E016-008 Room: IC Time: May 29 11:00-11:15

Developing Hydrothermal System and Self-potential Changes Associated with Magma Intrusion

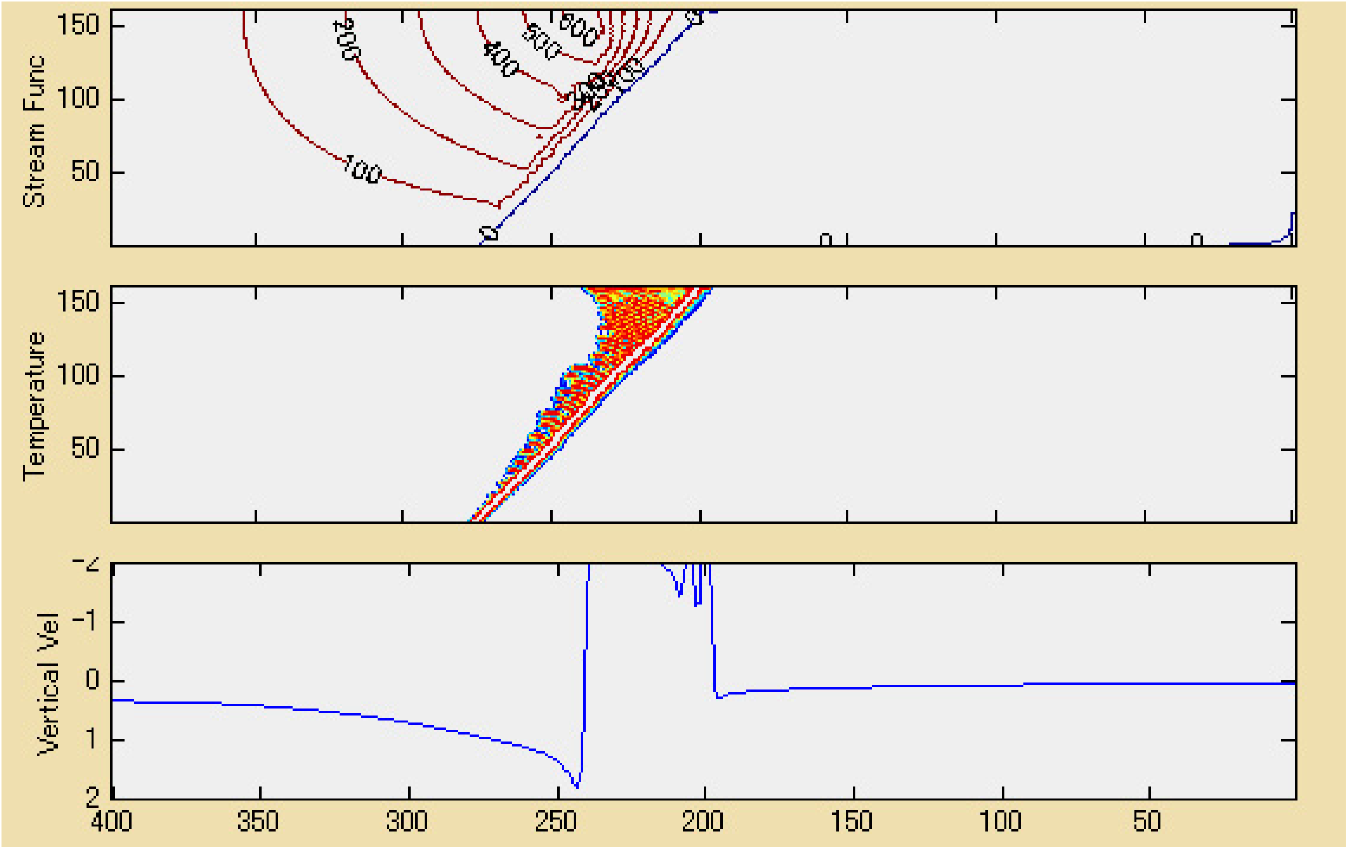
Takeshi Hashimoto[1], Yoshikazu Tanaka[2], Tsuneomi Kagiyama[3]

[1] Inst. Geothem. Sci.., Kyoto Univ., [2] Aso Volcanological Laboratory Kyoto Univ., [3] Earthquake Research Institute, University of Tokyo

http://w3.vgs.kyoto-u.ac.jp/staff/hasimoto/index.html

We have observed self-potential changes on the summit area of Unzen volcano since 1991, just before the extrusion of Heisei-Shinzan lava dome. Unzen extruded magma in 1991 after 200-years repose. From the hydrological viewpoint the 1991 event was a kind of disturbance in fluid flow by a heat source (magma), which was placed at a shallow depth of the volcano after the long-term quasi-steady state. Volcanologically a problem to be addressed is how the intruded magma or hot conduit cools down in the system of hydrothermal circulation within shallow edifice. We have been intending to infer the subsurface fluid flow and its evolution from ground-based self-potential measurements. On the other hand we will have direct measurements of subsurface physical properties such as temperature or permeability by ongoing project of conduit drilling. Hence Unzen is a quite desirable field to compare and verify our inferred model from ground-based observations and direct measurements.

We preliminary depict the evolution process of subsurface hydrothermal circulation from our SP observation as follows: (1) magma intrusion and consequent sharp increase of SP at the summit area. (2) following development of hydrothermal circulation at a shallow depth with a time-scale of 5 years. Our observational results imply that the hydrothermal circulation still persists, acquiring the thermal energy from the cooling conduit even 11 years after the eruption. We conducted 2-D numerical simulation of fluid flow in order to verify the scenario. We used the code from Yusa(1986), which calculates 2-D saturated porous flow of water and heat. Fig.1 shows an example of our simulation with a sheet-like inclined conduit (heat source at constant temperature) and a permeability of 1e(-12) (sqm). The stream function (upper panel) shows a clear fluid circulation in the upper part of the conduit. On the contrary, there is no distinct circulation below the conduit. This can be explained that buoyant fluid tends to flow up along the lower boundary of the conduit. Temperature distribution (middle panel) shows the broadening profile towards the surface. These features are established within a time-scale of about ten years. After the transient phase it goes into a quasi-steady state. Another feature is a down-flow zone adjacent to the main upwelling as shown in the vertical velocity at the ground surface (lower panel). This result implies that a down-flow zone as well as upwelling should be established during the evolution process of the circulation, being consistent with our observational result indicating the considerable decrease of SP at the western part of the dome after the extrusion.



Stream Func
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Temperature
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Vertical Vel
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350
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250
200
150
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50