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The effect of trace elements on the olivine-wadsleyite transformation

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ABSTRACT

Multianvil experiments were conducted at 1400 to 1600 °C on olivine and peridotite starting compositions to determine the partitioning of Ti, Al, Cr, Ni, Ca, and Na between coexisting olivine and wadsleyite. All of these elements occur as minor amounts in mantle olivine. Our experiments indicate that all, except Ca, partition preferentially into wadsleyite relative to olivine. The order of preference for wadsleyite is Ni<Na<Cr<Ti<Al, with $D_{tr}^{wad/ol}$ of about 2 for Ni, 3 for Na, and between 5 and 8 for Cr, Ti, and Al. We observe a strong negative correlation between the Si and Cr (+Al) contents of wadsleyite, indicating a coupled substitution of $2Cr^{3+}$ for $Mg^{2+} + Si^{4+}$. Modeling the influence of the trace elements on the olivine-wadsleyite transformation in the mantle indicates broadening effects on the order of 1–3 km, much smaller than that predicted to arise from mantle concentrations of H_2O. Therefore, effects of these trace elements on the properties of the 410 km seismic discontinuity are considered negligible. The maximum solubility of TiO_2 in wadsleyite (about 0.6%) is consistent with the suggestion that olivines containing about 1 vol% $FeTiO_3$ could be inverted wadsleyite.