Sound velocity measurements on lower mantle minerals by femtosecond pulse laser pump-probe technique

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The Earth's lower mantle is proposed to be an uniform chemical composition with the upper mantle (i.e., pyrolitic lower mantle model) based on previous studies on phase relation and density (e.g., [1][2]). High-pressure sound velocity measurements on candidate minerals can also provide the chemical composition of the lower matle by comparing to the obsearved seismic wave velocities. However, the pyrolitic lower mantle model has not been well verified in terms of elastic property due to the lack of experimental data of sound velocity in Fe,Al-bearing bridgmanite and (Mg,Fe)O ferropericlase, the abundant minerals in the lower mantle, with a wide range of pressures and compositions.

Here we measured the longitudinal wave velocitites (V_P) of $MgSiO_3$ and Fe,Al-bearing bridgmanite and (Mg,Fe)O ferropericlase at lower mantle pressures using femtosecond pulse laser pump-probe technique combined with a diamond anvil cell. The present technique was applied to the mineral samples for the first time and allows us to directly measure the V_P in a diamond anvil cell. We found that Fe and Al incorporation into bridgmanite reduces the V_P of bridgmanite. The V_P of (Mg,Fe)O ferropericlace was also lower than that of MgO periclase reported in previous study [3]. The V_P model calculated from our data suggests that the lower mantle composition similar to the pyrolitic model can reproduce seismic observation.

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