Introduction

Kinoshitalite, ideally Ba(Mg)$_3$(Al$_2$Si$_2$)O$_{10}$(OH,F)$_2$, was studied in a granulite-facies manganese ore associated with calcium-bearing magnesian tephroite, hausmannite, calcite and manganoan clinohlorel, and in a second assemblage together with hausmannite, altered tephroite, manganoan diopside, and calcite. The metamorphic rocks occur enclosed in peridotites of the Semail Ophiolite, Sultanate of Oman and were metamorphosed during ophiolite obduction.

Single-crystal X-ray data, collected on an inclusion-free kinoshitalite of Ba$_{0.99}$K$_{0.06}$Na$_{0.01}$ (Mg$_{2.64}$Mn$_{0.31}$Al$_{2.01}$Si$_{2.03}$)O$_{10}$(OH$_{1.61}$F$_{0.37}$Cl$_{0.02}$) composition, yielded a C-centered lattice of monoclinic symmetry with $a = 5.316(1)$, $b = 9.230(2)$, $c = 10.197(2)$ Å, $\beta = 100.06(1)$°, $V = 492.6$ Å$^3$, and $Z = 1$ characteristic of the 1$_M$ polytype. The structure was refined in two models assuming complete Si, Al ordering in the space groups C$2$ and C$\bar{2}$ allowing for additional twinning. The data clearly suggest that in spite of the Si/Al ratio of 1 assumption of complete Si, Al ordering can be rejected. Two models, both in agreement with space group C$2$/m, causing Si, Al disorder, are discussed. Three-dimensional Si, Al disorder would lead to violation of the Al avoidance rule and substantial Ba displacement. The rather well defined Ba position capped by two six-membered rings of Si$_3$Al$_3$O$_{18}$ composition suggests one dimensional disorder where completely Si, Al ordered layers exist parallel to (001). The disorder occurs perpendicular to (001) and may be interpreted as random stacking faults.

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Edwin Gnos1,* and Thomas Armbruster2

1Mineralogisch-Petrographisches Institut, Baltzerstrasse 1, Universität Bern, CH-3012 Bern, Switzerland
2Laboratorium für Chemische und Mineralogische Kristallographie, Universität Bern, Freiestrasse 3, CH-3012 Bern, Switzerland

*E-mail: gnos@mpi.unibe.ch

Kinoshitalite, Ba(Mg)$_3$(Al$_2$Si$_2$)O$_{10}$(OH,F)$_2$, a brittle mica from a manganese deposit in Oman: Paragenesis and crystal chemistry

Edwin Gnos1,* and Thomas Armbruster2

1Mineralogisch-Petrographisches Institut, Baltzerstrasse 1, Universität Bern, CH-3012 Bern, Switzerland
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Introduction

Kinoshitalite, Ba(Mg)$_3$(Al$_2$Si$_2$)O$_{10}$(OH,F)$_2$, belongs to the mica family (Guggenheim 1984) and was first reported by Yoshii et al. (1973a) as the Ba and Mg trioctahedral brittle mica. Natural barium-bearing micas occur in a variety of different rock types: igneous rocks (Thompson 1977; Wendlandt 1977; Mansker et al. 1979; Gaspar and Wyllie 1982; Edgar 1992; Bigi et al. 1993; Zhang et al. 1993), metasomatized rocks (Pan and Fleet 1991; Harlow 1995), marbles or calc-silicate rocks (Glassley 1975; Pattiaratchi et al. 1967; Rice 1977; Kretz 1980; Bucher-Nurminen 1982; Solie and Su 1987; Bol et al. 1989), and metamorphosed ore deposits (Frondel and Ito 1967; Yoshii et al. 1973a, Fleischer et al. 1975; Matsubara et al. 1976; Daspugata et al. 1989; Tracy 1991; Chabu and Baulègue 1992; Frimmel et al. 1995). Three end-member brittle mica minerals have the interlayer site completely occupied by Ba. Anandite, Ba(Fe)$_3$(Fe$_{3+}$Si$_3$)O$_{10}$(OH)$_2$, is characterized by a trioctahedral sheet formed by Fe$^{2+}$ octahedra, partial substitution of ferric iron in the tetrahedral layer, and unusual S$^{2-}$ replacing OH$^-$ or F$^-$ (Pattiaratchi et al. 1967; Loving and Widdowson 1968; Giuseppetti and Tadini 1972; Filut et al. 1985). In accord with the analyses published by Tracy (1991) and those of an un-named Fe-analogue of kinoshitalite by Frimmel et al. (1995) there is also a mineral of Ba(Fe)$_3$(Al$_2$Si$_2$)O$_{10}$(OH,Cl,F)$_2$ composition which differs from anandite because the tetrahedral sheet is formed by Si and Al tetrahedra and it lacks S$^{2-}$. Except for the Mn-poor but Fe-bearing kinoshitalite from a high-grade metamorphic marble (Solie and Su 1987) all other known kinoshitalites are manganese-bearing or even manganoan and occur in amphibolite to granulite-facies metamorphosed manganese deposits (Yoshii et al. 1973a; Matsubara et al. 1976; Daspugata et al. 1989), where barium is a common element of the protolith material (e.g., Kickmaier and Peters 1991).

Yoshii et al. (1973a) described the occurrence of kinoshitalite at Noda-Tamagawa mine in Japan where the mineral is associated with hausmannite and tephroite. In the same rock, but not in contact with kinoshitalite, occur celsian, quartz, spessartine, and rhodonite. In the Hokkejino occurrence described by Matsubara et al. (1976) the kinoshitalite is found in a banded manganese ore together with tephroite, manganoan diopside and sonolite, or associated with alabandite. The ore also contains in separate bands quartz and rhodonite, quartz and spessartine, and locally celsian, rhodochrosite and phlogopite. In the Precambrian Sausar Group of India (Daspugata et al. 1989), kinoshitalite is closely associated with dolomite but also braunite, hausmannite, hematite, bixbyite, alkali feldspar, manganoan calcite, and quartz are described in the same sample.

Crystal structure refinements of kinoshitalite-1M by Kato et al. (1979), Guggenheim and Kato (1984), and Brigatti and