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Fluids in the shallow mantle of southeastern Australia: Insights from phase equilibria

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Abstract

Small amounts of water (tens to hundreds of parts per million) can have a profound effect on the properties of mantle peridotites, including viscosities, conductivities, and melting temperatures. Measuring the water content of nominally anhydrous minerals (NAMs) has provided insight into the amounts of water contained within mantle rocks. However, converting from NAM water contents to the activity of H_2O is non-trivial. Equilibria involving amphibole can be used to determine values of the activity of H_2O (a_{H_2O}) at the time of mineral equilibration. This approach yields low values of the activity of H_2O (<0.3) for four peridotite xenoliths from Southeastern Australia. These four xenoliths also record values of oxygen fugacity (f_{O_2}) that range from –0.2 to –1.2 log units below the fayalite-magnetite-quartz buffer. All these values of f_{O_2} are inconsistent with the presence of a CH_4-rich fluid (too oxidizing), and the lowest value of oxygen fugacity, as recorded by one sample, is inconsistent with the presence of a CO_2-rich fluid.

Keywords: Mantle fluids, amphibole, peridotite, nominally anhydrous minerals, H_2O, CO_2; Isotopes, Minerals, and Petrology: Honoring John Valley