Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P01 Room:Convention Hall Time:May 27 18:15-19:30

The Petrological Study of Tokachidake Volcano: Especially about the Magma System of 20th Century Activities

KOBAYASHI, Kyohei[1*] ; NAKAGAWA, Mitsuhiro[1] ; KURITANI, Takeshi[1] ; FUJIWARA, Shinya[2]

[1]Hokkaido University, [2]Kokusai Kogyo Co. Ltd.

Tokachi-dake is an active volcano located in the central part of Tokachi-dake Volcanic Group. Volcanic activity of the group, started ca. 1 Ma, consists of three stages; Older, Middle and Younger stages (Ishizuka *et al*., 2010). Tokachi-dake volcano mainly formed in Younger stage, and has erupted with changing its eruptive craters since ca. 4700 years ago. According to volcanic dormancy, locations of eruptive center, and petrological features of ejecta, the activity of the volcano is divided into Stages 1-4 (Fujiwara *et al*., 2007, 2009).The 20th century activities, including 1926, 1962, and 1988-89 eruptions, belong to Stage 4. These three eruptions have been extensively investigated in terms of eruption processes (e.g., Tada and Tsuya, 1926; Katsui *et al*., 1963; Katsui *et al*., 1990). However, there were few petrological studies on the ejecta and magmatic processes have not been examined in detail, in spite of the importance in predicting the future volcanic activity.

In this study, a petrological study is carried out on ejecta of the three 20th-century eruptions to elucidate the evolution of magmatic system beneath the volcano. About 50 samples collected newly from the volcano, as well as 50 samples stored in Hokkaido University, were used for petrological analysis. The ejecta of three eruptions are basaltic andesite in composition, and contain olivine, orthopyroxene, clinopyroxene, plagioclase, and Fe-Ti oxide phenocrysts. The abundance of the phenocrysts is 26-47%, 36-43%, and 43-48% in 1926, 1962, and 1988-89samples, respectively. The groundmass of the 1926 scoria is heterogeneous in texture, whereas that of the 1962 scoria is homogeneous. The 1988-89 ejecta are characterized by high crystallinity in the groundmass and the presence of many olivine phenocrysts with reaction rim of pyroxene. Whole-rock compositions are essentially homogeneous in the 20th century ejecta, but Ti, Al and V contents in the 1962 products differ slightly from those in the 1988-89 ejecta. In a histogram of the cores of the olivine phenocrysts, bimodal peaks are observed at Fo=71 and 75 in the 1926 products, whereas unimodal peak is present at Fo=76 in the 1962 and 1988-89 ejecta. Mineralogical features of the pyroxene phenocrysts are essentially common in the three eruptive products, ranging from Mg#=68-77 in clinopyroxene and Mg#=66-75 in orthopyroxene, while those in the 1988-1989 volcanic bomb samples are relatively low in Mg#. Fe-Ti oxides have a compositional peak at Mg/Mn=~15 in 1926 and 1962 scoria, but the rim of those in the 1988-89 volcanic bomb have lower Mg/Mn of ~8. The An of the plagioclase phenocrysts ranges from 56 to 92. Reversely zoned pyroxene and plagioclase phenocrysts are dominant in the 1926 ejecta, but they are scarce in the 1962 and 1988-89 products.

The 1926 scoria have many plagioclase and pyroxene phenocrysts with reverse zoning, and the groundmass is heterogeneous in texture; these observations suggest that magma mixing occured immediately before the 1926 eruption. On the other hand, the 1962 magma did not experience a significant magma mixing event, as inferred from the relatively homogeneous texture in the groundmass. The whole-rock compositions of the 1926 and 1962 ejecta are essentially similar, but the plagioclase phenocrysts commonly show normal zoning unlike the 1926 products. These observations may indicate that the 1962 magma was derived from a portion which is different from the 1926 magma in the same magma chamber. The 1988-89 ejecta are relatively higher in the crystallinity of the phenocryst phases, suggesting that the temperature of the 1988-89 magma was lower than that of the 1962 magma. Considering that the rims of the Fe-Ti oxides are characteristically lower in Mg/Mn, relatively low-temperature magma may have been slightly mixed in the 1988-89 magma shortly before eruption.

Keywords: Tokachidake Volcano, Magma Plumbing System, Petrology

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P02 Room:Convention Hall Time:May 27 18:15-19:30

Volcanic gas measurements using the virtual Multi-GAS method

OKAMOTO, Risa[1*] ; HASHIMOTO, Takeshi[1] ; TANAKA, Ryo[1]

[1]Institute of Seismology and Volcanology, Graduate School of Science, Hokkaido University

Introduction: In recent years, so-called “Multi-GAS” system that consists of several gas sensors has been developed to measure the chemical composition of volcanic gases in the field (Aiuppa et al., 2005; Shinohara, 2005). While such systems are usually produced as all-in-one devices, we considered that assemblage of inexpensive ready-mode portable gas sensors might also work as a comparable system. In this study, we assembled three portable gas concentration meters in a plastic basket that has a good aeration property, and attached it to a stretchable aluminum stick. We applied this instrumentation to the fumaroles of Mt. Tokachidake and Mt. Tarumae, Hokkaido, Japan.

Field operation: As the commercial gas sensors used in this study were gas alarm devises for safety management, the resolutions were not very high (0.1ppm for H_2S, 1ppm for SO_2, 1ppm for CO_2). In addition, the response time of the CO_2 sensor was approximately one minute, which was considerably slower than the H_2S, SO_2 sensors. For these reasons, we walked slowly in rather dense plumes, and took one-minute moving average on the time series of H_2S and SO_2 in order to match them to the CO_2 sensor with the longest time constant. Since the SO_2 sensor did not have a logging function, its LCD was photographed at every two seconds by a smartphone.

Results: We measured the plumes from Taisho-vent at Mt. Tokachidake on September 23, 2014. Due to the prevailing wind and topographic constraint, several lines of plumes typically run up eastward along the crater wall, to the rim . Therefore, we walked along the crater rim to obtain sufficiently dense gas concentrations. The peak values of each component were H_2S ~ 50ppm, SO_2 ~ 80ppm and CO_2 ~ 170ppm (above background). Molar ratios between compositions were estimated from the linear trends of the scatter plots as H_2S/SO_2 ~ 0.48, CO_2/H_2S ~ 5.9 and CO_2/SO_2 ~ 2.9. Comparing our results to the ones measured by Geological Survey of Japan, AIST in July, 2014 (Shinohara, personal comm.) through direct sampling, the difference was less than 15%, suggesting our method had an enough accuracy.

We further performed the same measurements at A and E-vents of Mt. Tarumae on October 22, 2014. The peak values of each component were H_2S ~ 12ppm, SO_2 ~ 3ppm and CO_2 ~ 70ppm (above background). Unlike the result from Mt. Tokachidake, SO_2 concentration of Mt. Tarumae was close to the detection limit. Therefore, the estimations of H_2S/SO_2 and CO_2/SO_2 were relatively unreliable. Molar ratios were estimated as H_2S/SO_2 ~ 2.4, CO_2/H_2S ~ 6.1 and CO_2/SO_2 ~ 17 at A-vent, and H_2S/SO_2 ~ 8.9, CO_2/H_2S ~ 13 and CO_2/SO_2 ~ 100 at E-vent.

Emission rate: We tried to estimate not only the component ratios but also the emission rate for Tokachidake. We profiled the gas concentrations along the crater rim of Taisho-vent at three heights (2.7, 3.8 and 5.0m) by sliding the stretchable stick, and obtained a concentration map on the plume section. As described above, most of the gas passes just on the rim below 5.0m and thus the concentration above 5.0m was likely to be small. Therefore, the contribution of the upper flow was taken into consideration just by extrapolation from the lower part. The flow speed was estimated from the video image taken from a slightly remote site. Then, the SO_2 emission rate was estimated as 7-9t/d.

Conclusions: We verified that our system worked properly in measuring gas component ratios at least when applied to sufficiently dense plumes. We also demonstrated that it is possible to estimate the emission rate by contouring for the plumes flowing near the ground surface. We consider that the instrumentation is so light-weight that it can be attached to an unmanned aircraft such as a multicopter drone. It will be possible in the near future to widen the opportunities for gas measurements without exposing an observer to potential dangers in the field.

Keywords: volcanic gas, Mt.Tokachidake, Mt.Tarumae

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P03 Room:Convention Hall Time:May 27 18:15-19:30

Shallow inflation of Tokachi-dake Volcano detected by GNSS observation

MICHISHITA, Tsuyoshi[1*] ; NAGAYAMA, Hiroaki[1] ; MIYAMOTO, Masashi[1] ; ANZAI, Taro[1] ; USUI, Yuji[1] ; TAMURA, Makoto[2] ; OKAZAKI, Noritoshi[2] ; MIYAMURA, Jun'ichi[1]

[1]Sapporo Regional Headquarters, JMA, [2]Geological Survey of Hokkaido, HRO

1. Introduction.

Since 2001, Sapporo Regional Headquarters, Japan Meteorological Agency (JMA) have been operated GNSS continuous observation network in Tokachidake Volcano, located in central Hokkaido. At first, for topography restrictions, 3 GNSS stations had been biased to the western foot of the volcano. Since 2010, this problem has been settled gradually by adding and relocating the GNSS stations effectively. Furthermore in 2014, new 2 stations were installed around the active crater to detect the ground deformation in shallow region. JMA also have been conducted semi-annual campaign GNSS observation from around the active crater to northwestern flank since 2003. On the other hand, Geological Survey of Hokkaido (HRO) and Institute of Seismology and Volcanology (ISV), Hokkaido University have installed 2 GNSS continuous stations around the active crater in 2003. As a result of the observation, the volume inflation in shallow region beneath 62-2 crater (altitude1725m) was detected from 2006 to 2008 (JMA, 2010). In this study, we reinvestigate the ground deformation of Tokachidake Volcano more in detail with continuous and campaign GNSS observation data from 2003 to 2014.

2. Result

As a summary of the ground deformation after 2006, the distribution of horizontal displacements indicates two characters. One is a radially spreading pattern around active craters and another is the distance decay of amount of displacement from active craters, they suggest the shallow inflation beneath active crater. This inflation is also detected with Interferometric analysis of SAR (MRI, 2010 ; GSI, 2010). In order to analyze GNSS data in detail, we divide the sequence of displacement data into several periods. (Stage Ⅰ to Ⅴ) based on observation data in flank sites.

We estimate the location and the rate of the shallow inflation source by horizontal displacement in each stage, assuming spherical source (Mogi's model) added altitude correction (MRI, 2008). To estimate them, we use a software package named MaGCAP-V (MRI, 2008). As a result, the location of the source is at over 1000m above sea level beneath active craters, the rate is about $10^4 m^3$ per a year, in all stages. It was estimated that the location of the source in Stage Ⅲ and Ⅴ were shallower than that in Stage Ⅱ and Ⅳ. Therefore, it suggests the possibility that the inflation source migrates to shallower region, repeatedly, after 2006.

3. Discussion

Because of the other volume inflation in deeper region has never been detected since starting GNSS observation, we consider the shallow inflation is not directly related with magmatic activity.

