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Diogenites as asteroidal cumulates: Insights from spinel chemistry

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ABSTRACT

The chemical composition of spinel was determined for a suite of 19 diogenites (orthopyroxenites) thought to be from asteroid 4 Vesta. Previous studies (Fowler et al. 1994, 1995) of orthopyroxene demonstrated that these diogenites are linked genetically, perhaps through fractional crystallization, in one or more crustal intrusions. The present study focuses on spinel to see if it also retains some chemical signatures of an igneous history. The chemical compositions across spinel grains reveal flat concentration profiles, indicating major subsolidus exchange with orthopyroxene. Nevertheless, significant chemical differences exist among the average spinel compositions from individual diogenites in the suite. A chemical continuum exists from high-Cr, low-Al spinel in diogenite LAP 91900 (Cr_20_3 60.7 wt%; Al_20_3 6.1 wt%) to low-Cr, high-Al spinel in diogenite ALHA 77256 (Cr_20_3 44.7 wt%; Al_20_3 21.8 wt%), which may represent one or more fractionation series. In these trends, Al and Ti behave as incompatible elements whose abundances increase with crystallization. These systematics differ from those in spinel in terrestrial or lunar basaltic systems because of the extremely Al-depleted nature of the diogenite parental melts. In terrestrial and lunar basalts, the increase in Al concentration in spinel is interrupted when plagioclase crystallizes. In diogenite parental melts, plagioclase does not come onto the liquidus until the very end of spinel crystallization.