Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SVC51-P01 Room:Poster Time:April 29 18:15-19:30

Fluid geochemistry of hot springs at Kotakara-jima,Tokara Islands

TSUTSUMI, Saki[1*] ; ISHIBASHI, Jun-ichiro[1] ; KONNO, Uta[2] ; YOKOSE, Hisayoshi[3]

[1]Department of Earth and Planetary Sciences, Graduate School of Sciences, 33 Kyushu University, [2]JAMSTEC, [3]Graduate School of Science and Technology, Kumamoto University

Yokose et al.(2010) proposed giant calderas related to Quaternary volcanic activity, on the seafloor along the Tokara Islands. Kotakarajima is located on the rim of the Takarajima Caldera, which belongs to this caldera chain. A hot spring called as Yutomari-onsen is located at the coastline of the Kotakarajima island, which water temperature reaches higher than 90 degC. Fluid chemistry of this hot spring was studied with the aim of understanding a hydrothermal sytem associated with the seafloor caldera.

Hot spring water was collected in May, 2013. Temperature, pH, electorical conductivity, and oxidation-reduction potential were measured on site. Fluid samples were filtered with a 0.45 um diskfilter and stored. Major cations and anions were analyzed by ICP-AES and ion chromatography. Alkalinity was determined by HCl titration and Si concentration was determined by colorimetry.

Fluid chemistry of the hot spring water is characterized by high Cl^- concentration, Na/Cl ratio (=0.75) closed to that of seawater, and isotopic composition similar to seawater, which strongly suggests that it is originated from seawater. Depletion in Mg^{2+} and $SO_4{}^{2-}$ and enrichment in K^+ and Ca^{2+} compared with seawter, are in accordance with the idea that the fluid experiences seawater-rock interactions. Fluid temperature in the aquifer where interactions attain to equilibrium is estimated as 250-300 degC based on chemical geothermometers.

From these results, the Yudomari-hotspring at the Kotakarajima Island is considered as fluid discharge of a submarine hydrothermal system that is associated with Takarajima Caldera.

Keywords: Giant caldera, hydrothermal system, seawater-rock interaction

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Hydrothermal system beneath Shirahone hot spring, Nagano, Central Japan, revealed by resistivity survey

YAMAYA, Yusuke[1*] ; MOGI, Toru[2]

[1]GSJ, AIST, [2]ISV, Hokkaido Univ.

Shirahone hot spring is one of the most active geothermal area, located in the western part of Nagano prefecture, Japan. A source of hot water has not been clarified, because there are few geophysical exploration and borehole logging. We performed an electrical resistivity exploration employing the magnetotelluric (MT) method in order to identify a hot-water reservoir and whole hydrothermal system providing the Shirahone hot spring. The MT data were measured at six stations along the NNE-SSW line crossing the Shirahone area. The apparent resistivity and impedance phase were inverted to a two-dimensional resistivity section down to 3 km deep with the aid of the code developed by Ogawa and Uchida (1996). The estimated resistivity section generally indicates a range of resistivity 1-3000 Ωm, including two considerable conductors below 3 Ωm. These conductors are found at a depth 400-1000 m and deeper than 2000 m beneath the Shirahone hot spring. The upper conductor is interpreted as a hot-water reservoir which acts as a source of the Shirahone hot spring. The hot water would ascend from this reservoir to the discharge area through a fracture zone. The deeper conductor can be a heat source consisting of high temperature intrusive complex. This source might sustainably supply heat to the upper reservoir, which can keep itself a long time. A high resistivity zone is found beneath the Sakaigawa active fault zone. In general, an active fault is identified as a conductive zone due to saturated water into a fractured zone. Conversely, our resistivity section indicates a relatively resistive zone beneath the fault. This implies a locked part of the fracture zone where groundwater had declined after the last active phase of the fault.

Keywords: hydrothermal reservoir, Shirahone hotspring, resistivity, magnetotellurics, geothermal system

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Ground deformation around Ohaaki geothermal field, New Zealand inferred from persistent scatterer SAR interferometry

ISHITSUKA, Kazuya[1*] ; TSUJI, Takeshi[2] ; MATSUOKA, Toshifumi[1] ; FUJIMITSU, Yasuhiro[3] ; NISHIJIMA, Jun[3]

[1]Graduate School of Engineering, Kyoto University, [2]International Institute for Carbon-Neutral Energy Research (I2CNER), Kyushu University, [3]Faculty of Engineering, Kyushu University

There are several producing geothermal fields in Taupo Volcanic Zone (TVZ), northeast-trending zone of mainly andesitic to rhyolitic arc/back arc volcanism, within the central North Island, New Zealand. It has been reported that ground subsidence with the rate of 30-50 mm/year has occurred at the Wairakei geothermal field, one of the biggest geothermal fields in TVZ [Allis et al., 2009]. Such a research on ground deformation around geothermal field is, however, rarely documented. Thus, it would be important to study deformation pattern at the geothermal field.

