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# The pressure and thickness of the post-spinel transition in (Mg,Fe)2SiO4 explaining the sharp 660-km discontinuity

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The 660-km seismic discontinuity (D660) is key to understanding the structure and dynamics of the Earth's mantle. Seismological studies showed that the D660 is located at depths corresponding to 23.4 GPa, and its thickness is extremely small (less than 2 km = 0.1 GPa). It is believed that the post-spinel (Psp) transition, the decomposition of ringwoodite (Rw) to bridgmanite (Brg) + ferropericlase (fPc), causes the D660. In this scenario, thickness of the D660 corresponds to the region of three-phase (Rw, Brg and fPc) coexistence. Nevertheless, no high-pressure studies have successfully demonstrated that the pressure interval of the three-phase coexisting region is less than 0.1 GPa. Furthermore, previous high-resolution high-pressure experiments reported distinctly lower transition pressures than that of the D660. If this discrepancy were the case, the D660 could not be interpreted by the Psp transition. In this study, we examined the transition pressure and interval of the Psp transition in the system Mg2SiO4-Fe2SiO4 with paying special strategies explained below.

High-pressure-temperature energy dispersive in situ X-ray diffraction experiments were conducted using a multi-anvil press at the synchrotron radiation facility, SPring-8. Our strategies are: (1) The starting materials were mixtures of olivine, orthopyroxene and (f)Pc with bulk compositions of Mg2SiO4 (Fo100) and (Mg0.7Fe0.3)2SiO4 (Fo70), which allow both normal and reversal transitions. (2) We loaded both samples in the same sample chamber to determine their phase transitions simultaneously. (3) The whole shape of the three-phase region was depicted based on difference of transition pressures between Fo100 and Fo70. (4) Pressure drop during heating was suppressed by increasing press load. (5) Sample pressures were determined with a precision of $\sim$0.05 GPa by using many (typically eight) peaks of pure MgO. (6) The compositional width of the three-phase region was estimated based on available thermodynamic data from literature.

Our findings are as follows. (1) The transition pressure in Fo100 completely agrees with the D660 depth at an expected mantle temperature of 1900-2000 K, indicating that the apparently lower pressures reported by previous studies were experimental artefacts due to pressure drop upon heating. (2) Contrast to the previous understanding, the Fe-bearing system has a higher transition pressure than Mg-endmember. (3) The pressure difference between Fo70 and Fo100 is only $0.14\pm0.11$ GPa. (4) The pressure interval of the Psp transition at Fo90 is $0.01\pm0.11$ GPa at 1700 K, and even virtually zero at mantle temperatures. Thus, the seismic features of the D660 are interpreted by the binary phase relations of the Psp transition.