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Water in Garnet Pyroxenite from the Sulu Orogen: Implications for Crust-Mantle Interaction in Continental Subduction Zone

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Abstract

Mineral water contents, together with the elements and isotopes of minerals and whole-rock, were determined for garnet pyroxenites enclosed by ultrahigh-pressure (UHP) metamorphic gneiss at Hujialin in the Sulu orogen. The results suggest that the garnet pyroxenites were generated in the Triassic by metasomatic reaction of the mantle wedge peridotite with hydrous felsic melts derived from partial melting of the deeply subducted continental crust. Measured water contents vary from 523 to 1213 ppm for clinopyroxene, and 55 to 1476 ppm for garnet. These mineral water contents are not only correlated with mineral major and trace element abundances but also relatively homogenous within single mineral grains. Such features preclude significant disturbance of the mineral water contents during pyroxenite exhumation from the mantle depth to the surface and thus indicate preservation of the primary water contents for the UHP metasomatites. The garnet pyroxenites are estimated to have bulk water contents of 424–660 ppm, which are higher than those for the MORB source, similar to or higher than those for the OIB sources and close to the lower limit for the arc magma source. The relationships between contents of mineral water and some elements suggest that the high water contents of garnet pyroxenites are primarily determined by the abundance of water-rich clinopyroxene. Calculated whole-rock H_2O/Ce ratios are 63–145, higher than those for Hawaiian garnet pyroxenites and SWIR abyssal pyroxenites. These observations suggest that metasomatic pyroxene-rich lithologies have the capacity to contribute high H_2O concentrations and variable H_2O/Ce ratios to the mantle. This lends support to the interpretation that the source of some intraplate basalts may be a heterogeneous mixture of peridotite and pyroxenite. On the other hand, the high water contents of garnet pyroxenites suggest that the ultramafic metasomatites are an important water reservoir in the mantle wedge.

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