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The relationship between mantle processes and peridotite water contents: insights from Shuangliao, China

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Structurally bonded in many minerals of the subcontinental lithospheric mantle (SCLM), hydrogen (generally referred to as “Water”) has profound impacts on minerals' physical and chemical properties and SCLM geodynamic processes. As an incompatible element, hydrogen should be depleted from peridotite during melting and enriched during mantle metasomatism, however, contrasting observations from different localities worldwide have showed that hydrogen followed the control of either melting or metasomatism, or sometimes even neither. To shed some new light, major and trace elements and hydrogen contents of peridotite xenoliths brought up by three volcanoes of the Cenozoic Shuangliao Volcano Group in Northeast China were determined. Minerals showed variations of major and trace elements especially clinopyroxene. Water contents were measured by Fourier Transform Infrared Spectroscopy at the core of each mineral, and olivine showed no detectable water except for a few grains, while orthopyroxene and clinopyroxene had 14~157 ppm and 46~351 ppm of water, respectively. Samples were divided into 3 types according to trace element patterns: (1) Light Rare Earth Elements (LREE)-depleted, (2) “spoon-shaped” featuring slight enrichment of the most incompatible elements (La and Ce) and relative depletion of Mid-REE, and (3) LREE-enriched. Along with major element trends, Shuangliao SCLM experienced varied degrees of partial melting and cryptic metasomatism. Different water contents of the Shuangliao SCLM were the combined result of melting and metasomatism: less metasomatized samples (LREE-depleted and “spoon-shaped”) preserved the control of water contents by partial melting, while strongly metasomatized samples (LREE-enriched), having higher oxygen fugacity and equilibrium temperature at the same time, showed considerable post-melting modifications of their water contents. This further suggested that water-rich material released by the stagnant slab of the subducting Pacific plate has interacted with the shallow SCLM of Northeast China since the Cenozoic era.