

# Clinoptilolite

# (Na, K, Ca)<sub>2-3</sub>Al<sub>3</sub>(Al, Si)<sub>2</sub>Si<sub>13</sub>O<sub>36</sub>•12H<sub>2</sub>O

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**Crystal Data:** Monoclinic. *Point Group:* 2/m. Platy crystals, to 1 cm, showing {010}, {001}, {101}, {20 $\bar{1}$ }; commonly fine-grained, massive.

**Physical Properties:** *Cleavage:* {010}, perfect. Hardness = 3.5–4 D(meas.) = 2.16(2) D(calc.) = 2.146

**Optical Properties:** Transparent to translucent. *Color:* Colorless to white; colorless in thin section. *Luster:* Vitreous.

*Optical Class:* Biaxial (–) or (+). *Orientation:* Y = b; Z  $\wedge$  a = 30°–45°. *Dispersion:* r < v, strong.  $\alpha = 1.476$ – $1.488$   $\beta = 1.479$   $\gamma = 1.479$ – $1.489$  2V(meas.) = 32°–48°

**Cell Data:** *Space Group:* C2/m. a = 17.633(8) b = 17.941(8) c = 7.400(4)  $\beta = 116.39^\circ$  Z = 2

**X-ray Powder Pattern:** Agoura, California, USA.

8.92 (100), 2.974 (80), 3.897 (57), 3.964 (55), 2.728 (33), 3.419 (16), 3.119 (15)

## Chemistry:

	(1)	(2)
SiO <sub>2</sub>	69.93	68.44
Al <sub>2</sub> O <sub>3</sub>	11.89	11.86
Fe <sub>2</sub> O <sub>3</sub>	0.02	
MgO	0.47	0.12
CaO	1.07	3.26
Na <sub>2</sub> O	2.96	1.51
K <sub>2</sub> O	3.47	2.14
H <sub>2</sub> O	[10.19]	[12.67]
Total	[100.00]	[100.00]

(1) Agoura, California, USA; H<sub>2</sub>O by difference, corresponds to (Na<sub>1.22</sub>K<sub>0.94</sub>Ca<sub>0.24</sub>Mg<sub>0.15</sub>) $_{\Sigma=2.55}$ Al<sub>2.99</sub>Si<sub>15.01</sub>O<sub>36</sub>•11.6H<sub>2</sub>O. (2) Richardson Ranch, Oregon, USA; by electron microprobe, after removal of 0.46% FeO as impurity, H<sub>2</sub>O by difference; corresponds to (Ca<sub>0.78</sub>Na<sub>0.65</sub>K<sub>0.60</sub>Mg<sub>0.04</sub>) $_{\Sigma=2.07}$ Al<sub>3.10</sub>Si<sub>14.91</sub>O<sub>36</sub>•11.5H<sub>2</sub>O.

**Mineral Group:** Zeolite group.

**Occurrence:** Formed by devitrification of volcanic glass, and in cavities in rhyolites and andesites.

**Association:** Zeolites, montmorillonite, hectorite, thenardite, halite, gaylussite, celadonite, quartz, “opal,” calcite.

**Distribution:** Abundant in the western USA, as in Wyoming, at Mt. Hoodoo, Park Co.; in California, from near Agoura, Los Angeles Co., at Owens Lake, Inyo Co., and 10 km west of Hector, San Bernardino Co.; in Arizona, from northwest of Bowie, Cochise Co., and near Wikieup, Mohave Co.; in the Cuchillo deposit, near Winston, Sierra Co., New Mexico. In Oregon, large crystals from Agate Beach, Lincoln Co., Succor Creek, Malheur Co., and at Richardson Ranch, near Bend, Jefferson Co. At Kamloops Lake, near Kamloops, British Columbia, Canada. From near Kapfenberg, Styria, Austria. On the Vogelsberg, Hesse, Germany. From Val di Fassa and Alpe di Siusi, Trentino-Alto Adige, Italy.

**Name:** For its inclined optics and relation to *ptilolite* [mordenite].

**Type Material:** The Natural History Museum, London, England, 1939,314.

**References:** (1) Schaller, W.T. (1932) The mordenite-ptilolite group; clinoptilolite, a new species. *Amer. Mineral.*, 17, 128–134. (2) Deer, W.A., R.A. Howie, and J. Zussman (1963) *Rock-forming minerals*, v. 4, framework silicates, 377–385. (3) Wise, W.S., W.J. Nokleberg, and M. Kokinos (1969) Clinoptilolite and ferrierite from Agoura, California. *Amer. Mineral.*, 54, 887–895. (4) Alietti, A. (1972) Polymorphism and crystal chemistry of heulandites and clinoptilolites. *Amer. Mineral.*, 57, 1448–1462. (5) Smyth, J.R., A.T. Spaid, and D.L. Bish (1990) Crystal structures of a natural and Cs-exchanged clinoptilolite. *Amer. Mineral.*, 75, 522–528.

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