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Experimental study of two phase melt migration : an analogy of fluid migration in mantle wedge

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The water supplied from descending slab is thought to induce partial melting of the mantle wedge above the subducting plate. The hydrous melt generated from the subducting slab would separate into aqueous fluid and hydrous melt with decreasing pressure by upward?migration due to the buoyancy. The migration behavior of two immiscible fluids is an important process to understand magmatism and its time scale in the subduction zone.
In this study, we investigated migration of two phase fluid composed of hydrous basaltic melt and aqueous fluid in mantle wedge by using some analog materials. Interfacial energy of aqueous fluid -olivine at high pressures and high temperatures is relatively lower than that at condition of shallower part of mantle wedge. Because the interfacial energy between hydrous melt and olivine is lower than that between aqueous fluid and olivine, aqueous fluid tends to be isolated as a spherical particle in hydrous melt. Fe-FeS eutectic melt has extremely higher interfacial energy with olivine compared to the basaltic melt. Therefore, the system, basaltic melt with Fe-FeS eutectic melt in olivine aggregate would be expected to show similar behavior. In addition, the Fe-FeS melt is easy to observe by scanning electron microscope. Using Fe-FeS eutectic melt as an analogy of aqueous fluid, we conducted high pressure experiments to investigate two phase fluid migration in mantle wedge.
Migration couples were annealed at temperature between 1573K to 1673K at 1GPa for various duration using piston cylinder apparatus. Migration couples were composed of melt reservoir made of olivine grains, basaltic melt and Fe-FeS melt for upper cylinder, and olivine poly-crystal aggregates for lower cylinder. The migration profiles of basaltic melt and Fe-FeS melt were measured by analysis of back scattered electron images using field emission scanning electron micro scope (FESEM).
From the result of our experiments, it is suggested that there are two processes of Fe-FeS migration: migration through the initially established pathways of basaltic melt and migration by dissolution/precipitation of species forming Fe-S melt in basaltic melt path. Rate limiting process of migration by dissolution/precipitation is diffusion of sulfur in basaltic melt. The driving forces of Fe-FeS migration through the initially established pathways of basaltic melt might be pressure gradient and that of migration by dissolution/precipitation is chemical potential gradient.