According to the classification by MRI (2013), the shallower inflation is classified in inflation process related with volcanic hydrothermal activity. And MRI (2013) also suggests the possibility of small-scale eruption and growing hydrothermal activity after the classified inflation. We investigate correspondence with the shallow inflation and other volcanic activity in shallow region. (e.g.: plume, ground temperature, volcanic seismicity). As the result, it is found that plume height in 62-2 crater has decreased rapidly since Stage Ⅱ defined as a start of volume inflation in shallow region (JMA, 2006). In Stage Ⅲ, the period defined as the migration of the inflation source, it was increasing volcanic plume flux in Taisho crater and activation of B-type seismicity.

In Tokachidake, increasing amplitude level of volcanic micro-tremor was observed near active craters before small-scale eruption in 1985. (Katsui et al.1987) The similar increasing amplitude was observed in Stage Ⅴ, so we will need to investigate about the process of volcanic micro-tremor in detail, and will report the relation with the inflation and them on that day.

Keywords: Tokachidake, ground deformation, volcanic activity

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P04 Room:Convention Hall Time:May 27 18:15-19:30

Reconstraction of eruptive sequence of Chuseri tephra formation (eruptive episode C) in Towada volcano

IZAWA, Noritoshi[1*] ; MIYAMOTO, Tsuyoshi[2]

[1]Grad.Sci., Tohoku Univ., [2]CNEAS., Tohoku Univ.

Towada volcano is a caldera volcano, and the interior of crater is filled with much water. In recent eruptive episode from Nakanoumi crater, their activities are characterized by the transition from magmatic eruption to phreatomagmatic one (Hayakawa, 1985). In the latest episode, the change of eruptive styles progressed continuously without intermittent time (Hiroi and Miyamoto, 2011). Although the recent activities are a good instance to clarify a mechanism of the transition between eruptive styles, the continuity is not almost discussed in other episodes.

Chuseri tephra formation (To-Cu), which is the largest eruption from Nakanoumi crater, was formed at 6,2ka (Kudo and Sasaki, 2007). This formation consists of 3 units, Chuseri pumice (CP), Kanegasawa pumice (KP) and Utarube ash (UA) in ascending order, and has progressed from magmatic (CP) to phreatomagmatic (UA) (Hayakawa, 1983). Hayakawa (1985) reconstructed the eruptive sequence, however, the temporal relations among 3 units were not discussed. The interpretation about eruptive style and the stratigraphy of KP did not agree within previous studies. In this study, based on a detailed field survey, we clarify the reconstruction of eruptive sequence in To-Cu focusing especially on the continuity among all units.

CP is the plinian pumice deposits, and total thickness is 327cm at SE8.1km from source. We divide into 4 sub-units from CP1 to CP4 by a grain size variation. From CP1 to CP2, the grain size once becomes finer. In CP3, it changes coarser and finally turn very finer in CP4. CP was formed by an eruption column because these grain size variations are drastic and continuous. CP3 is homogeneous pumice fall deposits without changes of the grain size, and the thickness variation decreases systematically with distance from vent. On the other hand, the thickness of CP4 overlain directly by KP does not decreases systematically. This difference indicates that a part of CP4 is eroded before KP deposition, the transition from CP to KP is discontinuous.

KP is divided into 5 sub-units (KP1~KP5) from facieses; KP2, KP4, KP5 are lapilli layers and KP1, KP3 are fine ash layers. KP2 and KP4 consist of contrastive two parts. The lower part is a lithic rich containing about 70wt% lithic fragments with a little pumice. The upper part is a pumice fall deposit with about 30wt% lithic fragments. The transition of these parts is gradual and these two parts is observed far places. Thus these deposits are derived from one eruptive column formation. In previous studies, KP has been considered two normal grading pumice fall layers (Hayakawa, 1985) and alternation of pumice and lapilli (Matsuyama and Oike, 1986). However, KP is interpretated the fall deposits changing from lithic rich part to pumice rich part. KP5 is observed only lithic rich part and the thickness variation does not show a systematic decline alike CP4.

Hayakawa (1985) concluded that pyroclastic surge deposits in UA were distributed only inside caldera, however, we observed UA erodes the lower layer at the outside of caldera. It suggests UA consists of ash fall and pyroclastic surge deposits out of caldera.

Based on the result of our field survey, the eruption sequence are reconstructed as below; CP initiated from CP1, and the column once diminished (CP2). The column rapidly grew and became the largest keeping steadiness for a long period (CP3). Finally the column suddenly diminished (CP4). On the transition from CP to KP the short dormancy are indicated by the eroded surface of CP4 . KP progressed from explosive activity to steady column formation. KP repeated intermittent eruption and finally transited phreatomagmatic eruption (UA). Though erosion of KP5 by the surge deposits in UA makes unclear about the time relation from KP to UA, the lack of pumice part in KP5 implies a short dormancy. The above eruptive sequence suggests that 3 units of To-Cu are formed from 3 independent events divided by the short dormancy among each unit.

Keywords: Towada volcano, Chuseri tephra formation, magmatic eruption, phreatomagmatic eruption

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P05 Room:Convention Hall Time:May 27 18:15-19:30

Volcanic activity at Kusatsu-Shiranesan Volcano since March 2014

NAGAO, Jun[1*] ; SEISMOLOGY AND VOLCANOLOGY DEPARTMENT, Volcanology division[1]

[1] Japan Meteorological Agency

Volcanic seismicity became relatively high from early March 2014 at Kusatsu-Shiranesan. After that, the geomagnetic total intensity change caused by demagnetization process was observed, and Kusatsu-Shirane Volcano Observatory (Volcanic Fluid Research Center, Tokyo Institute of Technology; KSVO), also reported that the ground deformation and the change in chemical composition around Yugama (crater lake) had been observed corresponding to the increased volcanic activity. JMA raised the Volcanic Alert Level from 1 (Normal) to 2 (Do not approach the crater) on 3 June 2014, and urged to refrain from approaching up to 1 km away from the Yugama crater. On the basis of the volcanic activity described above, we report the observation data by JMA from March 2014.

Most volcanic hypocenters were located beneath and at the south of Yugama. A closer report on hypocenters is summarized in Matsuda et al., (2014).

Repeated GNSS measurements around Yugama revealed that inflated ground deformation was observed in 2014. Assuming a point source (i.e. Mogi-model), a ground deformation source was calculated at a depth of approximately 500m (elevation; approx. 1,700 m) on the north of Yugama, which is almost consistent with the analysis on tilt data (Terada et al, 2014) around Yugama installed by Volcanic Fluid Research Center. The ground deformation from July to November 2014 was calculated at slightly north of the one from September 2013 to July 2014. The analysis was performed by MaGCAP-V (MRI, 2013).

Kakioka Magnetic Observatory (KMO; Japan Meteorological Agency, 2014) reported the changes in geomagnetic total intensity observed from May 2014, which were estimated to be demagnetization beneath Yugama. This trend had become in a static state since July 2014. No changes in repeated geomagnetic total intensity observation were observed, indicating this demagnetization was significantly small in case.

Field observations were conducted on July and November 2014, and high-temperature areas and remarkable fumes were confirmed at geothermal areas at the northern wall of Yugama, and fumarolic areas on the northern slope of Yugama, where fumarolic activity had become high since 2008. We confirmed that the high fumarolic activity had been continuing in 2014. This activity was also confirmed by aerial observations in conjunction with the Gunma prefectural government and JGSDF (Japan Ground Self-Defense Force).

As described above, an inflated source existed around Yugama, deduced from geothermal activity with the highest activity from early May to July 2014 at Kusatsu-Shiranesan. We monitor the volcanic activity closely, in consideration of possible significant phenomenon.

Keywords: Kusatsu-Shiranesan, GNSS, thermal observation

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P06 Room:Convention Hall Time:May 27 18:15-19:30

Hypocenter relocation of microearthquakes of Kusatsu-Shirane volcano

KUWAHARA, Tomoyoshi[1*] ; TERADA, Akihiko[1] ; KANDA, Wataru[1] ; OGAWA, Yasuo[1]

[1]Tokyo Institute of Technology

Kusatsu-Shirane volcano is one of the most active volcano in terms of persistent release of volatiles. Mt. Shirane is a pyroclastic cone which contains a hot crater lake, called Yugama, with a diameter of 300 m. In addition to Yugama crater lake, vigorous fumaroles occur on the northern slope of Shirane pyroclastic cone that was formed by phreatic eruptions 70 years ago.

Earthquake swarms have been enhanced since March 2014 around the hot crater lake. The seismic activity was followed by an inflation at shallow depth beneath hot crater lake, changes in geomagnetic field and chemical compositions of volcanic gas emitted around crater lake. These unusual activities are thought to be caused by migration of hydrothermal hot water at shallow part beneath crater lake. To discuss where the hydrothermal water is supplied from, precise hypocenter gives valuable clue.

The objectives of this study are to reveal a shallow P -wave velocity structure of summit area of Kusatsu-Shirane volcano and to determine values of delay in travel time. Volcanic Fluid Research Center, Tokyo Institute of Technology deploys six seismic stations including three bore-hole types within 1km distance from Yugama crater lake. We pick arrival times of P and S-wave manually from 48 earthquakes of fine S/N signals.

Averaged residuals of P-wave travel times give optimal seismic structure showing slightly larger values than that of previous study (Mori et al., 2006). Travel times are systematically delayed at seismic stations which located on ground surface, corresponding to an existence of soft pyroclastic materials produced by recent phreatic eruptions.

Hypocenters are relocated using the optimal velocity structure with station corrections obtained in this study. Relocated hypocenters are significantly concentrated on the southern part of Yugama crater lake that is far from the fumarole area. Microearthquakes rarely occur near the pressure source, suggesting the inflation is caused by ductile deformation.

Acknowledgement: We are grateful to Dr. Shin'ya Onizawa, Dr. Tomoki Tsutsui and Mr. Rintaro Miyamachi for the field work. We also thank to Mr. Shin'ichiro Matsuda who helped us to pick arrival times.

Keywords: Kusatsu-Shirane Volcano, structure of seismic velocity, microearthquakes

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P07 Room:Convention Hall Time:May 27 18:15-19:30

Spatio-temporal changes of GNSS strain field caused by 2013 earthquake swarm activity in Hakone Volcano

DOKE, Ryosuke[1*] ; HARADA, Masatake[1] ; YUKUTAKE, Yohei[1] ; DAITA, Yasushi[1] ; SATOMURA, Mikio[1]

[1]Hot Springs Research Institute of Kanagawa Prefecture

During the past two decades, several intense swarm activities have occurred at the Hakone volcano: 2001, 2006, 2008-2009, 2011 and 2013 (e.g., Harada et al., 2013). Crustal deformations associated with an inflation of the volcanic body were observed during these activities (e.g., Daita et al., 2009; Harada et al., 2009), except for the 2011 activity that was triggered by the Tohoku earthquake. More than 1,800 earthquakes were observed in the 2013 swarm activity; the seismic activity was remarkably activated in the period from the beginning of January and the end of February, 2013.

