Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SVC49-01 Room:104 Time:May 24 15:30-15:45

Geotherml system of Maruo Hot Spring in Kirishima Volcano, Kyushu , Japan

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Water samples from Maruo hot spring in Kirishima Volcano were collected and analyzed geochemically. Besed on geochemical results, a geothermal system in this hot spring area was revealed; upwelling from northeastern side and moving to southwestern side with mixing with stem-heated waters along NE-trending fractures.

Keywords: Maruo hot spring, Geochemistry, Kirishima volcano, Geothermal system

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SVC49-02 Room:104 Time:May 24 15:45-16:00

Conductivity distribution of the surface layer around Kirishima Volcanic Group - on the aspect of failed eruptions

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Kirishima volcanic group consists more than 20 volcanoes; Shinmoe-dake, Ohachi, Iwo-yama, etc. Many geophysical and geological researches have been carried out since the large eruption of Shinmoe-dake in 2011. The authors carried out VLF-MT survey around Kirishima to clarify electrical conductivity distribution in the surface layer and also carried out repeated observation of electrical conductivity of hot spring water in and around Iwo-yama. The results are as follows.

1) High conductive areas were found around Iwo-yama, and along the trend of volcanoes from Shinmoe-dake to Ohataike. This trend is followed by the trend from Ohjibaru to Chishanoki hot spring in the east of Kirishima. Seismic activity is also determined along these trends. This result indicates magmatic gas is supplied along the fault system in Kirishima. On the other hand, low conductivity was found around the volcanoes in the southeastern Kirishima; Ohachi, Takachiho-nomine. High conductive area is also found on the southwestern flank of Kirishima.

2) Repeated measurement indicates gradual increase in conductivity of hot spring water around Iwo-yama. This may reflect the increase of supply rate of magmatic gas.

Keywords: Kirishima Volcanic Group, Conductivity distribution, volcanic activity, failed eruption

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SVC49-03 Room:104 Time:May 24 16:00-16:15

Evaluation of Geothermal Reservoir from the Gravity Changes at the Takigami Geothermal Field, Oita Prefecture, Japan

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When the geothermal power plant starts electricity generation, various surveys are conducted in the geothermal area in order to monitor the geothermal reservoir behavior. It is important to understand the geothermal reservoir behavior in order to produce geothermal fluid for a long time. Micro-gravity measurement is one of the methods for geothermal reservoir monitoring. The production of geothermal fluid and the reinjection of hot water cause mass changes and redistributions, which can cause measurable gravity changes on the ground surface. In Takigami geothermal area, we have conducted repeat micro-gravity measurements using Scintrex CG-3 and CG-3M relative gravimeters since before the commencement of Takigami geothermal power plant. We detected gravity changes in the both production and reinjection areas. These gravity changes are consistent with the changes in mass balance in the geothermal reservoir. This study suggests that repeat gravity measurement is an effective method to monitor geothermal systems. We, however, had measured only relative gravity measurements by using relative gravimeters, so we have not been able to evaluate the gravity change at the reference station of the relative gravity measurements. Hence, we introduced an A10 absolute gravimeter (Micro-g LaCoste, Inc.) in 2008. Though it was impossible that the A10 absolute gravimeter was applied at all of the stations because the condition of the measurement was strict, we utilized the A10 gravimeter for not only the assessment of the gravity changes at the reference station, but also the detection of the absolute gravity change caused by the subsurface fluid mass changes at some other measurement stations. We chose 4 stations (T13B, T22A, T26A and T27A) to conduct the repeat absolute gravity measurement. T26A lies in the reinjection area, and there are the other 3 stations in the production area. We have applied the relative gravimeters in such strict situations in which it was difficult to install A10. Thus both absolute gravimeter and relative gravimeter can complement each other.

As a result of absolute gravity measurements, the gravity change at the reference station of the relative gravity measurements is small enough for this evaluation, within about 10 microgal. Therefore, we estimated that this reference station is appropriate for the relative gravity measurements. Because we judged that the gravity change detected by the relative and absolute gravity measurements illustrated the mass transfer in the geothermal reservoir, we divided the Takigami geothermal area into 3 areas from the pattern of the gravity change after the commencement of the Takigami geothermal power plant, and we estimated the 4 stages of geothermal fluid flow pattern from temporal gravity change. Based on these classifications, we led a conceptual reservoir model of the Takigami geothermal area.

