Carbon circulation in the lower mantle based on high-pressure experimental results

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Calcite is the dominant carbon-bearing phase in the Earth's crust, and acts as a buffer for the long-term cycling of CO2 between the atmosphere, oceans, and solid Earth. It is unsurprising, therefore, that the high-pressure stability and behaviour of CaCO3 and related phases has attracted considerable interest. High-pressure X-ray diffraction experiments were performed using a laser-heated diamond anvil cell (LHDAC) high-pressure apparatus. The samples were probed using an angle-dispersive X-ray diffraction technique at the synchrotron beam lines BL10XU, SPring-8 and BL13A, Photon Factory in Japan. Calcite, which is the stable phase at ambient conditions, transforms to aragonite at high P-T conditions that correspond to the uppermost part of the upper mantle. The phase transformation from aragonite to a new calcium carbonate form was observed at pressures higher than 35 GPa, corresponding to the lower mantle. The new carbonate shows a hexagonal symmetry and was confirmed to remain stable to 90 GPa (2100-kilometer depth). This indicates that carbon might to be stored in the new carbonate phase in the deep mantle.