Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SVC049-P01 Room:Convention Hall Time:May 23 14:00-16:30

Volatiles and resistivity structure around the aquifer of Mt. Fuji

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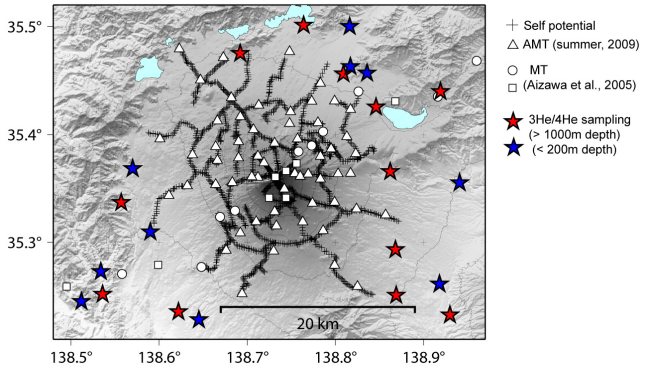
Recently, volatiles in magma are considered to be important for understanding volcanic eruptions, because they may control the occurrence and the style of eruptions. Even in the volcano without active crater or vent, volatile may escapes laterally to the interior of the volcanic body, and therefore, it is useful to investigate the volatile migration path in the volcanic body prior to the eruption. We think that electric resistivity structure may delineate the zone of laterally degassed volatile beneath a volcano. The laterally degassed volatiles are absorbed by groundwater at the shallow level beneath the volcano by dissolution. As a result, the amount of dissolved ions changes, and subsequently changes the groundwater conductive. In summary, the conductive zone in aquifer may indicate the large contribution of volatile. We will investigate the possibility of above scenario with the results of resistivity surveys and 3He/4He ration, D/H and 16O/18O ratios, chemical composition of groundwater at Mt. Fuji volcano. In particular, the relationship between the resistivity structure and the volatile in the deep groundwater (more than 1000m depth) is discussed.



Japan Geoscience Union Meeting 2011
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SVC049-P02 Room:Convention Hall Time:May 23 14:00-16:30

Hot spring waters in basement rocks of Hakone and Yugawara volcanoes

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Hot springs that contain volcanic hot waters or are affected by volcanic gases flow out from ejecta of Hakone volcano in those areas as Owakidani, Ubako, Gora and Ashinoyu located around central cones (e.g., Kikugawa, 2009). Besides these, hot springs originally contained in cracks in Yugashima formations and Hayakawa tuff breccia that compose basement rocks flow out in Hakone-Yumoto, Ohiradai, Miyagino and Dogashima spas distributed along Hayakawa and Sukumogawa rivers. Thermal waters from cracks in basement rocks also flow out in the Yugawara area along Fujikigawa and Chitosegawa rivers, though hot springs of fossil waters that are characterized by very high concentration of NaCl are seen along seashore. In this report features of hot springs in basement rocks of Hakone-Yumoto and Yugawara areas are compared by examining concentrations of main anions, their relative concentrations and oxygen isotope ratios. Then, flow systems of those hot springs are investigated.

One of the features that are common to both of hot springs in base rocks in Hakone-Yumoto and Yugawara is that concentration of HCO_3^- is very low (for almost all of them the concentration is below 100mg/L). Others are the inverse relationship between concentrations of HCO_3^- and $SO4_2^-$, and the positive relationship between concentrations of SO_4^{2-} and Cl^-. However, it should be noted that the relationship between concentrations of SO_4^{2-} and Cl^- is not one, but three types of different correlation coefficients are seen for hot springs in Hakne-Yumoto (Kikugawa and Itadera, 2008). Further, there exists such a group in Yugawara that relationship is not observed apparently between concentrations of SO_4^{2-} and Cl^- due to very low concentration of Cl^-. Weak correlation is observed between concentrations of HCO_3^- and Cl^- for hot springs in Hakone-Yumoto. On the other hand, in Yugawara, in addition to the similar group, there is another type of hot spring in which such a relationship is not recognized because of very low concentration of Cl^-. The latter type corresponds to the group where relationship is not observed between concentrations of SO_4^{2-} and Cl^-.

