Analysis of the formation process for a rock texture by using a solid particles-fluid multi-phase simulation

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It is important to decipher a rock texture engraved the earth history in order to better understand the evolution process of the earth. An igneous rock texture is formed by the interaction between melt and crystal-particles during the cooling of magma, which is sensitive for the variety of the earth fluctuation. Therefore, the clarifying of formation mechanism of igneous rocks must give us the one of keys to understand the truth of the earth dynamics.

Magma has various rheological properties which are depend on the concentration of solid particles and the interactions of particle-particle and particle-melt. As a kind of those magma behaviors, there is the separation process of melt from crystal-particles bed. For example, melt is separated from solid particles bed when crystal-particles and/or partial melt are generated, and also, the melt of metal-iron alloy is separated from the silicate mantle in the earth's core formation. These are issues to be solved because the separation process is concerned in many geological phenomena. However, the microscopic behaviors of melt and crystal-particles have not been clarified because the experimental observation of a rock formation process is difficult.

In this research, the groundmass texture of andesite lava with shear flow is modeled and the formation mechanism of the rock texture is examined by a numerical simulation. First, the three dimensional simulation method for the behavior of melt and crystal-particles is developed by coupling a discrete element method with computational fluid dynamics. Individual crystal-particle is created by bonding particles. And the hydrodynamic interaction between melt and crystal-particles is considered. The formation mechanism of a rock texture is investigated through the analysis of crystal-particles motion and the pore melt flow in crystal-particles bed due to the interaction of melt and crystal-particles under certain shear stresses.

The system contains crystal-particles with diameter of 100 micron as major axis and 20 micron as minor axis by 40 percent of whole volume. Here, crystal-particles are initially randomly located with random orientation. As shear stress was applied on the system, crystal-particles began to be oriented in a same direction by the velocity gradient of melt flow. After this process, the vortex flow of melt, which contains the ascending and descending flows in the vertical axis of shear direction, was induced by the interaction between crystal-particles and melt. The oriented crystal-particles formed clusters on the junction of the ascending flow and the descending flow which were alternate in shear direction. These clusters were seriously influenced by the shear stress of melt and were broken into individual crystal-particles. In conclusion, it was found that the cluster structure of oriented crystal-particles in same direction was formed in a rock during the process of clustering and breaking repetition of crystal-particles due to the melt flow in vertical axis of shear direction caused by the interaction between crystal-particles and melt.