

Water carrier in the Earth's deep upper mantle and residues under hydrous condition

MATSUKAGE, Kyoko N.^{1*}

¹Earth and Planetary Sciences, Kobe University

The chemical differentiations and homogenizations of the Earth's mantle are largely controlled by melts and fluids (e.g., silicate melts, H₂O fluid). To understand the influence of H₂O to the chemical evolution of the Earth's mantle, hydrous melting experiments at temperatures up to 1900 K at pressure of 3-8 GPa were performed using the multi-anvil apparatus. In hydrous conditions, the stability field of residual orthopyroxene expands relative to olivine above solidus, and the harzburgitic residue contains large amounts of Mg-rich (Mg# >0.92) orthopyroxene at 4.5 to 6 GPa. The residual chemistry obtained from our experiments agrees well with the chemical variation of the continental cratonic garnet peridotites xenoliths, which was transported by kimberlite magmas. The observation indicates that the cratonic harzburgite with high orthopyroxene contents possibly reflects formation by melt depletion under various water contents from almost anhydrous to 2 wt% in the upper mantle at depths of about 100 to 200 km. The orthopyroxene-rich harzburgite similar to the continental cratonic harzburgite may be formed at deep mantle wedges in the present Earth because water is dragged into the deep mantle wedge by subducting slabs. In present, it is difficult to obtain a petrological evidences for the formation of Si-rich and Mg-rich residues at the deep wedge mantle because a magma upwelling from the deep mantle (>200 km) does not exist. However, the orthopyroxene-rich harzburgite may be detected by seismological observations because a jump of elastic wave velocities possibly occurs at 9-10 GPa (270-300 km in depth) in the orthopyroxene-rich harzburgite due to the orthorhombic to high-pressure monoclinic phase transition in (Mg, Fe)SiO₃ pyroxene. A small jump in seismic velocities at about 250-300 km in depth, the X discontinuity, has occasionally been observed in seismic profiles from some subduction zone, southern Africa and southern Pacific. I consider that the phase transition of (Mg, Fe)SiO₃ pyroxene in orthopyroxene-rich harzburgite may correspond to the X discontinuity.

Keywords: Hydrous melting experiments, high-pressure and high-temperature, wedge mantle, orthopyroxene, craton, X discontinuity