Although, among number of types of different origin in the Gora area, such hot springs exist that concentrations of SO_4^{2-} and Cl^- are related (Kikugawa et al., 2010; Itadera et al., 2010), there is no such hot springs that posses every feature recognized in hot springs flowing out from cracks in basement rocks. The relationship between the oxygen isotope ratio and the concentration of Cl- seems to be similar to that seen in some types of hot springs in the Gora area. However, relationships between the oxygen isotope ratio and the concentrations of SO_4^{2-} or HCO_3^- differ apparently.

Although hot springs flowing out in Hakone-Yumoto and those in Yugawara show common features as described above, clear differences can be also seen between them. For example, concentration of SO_4^{2-} for most hot springs in Yugawara is notably high compared to that for hot springs in Hakone-Yumoto. Further, as noted by Kikugawa and Itadera (2008), there are several types in hot springs in the area of Hakone-Yumoto for which concentration ratios between main anions are different. In Yugawara as well, it seems that there are multiple types of hot springs as shown above. This is considered to indicate that not one but multiple flow systems exist in each of the areas.

Keywords: hot spring, base rock, Hakone, Yugawara, dissolved constituent

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SVC049-P03 Room:Convention Hall Time:May 23 14:00-16:30

Fluid geochemistry and trace element composition of a marine hydrothermal circulation system at the Wakamiko crater

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Marine shallow-water hydrothermal activity was located in the Wakamiko submarine crater at 200 m depth in the northern part of Kagoshima Bay, which is considered as the main vent of a gigantic eruption that formed Aira caldera structure. WHV site in the northwest part of the crater was considered as the activity center, where vigorous venting of high-temperature fluid (Tmax = 200 degC) was observed. In SES site located approximately 1 km southeast of WHV site, weak diffusive fluid emanation (T = about 60 degree C) associated with vigorous fumarolic gas discharge was observed. Along the coast of the Kagoshima Bay, that is corresponded to the outer rim of the Aira Caldera, some onland hot springs (T = 43-81 degC) are pumped up from 500-1000m deep.

In this presentation, we will report fluid chemistry of submarine hydrothermal fluids from two sites (WHV site and SES site) in the Wakamiko crater and of onland hot springs, focusing on concentration of trace elements.

[Methods]

Submarine hydrothermal fluid samples were collected during NT10-05 expedition in March of 2010, using ROV *Hyper Dolphin* of JAMSTEC (Japan Agency for Marine Earth Science Technology). Onland hot spring water samples were collected in July of 2010.

We analyzed chemical composition of the fluid samples as follows; ion chromatography and atomic absorption spectrometry for potassium, ICP-AES for sodium, calcium, magnesium, ICP-MS for lithium, rubidium and cesium, AgNO3 titration for chloride.

[Results and discussion]

Both Wakamiko submarine hydrothermal fluids (WHV site and SES site) and onland hot springs have significantly low Na and Cl concentrations with the same Na/Cl ratio as seawater and significantly negative delta D value. These results suggest that both fluids are originated from common reservoir which is contributed from onland ground water and seawater.

It is notable that Ca and K concentrations of the submarine fluid from SES site are lower than those from WHV site. According to the conventional geothermometer assuming equilibrium for water-rock interactions, reservoir temperatures were estimated as 250 degC for WHV site and as 200 deg C for SES site. On the other way, based on temperature records of a platinum resistance thermometer during the fluid-sampling, vent fluid temperatures were estimated as 240 degree C for WHV site and as 180 degree C for SES site, after correction for seawater mixing. This accordance supports the idea that major elements composition of submarine hydrothermal fluids is controlled by hydrothermal interactions within the reservoir at different temperature condition. Fluid temperatures of the onland hot springs in the reservoir are estimated as around 100 degree C.

Li, Rb, and Cs concentrations of three fluids showed highest for WHV site followed by SES site and the onland hot springs. It is known that trace elements are subject to leach from the primary minerals into the fluid and not involved into the secondary minerals during fluid-rock interaction in the reservoir. Positive correlation between the Li, Rb, Cs concentrations and the estimated temperature among these three fluids implies that Li, Rb, Cs concentrations reflect the temperatures of aquifer.

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SVC049-P04 Room:Convention Hall Time:May 23 14:00-16:30

Geochemical studies of a marine-shallow water hydrothermal system in Kueishantao, Taiwan.

