SVC52-P01 Room:Convention Hall Time:May 21 18:15-19:30

Conductivity distribution of the surface layer around active volcanoes

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Kagiyama and Morita(2008) proposed that volcanism has a wide range of diversity represented by two typical end members controlled by the easiness of magma storage beneath volcano; Eruption dominant (ED) volcanism in difficult condition and Geothermal activity dominant (GD) volcanism in easier condition. In GD volcanoes, magma stagnates beneath volcanoes and maintains geothermal activity. This seems GD volcanoes continue to give much benefit to human society. However, GD volcanoes sometimes have large eruptions after repeated stagnations of magma. This fact suggests it is very important to understand where and why magma stops ascending. Kagiyama and Morita (2008) indicated magma degassing is one of the important factors to control magma ascending. On this aspect, the authors have carried out VLF-MT survey around some active volcanoes in Japan, because electrical conductivity of ground strongly depends on the conductivity of pore water.

Aso Caldera has an acid crater lake in Nakadake, which is one of the post caldera cones, and has many hot springs such as Uchinomaki, Akamizu. Conductivity distribution shows two typical features; caldera floor has almost homogeneous and high conductivity (> 10mS/m), while the post caldera cones show wide range. Most cones such as Kishima-dake and Ohjo-dake have lower conductivity (<3mS/m), except around Naka-dake Craters and western flank of post caldera cones such as Yoshioka and Yunotani (>30mS/m). Kusasenri Volcano, located between Naka-dake and Yoshioka has also rather high conductivity (3-10mS/m). These areas locate along the E-W trend of the major post caldera cones. Most part of the northern flank of the post caldera cones shows low conductivity (<3mS/m). However, higher conductivity was found around Sensuikyo, just north of Naka-dake Craters. This suggests down flow of hydrothermal water from Naka-dake Craters to the caldera floor.

Caldera floor has almost homogeneous conductivity. This feature is explained by the fact that the caldera floor was under the lake until 9 ka and is covered by lake deposit. However, extremely high conductivity was found at three areas (>50mS/m). Two of them correspond hot spring areas; Uchinomaki in the north and Akamizu in the west. The third area is distributed around old post caldera cones, Mietsuka. The age of these cones was estimated around 46 ka, and no hot spring is distributed. High conductive zones, Uchinomaki, Mietsuka and Naka-dake are located along the NNW-SSE line. Hydrothermal water may be supplied along this line.

These results suggest that hydrothermal water is supplied along the E-W trend crack from Naka-dake to Yoshioka, mainly supplied beneath Naka-dake, and expanded to the northern caldera floor. The NNW-SSE trend from Naka-dake to Uchinomaki may suggest a tectonic fault. Aso has wide high conductivity area and degassing in Aso might be large to be GD volcano.

Reference: Kagiyama and Morita, First steps in understanding caldera forming eruptions, J. Disaster Res., 3, 270-275, 2008.

Keywords: Active volcano, Electrical conductivity, Geothermal activity, Failed eruption

SVC52-P02 Room:Convention Hall Time:May 21 18:15-19:30

Temporal variations of self-potential at summit area of Izu-Oshima volcano

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In order to detect a signal associated with the change of volcanic activity, we has measured continuous Self-Potential(SP) variation at 11 stations in the summit crater of Izu-Oshima volcano from 2006. Electrical differences between sites are recorded every one minute. Rain fall and soil water content are recorded every ten minutes at one station. SP data commonly show the annual change; the values are high in summer and low in winter. The amplitude of the annual change is observed to be 100mV in maximum. The short period variations in several days are also observed after rain fall. These variations are produced by the change of soil water content near surface. On the analogy of the short period variation, the annual variation is thought to be caused by the seasonal change of soil water content at depth. The temporary trends excluding the annual variation do not show any signals suggesting the increase of volcanic activity.

We estimate SP variations associated with the change of magmatic activity using the simulation code named STAR. The simulation considers mass and heat transfer of vapor and liquid fluid within porous media, and calculates the drag electrical current with fluid flow and electrical potentials induced by the drag current. For the initial condition which is satisfied with the present state of SP distribution in Izu-oshima volcano (Onizawa et al., 2009), we simulate SP variation if magma intrudes at seawater level and degassing occurs at the top of magma. The resistivity of formations is approximated with the parallel circuit of solid and pore resistivity. The pore resistivity changes remarkably with dissolved component. We assume that the acid fluid produced by the condensed volcanic gas has the resistivity similar to that of sea water (0.25 ohm?m). When permeability of the degassing vent is higher than the surrounding formations with two order of magnitude, and degassing occurs at the rate of 80 kg/s which corresponds to half the maximum vapor discharge rate during 1986 eruption, the positive SP anomaly up to 100 mV appears near the summit crater at 1 year after the onset of degassing, although volcanic gas does not reach to ground surface at that time. Due to the cooling of volcanic gas, the counter flow of upward vapor and downward liquid develops around the degassing vent. The drag electric current is produced only by downward liquid flow, but low resistivity of the acid liquid causes a strong positive anomaly at ground surface.

