Self potential changes associated the emergence of fumaroles on Mt. Fuji

Koki Aizawa[1]

[1] Earth and Planetary Sci.Kyoto Univ

Self potential (SP) and magnetotellurics (MT) surveys were carried out in 2001 and 2002 on the summit area of Mt. Fuji. The SP surveys revealed that an intense positive anomaly (about 2000 mV) is located in the summit area. The MT surveys revealed that a strong conductor (about a few ohm-m) is located at the depth of 1km beneath the summit, and has a lateral extent of about 4km. The SP anomaly is interpreted to be of electrokinetic origin, suggesting the presence of a hydrothermal system.

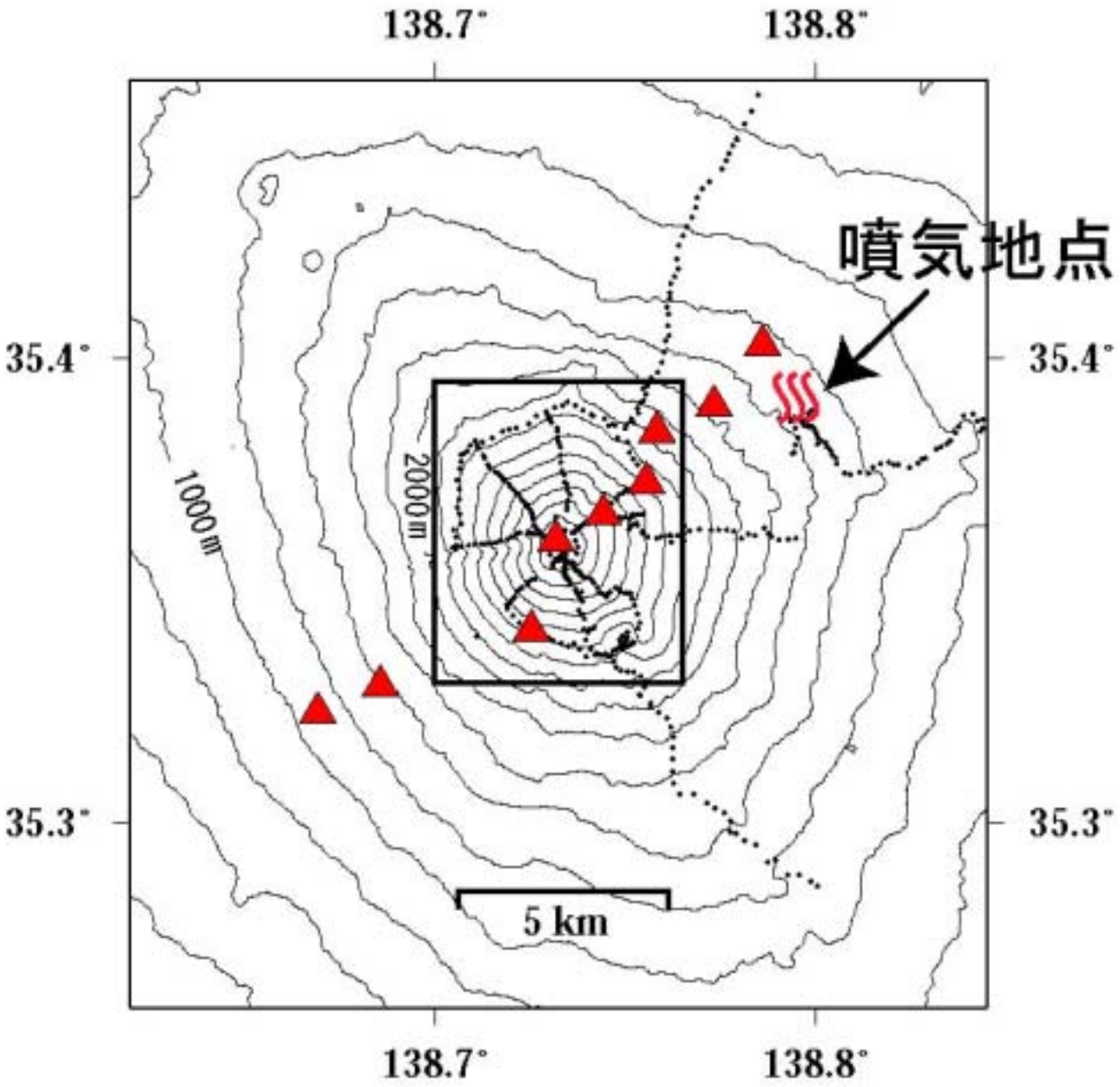
In order to detect the time variation in the positive SP anomaly and monitor the hydrothermal system, I conducted the repeated SP surveys 5 times on the south flank. The site at an elevation of 3270m was marked as a reference point. We confirmed that the SP distribution is very smooth (local variation is 10mV) around a reference point. Neglecting the fluctuations of the short wavelength field, the positive SP anomaly was very stable (about 900mV) on 2001 and 2002. However, its amplitude increased to about 1100mV on September 12, 2003 and suddenly decreases to about 750mV two weeks later. The day of the emergence of fumaroles was September 14, 2003. This result suggests that the state of the hydrothermal system highly changed during September 2003, and its change is related to the emergence of the fumaroles 6km away from the summit.

According to the laboratory experiments [Ishido and Mizutani, 1981] various physical (e.g. temperature, fluid mass flux) and chemical (e.g. pH and salt concentration) parameters affect the amount of electric charges that is conveyed by an electrokinetic effect. However, taking into account that the SP changed while the fumaroles appeared, only changes of fluid mass flux and/or temperature are thought to be the reasonable cause for the SP time variation. Since more positive charges are conveyed as the flux and temperature become higher, the amplitude of a positive SP anomaly can be interpreted as the intensity of the hydrothermal upwelling. I propose a possible model as follows on the viewpoint of the hydrothermal model.

Before the emergence of fumaroles, the hydrothermal upwelling beneath the summit crater became active temporally, hence the positive anomaly increased in amplitude. Then some of the hot water which contributed to the hydrothermal system has escaped, and moved 6km to east-northeast flank, warming the groundwater. Consequently, the activity of the hydrothermal upwelling beneath the summit decreased, and the amplitude of the SP anomaly diminished. The structure of east-northeast flank may be relatively weak and hot water was able to migrate rapidly without earthquakes. Finally the warmed groundwater rose to surface through the shallow weak zone and appeared as the fumaroles.

Reference

Ishido, T. and Mizutani, H. (1981). Experimental and theoretical basis of electrokinetic phenomena in rock-water systems and its application to geophysics, J. Geophys. Res.,Vol. 86, pp. 1763-1775.



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