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Kueishantao Is. is a volcanic island located about 10-kilometers off NE Taiwan, which is considered as located at the western end of the Ryukyu volcanic arc. The last major eruption of the volcano occurred about 7000 years ago, which formed andesite lava flow and pyroclastics (Chen et al., 2001). More than 30 submarine hydrothermal vents are located at the seafloor of 10 - 30 m water detph along the coast line. Temperature of the vent fluids was as high as 116 oC and the pH is as low as 1.52 (Chen et al., 2005).

With a view to evaluate influence of fluid discharge into the coastal region, we will discuss sources and its contribution to the hydrothermal fluid of Kueishantao. We conducted collaborative studies with National Sun Yat-Sen University in August, 2010. Three fluid samples were collected from hydrtoehrmal vents by scuba diving, and five seawater samples were collected by Niskin bottle from water column above the vent field. Chemical analysis of major elements composition was analyzed by conventional methods using ICP-AES, AAS and IC.

When analytical results are plotted in a two composition diagram, the plots of the obtained samples are aligned along a single line, which is interpreted as a mixing line between two endmemebers. The hydrothermal endmember shows lower concentrations in most species than the other endmeber which is correspond to the ambient seawater. Based on this signature, the hydrothermal component could be attributed as 1) a hydrothermal fluid that experienced water-rock interactions, 2) a vapor phase of the phase separated seawater, or 3) contribution of terrestrial water.

In the case 1), fluid chemistry should reflect results of the water-rock interaction where Mg is removed from the fluid and cations are leached into the fluid. However, the obtained samples showed low concentrations of all the cations including Rb that is a kind of mobile element. In the case 2), concentration ratios among major cation and anion should be close to those of seawater. However, the obtained samples showed rather diverse Na/Cl ratios, which ranges from 0.86 to 0.79. In order to discuss the possibility of the case 3), chemical composition of lake water collected from Lake xxxxx were plotted together for comparison. It is obvious that the plots of the obtained samples in our study are aligned along the mixing line between the lake water and seawater for major cations (Na, K, Mg, Ca). On the other hand, for major anions (Cl, SO4), the obtained samples showed enrichment compared with the mixing line. Strong acidity of the obtained samples suggests involvement of magmatic volatiles into the hydrothermal fluid composition, which well explains also the anion enrichment. We are planning to conduct isotope analyses to obtain more strong evidence.

Chen et al.,(2001)A date for volcanic-eruption inferred from a siltstone xenolith. Quaternary Science Reviews, 20, 869-873.
Chen et al.,(2005)Tide-influenced acidic hydrothermal system offshore NE Taiwan. Chemical Geology, 224, 69-81.

Keywords: shallow water hydrothermal system, Kueishantao

Japan Geoscience Union Meeting 2011
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SVC049-P05 Room:Convention Hall Time:May 23 14:00-16:30

Audio-frequency Magneto-Telluric survey on Tatun Volcanic group, Taiwan

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Tatun volcanic group (TGV) is located at northern Taiwan. More than 20 volcanic domes and cones have been created within and around Tatun Graben, which is bounded by Chinshan Fault in the north and Kanchiao Fault in the south. Most volcanoes have been created before 0.3 M (Wang and Chen, 1990), and no historical record of eruption at TVG. However, eruptions in 18 ka BP (Chen and Lin, 2002) and 3 ka BP (Chen, unpublished data) have been identified. Yang et al.(1999) found magmatic contribution in fumarolic gas. In our study, we would like to carried out MT (Magneto-Telluric) survey around TVG to clarify subsurface electrical conductivity distribution, which is the sign of degassing around volcanoes.

On TVG area, we made Audio-frequency Magneto-Telluric survey on 5 points. All points are located inside the Yanminshan national park. On this survey, survey line is arranged to cross Seven-star volcano north-west to south-west. The total length of survey line is about 10km. The purpose of this survey is to clarify the geothermal distribution beneath the active area of this volcano. We used three MTU-5A equipments (Phoenix Geophysics Inc.), and made observation during 2-3 hours on each points.

Keywords: Tatun volcanic group

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Fluid geochemistry and rock minarals on EGS system

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At EGS system, production fluid geochemistry depends on mineralogy of reservoir rock and circulation system.

During closed-loop circulation test at Habanero EGS site, South Australia, Na, K and Cl concentration were gradually increasing and highwer than those of the previous open flow production test.

In this system, increasing of Na, K may be due to dissolution of feldspars of granite rock at reservoir depth.

Similar trend is shown in production well at Hijiori EGS site, Japan. In Hijiori system, at first 3 month of 2000-2002 long term circulation test, Na,K,Cl were increased and about half concentration of Habanero site. And Ca and SO4 are slightly higher.

