

Spectroscopic estimation of the Moho depth from residual pressures of CO₂ fluid inclusions

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Yamamoto et al. (2002) applied micro Raman spectroscopy to the determination of residual pressures of CO₂ fluid inclusions of minerals in mantle-derived xenoliths and demonstrated that the mantle xenolith of the Far Eastern Russia originated from the depth up to 40 km corresponding to the uppermost mantle. In this study, we applied this method to ultramafic-mafic xenoliths of Oki-Dogo island in the Japan Sea. The eruption age was reported to be ranging 0.29-0.79Ma (Uto et al., 1994).

The analyzed samples are CO₂ fluid inclusions in granulite, lherzolite and olivine gabbro. Granulite and olivine gabbro originated from the lower crust while lherzolite from upper mantle. Comparing the depth origins among these samples can give rise to the determination of the boundary between crust and mantle. Raman spectra of CO₂ fluid inclusions of a few micrometers in size were obtained and splitting of the Fermi diad was estimated for the purpose of obtaining density (pressure) of the CO₂ fluid inclusions. Taking into account of the equilibrium temperature determined from chemical compositions of pyroxenes, the depths where fluid inclusions were equilibrated with host minerals can be obtained. The depth for granulite was in the range of 29-33 km and that for lherzolite was 28-32 km. The boundary between these two rocks corresponds to the Moho discontinuity; the present results demonstrate that the Moho discontinuity under Oki-Dogo island was 29-32 km.

The Moho depth can also be estimated by using seismological methods. However, there is no seismic station available and the seismicity is very low in the Japan Sea off Chugoku District. Hence at the present we cannot determine the Moho depth right under Oki-Dogo with a seismic method. However, a detailed seismic study of the crustal structure was made for the Japan Islands (Zhao et al., 1992). A slight northward extrapolation of their results gives a Moho depth of 26-27 km under Oki-Dogo. The reason for the slight difference between the geochemical and seismological results will be discussed in the presentation.

References

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Raman spectra of liquid H₂O under high temperature and high pressure

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Unpolarized Raman spectra of liquid H₂O were obtained in a pressure range up to 1.6, 2.9, 4, and 5.7 GPa at the following temperature of 25, 100, 200, and 300 °C, respectively. Some data were taken at supercooled conditions. The high pressure and temperature experiments were performed with a Bassett type externally heated diamond anvil cell which was placed within a gear box allowing a continuous compression. Temperature was monitored with two chromel-almel thermocouples attached to the diamonds. Pressure was estimated based on the ruby fluorescence by the use of established equations (D. D. Ragan, R. Gustavsen, and D. Schiferl, J. (1992), C-S Zha, H-k Mao, and R. J. Hemley, Proc. (2000)). Kaiser HoloLab 5000 Raman microscope with YAG laser of 532 nm and 30 mW for an excitation laser was used to take Raman spectra through a low fluorescence Ia diamond of the cell. Grams 5 and PeakFit 4 programs were used for baseline fitting and peak fitting processes, respectively. Although previous studies have suggested that liquid H₂O have five Raman shifts from O-H stretching (e. g., Carey and Korenowski, J Chem Phys, (1998)), in the present study the spectra observed in the O-H stretching region (2800 – 3800 cm⁻¹) were deconvoluted into the two Gaussian peaks: for example 3250 and 3475 cm⁻¹ at 100 °C and 0.11 GPa. At a constant temperature, the frequencies of these peaks show a negative correlation with pressure. This suggests that strength of hydrogen bonding increases as increasing pressure. In contrast, the peak frequencies increase with increasing temperature. This suggests the strength of hydrogen bonding weakens as increasing temperature. Based on the present experimental results, a possibility of phase transition of liquid state of H₂O in the present pressure range will be discussed.

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