Hydrogen diffusion in orthopyroxene within peridotite xenoliths from Nanjing, eastern China

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Water is key to many geodynamical processes in the Earth's upper mantle, yet its preservation and controlling parameters in mantle minerals is still debated. Here we carried out a detailed investigation of whole-rock and mineral chemistry, microstructures, and hydrogen concentrations in olivine and pyroxene within spinel lherzolites from three localities (Lianshan, Panshishan, and Tashan) in the Nanjing area, eastern China. Mineral and whole-rock compositions suggest that the studied peridotites interacted with silicate melt at different melt/rock ratios following various degrees of partial melting (up to 15%). Microstructural observations are concordant with melt-peridotite interaction as well. FTIR (fourier transform infrared) measurements show that olivine is almost dry (< 2 wt ppm H_2O) while the cores of orthopyroxene and clinopyroxene contain 14-151 wt ppm and 41-218 wt ppm H_2O, respectively. Profile analyses along > 100 orthopyroxene grains, which are homogeneous in major-element compositions, show hydrogen-depleted rims in all the studied samples, indicative of hydrogen diffusion. By contrast, no hydrogen zonation is observed in clinopyroxene. Our data confirm that clinopyroxene more likely preserves its original water at depth than orthopyroxene does. The hydrogen diffusion in orthopyroxene cannot be attributed to Al diffusion during cooling through proton coupled with Al or ionic diffusion triggered by melt-peridotite interaction, but is probably caused by longer duration of entrapment in a degassing magma. In addition, different from most previous studies, our study finds no relation between partial melting/metasomatism and hydrogen concentrations in pyroxene. However, a negative correlation between water content and oxygen fugacity is indicated by our data, suggesting a control of oxygen fugacity on water contents in pyroxene.