Data of GNSS stations installed by Hot Springs Research Institute of Kanagawa Prefecture (HSRI) was not available before the 2013 swarm activity. Thus, in the 2013 activity, we could observe crustal deformation first time by dense GNSS observation with an average interval of approximately 5 km, including GEONET and HSRI stations. The crustal deformation data observed by the dense network give us an important opportunity to clarify the spatio-temporal changes of strain fields associated with the volcanic activity and to understand a generation process of the earthquake swarms.

Through the analysis of areal strain field, we found that the crustal expansion occurred from the middle of December 2012, before the initiation of the 2013 swarm activity. The crustal expansion continued until the end of the swarm activity. An accumulated areal strain during this period was about 1.7 micro-strain at the central cone of the Hakone Mountain. By adding the GNSS data observed by HSRI stations, the location of expansion region could be well constrained.

To explain the distribution of the areal strain field, we assumed spherical pressure source models. Horizontal position of the sources were set at the center of the expansion region (139.000E,35.215N), and depths of them were assumed two cases, 7 and 10 km. In each case, volume changes were estimated 1.5×10^6 and 4.0×10^6 m^3, respectively, to explain the areal strain distributions. As a result, we found that the spherical pressure source at a depth of 10 km was more plausible to explain the strain field. This result is consistent with a location of magma chamber beneath the Hakone Mountain estimated by the seismic tomography (Yukutake et al., 2014).

From the result of this study, we concluded that the volume change started in the magma chamber at a depth of 10 km, prior to the 2013 swarm activity, and continued for two months until the end of the swarm activity. In future studies, it is important to interpret the relationship between other phenomenon for clarify the process of the activity in more detail.

Keywords: Hakone Volcano, earthquake swarm activity, GNSS, strain field

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P08 Room:Convention Hall Time:May 27 18:15-19:30

Chemical and isotopic composition of hot spring at the Owakudani geothermal areaon Hakone volcano, Japan

SAGO, Masakazu[1*] ; SHIGEMURA, Taisei[2] ; AOKI, Ryo[2] ; OOKI, Seigo[2] ; OHBA, Takeshi[2]

[1]Course of Chemistry, Graduate school of Science, Tokai University, [2]Course of Chemistry, School of Science, Tokai University

[Introduction]

Hakone volcano has a caldera whose size is about 8km and 12km in E-W and N-S direction, respectively. Late central cones are structured by andesitic-deictic lava and lava dome (Takahashi et al., 1991; Nagai et al., 2008). Owakudani geothermal area has been created by a sector collapse and developed on the north flank of Kamiyama central cone several thousand years ago (Aramaki and Oki, 1971). Hot spring water contains much SO_4^{2-} caused by oxidization of H_2S in volcanic gas near the surface and a small amount of Cl^- (Oomori et al., 1986). Volcanic gas from Owakudani has been investigated for a long time. However, the newest data about hot spring has been reported by Kikukawa (2001). In this study, we report the relationship between the volcanic activity and the chemical data variation, the chemical composition and isotopic composition (δD and δ^{18}O), for the last 2 years.

[Sampling and analysis]

Hot spring water was sampled in Owakudani geothermal area from May 2013 to December 2014. The sampling point was named point 1 sampling from May 2013 to January 2014 and point 2 sampling from April 2014 to December 2014. Point 1 was flowing out hot spring water. On the other hand, point 2 was kept the water level constant in the hole and not following out from verge of the hole. The distance of point 1 and point 2 is dozen of maters. The point 1 dry up if there is little precipitation. Temperature was measured on the field. Samples were filtered through a 0.45 micrometers disc syringe and determined pH in laboratory. Na^+, K^+ contents were analyzed by Atomic Absorption Spectrometer (AAS). Fe^{2+}, Ca^{2+}, Si, Al^{3+}, Mg^{2+}, Mn^{2+} contents were analyzed ICP- MS. Analysis of F^-, Cl^-, NO_3^-, SO_4^{2-} was conducted by ion chromatography (IC). δD and δ^{18}O were analyzed by Cavity Ring-Down Spectrometer analyzer.

[Results and discussion]

Major cations were Fe^{2+} (62-692 mg/L) and Al^{3+} (19-385 mg/L). Fe^{2+} and Al^{3+} show the similar temporal trend. Point 1 hot spring had high concentration of Ca^{2+} (140-473 mg/L), but point 2 hot spring had low concentration of Ca2+ (6-26 mg/L). The major anion was SO_4^{2-} (478-7300mg/L). Other anions were such as Cl^- (3-83mg/L). However, the pH, water temperature and chemical composition of this study point differed from previous research (Kikukawa, 2001). The above research sampling point was located within 100m from point 1 and 2, which suggests that the chemical composition of hot spring water could be changed even if they are located closely. Relationship the earthquake swarm and the volcanic gas have been indicated (Daita, 2013). The frequency of earthquake swarm surrounding Hakone volcano during (Hot Spring Research Institute of Kanagawa Prefecture) this study showed increasing trend along Cl^-/SO_4^{2-} rate increasing. Accordingly, Cl^-/SO_4^{2-} rate may be relevant to the volcano activity. The δD and δ^{18}O range of hot spring water in point 1 was from 53.3 to 10.2 ‰ and from -7.3 to 8.3 ‰, respectively. In case of point 2, that range was from -34.2 to 29.7 ‰ and from -0.7 to 2.5 ‰, respectively. Compared above, hot spring water point 1 had more wide isotopic variation than that of point 2. Those different isotopic characters among them might be caused by the different welling up styles. The δD and δ^{18}O of hot spring water showed decreasing trend along the number of earthquake swarm increasing.The point 2 was clearer correlation with earthquake swarm than point 1.

Keywords: hot spring, volcanic activity, Hakone

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P09 Room:Convention Hall Time:May 27 18:15-19:30

Estimation of chemical properties of lake water at Lakes Nyos and Monoun using sound velocity profiles and transparency

SAIKI, Kazuto[1*] ; KANEKO, Katsuya[2] ; NTCHANTCHO, Romaric[3] ; FOUEPE, Alain[3] ; JOHROKU, Keisuke[1] ; OHBA, Takeshi[4] ; TANYILEKE, Gregory[3] ; HELL, Joseph V.[3]

[1]Osaka Univ., [2]Kyoto Univ., [3]IRGM, [4]Tokai Univ.

Limnic eruptions in 1984 and 1986 at Lakes Monoun and Nyos in Cameroon were caused by sudden degassing of magmatic CO_2 dissolved in the lake water. The disasters killed about 1800 residents around the lakes. To prevent further disasters, monitoring of CO_2 in the lake waters is essential. For frequent measurement, we developed a convenient method of CO_2 monitoring using sound velocity (SV) as part of SATREPS project supported by JICA and JST. In the 2014 survey, we took movies of the under-water and the bottom of the lakes using an underwater camera with a pressure container of 200 m resist. The vertical change of transparency of water was observed by checking the visibility of reflectors set in front of the camera. A pressure sensor simultaneously monitored the depth. The thickness of the cloudy water layer with suspending substance was 6˜7 m at the surface of Lake Nyos and the transparency of water becomes clearer with depth. At Lake Monoun the transparency of water increases with depth near the surface, but decreases again with depth around the bottom. At the the deep part of Lake Monoun, there seems to be a negative correlation between transparency and CO_2 concentration , but at the deep part of Nyos the transparency does not decrease with the increase of CO_2 concentration. It may be caused by the difference of ion species between two lakes. We will survey again at Lake Nyos on March 2015. The results of the 2015 survey will be also presented at the meeting.

Keywords: Cameroon, Lake Nyos, Lake Monoun, volcanic lake, limnic eruption

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P10 Room:Convention Hall Time:May 27 18:15-19:30

Subsurface geology of Mt. Fuji based on continuous cuttings from a borehole at Jyuriki, Susono City, Central Japan

TAKASUKA, Toshifumi[1*] ; FUJIMOTO, Koichiro[1] ; MANNEN, Kazutaka[2]

[1]Tokyo Gakugei University, [2]Hot Springs Research Institute of Kanagawa Prefecture

Many studies on the Fuji volcano have been done mainly based on surface geology. However, the subsurface geology such as distribution of the precedent volcanoes (Sen-Komitake, Komitake, and Ashitaka Volcanoes) and basement structure are not well known since the surface is mostly covered by young lavas and pyloclastics.

We analysed cutting samples retrieved from a borehole drilled at Jyuriki, Susono City, Central Japan (Latitude:35.2609 dN,longitude:138.7898 dE, Altitude: 900m,total drilling length: 1500m).

We recognized four units based on lithology and electlic logging. They are unit I (0 to 220 m depth), unit II (220 to 510 m depth), unit III (510 to 980 m depth) and unit IV (980 to 1500 m depth).

Unit I, II, and III are mainly composed of basaltic to andesitic lavas. Whole rock chemical composition data suggest that unit I is derived from Fuji volcano and Unit II and III are derived from Ashitaka volcano.

Unit IV is mainly composed of altered andesitic to dacitic lavas and pyroclastics, probably belonging to the basement of Miocnene formation. The altitude of the basement at Jyuriki is -80 m, which is similar level at Obuch, about 8 km west from the Jyuriki.

Keywords: Fuji volcano, Ashitaka volcano, Basement

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P11 Room:Convention Hall Time:May 27 18:15-19:30

Volcanic deformation associated with increase of earthquakes in the northern part of Izu-Oshima in July 2014

YAMAMOTO, Tetsuya[1*] ; TAKAYAMA, Hiroyuki[1] ; TAKAGI, Akimichi[1] ; NAGAOKA, Yutaka[1] ; KIMURA, Kazuhiro[1] ; ONIZAWA, Shin'ya[2]

[1]MRI, [2]JMA

Late July 2014, an earthquake swarm was occurred in the northern part of Izu-Oshima, a volcanic island, and many volcanic earthquakes were observed including 17 felt quakes, the maximum JMA seismic intensity was 3, observed at Motomachi Town. Though swarm in this region observed once in three or four years, the event in June 2014 was most intensive since 2002. These events may provide the key to assess the volcanic activity of Izu-Oshima, and should be investigated in various respects. We made a research about volcanic deformation associated with the event using GPS data observed at about 15 stations of MRI, JMA and GSI.

Examining daily mean values of base line length between GPS stations, step-like temporal variation was found in the northern part of the island in late July. The steps were as large as about 1 cm, and more clear in the base lines along the north-south direction. These steps were restricted in the northern part, and seemed to be associated with the M3.7 earthquake, the maximum in the swarm, occurred on July 28. No corresponding step was observed in the middle or the southern part of the island.

Horizontal displacement was inspected referred to a site located on the northwestern rim of the summit caldera. For the two months just before the swarm event, only small displacements less than 3 mm were observed in many sites. It means the volcanic deformation of the island was slowed down when the swarm began. However, for the next two months of the event, large displacements indicating the deflation over the island was detected, especially in the eastern part, eastward movement over 1 cm. The rate of the displacement was as much as about 0.5 cm/month, it is comparable to the rate from November to December in 2012, the largest rate in recent years.

