THE GEODYNAMICS SEMINAR №617

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2024.10.11 (Fri.) 16:30 ~

Venue: Meeting Room #486

Science Research Bldg. 1, 4th floor.
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Keywords:

1. Orthopyroxene
2. Elastic Wave Velocity
3. Lunar Mantle

Elastic wave velocity measurements of lunar mantle composition orthopyroxene under high pressure and high temperature conditions

Understanding the structure and composition of the lunar mantle is important for discussing the formation and evolution of the Moon. Seismic data of the lunar interior obtained by seismometers at the surface of the Moon have been widely used for inferring the internal structure and bulk chemical composition of the lunar mantle (e.g., Weber et al., 2011). Based on these constraints and samples returning from the Apollo mission, petrological studies have shown that olivine and orthopyroxene should be the main minerals crystallizing from the lunar magmatic ocean. Despite this general consensus, there is no study that verified the assemblage of olivine and orthopyroxene can explain seismic velocities of the lunar interior, which is largely due to our poor knowledge of the P- and S-wave velocities, V_P and V_S, of olivine and pyroxene with lunar compositions at simultaneous high pressure and high temperature conditions relevant to the Moon interior. While such elastic wave velocity data have been reported for San Carlos olivine by Bejina et al. (2021) and Kono et al. (2023), there is no such measurements for $(Mg,Fe)SiO_3$ orthopyroxenes.

In this study, we investigate Vp and Vs of a lunar pyroxene with the composition $(Mg,Fe,Ca)SiO_3$, derived from the lunar mantle mineralogical model of Lin et al. (2017). Ultrasonic interferometry, X-ray radiography, and X-ray diffraction measurements were carried out at the high pressure and high temperature conditions of the lunar mantle (0.9-6.6 GPa and 300-1273 K) at the beamline BL04B1 in SPring-8. Fitting of the experimentally obtained V_P, V_S and density of the lunar pyroxene, by finite strain functions to the third order, yielded the zero-pressure bulk and shear moduli, K_{S0} and G_0, their pressure derivatives K_S' and G', as well as their temperature derivatives, $(\partial K_{S0}/\partial T)_P$, and $(\partial G_0/\partial T)_P$. These newly determined elastic parameters were used to constrain models of elastic wave velocity as function of pressure and temperature for the lunar upper mantle. The results suggest an iron-enriched lunar upper mantle could reconcile seismic models with petrological studies.

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