

The effect of particle size on dynamics of pyroclastic density currents

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Pyroclastic density currents consist of hot pyroclastic particles and gases, and these deposits have wide range of depositional characteristics. However, these complication unable us to understand the flow dynamics easily. In recent years, analogue experiments such as solid-liquid two-phase flows and numerical simulations have been carried. It is not clear similarity between liquid-solid two-phase flows with laboratory scale and gas-solid two-phase flows with volcanic scale. To understand the relationship between liquid-solid and gas-solid two-phase flows, this study carried out analogue experiments with laboratory scale using 'water-granular flow' and 'air-granular flow'. This experiment intended to simulate the pyroclastic density current generated by column collapse.

Water-granular flow experiments were conducted in an acrylic circular tank 30 cm in diameter and 15cm high, filled with tap water to a depth of 13cm. An acrylic cylinder with a gate was situated upward the tank. The dry silica sand were placed in the cylinder. The lock gate was opened to fall the sand into the main tank. The other experiments, using air-granular flow, were conducted in a flat surface. The same cylinder situated 15cm high upward the surface. The lock gate was opened to fall the sand into the surface.

In order to investigate the dynamic behaviour of the flow motion, digital video cameras was used for all the experiments. To preserve and analyze, the experiments were recorded digitally at rates of 30 frames per second. Velocity data of the flow front were obtained. In this study, we set up the parameter that controlled the velocity are diameter of cylinder, mass of the sand.

Our observations of the experiment reveal the subdivision into two regimes of flow motion; a falling region and an outer flowing region. In liquid-granular flow experiments, the falling region was observed two flow motion; plume and thermal. The outer flowing region divides into a dilute cloud region and a dense deposit region roughly just under the cylinder. In air-granular flow experiments, flow shape in a falling region is neither plume nor thermal but almost same columnar as the cylinder. And the outer flowing region was not observed a dilute cloud region but a dense granular flow region.

Following characteristic features were obtained.

It was considered that there was no effect of mass of the sand and the diameter on the range. Velocity of falling region in air-granular flow was much larger than water-granular flow. This suggests that, in air-granular flow, inertial force due to gravity control bulk flow motion and that, in water-granular flow, particle motion more reduce due to viscous forces in water, so particle motion can be neglected in bulk flow motion.