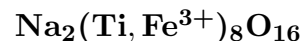


# Freudenbergite



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**Crystal Data:** Monoclinic. *Point Group:*  $2/m, m, \text{or } 2$ . As irregularly shaped grains, to 0.15 mm.

**Physical Properties:** *Cleavage:*  $\{001\}$ , and another prismatic, good. *Hardness* = < 5  
 $D(\text{meas.}) = 3.956$   $D(\text{calc.}) = 3.97$

**Optical Properties:** Opaque, transparent in thin fragments. *Color:* Black; deep brown to light yellowish brown in transmitted light with yellow-brown internal reflections. *Streak:* Pale yellow-brown.

*Optical Class:* Biaxial (+), near uniaxial. *Pleochroism:* Deep brown to pale yellow-brown.  
 $n = \sim 2.37\text{--}2.42$  (Li).  $2V(\text{meas.}) = \text{n.d.}$

**Cell Data:** *Space Group:*  $C2/m, Cm, \text{or } C2$ .  $a = 12.305(5)$   $b = 3.822(2)$   $c = 6.500(3)$   
 $\beta = 107.30(3)^\circ$   $Z = 4$

**X-ray Powder Pattern:** Michelsberg, Germany.

3.63 (100), 1.911 (90), 3.10 (80), 3.02 (80), 2.731 (80), 2.069 (80), 1.596 (80)

## Chemistry:

	(1)	(2)
Nb <sub>2</sub> O <sub>5</sub>	1.24	1.2
SiO <sub>2</sub>	< 0.02	
TiO <sub>2</sub>	70.37	71.6
ZrO <sub>2</sub>		0.1
Al <sub>2</sub> O <sub>3</sub>	< 0.01	
Fe <sub>2</sub> O <sub>3</sub>	18.15	19.1
MnO	0.14	0.1
MgO	< 0.03	
Na <sub>2</sub> O	8.73	8.1
K <sub>2</sub> O	0.04	0.1
Total	98.67	100.3

(1) Michelsberg, Germany; by electron microprobe, total Fe as Fe<sub>2</sub>O<sub>3</sub>; corresponds to (Na<sub>1.98</sub>K<sub>0.01</sub>)<sub>Σ=1.99</sub>(Ti<sub>6.22</sub>Fe<sub>1.59</sub>Nb<sub>0.07</sub>Mn<sub>0.01</sub>)<sub>Σ=7.89</sub>O<sub>16</sub>. (2) Do.; by electron microprobe, total Fe as Fe<sub>2</sub>O<sub>3</sub>.

**Occurrence:** A late-stage mineral in an apatite-bearing alkali syenite.

**Association:** Hematite, högbomite, diopside, apatite, ilmenite, titanite, biotite, sanidine.

**Distribution:** Found at Michelsberg, on the Katzenbuckel, Odenwald, Baden-Württemberg, Germany.

**Name:** For Professor Wilhelm Freudenberg (1881–?), who studied Katzenbuckel rocks.

**Type Material:** n.d.

**References:** (1) Frenzel, G. (1961) Ein neues Mineral: Freudenbergit (Na<sub>2</sub>Fe<sub>2</sub>Ti<sub>7</sub>O<sub>18</sub>). Neues Jahrb. Mineral., Monatsh., 12–22 (in German with English abs.). (2) (1961) Amer. Mineral., 46, 765–766 (abs. ref. 1). (3) McKie, D. and J.V.P. Long (1970) The unit-cell contents of freudenbergite. Zeits. Krist., 132, 157–160. (4) Frenzel, G., J. Ottemann, and B. Nuber (1971) Neue Mikrosonden-Untersuchungen an Freudenbergiten. Neues Jahrb. Mineral., Monatsh., 547–551 (in German with English abs.). (5) Ishiguro, T., K. Tanaka, F. Marumo, M.G.M.U. Ismail, S. Hirano, and S. Somya (1978) Freudenbergite. Acta Cryst., 34, 255–256.