Keywords: Izu-Oshima volcano, Self-potential, Hydrothermal system, Numerical simulation

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SVC52-P03 Room:Convention Hall Time:May 21 18:15-19:30

Resistivity structure around Chishinshan, Matsao, and Tayukeng areas, Taiwan, revealed by audio-magnetotellurics

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Electromagnetic surveys have found the low resistivity region beneath the active volcanoes. This is because high- salinity and temperature hydrothermal fluids decrease the resistivity of the pore water and rock matrix, when the volcanic fluids are released from magma and injected into the aquifer. The spatial extent of the low resistivity region could be used for evaluating the eruptive potentiality of volcanoes from the viewpoint of magma degassing.

Tatun Volcano Group is composed of over twenty volcanoes, which were formed within the graben at the northern part of Taiwan. So far, these volcanoes were regarded as extinct because of no historical record of eruption. However, recent studies have found the relatively young ejecta (Chen and Lin, 2002; Belousov et al., 2010), high $^{3}He/^{4}He$ ratio (Yang et al., 1999; Ohba et al., 2010), and hypocenter distribution suggesting the fluid flow and the high temperature condition (Konstantinou et al., 2007); that suggest the presence of potentially eruptive magma beneath TVG. Further, active heat discharge from fumaroles and springs also suggests a large amount of the volcanic fluids released from magma beneath Chishinshan volcano. Focusing on this phenomenon, Utsugi et al. (2012, workshop at TVO, Taiwan) conducted AMT surveys at the volcano for a better understanding of this magma degassing, and showed the preliminary resistivity structure suggesting the low resistivity region at the depths of 1-2km.

On the basis of their work, the authors conducted further AMT surveys around Matsao hot spring and Tayukeng fumarole areas, about 2 km northeast of the volcano from Dec. 9th to Dec. 16th in 2012. Two Phoenix MTU5A systems were used at the same time for the remote reference processing (Gamble et al., 1979). Time series of the electric and magnetic fields were acquired for about 4 hours at each site. Totally 10 observation sites were configured to cover the areas. After data acquisition, the frequency domains were obtained from the time series, using FFT processing. The impedances were estimated for each frequency. The obtained frequency range was between 1 and 10400 Hz.

First of all, the spatial extent of the rotational-invariant apparent resistivity was estimated, using the both data obtained by the authors in 2012 and Utsugi et al. (2012) in 2011. At a several thousands Hz, the low resistivity areas of 10-30 Ohm-m are found separately at Lengshueiken, Matsao, and Tayukeng. With decrease in the frequency, the area is extending more spatially. At a several tens Hz, the above three low resistivity areas are connected to each other, and the extremely low resistivity area less than 3 Ohm-m emerges near the central part of Chishinshan volcano. These features suggest the hydrothermal fluids are flowing from the central area of the volcano toward Matsao and Tayukeng areas.

Impedance phase tensor analysis (Caldwell et al., 2004) found that Chishinshan volcano, Matsao, and Tayuheng areas have each features with respect to its main axes. The axes almost perpendicular to the Jinshan fault are dominant at Chishinshan volcano. Matsao area has two modes of the axes; one is almost perpendicular to the fault, and the rest is toward the valley between Chishinshan and Chigushan, where hot spring is discharged. Tayuken area has the axes toward its fumarole area. Following the above features, the following regional strikes were estimated: N52.5E for Chishinshan volcano, N70E for Matsao, and N90E for Tayuken. In the presentation, the estimated two-dimensional resistivity structures beneath three areas will be shown.