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

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SVC49-04 Room:104 Time:May 24 16:15-16:30

Gravity-gradients measurements of Mt Aso using a laser-interferometric gravity-gradiometer

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A laser-interferometric gravity-gradiometer has been developed at the Institute for Cosmic Ray Research of Tokyo University for a couple of years and their laboratory test showed that the instrument had a resolution of about 1 microGal/m. As the first practical application of the newly developed instrument, we plan to measure gravity gradients at observation sites near Mt Aso. By carrying out the gravity-gradient measurements, we intend to study possible flows of volcanic fluids beneath the area of Mt Aso. We will report the current status and future prospects of the measurements.

Keywords: measurements of gravity-gradients

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SVC49-05 Room:104 Time:May 24 16:30-16:45

Investigations for the hydrothermal system of the Yumugi area in the Kuchinoerabujima volcano

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The Kuchinoerabujima volcano forms Kuchinoerabujima Island, Kagoshima Prefecture, which is located west of Yakushima Island, and is the andesitic volcanoes which include an active volcano, Shin-dake. Development of hydrothermal system is inferred because there are some hot springs in the island. The plan of binary cycle power generation by using the hot springs is in process, and according to the results of the former research and investigation, the Yumugi area is a geothermal prospect area. Following these investigation results, the authors had conducted gravity surveys, soil carbon dioxide concentration measurements, 1m-depth ground temperature measurements at the Yumugi area, and estimated heat discharge rate from Shin-dake in August 2011. And we constructed a conceptual model of the hydrothermal system of the Kuchinoerabujima volcano, mainly in the Yumugi area.

Keywords: Kuchinoerabujima, gravity, soil carbon dioxide concentration, ground temperature, heat discharge rate

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Water-rock Interaction of Enhanced Geothermal 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, Water rock Interaction

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Porosity and permeability changes during fracture experiments of Inada granite as a pilot study of Hot Dry Rock geotherm

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Hot Dry Rock geothermal system can produce energy from previously unusable site, which does not require natural convective hydrothermal resources, and therefore it has large potential as a sustainable power generation. In this system, artificial reservoir is produced by hydro-fracturing in the basement due to water injection, and then water travels through fractures in the rock and inject back into the ground. To test time-scale of water circulation in this system, we investigate porosity and permeability changes during fracture experiments in the laboratory.

Inada granite was used as an experimental sample, which has been deformed by uniaxial compression test. Porosity and permeability were measured using intra-vessel apparatus at our institute, which is capable to generate pressure as high as 500 MPa at room temperature. The intact sample before compressional test has porosity of 0.8-0.9% and permeability of 1.0x10-18m2 at confining pressure Pc = 10 MPa, which is similar values reported by previous studies (Takeda et al. 2000). The fractured samples after deformation show systematic increase of porosity and permeability, 7.0% and 2.0x10-15m2.

Using these hydrological data of fractured rock, water migrating velocity is estimated to be 3.3x10-5m/s. This results travel time of water circulation as long as 670 hours in the Ogachi HDR test site. However, chemical tracer test shows approximately 70 hours as a water travel time in this site (reported by Central Research Institute of Electric Power Industry), which is one order of magnitude shorter than that expected from our experimental data. The discrepancy might be caused by different fracture structures in the laboratory compression test relative to the hydro-fracturing in natural test. We plan to perform water injection text in the laboratory and try to simulate more realistic system as a Hot Dry Rock geothermal test.

Keywords: porosity, permeability, granite, fracture experiments, Hot Dry Rock geothermal system

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SVC49-P02 Room:Convention Hall Time:May 24 17:15-18:30

Distribution of minor elements within the unconsolidated sediments covered active shallow-seafloor hydrothermal system

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On the seafloor off northeast Sakurajima volcano in the innermost part of the Kagoshima bay, south Kyushu, Japan, an active volcano ”Wakamiko”is located, and the volcano is characterized by vigorous fumarolic activity. The ”Wakamiko” volcano is considered one of the craters of Aira caldera, which occupied the bay head area, and is formed small depression of 200 m in depth deeper than the caldera floor of about 140 m in depth. In the depression, i.e., Wakamiko crater, at least three active hydrothermal vents have been identified and maximum temperature emitting the vents reach 200 degC. In addition several hydrothermal fluid shimmering sites have been found, distribution of them have been continuously surveyed by ROV and AUV.

The coastal line is close to the crater, therefore, much clastic sediments include volcaniclastics emitted from surrounding volcanoes are filled the crater. The unconsolidated sediments in the crater is considered to reach up to 80 m by seismic observation. The venting and shimmering hydrothermal fluids penetrate the unconsolidated sediment layer, then several commercially important elements, it means rare metals, have been precipitated and condensed in the sedimentary layer. Actually, vein formed antimony sulfide, stibnite, has been often observed in the 5 - 6 m long core sediments obtained by piston coring. However, hydrothermal minerals currently precipitated from hydrothermal fluid are small grain and degree of crystallinity is still low. Therefore, it is difficult to find visible grain of such minerals and even to detect by XRD analysis. This study aim to clarify the distribution of minor elements, such as rare metals, in the bulk sediment samples obtained from the Wakamiko hydrothermal field using neutron activation analysis (NAA).