Keywords: Izu-Oshima, ground deformation, GPS, volcanic earthquake

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P12 Room:Convention Hall Time:May 27 18:15-19:30

Separation of long and short term crustal deformation of Izu Ohshima islands and each sources

TAKAYAMA, Hiroyuki[1*] ; YAMAMOTO, Tetsuya[1] ; ONIZAWA, Shin'ya[3]

[1]MRI, [2]MRI, [3]JMA

Takayama et al. (2014) showed that we could separate Izu Ohshima crustal deformation into short term and long term variation. We divided short term variation into dilatational component and compressional component. Dilatational component and compressional component were almost same in the direction without polarity, but long term variation was different from them.

We analyzed long term variation and short term variation by Yamakawa-Mogi model and dyke model. We use MaGCAP-V, a program that can fit crustal deformation data using Yamakawa-Mogi model and dyke model.

Short term sources of dilatational and compressional components are at the north caldera and 4km depth. Observed height variation are fit for calculated variation too. Long term source is beneath north caldera rim and 7km depth. But observed height variation are not fit to calculated height variation. So, we add dyke model to Yamakawa-Mogi model. Then, observed height variation are fit to calculated height variation.

Keywords: Izu Ohshima, crustal movement, long term, short term, source

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P13 Room:Convention Hall Time:May 27 18:15-19:30

Reconstruction of eruptive sequence of AD 838 eruption in Kozushima Island

NAITO, Takeshi[1*] ; SUZUKI-KAMATA, Keiko[1]

[1]Department of Earth and Planetary Sciences, Graduate School of Science, Kobe University

Kozushima Island locating on Zenisu Ridge is composed of 16 rhyolitic monogenetic volcanos. The latest AD 838 eruption started by pyroclastic eruption and ended lava dome forming. Pyroclastic eruption was mainly pyroclastic flow, which formed pyroclastic plateau in the topographically low area and covered thinly the basement topography in high area. Lithofacies of pyroclastic-flow deposit is different according to the distribution area. We will discuss the eruptive sequence of AD 838 eruption based on the lithofacies and emplacement temperature of the deposit.

Lithofacies of pyroclastic-flow deposit are mainly laminated pyroclastic surge where topographical barrier exist between the source and depositional area. Massive lithofacies are observed in pyroclastic-flow deposit where there is no topographic barrier from the source area. Massive pyroclastic-flow deposit changes into the laminated pyroclastic-surge deposit along the slope from lower area to higher area on Matsuyamabana, suggesting that pyroclastic flow changed to pyroclastic surge when the pyroclastic flow climbed the slope.

We collected 79 samples for the thermal demagnetization experiments. 50 samples show stable magnetization. They show a broad emplacement temperature values from ambience temperature to 650 ℃. Emplacement temperature of pyroclastic-flow deposit is 20 ℃-350 ℃ in south and southwest area. In the west and northwest area, pyroclastic-flow deposited at above 450 ℃, and pyroclastic surge deposited above 500 ℃.

We estimated following eruptive sequence of AD 838 eruption of Kozushima Island. Lava dome forming started at first, then earlier pyroclastic flows occurred by cooled dome collapse, which flow down toward south area. Pyroclastic flow in the west and northwest emplaced preserving the high temperature by hotter lava dome collapse. Pyroclastic flow ascending topographical barriers changes to pyroclastic surge by dropping the pyroclastic materials.

Keywords: pyroclastic flow, pyroclastic surge, emplacement temperature

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P14 Room:Convention Hall Time:May 27 18:15-19:30

Volcanic activity of Nishinoshima volcano in 2013-2015

ONO, Tomozo[1*]

[1] Japan Coast Guard

Nishinoshima volcano, which belongs to Ogasawara Islands (Bonin Islands), restarted its volcanic activity on November 20, 2013 and we already reported the status of its activity until April, 2014 at the meeting of the Japan Geoscience Union 2014. It has been active (as of January 21, 2015).

The Japan Coast Guard has been carrying out observation of Nishinoshima volcano in cooperation with the Tokyo Institute of Technology since the volcanic activity's restart was confirmed. We outline the observed development of volcanicity after the report at the previous meeting.

Lava was flowing out from several lava craters on the east side of the newly formed land and the lava enlarged the new land to the east direction from May to July 2014.

A lava mound was formed in the then largest crater on August 26, 2014.

A large quantity of lava was flowing out into the north direction of Nishinoshima on September 17, 2014. Then, the lava reclaimed the new land area from shallow waters on the north side of Nishinoshima and "Nishinoshima-Shinto" formed at the previous volcanic eruption of Nishinoshima from 1973 through 1974 was buried. The original island of Nishinoshima was almost buried by December 25, 2014 and a small-scale lava field has been formed.

On the other hand, a large pyroclastic cone has been being formed near the centre of the newly formed land. A few craters on the pyroclastic cone repeated Strombolian eruption from April to July 2014. Now, there is only one active crater after the lava mound formation in August 2014 and the pyroclastic cone has been growing stably and steadily.

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P15 Room:Convention Hall Time:May 27 18:15-19:30

Monitoring of Nishinoshima volcano from space

FUKUI, Keiichi[1*] ; SAKURAI, Toshiyuki[2] ; ANDO, Shinobu[3]

[1]Volcanology Research Department, Meteorological Research Institute, [2]Tokyo VAAC, Japan Meteorological Agency, [3]Seismology and Tsunami Research Department, Meteorological Research Institute

The eruption column was discovered near Nishinoshima, Ogasawara islands, Japan on November 20, 2013 by the aircraft of Japan Maritime Self-Defense Force, and a new islet was confirmed by Japan Coast Guard on the same day. The new island continues growing up with lava flows for more than a year. For monitoring of volcanic activity of Nishinoshima, Japan Coast Guard and the Self-Defense Forces carry out the aerial observations at least once a month (a few times a month until March 2014). The changes of the area of island, position of crater, land form, eruption style, and discolored seawater are investigated from these observations. Also, aerial survey of 5 times was carried until January 2014 by the Geospatial Information Authority of Japan. In addition, Earthquake Research Institute estimated temporal change of the effusion rates from TerraSAR-X images and aerial photos taken by JCG and others.

Various data is acquired periodically from space. In particular, the data of Earth observation satellites such as LANDSAT-8 has quickly become available through internet at no charge.

Thermal activity and the feature of ground surface of Nishinoshima volcano were estimated with following satellite images.

1) Heat discharge rates were evaluated from plume rise method (Kagiyama, 1978) by using images of panchromatic band of LANDSAT-8/OLI and EO-1/ALI, and visible band of Terra/ASTER.

2) Surface temperature of Nishinoshima was evaluated from the thermal band of LANDSAT-8/OLI, EO-1/ALI, EO-1/Hyperion, Terra/ASTER, and MTSAT (Himawari).

3) Land area assessments by ALOS-2/PALSAR-2.

4) Extraction of time variation of the spectral data of EO-1/Hyperion.

The effusion rates of lava, which estimated by Earthquake Research Institute, had decreased temporarily in around June to September 2014. The temporal change of temperature estimated from thermal band (3.8 μm) of MTSAT showed the similar changes to effusion rates. The heat discharge rates estimated from volcanic plumes keep at the same level for more than a year.

Keywords: Nishinoshima, volcano monitoring, volcanic plume, ground temperature, remote sensing

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P16 Room:Convention Hall Time:May 27 18:15-19:30

Summary of volcanic activity at Ontakesan Volcano in 2014

NAKAMURA, Masamichi[1*] ; SEISMOLOGY AND VOLCANOLOGY DEPARTMENT, Volcanology division[1]

[1] Japan Meteorological Agency

An eruption occurred on 27 September 2014 at Ontakesan volcano. We report the summary JMA observation data in 2014, including this eruption.

Ontakesan is considered to erupt at 11:52 on 27 September. Though visual observation was interrupted by poor visibility, a pyroclastic flow, which flowed to Jigokudani direction, was observed. JMA raised the Volcanic Alert Level from 1 (Normal) to 3 (Do not approach the volcano) on the same day, because of the increased activity by the eruption.

According to an aerial observation conducted in collaboration with Japan Ground Self-Defense Force (JGSDF) and Chubu Regional Development Bureau (Ministry of Land, Infrastructure, Transport and Tourism; MLIT) on the following day, we confirmed that pyroclastic flows came down from newly formed crater chains in the SW of ones in 1979 eruption, and flowed down to the 2.5 km SW and 1.5 km NW from new crater chains.

The plumes from new craters became visible after 28 September. Eruption produced grayish and milky white plume, but changed to white plume after approximately 10 October. A Maximum plume height was 800 m above the crater rim on 28 September 2014, however, it gradually became lower, and plume height was ranged 100 - 300 m above the crater rim through the most of the period after November 2014.

Seismic activity remained at low levels before August 2014. Seismicity increased from the night of 10 September. Low-frequency earthquakes started to be observed though seismicity decreased gradually after 12 September. A continuous volcanic tremor occurred on around 11:41, just before the eruption. Seismicity became higher before and after the eruption. A continuous volcanic tremor fluctuated the amplitude and continued until about 6 October. The highest seismicity was observed on 27 September, and decreased since then. The number of volcanic earthquakes per day has fluctuated from several to ten and several times. All hypocenters of these volcanic earthquakes and tremors were located beneath the summit of Kengamine.

A tiltmeter, located at the 3 km SE at the summit (Kengamine), a rapid NW-up deformation was observed from 11:45 just before the eruption, but it reversed on around 11:52, then a gradual SE-down ground change continued.

JMA started to observe the amount of sulfur dioxide (SO_2) flux just after the eruption. It was approx. 1,000 t/d on 28 September 2014, but gradually decreased, and has remained approximately 200-300 t/d after November 2014.

These observations support that volcanic activity became quite high before and after the eruption on 27 September 2014, but has not yet got back on the activity before August 2014 though it has gradually been at lower state,. We have been intensifying the surveillance of Ontakesan volcano more than ever.

Keywords: Ontakesan volcano, eruption, volcanic tremor, tiltchange, sulfur dioxide (SO_2)

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P17 Room:Convention Hall Time:May 27 18:15-19:30

Explosion energy in Ontake 2014 eruption - estimation from thermodynamic properties of water-

NARITA, Shohei[1*] ; MURAKAMI, Makoto[2]

[1]Hokkaido University, [2]Institute of Seismology and Volcanology, Hokkaido Univ.

On 27 September 2014, eruption occurred near the summit of Mt. Ontake (3,067m above sea level) located in central Japan. This is a phreatic explosion caused by rapid expansion of gas-liquid mixed water. This study aims to estimate an energy balance to estimate how much of original thermodynamic energy was released as kinetic energy at the early stage of eruption. In the analysis we followed the method proposed by R.Tihery and L.Mercury (2009) to calculate total thermodynamic energy released by the water which was originally situated in magma or hydrothermal reservoir with high pressure and temperature. We also assumed that the thermodynamic process the water experienced was the decompression to an atmospheric pressure. Generally speaking, in the volcanic eruption, not all the thermodynamic energy of the water is converted into the kinetic energy leading to explosive event. In this study, we thus define an index ζ to represent a ratio of the kinetic energy versus the total thermodynamic energy of the original water at the reservoir with high pressure and temperature. Here we try to estimate ζ for Ontake, 2014 using all the available observation results reported about this eruption.

