Olivine to Modified Spinel Phase Boundary in the System $(Mg,Fe)_2SiO_4$

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Olivine, $(0.9Mg, 0.1Fe)_2SiO_4$, is the most abundant mineral in earth's upper mantle, and it undergoes important phase transitions which are critical for understanding upper mantle seismic structure. One of the most important transitions is the Olivine (alpha phase) to Wadsleyite (modified spinel or beta phase) transition which is widely recognized to be responsible for the seismic discontinuity at ~ 410 km. I have been working together as a team with scientists from the Institute for Study of the Earth's Interior, Okayama University, to determine this important phase boundary in situ at SPring 8. Initially, the intent of this experiment was to determine the olivine-modified spinel transition. However, the experiment performed just prior to mine by a member of our team, Michael Walter of ISEI, was made on the analogous alpha-beta transition in the Mg_2SiO_4 endmember system. The results of that experiment were very interesting, so we decided that the most efficient use of my beam time was to further investigate that transition in order to establish the boundary condition in the Fe-free system. The experimental details can be found in the report of M. Walter (1998A0233-ND -np). The results of the experiments are shown in Fig. 1. Open symbols on this figure show beta phase stability and solid symbols show alpha phase. The arrows depict the P-T path of the experiment. Fig. 1 shows that the dT/dP slope of the transition is ~135 K/GPa, much less temperature dependent than found in a previous study by Morishima et al. (~330 K/GPa). If these data are correct then there are two important geophysical implications: 1) the temperature assigned to the 410 km seismic discontinuity would be significantly different depending on which determination is used, and 2) the expected deflection of the seismic discontinuity to shallower depths caused by slab penetration would be significantly more using our determination. The next task is to add approximately 10% FeO to the system in order to investigate compositions directly analogous to Earth's upper mantle.

Morishima et al. (1996), Science, 265, 1202.

Fig. 1