Chemical composition of the mantle transition region: constraints from combined in situ X-ray and ultrasonic measurements

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Mineralogy of the mantle transition region (MTR) has been one of the major controversial issues in the studies of the Earth's deep interior. A. E. Ringwood proposed that whole mantle is basically of a pyrolite or peridotite composition, while D. L. Anderson and coworkers claim that MTR is composed of a piclogite composition with less olivine content. We recently conducted precise measurements of elastic wave velocities of hot-pressed polycrystalline samples of high-pressure phases under the P-T conditions of MTR by a combination of ultrasonic interferometry, in situ X-ray observation, and Kawai-type multianvil (KMA) technology to address this issue. Sintered polycrystalline samples of (Mg0.9Fe0.1)2SiO4 ringwoodite and those of majorite with a pyrolite minus olivine composition were synthesized with a large KMA at GRC (ORAGNGE-3000), and were subjected to the simultaneous ultrasonic and in situ X-ray measurements using a KMA at SPring-8 (SPEED-1500) at pressures up to ˜19 GPa and temperatures to ˜1700K. The results on the ringwoodite sample were consistent with those of earlier studies at lower pressure/temperature conditions, whereas the velocities of majorite with the complex chemical composition were substantially lower than the earlier estimates based on the measurements for simpler compositions under lower P/T conditions. The present result suggests that pyrolite yields seismic velocities consistent with those of typical seismological models in the MTR with an exception of the bottom ˜100km part of this region, suggesting the possible existence of a basaltic garnetite layer in this depth region.