This difference is due to the circulation system. At Hijiori, open loop system and injection fluid was supplied from near river water. Then, anhydrite (CaSO4) was dissolved.

On the other hand, at Habanero, closed loop system and no fluid was supplied during circulation. In addition the chemical composition of the granite in which the fluid is circulating is also different, with low-calcium granite at Habanero and high calcium tonalite/granodiorite at Hijiori.

Keywords: geothermal, EGS, fluid chemistry, Rock minerals

Japan Geoscience Union Meeting 2011
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SVC049-P07 Room:Convention Hall Time:May 23 14:00-16:30

Geothermal Reservoir Monitoring by the Hybrid Repeat Gravity Measurement in Takigami Geothermal Field

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It is important to understand the geothermal reservoir behavior in order to produce geothermal fluid for a long time. And it is required to evaluate the influence of the production and reinjection of a large quantity of geothermal fluid in the geothermal area. The mass changes in the geothermal reservoir with production and reinjection of geothermal fluid cause the gravity changes on the surface. Repeat gravity measurements have been applied at the Takigami geothermal field in Central Kyushu, Japan, where the Takigami power plant (25MW) has been generating since November 1996. We started the repeat gravity measurement in May 1991, before the commencement of power generation at the Takigami geothermal power plant, at 26 observation stations. We used a Scintrex CG-3, CG-3M and CG-5 relative gravimeters in order to measure gravity change caused by production and reinjection of geothermal fluid, but we could not estimate the gravity change at the reference station. To solve this problem, we introduced an A10 absolute gravimeter (Micro-g LaCoste, Inc.). In addition, the A10 was used for not only the assessment of the gravity changes at the reference station, but also the detection of the gravity change caused by the subsurface fluid mass changes at some other measurement stations. However, it was impossible that the A10 absolute gravimeter was applied at all of the stations, because the condition of the measurement was strict. We chose 4 stations (T13B, T22A, T26A and T27A) to conduct the repeat absolute gravity measurement. T26A is located in the reinjection area, and there are the other 3 stations in the production area. Therefore we have applied the relative gravimeters to the stations in such strict situation. Thus both absolute gravimeter and relative gravimeter can complement each other in the hybrid gravity measurement.

We have detected the gravity changes which were consistent with the changes of mass balance in the geothermal reservoir by the relative gravity measurements since 1991. We inferred that the current fluid mass in the Takigami geothermal field has recovered to as much as that before production and reinjection had started. As a result of the absolute gravity measurement, the seasonal variation has not been drastic at the reference station (T1), so we have concluded that T1 is appropriate as the reference station of the relative gravity measurements. In Takigami geothermal power plant, the reinjection was stopped for the regular maintenance. We observed the gravity changes caused by suspension of the reinjection before and after the maintenance period in the reinjection area.

Keywords: Repeat Gravity Measurement, Absolute Gravimeter, Relative Gravimeter, Takigami Geothermal Area

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Remote temperature sensing on the fumarolic area in Aso Volcano using hydrogen isotopic compositions of plume H_2

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Molecular hydrogen (H_2) in a high-temperature volcanic fumarole ($>$ 400 degreeC) reach to the hydrogen isotope exchange equilibrium with coexisting fumarolic H_2O under the outlet temperature of the fumarole. In this study, we applied this hydrogen isotope exchange equilibrium of fumarolic H_2 as a tracer for the remote temperature sensing on the fumarolic area in the 1st crater of Mt. Naka-dake (Aso volcano) where direct measurement on fumaroles was not practical, by deducing the hydrogen isotopic composition (dD value) of fumarolic H_2 remotely from those in volcanic plume.

The reciprocal of H_2 concentration in the plume samples showed a good linear relationship with the dD values. The linear relationships suggested that both the concentrations and the dD values of H_2 in the plume samples can be explained by simple mixing between two end-members, both of which can be classified to a single category at least for the dD values of H_2. By extrapolating the linear relationship between $1/H_2$ and dD to $1/H_2$=0 to exclude the contribution of the tropospheric H_2 from the dD value of each sample, we estimated that the dD value of fumarolic H_2 to be -172+-16 per mil vs. VSMOW and the apparent equilibrium temperature (AET_D) to be 868+-97 degreeC. Although the estimated temperatures using the IR thermometers were much lower than the AET_D, we concluded that the AET_D represented the highest outlet temperature of the fumaroles in Aso volcano and that the dimensions of the fumaroles at surface smaller than the pixel of the IR thermometers was responsible for the temperatures lower than the AET_D. That is to say, temporal variation in the dimensions of fumaroles at surface, probably due to variation in the emission flux of fumarolic gases, was responsible for the temporal variation in the temperature determined by the IR thermometers, while the actual outlet temperature of the Aso fumaroles keeps the temperature almost equal to the equilibrium temperature of fumarolic gases.

