

LETTER

Incorporation of high amounts of Na in ringwoodite: Possible implications for transport of alkali into lower mantle

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ABSTRACT

Here we report on the coexistence between Na-rich ringwoodite and bridgmanite in the system MgSiO₃-Na₂CO₃-Al₂O₃ at 24 GPa and 1700 °C. In our experiments ringwoodite incorporates up to 4.4 wt% Na₂O, with Na entering the octahedral site together with Si, according to the mechanism: Mg²⁺ → 2/3Na⁺ + 1/3Si⁴⁺. The volume of the unit cell increases along with the Na content. A similar behavior is observed for the unit-cell volume of Na-bearing bridgmanite, although the mechanism of Na incorporation into this structure remains unknown because of the lack of sufficient crystallographic data. Na₂O is compatible in ringwoodite relative to bridgmanite with a partition coefficient (D) of 5 (+5/-4), but is incompatible in ringwoodite relative to carbonate-rich melt/fluid, with the D value ranging between 0.5 and 0.1. Al is highly enriched in bridgmanite relative to the other coexisting phases. Carbonatitic melt metasomatism in the deep transition zone may lead to local Na-enrichment, and ringwoodite may be an important host for Na in the deep transition zone. Subsequent convection or subduction of metasomatized mantle may lead to enrichment of alkaline elements in the upper and lower mantle.

Keywords: Ringwoodite, bridgmanite, sodium, spinel, crystal structure, microprobe analysis, alkalis