

Spatial distribution of diapir in mantle wedge: Preliminary experiments

Katsuya Kaneko[1], Kazuhisa Inoue[2], Takafumi Suzuki[3]

[1] Earth Sci., IHS, Kyoto Univ., [2] IHS, Kyoto Univ., [3] IHS, Kyoto Univ.

Magmatism in subduction zone is caused by upwelling mantle plumes in mantle wedge. In order to understand temporal and spatial distribution of the magmatism, generation and upwelling processes of the mantle plumes must be clarified. In the processes, mantle shear flow in the wedge driven by the subducting slab is very important as well as gravitational instability of the buoyant mantle. The mantle in the lower part of the mantle wedge is dragged down by the subducting slab while horizontal shear flow of the mantle toward forearc occurs in the shallow region of the wedge. The shear flow affects the processes of the mantle plume. Some recent studies pointed out that volcanoes in subduction zone distribute linearly from the volcanic front to the backarc. This implies that convection in shear flow occurs.

In this study we aim to clarify characteristics and physics of temporal and spatial distribution of the mantle plumes in the mantle wedge. At the present, we report the results of preliminary experiments to observe effects of shear flow on the thermal structure and spatial distribution of upwelling plumes in thermal convection.

In the experiment, a conveyor belt with 21 cm wide set at angle 30 degree to the horizontal in a Perspex experimental tank (inner dimensions of 25 x 35 x 20 cm high) filled with glycerol (viscosity is about 1 Pas). The shape of glycerol above the conveyor is a right-angled triangular prism with 13 cm high (this region is referred to as wedge region). We moved the conveyor downward and formed shear flow in the wedge region like that driven by subduction of slab. 20 nichrome wires with the same length as the width of the conveyor were placed parallel to the strike direction of the conveyor at 5 mm horizontal intervals near the center of the wedge region. The level of the wires is 3 cm beneath the surface of the glycerol. Thermal convection can occur in the fluid above the wires by turning on electric current in the wires. We observed flow pattern and thermal structure in the fluid with fine particles and thermochromic liquid crystals.

The experimental results show that shear flow in the wedge region substantially affects the pattern of the thermal convection. When the shear flow existed, several hot areas elongating along the direction of the shear were observed above the wires. In this case, many upwelling plumes tended to align along the direction of the shear. On the other hand, when the shear flow did not exist, some hot areas elongating along the direction of the wire formed in the early stage of the run, and then the pattern of the hot areas became unclear. Alignment of upwelling plumes was also observed unclearly.

We plan to carry out further experiments where the experimental conditions (e.g., speed and angle of the conveyor, and heat flux from the wires) are systematically changed. On the basis of these experimental results and consideration of similarity between the experimental and natural systems, we investigate features and mechanics of flow that produces magma in the mantle wedge.