We started from the energy and mass conservation laws of water, ash, and rocks involved in the eruption. In the previous works done by R.Tihery and L.Mercury (2009) and Mastin (1995), the authors proposed methods to estimate theoretical maximum thermodynamic energy emitted by explosive process by assuming that all the ejecta derived from the deep hydrothermal reservoir. However, in actuality, rocks and mud which existed in the close proximity of the vent exit were also expelled by the erupting water, and acted as a conveyer of the kinetic energy. Therefore, in this study, we assumed that considerable amount of mud and rocks originally situating near the surface were also emitted from the vent with the same speed of the erupting water. Here we define another index η to represent the ratio of mass of the rocks conveyed from the reservoir versus the total ejecta emitted in the eruption. We substituted the observed numerical values of related parameters that appear in the equations of energy and mass conservations for the equation.

As a result, we came up with an equation which relates η to ζ. However, because of lack of constraints, we could not uniquely determine η and ζ, but were able to suggest upper and lower limits for those indexes. The estimated results for ζ and η were 0.2˜1 and 0˜0.5, respectively. To further narrow the range of η, we used the estimation for ζ (0.2˜0.4) by Ohba et al. (2007) for Akita Yakeyama phreatic eruption in 1997 because we recognize the high similarity between the two eruptions and because it seemed to be reasonable to assume ζ would be similar. Thus we assume ζ is also 0.2˜0.4 in the Mt. Ontake 2014 eruption, and we obtain η is 0˜0.3. For this range of ζ, the calculated mechanical energy was estimated to be 10^3˜10^4 GJ. This estimate means the total kinetic energy of the ejecta erupted during the early period of eruption, and hence this result is consistent with that of Taniguchi and Ueki (2014), which means discrete explosion energy causing formation of explosion craters.

Keywords: phreatic eruption, explosion energy, water, Ontake, thermodynamics

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P18 Room:Convention Hall Time:May 27 18:15-19:30

Development of Automatic Ash Observation System

FURUKAWA, Ryuta[1*] ; OIKAWA, Teruki[1]

[1]Geological Survey of Japan, AIST

We developed an automatic ash observation system with 2011 eruption of Kirishima Shinmoedake volcano as an opportunity. Our goal is to develop a method to obtain the semi-real time information of pyroclastic fall phenomena to contribute eruption forecasting and to advance high precision reconstruction of the sequence of the past eruption. Our equipment contains sensors of particle counter, load cell, and network camera, suppliers of 12V battery, solar panel, and wind power generator, and their controller. We newly deploy advanced equipment of ultra-sonic distance meter to measure the thickness of pyroclastic fall deposits. We tested each equipment in Kirishima and Sakurajima volcanoes and made sure to continuously observe and detect the eruption with acquring data of weight and image of deposits. Particle counter and internet rooter are troublesome with volcanic gas rich environment.

Keywords: volcanic ash, observation equipment, pollen sensor, load cell, internet

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P19 Room:Convention Hall Time:May 27 18:15-19:30

The ash fall of Ontake Volcano 2014 eruption by the pollen sensor networks observation

OIKAWA, Teruki[1] ; FURUKAWA, Ryuta[1*]

[1]GSJ/AIST

Ash fall of Ontake volcano 2014 eruption was observed by the pollen monitoring sensor of NTT DOCOMO of environmental sensor networks. Area of the ash-fall of over 2 g/m^2, a change in the significant sensor values was observed. Ash that could be observed in pollen sensor, with a particle size 35 μm or less, not a circular shape in order polarization from 1 to 0.2. The ash fall time is estimated from the sensor value; there was ash fall to 3 and 5 hours after the eruption, at the 30 km and 50km area of east from the crater, respectively. The Nigorigo Onsen, the foot northwest of volcano, the ash fall is estimated at 27th 21:00. Based on this example, the pollen sensor values became clear that it can be observed in a few g/m^2 ash-fall.

Keywords: Ontakesan, Ontake Volcano, 2014 erpution, Pollen sensor, volcanic ash, sensor network

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P20 Room:Convention Hall Time:May 27 18:15-19:30

Possible detection of fine ash particle from 2014 phreatic eruption at Ontake Volcano by pollen sensor network

MIWA, Takahiro[1*] ; NAGAI, Masashi[1] ; KAWAGUCHI, Ryohei[1] ; TANADA, Toshikazu[1]

[1]NIED

Very fine ash particle with size of $<30\mu$m is consider to remain suspended for days to week due to their small terminal velocity, and influence many environmental and economic factors (e.g., Rose and Durant, 2011). This study presents continuous data of pollen sensor network that possibly detected fine ash particle from 2014 phreatic eruption at Ontake volcano. The pollen sensor shots polarizing laser, and counts a particle introduced into the chamber. Also the shape of particles is estimated from scattering and polarization properties of the particles. The particle size that can be counted by the pollen sensor ranges from 20 to 30μm which corresponds to fine ash. We examined continuous data from 150 pollen sensor stations installed in Nagano, Gifu, and Yamanashi prefectures that were around the Ontake volcano during September 26-28th, 2014. We evaluated temporal change of the counting number of the particles on the basis of ratio of the counting number at a time to average value in each station. The ratio shows step-like increasing at few hours after the eruption which occurs in 11:52 September 27th. The increasing of ratio could be explained by falling and resuspension of fine ash particle after the eruption. Examination of shape of particle and extension of studied term are future work.

Keywords: volcanic ash, Ontake volcano, pollen sensor

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P21 Room:Convention Hall Time:May 27 18:15-19:30

Spectral characteristics of volcanic earthquakes before and after the 2014 eruption of Ontake volcano

NAGAOKA, Yutaka[1*] ; KATO, Koji[2] ; YAMAMOTO, Tetsuya[1] ; YOKOYAMA, Hirofumi[1]

[1]MRI, JMA, [2]JMA

Ontake volcano started phreatic eruption on 27 September 2014. The volcanic earthquake activity began from 29 August preceding the eruption and increased remarkably during 10-11 September. However, the volcano showed the decrease of earthquakes after that, followed by the phreatic eruption. We investigated the spectral characteristics of volcanic earthquakes with a view to reveal the eruptive process before the eruption implied by the earthquakes.

We classified the volcanic earthquakes occurred at Ontake volcano based on the spectrum of vertical record at Tanoharaue seismic station (JMA) into two groups defined as follows; earthquakes containing high frequency component over 20 Hz called HF, and otherwise called LF.

Comparing the activity of two groups before and after the eruption, LF was dominant for about a month before the eruption. In contrast, HF comprised a majority for about a month after the eruption. The duration of each LF earthquake was relatively long before the eruption, but became short after that. HF showed little difference about the duration between before and after the eruption. A number of successive volcanic earthquakes occurred before the eruption, and the majority of those had LF characteristic, however decreased after the eruption.

Keywords: Ontake volcano, volcanic earthquake, spectral characteristics

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P22 Room:Convention Hall Time:May 27 18:15-19:30

Comparison of seismic waveforms in process of past eruptions at Ontake volcano

OTSUKA, Yoshihiro[1*] ; FUJIWARA, Yoshiaki[1]

[1]Japan meteorological agency

We estimated the focal depth using the maximum amplitude ratio of seismic station "Kaida" (Nagoya.Univ) to station "Tanoharaue" (JMA) about the past eruptions in 2007 and 2014, and evaluated the characteristics of seismicity before and after the eruptions in 1991, 2007 and 2014.

On the eruption of September 27 2014, volcanic earthquakes increased from September 10. In addition to A-type earthquakes (HFs), BH-type earthquakes (MFs) were frequently observed. Most of BH-type earthquakes (ration; approx.. 4) occurred at shallower depth than the one (ratio; approx.. 2) during the dormant period. Volcanic tremor (ratio; approx..6) was observed at approximately 10 minutes ahead of the eruption occurred at another shallower depth, and HFs and MFs (ratio; approx..10) occurred at much shallower depth, which led to the eruption. After the eruption, MFs (ratio; approx..3) occurred at deeper depth once, then BL-type earthquakes (LFs) (ratio; over approx..8) occurred very often. After that, volcanic earthquakes with large amplitudes temporarily decreased, but they (mostly HFs) distribute dispersedly after the mid-October. Also, volcanic tremors (ratio; almost 3) at deeper depth in comparison with the previous ones occurred in a short period.

In case of 2007 eruption, many MFs (ratio; almost 3) from December 2006 to January 2007 occurred at deeper depth, compared to the ones in 2014. The burst of MFs and tremors occurred at shallower depth with large amplitude ratio, which was synchronized with Very-Low-Frequency earthquake (VLF). After the tremors at shallower part occurred for half a month, seismicity became temporarily dormant. After LF occurred on May 2 2007, a very small-scale eruption occurred in the course of the occurrence of LFs and tremors at shallower part (ratio is larger).

In case of 1991 eruption, though amplitude ration has been unexamined, waveform classification suggests that HFs occurred mostly as well as the other cases before the burst of earthquakes, in which most of earthquakes were MFs, including LFs and tremors. After approximately 1 month from these burst, a very small-scale eruption occurred. After that, tremors, MFs and LFs were observed for almost about 2 months.

As demonstrated above, seismicity before past eruptions are divided into two patterns: 1) shallower LFs, HFs and tremors (ratio is larger) were observed compared to the dormant period prior to eruption, 2) no or little shallow LFs, HFs and tremors were observed. In either pattern, the increase on MFs was confirmed prior to the eruptions. The presentation also investigated the similarities in each eruption process, using seismic waveforms in 2014 eruption and seisimic data during other eruptions.

Acknowledgement

We express great thanks to Nagoya University to use the waveform data on Kaida seismic station.

Keywords: Ontake volcano, maximum amplitude ratio, characteristics of seismicity

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P23 Room:Convention Hall Time:May 27 18:15-19:30

Detection of crustal deformation accompanied by the 2014 eruption of Ontake volcano using GNSS stacking data.

MIYAOKA, Kazuki[1*] ; YOKOTA, Takashi[2] ; TAKAGI, Akimichi[1] ; ONIZAWA, Shin'ya[3]

[1]Meteorological Research Institute, JMA, [2]Tokyo District Meteorological Observatory, [3]Japan Meteorological Agency

Phreatic eruption occurred at Mt. Ontake on September 27, 2014.

Although remarkable crustal deformations preceded the eruption were not detected at that time, some small changes in GNSS baseline data were reported by JMA and GSI afterward.

In this study, we applied the stacking method (Miyaoka and Yokota, 2012) to GNSS data and tried to find the crustal deformation induced by that volcanic activities.The stacking method can extract a common signal component included in the plural of the data. This method is intended to improve the SN ratio by cumulating the time series data of crustal deformation.

We set two types of combinations that composed the short baselines (Short Combination) and long ones (Long Combination). They are expected to detect crustal deformations due to a shallower pressure source and a deeper one respectively.

As the result of this analysis, we detected small expansionary changes before the eruption and small contractive changes after the event in Short Combination.

