Compositional zoning in hydrothermal aegirine from fenites in the Proterozoic Gardar Province, South Greenland

JENS RANLØV* and ROBERT F. DYMEK

Department of Earth and Planetary Sciences, Washington University, St. Louis MO 63130, U.S.A.

Abstract: Composit ionally zoned Ti-bearing aegirin e is a common constituent in fenites and hydrothermal veins and vugs associated with nepheline syenites from the mid-Proterozoic Gardar Province of South Greenland.

A typical assemblage in these mineralizations includes quartz, albite, microcline, aegirine, calcite, stilpnomelan, apatite, monazite and Nb-Fe-Ti-Mn oxides, with a wide range of unusual REE-Zn-Be-Ba-Mn-silicates as accessory phases.

Individual aegirine crystals display evidence of sequential growth, concentric- and sector-zoning that represent large variations in wt. % TiO₂ (0.1 – 3.0), Na₂O (11.6 – 12.8), CaO (0.0 – 2.0), FeO (25.4 – 30.9) and ZrO₂ (0.0 – 0.74). Concentrations of Al₂O₃ (<1.34 but typically less than 0.7 wt. %) and MgO (<0.76 but typically less than 0.4 wt. %) are both very low. In terms of pyroxene end-members, these compositions correspond to from 70-95 mole % NaFe³⁺[Si₂O₆] (Aegirine), <1-6 mole % NaAl[Si₂O₆] (Jadeite), <1-8 mole % Ca (Mg,Fe²⁺)[Si₂O₆] (Enstatite-Ferrosilite), and from < mole % of an unnamed end-member having the composition Na(Mg,Fe²⁺)₅(Ti,Zr)₃[Si₂O₆]. As such, the principal chemical variation in the analyzed crystals involves the substitution: \( V_I(Fe^{2+},Mg) + V_T(Ti^{4+} = 2V_I(Fe^{3+}) \) in the M₁-position.

Textural relationships, together with the chemical inhomogeneities of the pyroxenes, suggest rapid nonequilibrium crystallization from a hydrothermal fluid of changing composition and/or temperature.

Key-words: fenitization, aegirine, sector-zoning, South Greenland, pyroxene.

Introduction

Compositional zoning within individual mineral grains is common in both igneous and metamorphic rocks. It reflects local variations in composition, pressure and temperature conditions during crystal growth and has the potential for providing important constraints on the petrogenesis of a rock system. In pyroxenes, compositional sector-zoning is quite common and several models have been proposed to explain its origin (e.g., Strong, 1969; Hollister & Gancarz, 1971; Nakamura, 1973; Wass, 1973; Ferguson, 1973; Leung, 1974; Dowty, 1976; Carpenter, 1980; Larsen, 1981). These models utilize the basic kinetic requirement that the growth of the crystal perpendicular to the growth surface is fast with respect to solid state diffusion in the crystal.

Virtually all reported occurrences of sector-zoned clinoxyroxene are from migmatic rocks, with only very few examples reported for non-magmatic pyroxene (e.g., Carpenter, 1980). Furthermore, most of these are occurrences of calcic pyroxene, whereas descriptions of complex zoning in sodic pyroxene are rare (Larsen, 1981).


* present address: Geological Museum, Øster Voldgade 5-7, DK-1350 København K, Denmark.