

Minor- and trace-element sector zoning in synthetic enstatite

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ABSTRACT

Minor- and trace-element sector zoning is nearly ubiquitous in pyroxene grown from basaltic melts using 1 atm gas-mixing furnaces. Mineral/melt partition coefficients can differ between sectors by more than a factor of five. A synthesized hypersthene-normative basalt composition was doped with Al, Cr, and Ti using a matrix of doping experiments, to understand better the mechanisms behind the formation of sector zoning. Isothermal and controlled-cooling experiments were conducted. The {010} sectors contain higher enrichments of Al, Cr, and Ti than {100} sectors, at the expense of Mg and Si. Evaluation of these relative sector enrichments indicates that sector zoning results from several kinetic mechanisms, which exert influence even when attempting laboratory conditions that approximate equilibrium: (1) rapid growth rate, not necessarily synonymous with rapid cooling; (2) crystal-chemical control by means of charge-coupled substitutions; and (3) diffusion limitations of Si tetrahedra in the melt boundary layers respective to the different crystal faces.

Keywords: Enstatite, sector zoning, charge-coupled substitution, kinetic mechanisms, crystal growth