Furthermore, we also analyzed GNSS data of 2007 eruption with the same method. Then we found that the amount of Short Combination's change in 2007 is same as or slightly larger than that in 2014.On the other hand, in Long Combination, although the change observed in 2014 was small as comparable to the noise or less, a distinct change was found in 2007 and it was much larger than that in 2014.

These differences of changes in Short and Long Combination between 2007 and 2014 may reflect the difference in behavior of a material at shallower and deeper part of Ontake volcano.

Miyaoka, K., Yokota, T., 2012.Development of Stacking Method for the Detection of Crustal Deformation: Application to the Early Detection of Slow Slip Phenomena on the Plate Boundary in the Tokai Region Using Strain Data (in Japanese), J. Seism. Soc. Jpn.(Zisin) 65, 205-218.

Keywords: Mt Ontake, stacking, eruption, crustal deformation, GNSS

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P24 Room:Convention Hall Time:May 27 18:15-19:30

The rainfall correction of E-W component of the tiltmeter at Mt. Ontake Tanohara (1)

KIMURA, Kazuhiro[1*] ; NAKAHASHI, Masaki[2]

[1]Meteorological Research Institute, [2]Japan Meteorological Agency

Several minutes before eruption of Mt. Ontake of September, 2014, it is an obvious fact that there was a change of the clear mountain rise to the tiltmeter of Mt. Ontake Tanohara. However, the tiltmeter is affected by the rainfal, and we were not able to confirm other changes until now.

We tried the rainfall correction of E-W component of the tiltmeter at Mt. Ontake Tanohara, and I was able to get the good result during the period when rainfall is liquid (from June to October). As a result, We were able to confirm a change of the mountain rise from about September 10, 2014 in the same timing that earthquakes increased under the summit of Mt. Ontake. However, the change of such the tiltmeter was confirmed several times in the past. This change of the tiltmeter is thought to be a noise or a signal, a judgement is divided by each person.

Keywords: tiltmeter, Mt. Ontake, rainfall correction

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P25 Room:Convention Hall Time:May 27 18:15-19:30

Preliminary report of the gravity measurement around Mt. Ontake

HONDA, Ryo[1*] ; TANAKA, Toshiyuki[1] ; MIYAGI, Yosuke[2] ; MIYAJIMA, Rikio[1]

[1]TRIES, [2]NIED

Mt. Ontake (3067 m), which lies between the Nagano and the Gifu prefecture, erupted in September 27, 2014. This eruption caused 57 casualties. The gravity observation is important in monitoring volcanic activities, because it is able to detect the subsurface mass movement directly. Because we thought it is essential to make an early observation after the eruption, the hybrid observation of the absolute and the relative gravimeter was performed. We also established the gravity stations for the annual recurrent observations.

For it is important to comprehend the height change in the recurrent gravity measurement, we installed gravity stations along the benchmarks of the leveling line (Kimata et al., 2011). Adjoining the benchmarks, we drilled two shallow pits for each stations for the convenience of the recurrent observations. We installed 30 gravity stations along leveling line, and two more stations close to the mountain top; at the Tanohara and the Ontakesan Kyuka-Mura.

We executed the observation and the construction of the gravity stations during 18 to 21 November, 2014. The absolute gravity measurement was operated at the branch office of the central Mitake-cho civic center, while the relative measurement was operated with two gravimeter; CG-3 (TRIES) and CG-5 (NIED). We will recurrently operate this observation for the monitoring of the volcano.

Kimata et al., 2011, Vertical deformation detected by the accurate leveling around the Eastern sub-montane swarm area of Mt. Ontake, (2002-2009), Rep. Res. Committee for Crustal Activity, 27, 67-74, 2011 (in Japanese).

Keywords: Gravity, Mt. Ontake, Crustal Deformation

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P26 Room:Convention Hall Time:May 27 18:15-19:30

Self-potential mapping around the summit area of Ontake volcano and continuous telluric observations

YOSHIMURA, Ryokei[1*] ; OKADA, Yasuaki[1] ; YAMAZAKI, Ken'ichi[1]

[1]Disaster Prevention Research Institute, Kyoto University

In this presentation, we will report the result of self-potential (SP) mapping around the summit area of Ontake stratovolcano obtained by campaign measurements in summer season of the years 2005 and 2006. By comparing the distribution of SP with the location of the 2014 phreatic eruption, we discuss whether it was possible to know a potential risk of such phreatic eruption in advance.

In February 2007, we established a continuous SP observation network the eastern submontane area of Ontake volcano with the aim of monitoring the crustal/hydrothermal activity. This network consists of 8 long dipole telluric observations using leased telephone infrastructures as the cables connecting the electrodes and is about 10 km away from the summit. We will also introduce long-time variations detected by this telluric observation network and report the presence or absence of a remarkable change around the time of the 2014 phreatic eruption.

Keywords: Self-potential, Ontake volcano, continuous telluric observations

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P27 Room:Convention Hall Time:May 27 18:15-19:30

Recent volcanic activity of Unzen volcano

MATSUSHIMA, Takeshi[1*] ; UMAKOSHI, Kodo[2] ; SHIMIZU, Hiroshi[1] ; MATSUMOTO, Satoshi[1] ; AIZAWA, Koki[1] ; KAMIZONO, Megumi[1]

[1]SEVO, Kyushu Univ., [2]Fac. of Environmental Studies, Nagasaki Univ.

Unzen volcano that made the volcanic activity, such as lava dome and pyroclastic flow in 1990-1995, the volcanic activity on the surface is followed by a calm situation. However, seismic activity just below Fugendake is gradually activated for the last few years, change has appeared in its activities.

After growth arrest of lava dome, it was state for a while less occurrence of volcanic earthquakes. However, since 2008 in 1km B. S. L. near the Fugen, a small earthquake with seismic magnitude -1 to 0 occurs in two to three times the frequency of the past. In recent years, the number of volcanic earthquakes magnitude from 0 to 1 increases.

Previously the temperature of the fumarole gas lava dome had been steadily reduced. However, the measurement in November 2014 fumarole temperature increases 5 to 10 degrees, the amount of gas fumarole is large.

In the leveling route of the west bank of Shimabara Peninsula, is progressing sedimentation during few years. Supply of magma from deep underground has stopped.

The results of the GPS observations Meteorological Research Institute has conducted, lava dome has continued to shrink, old mountain upper body directly under its also seen a contraction trend.

Given From the above, supply of magma from deep under the Chijiwa bay has stopped. Lava dome on the surface of Fugendake also is progressing steadily cooling. However, directly under the sea under the depth 1km Fugen is, volcanic earthquakes have increased by some volcanic activity. Fumarole temperature of the dome is slightly increased and amount of fumarole is so large, some activity in this depth 1km there is a possibility that effect.

Keywords: Unzen volcano, Volcanic earthquake, Leveling survey, fumarole gas temperature, lava dome

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P28 Room:Convention Hall Time:May 27 18:15-19:30

The 2014-2015 eruptive activity of Aso Volcano, Kyushu, Japan

HIRAMATSU, Hideyuki[1] ; INOUE, Hideho[1] ; MATSUSUE, Shinichi[1] ; KATO, Koji[2*]

[1]Fukuoka Regional Headquarters, JMA, [2]Japan Meteorological Agency

Mt. Aso is one of the most active volcanoes in Japan. The volcanic activities of Mt. Aso has increased gradually since 2013. Small eruptions sometimes occurred and number of volcanic earthquakes and volcanic tremor amplitude increased relatedly.

Mt.Aso began to erupt on November 2014. This eruption was Strombolian and accompanied with ejection of scoria. We report about recent volcanic activity of Mt. Aso

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P29 Room:Convention Hall Time:May 27 18:15-19:30

Ground deformation in Aso Volcano before and during 2014-15 eruptive activity

OHKURA, Takahiro[1*] ; YOSHIKAWA, Shin[1] ; INOUE, Hiroyuki[1]

[1] AVL, Kyoto Univ.

Aso Volcano, one of the most active volcanoes in Japan, is located in the central part of Kyushu and consists of an elliptical caldera with a diameter of 18km in E-W and 25km in N-S, and of central cones with more than 10 volcanoes aligned in E-W direction. Among central cones, Nakadake volcano is the only active cone and its recent activity is characterized by ash and strombolian eruptions and phreatic or phreatomagmatic explosions. The last strombolian eruptions ended in the beginning of the 1990s and after that, surface activities have been restricted to the fumarolic gas and ash emission from the northernmost crater of the volcano accompanying activity of long period tremors (LPT) or very long period (VLP) events.

Aso volcanological laboratory has an observation tunnel for the precise measurement of ground deformations. The 30m-deep tunnel is located at Hondo observatory, 1km southwest from the active crater. Waterlube tiltmeters and invar-rod extensometers are working in the tunnel to monitor the ground deformation of Aso.

Since 1990s, observations using broadband seismometers at the tunnel have revealed that the source of LPT is a crack-like conduit located at depths of 1-1.5 km beneath Nakadake, with a length of 1km and width of 2.5km. It is also revealed that at this depth a pressure was located and caused long-period displacements a few minutes before phreatic eruption that occurred in 1993 and 1994.

After 21 year's dormancy, Aso volcano started magmatic eruptions in November, 2014.

During pre-eruptive stage, remarkable ground deformations were detected by the tilt meters and extensometers in September 2013, January 2014 and July 2014 associated with increase in VLP events activity. By comparing the calculated deformation assuming a Mogi source and a dyke, it is found that observed deformation could be attributed to the expansion of the crack-like conduit.

Just before the eruption that occurred on 25 Nov. 2014, we have detected a rapid extension of the radial component of the extensometers.

We also detected a expansion at a depth of 1.3km just beneath the active crater of Nakadake 2 days before successive eruptions in Jan. 2015. It is found that the located deformation source almost coincides with the location of the pressure source before the phreatic eruption in 1993 and 1994.

Keywords: Aso Volcano, Eruptive activity 2014-2015, Crustral deformation

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P30 Room:Convention Hall Time:May 27 18:15-19:30

Detection of long period events of the Aso volcano applying a matched filter technique to F-net broadband seismic data

MATSUZAWA, Takanori[1*] ; MATSUMOTO, Takumi[1] ; TANADA, Toshikazu[1]

[1]National Research Institute for Earth Science and Disaster Prevention

It has been reported that long period seismic waves above the period of 10 s are excited at the Aso volcano (Kaneshima et al., 1996, Science). These events have been activated from the summer in 2014. We are now developing a monitoring system of these events, applying a matched filter technique to F-net broadband seismic data (e.g., Asano et al., 2015, GRL).

In this method, cross correlation (CC) values between a template event and target data are calculated using three component continuous data of nine F-net broadband seismometers around the Aso volcano. Long period events are detected, if average value of CC exceeds threshold values. Assuming that the epicenter is within the volcano, only origin times of the events are estimated in this analysis, while Asano et al. (2015) estimated origin time and epicenters of shallow very low frequency earthquakes simultaneously. We selected the event at 6:05am on Mar. 31, 2009, as a template event, in this study. Waveforms are band-pass-filtered between 10 s and 20 s. Then, averaged value of CC of all components at all stations is calculated. If maximum value of averaged CC within 1 minute exceeds threshold values, the signal is detected as an event. In the following of this study, we show results from Apr. 2003 to Jan. 2015, assuming 0.3 and 0.5 as the threshold values. To measure the size of events, averaged amplitude ratio (AAR) is given by logarithmical average of ratios of maximum amplitude between target period and a template event. Daily values of AAR and number of events are defined by median of values in one day. We use these daily values in the following discussion. Daily number of events with threshold of 0.3 and 0.5 is denoted by N03 and N05, respectively.

