United Verde mine, Arizona, USA. 4.97 (FF), 3.15 (F), 3.59 (mF), 3.05 (mF), 3.22 (mf), 2.48 (mf), 6.17 (ff)

<b>Chemistry:</b>	(1)	(2)
SO <sub>3</sub>	38.63	39.07
Al <sub>2</sub> O <sub>3</sub>	0.55	
Fe <sub>2</sub> O <sub>3</sub>	36.31	38.96
FeO	0.41	
Na <sub>2</sub> O	2.73	
H <sub>2</sub> O	22.83	21.97
Total	101.46	100.00

(1) United Verde mine, Arizona, USA. (2) Fe(SO<sub>4</sub>)(OH)·2H<sub>2</sub>O.

**Polymorphism & Series:** Dimorphous with parabutlerite.

**Occurrence:** Rarely formed from the oxidation of pyritic ore; may be formed under fumarolic conditions from mine fires.

**Association:** Parabutlerite, copiapite, fibroferrite, other iron sulfates.

**Distribution:** In the USA, from the United Verde copper mine, Jerome, Yavapai Co., Arizona; at the Lone Star mine, La Bajada district, Santa Fe Co., New Mexico; in the Dexter No. 7 mine, Calf Mesa, San Rafael district, Emery Co., Utah; from near Cimarron, Gunnison Co., Colorado. At the Santa Elena mine, Quebrada de La Alcaparrosa, San Juan Province, Argentina. From Chuquicamata and Quetena, west of Calama, Antofagasta, Chile. At Saghand, Yazd, Iran. From the Xitieshan Pb-Zn mine, south of Mt. Qilianshan, Chaidamu, Qinghai Province, China.

**Name:** Honors Professor Gurdon Montague Butler (1881-1961), American mining geologist, University of Arizona, Tucson, Arizona, USA.

**Type Material:** University of Arizona Mineral Museum, Tucson, Arizona, M52; Harvard University, Cambridge, Massachusetts, 90539; National Museum of Natural History, Washington, D.C., USA, 95953.

**References:** (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 608-609. (2) Cesbron, F. (1964) Contribution à la minéralogie des sulfates de fer hydratés. Bull. Soc. fr. Minéral., 87, 125-143 (in French). (3) Fanfani, L., A. Nunzi, and P.F. Zanazzi (1971) The crystal structure of butlerite. Amer. Mineral., 56, 751-757.

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