Crystal chemistry of meteoritic kirschsteinite

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Abstract: Individual kirschsteinite grains from the Vulcano Laziale iron meteorite are chemically homogeneous, with compositions close to Ca1.00Fe0.61Mn0.17Mg0.22Cr0.22Si0.0004O0.90.

The crystal structure of two different crystals (Fa39Fo11La50 and Fa35Fo14La51, respectively) are refined (orthorhombic unit cell parameters: a = 4.877 and 4.875, b = 11.166 and 11.164, c = 6.448 and 6.447 Å), yielding similar results. In particular, the geometry of the M2 and T coordination polyhedra does not change with respect to other calcium bearing olivines, whereas M1 is sensitive to the site population.

Key-words: kirschsteinite, crystal structure, meteorite.

Introduction

Kirschsteinite, CaFeSiO4, was first found by Sahama & Hytönen (1957) in the silica undersaturated melilite-nepheline lava from the Mt. Shaheru crater, Nyiragongo. The mineral is a natural counterpart of the high-temperature synthetic phase common in iron sinters (Wyderko & Mazanek, 1968), which is also found in the debris associated with underground nuclear explosions (Kahn & Smith, 1966). Natural kirschsteinite, always less than 70 % end-member composition, also occurs in the wollastonite-melilite skarns of the Tazheran alkaline intrusion (Konev et al., 1970) and in serpentinized peridotites (Chien-Lu, 1995).

The mineral crystallizes from a limited range of bulk compositions and is stable only at fairly reducing conditions at high temperatures and under silica-undersaturated conditions (Gustafson, 1972). Such conditions occur in extraterrestrial environments; in fact, kirschsteinite has been recognized in different types of meteorite: the Sharps H chondrite (Dodd, 1971), the Vulcano Laziale iron (Burragato & Mattias, 1972) and the Lewis Cliff 86010 angritic achondrite (Crozaz & McKay, 1990; Mikouchi et al., 1995).

The mineral has an olivine-type structure (Brown, 1982) and, together with glaucochroite CaMnSiO4 (Lager & Meagher, 1978), represents an extreme isomorphous substitution that still preserves the olivine structure.

Chemical data

Grains of kirschsteinite from the Vulcano Laziale meteorite (VLM) were obtained from the Mineralogical Museum of Rome University, by