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Stability of Fe-bearing antigorite at 1.2GPa

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Dehydration instability of serpentinite has been considered as a mechanism of earthquake faulting in subducting slabs and hydrated mantle wedges. When dehydration instability is discussed, stability field of antigorite in MSH or MASH system has often been referred, although it is well known that serpentinites have wide range of bulk-rock compositions and solid-solution composition of serpentine is variable. Compositional dependence of serpentine stability was examined only on Al content (Bromiley and Pawley, 2003), although antigorite in natural serpentinites contains inegligible amount (up to 7-8 %) of Fe. The purpose of this study is to determine the detailed stability of Fe-bearing antigorite with two different Fe/Mg ratios at 1.2GPa to provide a mineralogical basis for understanding porosity and fluid distribution in the dehydrating serpentinite.

For starting materials, two synthetic gel powders (S90, Mg# = 90; and S95, Mg# = 95) and two natural antigorite powders (N90, Mg# = 89.5; N97: Mg# = 97) were prepared. The natural antigorite powders were separated from serpentinite rock powders using SPT heavy liquid. N90 was from dunitic serpentinite and N97 from wherlitic. Distilled H2O was added in the capsule just before starting the runs. The high-pressure experiments were performed in an end-loaded piston cylinder apparatus at 500 – 700 deg.C and 1.2 GPa. In addition to the runs for ca.6700 - 10000 min, which are the typical run durations for the previous experiments in MSH-system, prolonged time-series experiments for ca.27100 - 40000 min have been carried out. The run products were analyzed with EPMA and Raman spectroscopic analyzer.

Gels did not react at 600 deg.C, and small amounts of forsterite and talc were formed at 625 deg.C in the experiments for 7000 min. While in the run products at 550 deg.C for 39996 min, we found that forsterite and talc were formed in the two runs using gel powders. Namely, the stability of antigorite obtained in the prolonged runs is 75 deg.C lower than that in the shorter (ca. 1 week) experiments. Antigorite was formed in a run at 500 deg.C for 27285 min, whereas it was never found in the higher temperature runs. This means that antigorite is stable at 500 deg.C and antigorite stability limit at 1.2 GPa lies between 500 and 550 deg.C. Since the high-temperature anhydrous assemblage (enstatite + forsterite) was obtained from each starting materials at 600 deg.C for 27100 min, the talc breakdown reaction should occur between 550 and 600 deg.C. No compositional dependence of the stability limit of antigorite and talc was observed.

The result of this study shows that stability limits of Fe-bearing antigorite and talc at 1.2 GPa are significantly lower in temperature than those reported for the previous MSH experiments. The lowest reported for talc + forsterite assemblage at ˜1 GPa is 570 deg.C (at 1.1 GPa; Perrillat et al., 2005), but this assemblage is observed at 550 deg.C in this study, showing that antigorite stability lowers for 20-70 deg.C. There are two possibilities to explain this temperature decrease of antigorite stability. One is the effect of Fe, and another is insufficiency of run duration in the previous MSH experiments. It is also shown that Mg# dependence of antigorite break-down temperature, if any, is small in the studies range. This suggests that the dehydration reaction can occur in a small temperature range, which is advantageous to dehydration instability hypothesis as a mechanism for fault plain propagation.