

## Brownmillerite

## Ca<sub>2</sub>(Al, Fe<sup>3+</sup>)<sub>2</sub>O<sub>5</sub>

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**Crystal Data:** Orthorhombic. *Point Group:* *mm2*. As square platelets, to about 60 μm; massive.

**Physical Properties:** Hardness = n.d. D(meas.) = 3.76 D(calc.) = 3.68–3.73

**Optical Properties:** Semitransparent. *Color:* Reddish brown.

*Optical Class:* Biaxial (-). *Pleochroism:* Distinct; X = Y = yellow-brown; Z = dark brown.

*Orientation:* Y and Z lie in the plane of the platelets; extinction in that plane is diagonal.

$\alpha = < 2.02$   $\beta = > 2.02$   $\gamma = > 2.02$  2V(meas.) = n.d.

**Cell Data:** *Space Group:* *Ibm2*. *a* = 5.584(5) *b* = 14.60(1) *c* = 5.374(5) *Z* = 2

**X-ray Powder Pattern:** Near Mayen, Germany.

2.65 (vs), 7.19 (s), 2.78 (s), 1.93 (s), 2.05 (ms), 3.65 (m), 1.82 (m)

### Chemistry:

	(1)	(2)	(3)
TiO <sub>2</sub>		1.5	1.9
Al <sub>2</sub> O <sub>3</sub>	17.2	22.3	13.1
Fe <sub>2</sub> O <sub>3</sub>	30.5	27.6	41.9
Cr <sub>2</sub> O <sub>3</sub>		0.1	n.d.
MgO		n.d.	n.d.
CaO	46.2	44.8	43.7
insol.		4.0	
LOI	0.5		
Total	94.4	100.3	100.6

(1) Near Mayen, Germany; by semiquantitative spectroscopy. (2) Hatrurim Formation, Israel; corresponds to Ca<sub>1.99</sub>(Al<sub>1.09</sub>Fe<sub>0.86</sub>Ti<sub>0.05</sub>)<sub>Σ=2.00</sub>O<sub>5</sub>. (3) Do.; corresponds to Ca<sub>1.95</sub>(Fe<sub>1.31</sub>Al<sub>0.64</sub>Ti<sub>0.06</sub>)<sub>Σ=2.01</sub>O<sub>5</sub>.

**Occurrence:** In thermally metamorphosed limestone blocks included in volcanic rocks (near Mayen, Germany); in high-temperature, thermally metamorphosed, impure limestones (Hatrurim Formation, Israel).

**Association:** Calcite, ettringite, wollastonite, larnite, mayenite, gehlenite, diopside, pyrrhotite, grossular, spinel, afwillite, jennite, portlandite, jasmundite (near Mayen, Germany); melilite, mayenite, wollastonite, kalsilite, corundum (Klöch, Austria); spurrite, larnite, mayenite (Hatrurim Formation, Israel).

**Distribution:** From the Ettringer-Bellerberg volcano, near Mayen, Eifel district, Germany. Found at Klöch, Styria, Austria. In the Hatrurim Formation, Israel.

**Name:** The artificial compound was named for Dr. Lorrin Thomas Brownmiller (1902–), Chief Chemist of the Alpha Portland Cement Company, Easton, Pennsylvania, USA, in 1932, the name then transferred to the naturally-occurring mineral.

**Type Material:** Mineral Museum, University of Cologne, Cologne, Germany, M5026/86; National Museum of Natural History, Washington, D.C., USA, 120045.

**References:** (1) Hentschel, G. (1964) Mayenit, 12CaO•7Al<sub>2</sub>O<sub>3</sub>, und Brownmillerit, 2CaO•(Al, Fe)<sub>2</sub>O<sub>3</sub>, zwei neue Minerale in den Kalksteineinschlüssen der Lava des Ettringer Bellerberges. Neues Jahrb. Mineral., Monatsh., 22–29 (in German with English abs.). (2) (1965) Amer. Mineral., 50, 2106 (abs. ref. 1). (3) Colville, A.A. and S. Geller (1971) The crystal structure of brownmillerite, Ca<sub>2</sub>FeAlO<sub>5</sub>. Acta Cryst., 27, 2311–2315. (4) Gross, S. (1977) The mineralogy of the Hatrurim Formation, Israel. Geol. Sur. Israel Bull. 70, 11–13.

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