American Mineralogist, Volume 88, pages 131–141, 2003

An overgrowth model to explain multiple, dispersed high-Mn regions in the cores of garnet porphyroblasts

DAVID M. HIRSCH,[1,*] DAVID J. PRIOR,[2] AND WILLIAM D. CARLSON[1]

[1]Department of Geological Sciences, University of Texas at Austin, Austin, Texas 78712, U.S.A.
[2]Department of Earth Sciences, University of Liverpool, Liverpool, L39 3BX, U.K.

ABSTRACT

The central portions of garnet porphyroblasts from Harpswell Neck, Maine, exhibit small discrete regions of high Mn content, dispersed in three dimensions. Orientation contrast imaging (OCI) and quantitative crystallographic orientation measurements from electron backscatter diffraction (EBSD) patterns show that most garnet porphyroblasts contain no variations in crystallographic orientation. It is difficult to reconcile these data with a model in which each high-Mn region represents a discrete garnet nucleus.

An alternative hypothesis invokes a model of garnet growth in which precursor phases rich in Mn are overgrown, and their Mn is incorporated locally into the garnet structure. Although this model requires length scales for equilibration of Mn during the early stages of garnet growth that are shorter than any previously documented, that inference is consistent with the very low temperatures of garnet nucleation in these rocks, and with compositional evidence for progressively larger scales of equilibrium as reaction progressed.

Very short length scales for equilibration of Mn, identified in this study for the lowest-grade portion of the history of the rocks, call into question the common assumption of rock-wide equilibrium for Mn during garnet growth at low temperature. The absence of rock-wide equilibrium for Mn at low grade has potential negative implications for all common interpretive methods based in phase equilibria, including thermobarometric studies and thermodynamic analysis of the origin and meaning of zoning in low-grade garnet.