In our result, long period events are relatively quiescent from Aug. 2010 to Feb. 2012. Number of events and AAR start to increase in Aug. 2014. After Oct. 10, 2014, N03 and AAR frequently exceed 500 and 2, respectively. Then, N05 and AAR decreases after the end of Nov. 2014. However, N03 is kept high. This suggests that number of events is still large, while the amplitude becomes low.

It remains some problems to be improved in our simple method. For example, CC value tends to be low, when far field large earthquakes occur. In addition, detectability of events may be saturated, when long period events recur within 1 minute, which is the length of the time window to select an event. Threshold value also should be examined, while we adopt the values of 0.3 and 0.5 in this study. However, as our method can quantitatively evaluate the activity of long period events, number of events and AAR are still useful parameters to evaluate the activity of the Aso volcano.

Keywords: Aso volcano, long period tremor, matched filter technique, monitoring

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P31 Room:Convention Hall Time:May 27 18:15-19:30

Locating sources of the continuous tremor at Aso Volcano

ICHIMURA, Misa[1*] ; YOKOO, Akihiko[1] ; KAGIYAMA, Tsuneomi[1] ; OHKURA, Takahiro[1] ; YOSHIKAWA, Shin[1] ; INOUE, Hiroyuki[1]

[1]Graduate School of Science, Kyoto University

At Aso Volcano in southwest Japan, volcanic tremors have been well-studied based on observations since early 1900s and have been classified into several types (e.g. Sassa, 1935). One of these tremors, a continuous tremor, dominates in the frequency of 3-10 Hz and its source location is determined in the area shallower than a depth of 600 m beneath the active crater (Takagi et al., 2006; 2009). This suggests that an intrusion of gas flow into an aquifer occurs at this depth. There is another idea about source process of this tremor; it might be associated with increasing a cross-sectional size of a conduit as change of seismic amplitude often corresponds to change of volcanic activity (Sudo, 2012). However, precise source location and source mechanism of the continuous tremor have not yet been elucidated in either case.

In January 2014, it was found that a new vent had been opened in the crater of Aso Volcano on the 7th day and that a small eruption occurred on the 13th day (Japan Meteorological Agency, 2014). A temporal change of the tremor amplitude was observed since more than one month before these surface phenomena. In a 5-10 Hz band-passed vertical seismogram at a station SUN, 1 km south from the crater, the RMS amplitude started to increase gradually in November 2013 (0.006 μm/s/day). After that, it increased rapidly for 2 weeks (0.16 μm/s/day) and then sharply decreased to the same level as in early November for 3 days (-0.25 μm/s/day). Similar changes of the amplitude were observed for 10 days afterward.

In this study, we focus a period from December 2013 to January 2014 and determine source locations of the continuous tremor. We then discuss a source process of the tremor linking to a shallow structure beneath the active crater.

For locating sources of the continuous tremor, we assume that the tremor is composed of the S-wave radiating isotropically (Vs=1.12 km/s; Q=204). Grid search method is applied to reproduce a spatial distribution of the seismic amplitude (vertical component) observed at our 7 stations around the crater. The space for searching is about 1,500 m$\times$1,500 m$\times$1,200 m at a 25 m interval. The terms when we have data with good azimuthal coverage by more than 4 stations are picked up to the calculation.

As a result, source locations of the tremor were determined at the depth of several tens m beneath the crater in early December when the amplitude increased gradually, and near the ground surface of the crater bottom in late December when the amplitude increased rapidly. In early January when we observed the similar change of amplitude to in December, the sources were located from the depth of a few hundreds m to just beneath the crater bottom.

These results indicate that we could shed a light on the distribution of a path of volcanic fluid beneath the active crater. Yamamoto et al. (1999) proposes that a crack-like conduit whose upper edge is situated in a depth of 300 m beneath the crater is the path of volcanic fluid. The fluids may always be supplied to the crater through the conduit (Terada et al., 2012). The tremor sources determined here are distributed to fill a space between upper edge of the crack-like conduit and the crater. In this area, there are a cap rock and a hydrothermal fluid reservoir (Kanda et al., 2008). We thus interpret source processes of the continuous tremor as follows. In December, fluid influx exceeded the usual amount as increasing of volcanic activity. This widened the path with radiation of the continuous tremor. Especially the tremor at shallower depth of the crater would associate with fracturing in the cap rock region. Since this phenomenon must have reached to the ground surface, we observed the new vent opened inside the crater on 7 January. In the next 10 days, as further increase of the influx causing the January 13 eruption would occur, the observed tremor amplitude changed like in December.

Keywords: volcanic tremor, Aso Volcano

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P32 Room:Convention Hall Time:May 27 18:15-19:30

Results of the electromagnetic survey related to the eruption of 2014 on Aso volcano.

UTSUGI, Mitsuru[1*] ; OHKURA, Takahiro[1] ; YOKOO, Akihiko[1] ; KAGIYAMA, Tsuneomi[1]

[1]Kyoto Univ.

On Aso volcano, eruption was occurred at Nov. 2014, first time in 21 years. Around the Nakadake 1st crater, which is the most active crater of Aso volcano, we conducted continuous geomagnetic field observation (since 1991) and subsurface resistivity monitoring by repeated EM induction survey (since 2011). From these observations, we obtained the data which suggest the subsurface thermal state had drastically changed before the beginning of the eruption.

From the continuous geomagnetic field (total field) observation, significant temporal change was observed. This temporal change began from Oct. 2014, 1 month before the eruption. The sense of this change is demagnetization and it suggests subsurface temperature was increased. From the data analysis, it was revealed that this change in temperature was occurred on 150m depth from the rim of crater, about 50m depth from the bottom of the 1st crater.

From the monitoring of subsurface resistivity using ACTIVE system (control sourced EM induction survey), significant temporal change of resistivity structure was also observed. The repeated ACTIVE survey was carried out on Sep. 20 before the eruption and Nov. 26 just after the eruption. From the data obtained by these surveys, temporal change was observed in 100 to 150m depth from the rim of crater and the resistivity was increased on this depth. The source depth of geomagnetic change and the depth that the resistivity has changed are very similar. From this, we are considering the following scenario: Magma began to rise from before about one month of eruption. By this magma, crustal rock was heated and demagnetized. And the underground water, hydrothermal fluids was pushed away by the high temperature of magma and subsurface resistivity became relatively high.

On our presentation, we will show the detail about our observation data and results of data analysis related to the eruption on 2014.

Keywords: geomagnetic field observation, demagnetization, resistivity monitoring

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P33 Room:Convention Hall Time:May 27 18:15-19:30

Relative source locations of continuous tremor before and after the subplinian events at Shinmoe-dake

ICHIHARA, Mie[1*] ; MATSUMOTO, Satoshi[2]

[1]Earthquake Research Institute, University of Tokyo, [2]Institute of Seismology and Volcanology, Kyushu University

Shinmoe-dake volcano started its climatic events on January 26, 2011, and three subplinian events occurred in 2 days. Although precursory evidences indicating magma intrusion were found in the time scale of a year, any decisive geophysical signals showing the final stage toward the eruption have not been identified. Volcanic tremor started to be recorded at stations around the summit of Shinmoe-dake at 12:45 on 18 January and had a high intensity after the phreatic eruption at 01:27 on the 19th until Februay 7, If there was any sign indicating rise of new magma to the shallow depth before the phreatic eruption, the tremor could be the candidate. Here we analyze the locations of the continuous tremor before, during, and after the subplinian events.

Seismic stations were sparse especially in the west of Shinmoe-dake before the eruption. A good number of seismic stations were installed after the start of the eruption, which included a dense seismic array operated by Kyushu University. The array was deployed on January 29 about 3 km from the Shinmoe-dake crater in the direction N115^{o}W. Twenty-five 3-component seismometers with a natural frequency of 2 Hz were installed at a sensor interval of 20-40 m.

We first investigated the source location of a long steady tremor on February 2 from 0:00am to 4:05am. Any clear spectral peaks common among the stations were not observed, and the power was broadly distributed in the rages below 2 Hz and 4.5-7 Hz. A MUSIC spectrum analysis was performed for the data from the seismic array using 1.5-2.5 Hz and 3.5-4.5 Hz bands. The results showed that P and S waves constantly came from the direction of the Shinmoe-dake crater. In addition to the array, 16 seismic stations recorded good quality data in this period. The tremor centroids were calculated by simply summing the coordinates of the stations weighted with the route-mean-square amplitudes of the tremor in a 1-7 Hz band. They fell on the center of the Shinmoe-dake crater. When only the stations that were operated before the eruption were used, the centroids were shifted to the northeast because of the biased distribution.

The amplitude distribution of this tremor was used as a reference. The seismic amplitude from January 18 to February 2 at each station was normalized by this reference amplitude. From dependence of the normalized amplitudes on the directions and distances from the Shinmoe-dake crater, the relative source locations of the tremor were estimated. In the afternoon of January 18, when the continuous tremor started, the source moved from the west to the center of the crater and then to the north and the deeper. The tremor source because shallower after the phreatic eruption on the morning of January 19, and a narrow gliding spectral peak appeared around 2 Hz on the night. The tremor declined at 8:00 on January 23 and restarted at 13:15 at a further shallower depth. This shallow source was active until the phreatic eruption on the morning of January 26 before the first subplinian event. The amplitudes at the southern stations were relatively strong during the first and second subplinian events and the same location as the reference event became active after the second subplinian event. It is consistent with the visual observation that the eruption center shifted from the south edge to the center of the crater at the final stage of the second subplinian event.

Keywords: Volcanic tremor, Eruption, Seismic source, Shinmoe-dake

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P34 Room:Convention Hall Time:May 27 18:15-19:30

A precise evaluation of magma-derived CO_2 flux from seafloor on Aira Caldera in Kagoshima Bay, Southern Kyushu,

KONDO, Kazuna[1] ; YAMANAKA, Toshiro[1*] ; TSUNOGAI, Urumu[2] ; TAKAHASHI, Hiroshi[3] ; YAMAMOTO, Tomoko[4]

[1]Okayama University, [2]Nagoya University, [3]AIST, [4]Kagoshima University

Aira Caldera is one of the huge volcanic depressions located Kyushu, Japan, and it occupied the innermost part of Kagoshima Bay, southern Kyushu. The caldera is designated one of the active volcanoes in Japan due to its vigorous fumarolic activity on seafloor in Wakamiko Crater. The caldera is almost submerged (caldera floor is about 140 m in water depth) and is about 20 km in width from east to west. Wakamiko Crater is another depression located at the east side of the caldera floor, water depth of the crater floor is about 200 m. Vigorous fumarolic activity in and around the crater has been known as “Tagiri” by local fishermen, and the gas is composed mainly of carbon dioxide with significant amount of methane derived from thermal decomposition of organic matter.