Sediment core samples obtained during KT08-9 cruise by RV/Tansei was provided for this study. Those sediment samples already have studied pore water chemistry and clay mineral compositions. We used two core samples, which are significantly affected by hydrothermal fluid. Subsamples picked up each 20 cm interval were freeze-dried and packed about 30 - 40 mg dried sediment into polyethylene bag. NAA was carried out at Kyoto University Research Reactor Institute.

In, Se, V, Mn, Au and so on in addition to As, Sb and Hg, which are previously reported anomalous condensation in this area, were detected by NAA. As, Sb, Hg and Au were condensed at the layer where present contribution of hydrothermal fluid was obvious. On the other hand, condensation of Mn, V and In was observed at about 50 cm depth below seafloor from the both core samples.

As, Sb and Hg are expected to precipitate directly from the hydrothermal fluid, while Mn, V and In were even condensed at the hydrothermal fluid-free layer. It may suggests that Mn, V, and In are precipitated from hydrothermal plume once emitted from the vents under suitable physicochemical condition.

Keywords: shallow-seafloor hydrothermal system, Wakamiko crater, neutron activation analysis, rare metals, unconsolidated sediments

Japan Geoscience Union Meeting 2012
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Water chemistry of lakes Nyos and Monoun, Cameroon in 2011

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1. Introduction

The explosive discharges of CO2 gas (= limnic eruption) at Lake Nyos and Monoun killed about 1800 people around the lakes in mid-1980s. The cause of the limnic eruption was the excessive accumulation of CO2 gas in lake water. The CO2 gas originated from a degassing magma. A mineralized water containing CO2 gas is expected to be discharged on the lake floor. The accumulation of the dissolved CO2 gas facilitated strong stratification of lake water. Investigation on the water chemistry and the formation of stratification is important for the prediction of the next limnic eruption.

2. Observation

The lake water was sampled on January 2011 at various depths on lake Nyos and Monoun. The anionic components were analyzed by a Dionex ion chromatograph. The stable isotope ratio of H2O was measured by a Picarro laser absorption isotope analyzer. The carbonic (=CO2aq + HCO3-) concentration was determined by the combination of the method by Kusakabe (2001) and micro diffusion volumetric analysis.

3. Lake Nyos

The carbonic concentration was high between the bottom (= about -210m) and -200m extending to 372 mmol/L. The concentration decreases gradually along ascent to -80m, being 6 mmol/L at -60m. The concentration of Cl- and SO42- was less than 1 and 0.5 mg/L, respectively. The dD of H2O was -8 permil between surface and -80m. The dD decreased to -10 permil deeper than -80m and stable to -200m. The dD again decreased gradually unitl -11.2 permil at -210m. The summation of the NO2- and NO3- concentration was high as 0.3 mg/L between surface and -50m. The concentration decreased to 0.02 mg/L between -80 to -170m. The NO2- and NO3- were not detected at the depth deeper than -175m.

4. Lake Monoun

The carbonic concentration was high as 73 to 93 mmol/L between -98 to -86m. The concentration decreased quickly along ascent until 6 mmol/L at -70m. The dD of H2O was -18 to -17 permil between the surface and -70m. The dD was low as -21 to -20 permil at the depth deeper than -80m. The total concentration of NO2- and NO3- was high at -98 and -40m as 2.6 mg/L. The concentration other than the above depth was less than 0.1 mg/L. The NO2- was detected at the depth near the bottom.

5. Stratification of lake water

The isotope ratio of lake water between the surface and -80 or -70m for both Nyos and Monoun suggests the effect of evaporation. The low isotopic ratio of water near the bottom suggests the discharging of mineralized water with isotope ratio similar to local meteoric water. Mixing of water is taking place in the intermediate depths. Cattle grazing is seen around Lake Nyos. This activity results in inflow to lake of nitrogenous constituent to the lake giving rise the source of NO2- and NO3- in the lake. Nitrogenous component were found down to -170, suggesting the influence of surface water at Lake Nyos. In Lake Monoun, the influence of surface water reaches near the lake bottom.

