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Kinoite from Calumet, Michigan

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Abstract

Kinoite, $Cu_2Ca_2Si_3O_{10} \cdot 2H_2O$, was described by Anthony and Laughon (1970). Associated minerals at the type locality are typical skarn minerals. The Michigan occurrence, at the Laurium Mine, Calumet, represents a different environment. Here, kinoite is found as subhedral to euhedral crystals within quartz and calcite; other associated minerals include native copper, native silver, epidote, pumpellyite, and chlorite.

The host rock is the mineralized top of the Kearsarge amygdaloid.

Mineral data for the Michigan kinoite are essentially the same as the type kinoite.

Introduction

Kinoite, $Cu_2Ca_2Si_3O_{10} \cdot 2H_2O$, was described as a new mineral species by Anthony and Laughon (1970); its crystal structure was determined by Laughon (1971). The associated minerals at the type locality, according to Anthony and Laughon (1970), are those typically found in a skarn—diopside, garnet, calcite, and quartz, with lesser amounts of bornite, djurleite, chalcopyrite, apophyllite, and very minor native copper. Williams (1976) recently described junitoite, a new hydrated calcium zinc silicate, in this association.

The Michigan occurrence represents a considerably different environment. Kinoite was obtained from the Laurium Mine, which is located near the southwestern extremity of the mineralized portion of the Kearsarge flow, about two miles south of Calumet. Here, kinoite is found as subhedral to euhedral crystals. Single crystals are common; the largest is 1.5 × 0.3 × 0.1 mm. The host rock is albite basalt. Associated minerals include quartz, calcite, native copper, native silver, epidote, pumpellyite, and chlorite.

Mineral data

The optical data for Michigan kinoite are listed in Table 1. Comparable data obtained by Anthony and Laughon (1970) are listed for comparison.

Unit-cell constants were determined from Weissenberg photographs taken with Cu$K\alpha$ radiation. These data are listed in Table 2, together with comparable data from Anthony and Laughon (1970).

Table 1. Optical data of kinoite

	Kinoite Anthony and Laughon (1970)	Kinoite This Paper
α	1.638 ± .002	1.640 ± .002
β	1.665 ± .002	1.663 ± .002
γ	1.676 ± .002	1.680 ± .002
sign	(-)	(-)
2V (calc)	64°	80°

Table 2. Unit-cell constants of kinoite

	Kinoite Anthony and Laughon (1970)	Kinoite This Paper
a	6.990 ± .004 Å	7.007 ± .008 Å
b	12.890 ± .003 Å	12.983 ± .007 Å
c	5.654 ± .002 Å	5.667 ± .006 Å
β	96°05' ± 04'	96°00' ± 06'
Space Group	$P2_1/m$	$P2_1/m$
V	507.097 Å^3	512.713 Å

Paragenesis

The occurrence of amygdule minerals in the lava flows of the Keweenaw Peninsula, Michigan, has been described in numerous publications; however, Stoiber and Davidson (1959) first recognized an amygdule mineral zonation. Later, Jolly and Smith (1972) described a metamorphic zonation which they called the laumontite zone, pumpellyite zone, and epidote zone, which, respectively, represent higher rank and depth. The occurrence of kinoite in the Kearsarge flow is within the pumpellyite zone of Jolly and Smith.

Kinoite is contemporaneous with native copper, quartz, and calcite. Both copper and kinoite are found as inclusions in calcite and quartz crystals. In quartz crystals, kinoite forms "phantoms" by alignment around a previously-existing crystal, thereby outlining its hexagonal symmetry.

Minerals that are associated with kinoite, but crystallizing before it, include epidote, pumpellyite, copper, and silver. Minerals that crystallized after kinoite include chlorite and calcite (second generation).

References

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