Keywords: fumarolic gases, volcanic plume, molecular hydrogen, stable isotopes, isotope exchange equilibrium, remote temperature sensing

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Remote sensing of the temperature and the amount of water of volcanic fumarole gas using lidar technique

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Temperature and water vapor (including waterdrops) measurements of volcanic fumarole gas is important to know the activity of volcanoes and to predict eruptions. However, volcanic fumarole gas is usually poisonous and quite high temperature. So, getting too close to the volcanic fumarole for a gas sampling and direct measurement of temperature are extremely dangerous. We, therefore, are developing two lidars for remote sensing; one is a portable Raman lidar for measuring of water vapor and waterdrops in volcanic fumarole and the other is a portable bistatic lidar for temperature measurements of volcanic fumarole gas. In this presentation, we introduce the developing lidars and report results of observation test of fumarole gas that was carried out at Bandaiko (Kusatsu) in October, 2010.

Keywords: water vapor, temperature, volcanic fumarole gas, remote sensing, Lidar

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Relationship between the coefficient of geothermal flux for the heat balance technique and micrometeorological data

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The coefficient of geothermal flux is essential for the heat balance technique (Sekioka and Yuhara, 1974), which is one of the methods for measurement of heat discharge rate from geothermal fields, and is determined by micrometeorological data of a target area. In order to comprehend the temporal change of the micrometeorological conditions and the coefficient of geothermal flux, we have manufactured an automated continuous micrometeorological measurement system and measured micrometeorological data at the Kyu-Hachiman-Jigoku geothermal unit in the Unzen geothermal area in Nagasaki Prefecture, the Komatsu-Jigoku geothermal unit in Oita Prefecture, Aso Volcano in Kumamoto Prefecture and Hakozaki Campus in Fukuoka Prefecture. As a result, the values of the coefficient of geothermal flux showed turbulent changes in a wide range and in a short time (Fujimitsu et al., 2009).

We conducted the continuous micrometeorological measurements in Aso in 2005 and in Komatsu-Jigoku in 2005 and 2006 with 1-minute, 10-minute and 5-second intervals, respectively. And we obtained 5596, 534 and 4621 sets of the observed micrometeorological data and the coefficient of geothermal flux values calculated by using the observed data, which were applicable for the statistical processing. The correlation coefficients (multiple correlation: R) between the 8 micrometeorological conditions (atmospheric temperatures at 10, 50, 55, 150 cm heights, relative humidity values at 10, 50, 150 cm heights and a wind velocity at 100 cm height) and the values of the coefficient of geothermal flux did not show very strong correlations (the maximum R is 0.45 with the atmospheric temperature at 55 cm height at Komatsu-Jigoku in 2005). The values of R between the 4 parameters (the vapor pressure, the density of the air, the transfer velocity, the reciprocal of the Bowen ratio) calculated by using the observed micrometeorological data and the values of the coefficient of geothermal flux indicated a weak negative correlation with the density of the air and no obvious correlation with the vapor pressure. And although the values of R with the transfer velocity and the reciprocal of the Bowen ratio showed some positive correlations but large variations, the values of R with the product of the transfer velocity and the reciprocal of the Bowen ratio indicated extremely strong positive correlations (R=0.97 to 0.99) in every case. Therefore, we obtained a regression equation for the relation between the coefficient of geothermal flux and the product of the transfer velocity and the reciprocal of the Bowen ratio. It means that we can estimate the value of the coefficient of geothermal flux with simpler process than before.

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Fujimitsu, Y., Nishijima, J. and Ehara, S. (2009) Temporal change of the coefficient of geothermal flux used in the heat balance technique. Abstracts of Japan Geoscience Union Meeting 2009, V161-P012.

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Keywords: Heat balance technique, coefficient of geothermal flux, micrometeorology, continuous measurement, heat discharge rate