

Diopside and magnetite lamellae in olivine xenocrysts from the Colorado Plateau: Former ringwoodite?

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Ringwoodite, the γ -phase of olivine, is a dominant phase in the mantle transition zone, but its natural occurrence is limited to inclusions in diamond since ringwoodite normally decomposes during mantle upwelling. In our search for ultra-deep evidence from Navajo Volcanic Field in the Colorado Plateau, we discovered unusual oriented lamellae of diopside and magnetite in several olivine grains suggesting former ringwoodite among examined hundreds of olivine xenocrysts from the Oligocene diatremes at Green Knobs and Buell Park. Discrete host olivine crystals (2-5 mm across) are Fo₈₉₋₉₃. Lamellae of diopside and magnetite occur in slightly Fe-rich grains (Fo₈₉₋₉₂). Diopside lamellae is Di₉₅ with minor amounts of Al₂O₃ (0.5 wt%), Na₂O (0.2 wt%), and Cr₂O₃ (0.2 wt%). Magnetite lamellae contain significant amounts of Cr₂O₃ (13-17 wt%) in one olivine grain (Fo₉₁) containing lamellae densely. These olivine grains with diopside and magnetite lamellae are consistent with previous experimental predictions of hydrous Fe-rich ringwoodite breakdown (Koch-Muller et al. 2009). Discovered lamellae of diopside and magnetite in olivine suggest the decomposition of hydrous Fe-rich ringwoodite coexisting with α -olivine. Fe³⁺ in magnetite was produced by dehydration-oxidation reaction when ringwoodite was decomposed by the reaction, Fe²⁺ + OH⁻ = Fe³⁺ + O²⁻ + 1/2H₂. This OH-associated oxidation reaction consumed water of ringwoodite itself. The ringwoodite stability in the (Mg,Fe)SiO₄ system requires that the precursor materials formed in a deep mantle setting (> 300 km) and were transported by a mantle plume from around the transition zone to break down into olivine and diopside- magnetite lamellae. Finally, they were transported to the surface by an explosive SUM diatreme eruption. Some olivine xenocrysts in the Colorado Plateau may be originated from deeper mantle than we thought.

Koch-Muller et al. (2009) Phys. Chem. Minerals **36**, 329-341.