6. Magmatic component

For both lakes, concentration of Cl- and SO42- concentration is proportional to the carbonic concentration. The Cl/CO2 molar ratio is 5.08E-5 and 5.31E-4 for Lake Nyos and Monoun, respectively. The SO4/CO2 molar ratio is 5.31E-6 and 6.41E-5 for Lake Nyos and Monoun, respectively. The gas phase equilibrated with basaltic magma should have Cl/CO2 and S/CO2 ratios of (1.5˜10)E-6 and (5˜13)E-4, respectively (Giggenbach, 1996). The SO4/CO2 ratio for both lakes is much lower than the magmatic S/CO2 ratio. It is speculated that sulfur species in the magmatic fluid was reduced during migration through a hydrothermal system which might develop beneath the lakes.

Keywords: Nyos, Cameroon, CO2, Limnic eruption

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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(AMT) survey on 10 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 5-6 hours on each points.

Keywords: Audio fiequency Magneto-Tellric survey, Tatun volcanic group

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Hydrothermal system at Kuchi-erabu-jima volcano, inferred from surface temperature and self-potential distribution

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The hydrothermal system at Kuchi-erabu-jima volcano, which induces phreatic eruptions frequently, is investigated by means of the surface temperature and self potential observations. The surface temperature measurement was conducted on March 11, 2008. The observation was operated by the airplane which has a hole on the floor for aerial photo of vertical direction. The portable infrared thermal camera (AVIO TVS-620) was fixed on the hole to face the ground perpendicularly using the stand designed for this survey. The airplane kept the constant speed and height during the measurement over the volcano. The respective thermal images with suitable condition were combined considering the horizontal orientation, vertical angle and the position. The resultant image represents the overall surface temperature distribution at the selected field. The temperature anomalies up to 40^{o}C at maximum are observed widely on and around Shin-dake and Furu-dake craters. The similar observation was also conducted at Satsuma-iwojima volcano, which is active volcano showing the persistent high temperature gas discharge at the summit crater. The total amount of the gas discharge is one order of magnitude larger than that of the Kuchi-erabu-jima volcano. The comparison of two volcano shows that the area of surface temperature anomaly of Kuchi-erabu-jima volcano is quite smaller than that of Satsuma-iwojima volcano, and the temperature of kuchi-erabu-jima volcano is sufficiently low. The self potential observation was conducted on November 26-29, 2009. The result indicates that the distribution at western mountainside has the positive correlation with topography, contradicting to the terrain effect. The anomaly reaches 300mV at the summit. The self potential at eastern mountainside has not correlation with topography and shows the flat distribution. This eastern flat distribution is probably related to the subsurface low resistive altered layers. The wide ranging positive anomaly at western mountainside suggests the active hydrothermal circulation within the mountain edifice.

Keywords: surface temperature, self potential, hydrothermal system, numerical simulation

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Evaluation of the mass flux of volcanic fluids using the electrical condutivity structure

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The efficiency of degassing of volcanic fluid in magma is one of the key parameters controlling the explosibility of eruption and the diversity of the volcanic activity (Eichelberger et al., 1986; Kagiyama, 2008). Therefore, it is possible to quantify the constraint condition which controls these phenomena by evaluating the mass flux of volcanic fluids released from magma. A portion of released volcanic fluids is discharged from the crater to the atmosphere; the rest is considered to be dissipated by groundwater flow of the aquifer under a volcano. The latter part has not yet been quantified precisely. The electrical conductivity structure of a volcano has a potentiality for estimating the volcanic fluid mass flux by groundwater flow of the aquifer, because the pore water dissolving volcanic fluids has a high electrical conductivity due to high salinity of the pore water. As well as pore water conductivity, matrix conductivity is also increased by hydrothermal alteration. Electromagnetic surveys on a volcano reveal the bulk conductivity, which contains both contributions of pore water and matrix. Therefore, it is required for the estimation of volcanic fluid fluxes using bulk conductivity to take both two conduction components into account.

In this study, the quantitative relation between mass flux of volcanic fluids and electrical conductivity structure is examined, by developing the simple model and using numerical simulations. Numerical simulations calculate the spatial distributions of salinity and temperature of pore water under the controlled condition of the mass flux of the volcanic fluids which are injected from the volcanic center(Komori and Kagiyama, 2008,2009; Komori et al., 2010).Using these distributions, the spatial distributions of pore water conductivity and surface conductivity are estimated (Komori et al.,2011). Eventually, the spatial distribution of bulk conductivity is estimated using these two conduction components by Revil's model (Revil et al.,1998; 2002).

These methods are applied to the bulk conductivity structure of Unzen volcano and Aso volcano obtained by wide-band MT (Komori et al., 2010; Utsugi et al, 2009). There is distinctive difference of the eruption style between these two volcanoes. To clarify the quantitative relationship between these eruption styles and the efficiency of magma degassing, the volcanic fluid fluxes at Unzen and Aso are evaluated.

Keywords: electrical conductivity structure, volcanic fluids, magma degassing, eruption style