In this study, we mapped ground deformation around Ohaaki geothermal field located northeast of TVZ using persistent scatterer SAR interferometry (PS-InSAR). Since the analysis makes use of high quality phase information of the coherent target of SAR image, the estimated deformation is more accurate compared with the standard differential SAR interferometry (DInSAR). We processed 21 ALOS/PALSAR images acquired from January 2007 to January 2011 from an ascending orbit. As a result, we estimated ground deformation opposite to line of sight direction, which may correspond to ground subsidence. Moreover, the deformed area showed sharp boundary which we can be attributed to fault location in the area.

Allis, R., C. Bromley, and S. Currie, Update on subsidence at the Wairakei-Tauhara geothermal system, New Zealand, *Geothermics*, vol. 38, pp.169-180, 2009.

Keywords: ground deformation, persistent scatterer SAR interferometry, Ohaaki geothermal area

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Gravity Monitoring at Takigami Geothermal Area, Oita Prefecture, Japan

PRATIWI, Maryati[1*] ; FUJIMITSU, Yasuhiro[1] ; NISHIJIMA, Jun[1]

[1]Kyushu University, Fukuoka, Japan

The gravity monitoring at Takigami geothermal area has been applied since November 1996 (Oka et al., 2011). In this area, the nearest geothermal manifestations are about 1-2 km to north and east of Takigami (Furuya et al., 2000). So, there are no geothermal manifestations at the surface. The geothermal power plant was built at Takigami in August 1991. It was reported that its power plant output was changed from 25,000 kW to 27,500 kW in June 2010 (Kyushu Electric Power Co., Inc., 2010)

We analyzed the gravity data from August 2008 until August 2013. We found that the gravity changes at the northern zone, the western zone, and the southwestern zone of this area are quite stable historically. This result indicates that the recovery state for these zones is almost done. However, the data at the eastern zone shows gravity increasing. It was assumed that the subsurface fluid at Takigami area flows from south, which is the direction Kuju Mountain area. Then, we noted that the fluid from south is filling the faults in eastern area in the beginning before going through to northern area (due to its high permeability (Jalilinasrabady et al., 2011)), thus the recovery state in the eastern zone has not been done.

By using theorem of Gauss, we calculated the mass changes based on the gravity changes from August 2009 to August 2012. This calculation is excluding the northern area as it has different water system, and removed the effects of precipitation and evapotranspiration by Gwater-e program (Kazama, 2011). And, we found that the mass increases as much as 10.12 Mt in the Takigami geothermal area. This mass change is associated with the production and reinjection process of geothermal fluids.

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Keywords: gravity change, gravity monitoring, mass change, Takigami

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Heat balance technique under the condition that the influence of solar radiation can be negligible

FUJIMITSU, Yasuhiro[1*] ; NISHIJIMA, Jun[1]

[1]Faculty of Engineering, Kyushu University

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 some geothermal fields. And we have discussed about the coefficient of geothermal flux (Fujimitsu et al., 2009; Fujimitsu et al., 2010; Fujimitsu et al., 2011).

In the heat balance technique, a reference temperature is set on a ground surface where there is no geothermal anomaly, and the area that indicates higher ground surface temperature than the reference temperature is regarded as the geothermally anomalous area. However, the influence of solar radiation on the determination of the reference temperature is one of the main factors in accuracy of the estimated heat discharge rate by the heat balance technique. Therefore, we assumed the condition that the influence of solar radiation can be negligible, and conducted the observation experiments during the nights by using an artificial heating element as a heat source in order to improve the accuracy of the heat balance technique by a new analytical method.

For the new analytical method, we considered the heat balance at the ground surface under the condition of no solar radiation, adopted Richardson number for determination of the transfer velocity, and changed the determination procedure of the reciprocal of the Bowen ratio. As a result, the new analytical method estimated the heat discharge rates that are almost the same as the actual heat generation rates from the artificial heating element.

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Keywords: Heat balance technique, coefficient of geothermal flux, micrometeorology, heat discharge rate, solar radiation, reference temperature