Keywords: low resistivity region, hydrothermal fluids, hydrothermal alteration, magma degassing, Tatun Volcano Group, Taiwan

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Fluid injection at the 1st crater of Aso volcano

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An active crater at Aso volcano, Japan, is typically filled with green colored hot water, which is seen as a crater lake. The water is sometimes dried up and then an eruption occurs. Although these two stages seem to be quite different, both may be same in essential quality. The author applied the cross correlation method of infrasound and seismic signals (Ichihara et al., GRL, 2012) to data observed at the small events of gas emissions in 2011, and also the data after the eruption period. As a result, clear patterns of cross correlation functions (CCFs) during the eruptive period, May-June 2011, could be recognized; a stable node of the CCFs was positioned around dt=0, and the seismic data had a pi/4 phase delay relative to the infrasound. It suggests that infrasound signals were generated at the gas emissions and they thus induced ground motions at local area around the station, although we could not identify the signals from the original infrasound wave traces. Characteristic patterns of CCFs were also identified several times after the eruptive period, when the crater was perfectly refilled with hot water. The patterns in these post-eruption periods had different features from the ideal ones; the maximum value of the CCFs was seen at the lag time far from the expected pi/4 phase delay of the seismic data, and the position of the node was not same as those during the eruptive period. In some cases, the seismic data had a phase ahead of that of the infrasound. From numerical calculations, it was confirmed that these seemingly-peculiar features are owing to continuous tremors in the background (Takagi et al., JVGR, 2009). When the patterns of CCFs were observed, whether they were affected by the background continuous tremors or not, the source location of the infrasound signals were determined as the central part of the crater based on analysis of infrasound network data. Therefore, it is interpreted that some kind of events which emit infrasound signals also occurred in the crater after the eruption. One possible candidate of this infrasound source is an ejection of thermal fluids into the crater lake from the bottom, which made the water surface just above the vent swing. If much stronger ejections occur, we will be able to observe them as jets and/or ash plumes through the water surface such as the 2003 and 2004 eruptions (Miyabuchi et al., BVSJ, 2005). In order to clarify this hypothesis, we should carefully monitor the seismic signal relating to the fluid movement as well as the temporal change of the temperature and the water level of the crater lake, and compare them to the results of the cross-correlation analysis. In the presentation, the author also would like to discuss time relation between migration processes of volcanic tremors based on the amplitude ratio analysis of seismic signals (Taisne et al., GRL, 2011) and the fluid injections interpreted from patterns of CCFs.

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Rising of the temperature of Kawayu hot springs in recent years, eastern Hokkaido, Japan

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The author and co-warkers performed suryeying the present conditions of Kawayu hot springs concerned with the civil engineering plan of Teshikaga Town. He comprehend that most springs in Kawayu had 50 to 65 degrees centigrade water temperature, and come back to high temperature conditions in 1950's to the middle of 1960's in conseqence.

Keywords: Kawayu hot springs, Atosanupuri volcano, Kutcharo Caldera

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Estimation of volcanic carbon dioxide emission rate from Kuju Volcano, Japan

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Kuju Volcano is located in Kyushu and one of the active volcanoes in Japan. In order to provide data for construction of a numerical model of the hydrothermal system in the Kuju volcanic area, we tried to estimate volcanic carbon dioxide emission from Kuju Volcano.

We considered four forms of volcanic carbon dioxide emission; from the fumaroles, the bare area around the fumaroles, the flank by the soil gas, and some hot springs at the foot of the volcano. The present activity of Kuju Volcano is thought to return to the level of before 1995 phreatic eruption by the recent observation data (earthquake activity, heat discharge rate etc.). Therefore, we adopted the value of about 166 t/day from the plumes of Kuju Volcano estimated by Ehara et at. (1981). On the other hand, Itoi (1993) shows the distribution of soil gas carbon dioxide concentration in the bare area around the fumaroles. In our previous study (Araragi et al., 2008), the relationship between the soil gas carbon dioxide concentration measured by the Kitagawa Gas Detector Tube System and the carbon dioxide flux measured by a CO_2 flux meter in Kuju Volcano was found. Therefore, the soil gas carbon dioxide concentration values shown by Itoi (1993) were converted into the carbon dioxide flux values by using the relational expression, and the volcanic carbon dioxide emission from the bare area was estimated at about 0.8 t/day. We measured soil gas carbon dioxide concentration at 60 points on the flank of the volcano by the Kitagawa Gas Detector Tube System and collected 15 soil gas samples to conduct the carbon isotope analysis to identify the origin of the soil gas carbon dioxide. As a result, we concluded that the volcanic carbon dioxide emission from the flank was 0 t/day. And for the carbon dioxide emission from the hot springs at the foot of the volcano, the data of the Nagayu Hot Springs area was adopted because Iwakura et al. (2000) indicated that the carbon dioxide of the carbonated water from Nagayu Hot Springs was volcanic. The volcanic carbon dioxide emission from Nagayu Hot Springs was estimated at about 5.0 t/day by using the data of the hot water discharge rate and the average carbon dioxide concentration in the carbonated water. These results show that the volcanic carbon dioxide emissions by the plumes from the fumaroles and by the carbonated water from a hot springs area are dominant in Kuju Volcano.

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Keywords: Kuju Volcano, carbon dioxide, emission rate