Possibility of percolation of Fe-S melts in asteroids

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Many asteroids and planetesimals have been reported to compose of metallic cores surrounded by silicate mantles (Barrat et al., 2015). Due to negligible accretional heating in asteroids, percolation of liquid iron alloy through solid silicates is likely to be one of the plausible core formation process in asteroids. It is important for understanding asteroid core formation process to clarify whether or not liquid iron alloy percolates through solid silicate matrix. In previous percolation experiments, the dihedral angle between olivine and Fe-S melts is reported to be less than 60˚ below 2-3 GPa depending on olivine composition at oxidized conditions, indicating that the Fe-S melt can percolate through crystalline olivine (Terasaki et al., 2008). To understand core formation process in asteroids, it is important to measure the dihedral angel between Fe-S melts and orthopyroxene (opx) which is one of the major mantle mineral of asteroid as with olivine.

In this study, percolation experiments were performed at 2.5 GPa and 1863 K using cubic multi-anvil devices. Annealing durations range from 15 to 60 min at target temperatures. Starting material was natural opx powder (Fe#=0.29) and Fe-S (S=40, 50 at%). Fe-S layer was set between orthopyroxene layers. Textures of recovered samples were observed using scanning electron microscope. We observed that FeS did not percolate in solid opx, while $Fe_{60}S_{40}$ percolated in opx. In the percolated region, opx was turned into olivine by chemical reaction during experiment. Based on these results (texture, measured dihedral angle, and chemical compositions), we will discuss a possible process of percolation of Fe-S melt in opx solid.

Keywords: Percolation, Asteroid, Core formation