Monitoring of gas flux and composition associated with volcanic activity is expected one of the useful proxies for evaluation of volcanic activity. CO_2 is the most sensitive indicator to reflect clearly the state of magma because CO_2 is degassing preferentially relative to the other components. Since 2007, we have tried to estimation of CO_2 flux from the seafloor in the caldera based on accumulation rate of dissolved inorganic carbon (DIC) in the stagnant bottom water with in the crater. However, the DIC possibly include additional CO_2 derived from methane oxidation in water column and decomposition of organic matter in the sedimentary layers filled in the crater and caldera. Therefore, we evaluate the contribution of the additional CO_2 and try to estimate pure CO_2 flux from magma excluding the additional CO_2.

Significant high δ^{13}C and δD values of dissolved methane in the seawater samples indicated that methane oxidation was occurred in the water column overlying Wakamiko Crater. Based on the isotopic data the isotope fractionation factor (α) for carbon and oxidation rate of dissolved methane were estimated α = 1.023 and 3.4 μM/d, respectively. The oxidation rate is significantly higher relative to the previous reported values from other seafloor hydrothermal systems, suggesting that quite active methane oxidation is occurred within seawater occupied in Aira Caldera. Using those results we calculated the original methane concentration before oxidation as 0.01mM. Therefore, the contribution of methane oxidation to concentration and isotopic ratio of DIC in the water column can be ignored because dissolved CO_2 concentration is two orders of magnitude higher than the methane concentration.

Furthermore, we estimated the contribution of CO_2 derived from decomposition of organic matter in the sedimentary layer. δ^{13}C value of CO_2 in the fumarolic gas from the crater could be estimated c. -10 ‰ based on those of DIC in the water column. The δ^{13}C value of CO_2 in magma volatile was assumed -5.5 ‰ based on the data of adjacent volcanoes. The δ^{13}C value of CO_2 derived from organic matter was reported c. -30 ‰. According those data the contribution of additional CO_2 from organic matter is estimated c. 18 %. Based on the estimation, we can calculate an accurate flux of magmatic CO_2 from the Aira Caldera.

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P35 Room:Convention Hall Time:May 27 18:15-19:30

Vertical ground deformation in Sakurajima volcano measured by precise leveling survey (during Nov. 2013 - Nov. 2014)

YAMAMOTO, Keigo[1*] ; YOSHIKAWA, Shin[2] ; MATSUSHIMA, Takeshi[3] ; OHKURA, Takahiro[2] ; YOKOO, Akihiko[2] ; INOUE, Hiroyuki[2] ; MISHIMA, Taketoshi[2] ; UCHIDA, Kazunari[3] ; SONODA, Tadaomi[1] ; SEKI, Kenjiro[1] ; KOMATSU, Shintaro[1] ; HOTTA, Kohei[2] ; FUJITA, Shiori[3]

[1]Disaster Prevention Research Institute, Kyoto University, [2]Graduate School of Science, Kyoto University, [3]Faculty of Sciences, Kyushu University

We conducted the precise leveling survey in Sakurajima volcano in November 2014, in order to evaluate the vertical ground deformation associated with the recent eruptive activity of this volcano. The leveling routes measured in 2014 survey are about 56 km long in total, including Sakurajima coast route, Sakurajima western flank route, Sakurajima northern flank route. These leveling routes were measured by the joint university team during the period of November 5-20. Mean square errors of the conducted survey were achieved with a good accuracy as the range from $\pm$0.25 to $\pm$0.32 mm/km.

From the measured data, we calculate the relative height of each bench mark referred to the reference bench mark BM.S.17 which is located at the western coast of Sakurajima. The calculated relative heights of the bench marks are then compared with those of the previous survey conducted in November 2013, resulting in the relative vertical displacements of the bench marks during the period from November 2013 to November 2014.

The results show that no remarkable vertical displacements are seen at bench marks around the northern part of Sakurajima, where the ground uplifts have been observed since around 1993 when the eruptive activity at the summit crater of Sakurajima volcano was gradually decayed. The uplifts reflect the inflation of the magma reservoir beneath Aira caldera. Thus it is suggested that the magma storage at the magma reservoir beneath Aira caldera almost stops during the period from November 2013 to November 2014. On the other hand, the resultant displacements indicate the ground subsidence near the central part of this volcano. This subsidence reflects the deflation of the magma reservoir located beneath the summit crater, caused by the recent increase of the volume of ejected magma associated with the eruptive activity at Showa crater.

Keywords: Sakurajima volcano, Aira caldera, precise leveling survey, vertical ground deformation

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P36 Room:Convention Hall Time:May 27 18:15-19:30

Activity of micro VT earthquakes derived from repeating seismic observations using OBSs around Sakurajima Volcano

YAKIWARA, Hiroshi[1*] ; HIRANO, Shuichiro[1] ; MIYAMACHI, Hiroki[1] ; TAKAYAMA, Tetsuro[2] ; ICHIKAWA, Nobuo[2] ; TAMEGURI, Takeshi[2] ; IGUCHI, Masato[2]

[1]GSE, Kagoshima Univ., [2]SVRC, DPRI, Kyoto Univ.

We have performed seismic observations with three or four Ocean Bottom Seismographs (OBSs) around Sakurajima Volcano, in order to observe micro volcano-tectonic earthquakes (MVTs) which occur beneath sea bottom of Kagoshima Bay. Although the observation cannot be continuously conducted through a year, we successfully retrieved all OBSs for six observation periods (P0 to P5) from 2009 to 2014. Yakiwara et al. (2014, JpGU) compared the hypocenter distributions with three-dimensional seismic velocity model of the upper crust in and around the volcano, though several problems to be solved were remained; 1) the hypocenters were determined using a one dimensional velocity model (Kakuta et al., 1991: Vp/Vs=1.73=const.) optimized for regional area of southern Kyushu Island, 2) Station corrections were not estimated adequately, 3) Temporal changes of the hypocenters were not be mentioned. We therefore re-evaluated the corrections to alternative velocity models, and relocated the hypocenters. Present study reports the comparisons between relocated hypocenters and temporal changes of baseline lengths of GEONET stations, and a three-dimensional resistivity in and around Aira Caldera (Kanda et al., 2013).

As alternative velocity models, we adopted one- and three- dimensional velocity models derived from tomographic modeling in and around central and southern Kyushu (Yakiwara et al., 2013, IAVCEI; Yakiwara et al., 2014, JpGU). Selecting earthquakes used in the tomographic studies and also observed by the OBSs, medians of travel time residuals for each model were assigned as station corrections. Then, hypocenter relocations were performed by use of the corrections and the velocity models. Among the relocations, the hypocenter distributions determined by three-dimensional velocity model is most suitable in that the residuals reached minimal.

Among the observation periods, the relatively obvious increase of baseline elongations was observed only in P3 (October,2011 to January,2012). We therefore estimate P3 as an acceleration period of ground expansion in and around Aira Caldera. The ground deformation corresponds to magma accumulations at a main magma reservoir of the volcano. In the period of P3, MVTs from 7 to 15 km depth were activated beneath the area between Wakamiko Caldera and northeast coast of Sakurajima Volcano. On the other hand the ground deformation seems to be stationary in P5 (November,2013 to March,2014) because the baseline lengths did not change significantly. In this period, only few MVTs occurred 3 to 6 km depth beneath Wakamiko Caldera. No earthquake was observed below 7 km depth. The activity and depth range of MVTs in P5 were different from ones in P3. The ground expansion progressed on average rate in P1, P2, and P5. Almost MVTs occurred at depth range from 3 to 6 km beneath Wakamiko Caldera. The relatively deep MVTs below 7 km depth may occurred due to stress changes generated the magma accumulations at main reservoir of the volcano. We suppose that the shallow MVTs from 3 to 6 km beneath Wakamiko Caldera relates to hydrothermal activities supplying fluid to sea bottom fumaroles. We also compared the hypocenters of MVTs with a three-dimensional resistivity structure (Kanda et al., 2013). The hypocenters locate around the low resistivity area and/or the top of the area. This comparison supports that the shallow MVTs may relate the hydrothermal activity beneath Wakamiko Caldera.

Keywords: Sakurajima Volcano, Volcano-tectonic earthquakes, Three-dimensional velocity model, Three-dimensional resistivity structure

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P37 Room:Convention Hall Time:May 27 18:15-19:30

A subsurface structure change associated with the eruptive activity at Sakurajima volcano, Japan, inferred from ACROSS

MAEDA, Yuta[1*] ; YAMAOKA, Koshun[1] ; MIYAMACHI, Hiroki[2] ; WATANABE, Toshiki[3] ; KUNITOMO, Takahiro[1] ; IKUTA, Ryoya[4] ; IGUCHI, Masato[5]

[1]Nagoya University, [2]Kagoshima University, [3]The University of Tokyo, [4]Shizuoka University, [5]Kyoto University

1. Introduction

At Sakurajima volcano, where up to 1000 vulcanian explosions are occurring a year, an active seismic source called ACROSS has continuously emitted a regular frequency-modulation signal into the ground since 2012 (Yamaoka et al., 2014 EPS). Deconvolving the signal at a nearby seismic station by the known source time function yields the Green function between the source and the receiver. Monitoring a temporal variation of the Green function would lead to the detection of a subsurface structure change associated with the volcanic activity.

As the first ACROSS-based survey of the Green function change at this volcano, we had stacked the Green functions at different times based on the time relative to eruptions and had found that the correlation coefficients between these stacked Green functions and the all-span average of the Green function had decreased around the times of the eruptions (Maeda et al., 2014 VSJ). However, it had not been certain if this correlation coefficient decrease had been due to a true subsurface structure change or an apparent Green function change caused by volcanic earthquakes and tremors.

In this presentation, we analyzed the Green function energies instead of the correlation coefficients, which enabled us to discriminate actual structure changes and the apparent Green function changes caused by the seismicity.

2. Analysis

We computed the Green functions every 400 s from 19 Sep 2012 to 21 July 2014 at Harutayama, the station closest to the source (distance : 615 m), using the ACROSS signal in a 12.505$\pm$2.5 Hz band. We stacked these 400 s Green functions based on the time relative to eruptions. We then computed the kinetic energy waveforms by taking the square summations of the three components of the stacked Green functions. We found an energy decrease in the later phase of the Green functions around the times of the eruptions.

To see this energy decrease more systematically, we averaged the energy in every 2 s window and plotted against the time relative to eruptions. This plot showed a clear energy decrease toward eruptions and a recovery of the energy after eruptions in 2-4 s window. At another station (distance : 1200 m), the energy decrease was visible in 2-4 s and 4-6 s windows.

3. Discussion

The seismogram at a station consists of not only the ACROSS signal but also volcanic earthquakes and tremors. Since the Green functions are estimated from the superposition of these signals, an apparent Green function change under a constant subsurface structure may appear due to an increased seismicity. To evaluate this effect, we formally applied the procedure to estimate the Green functions to 400 s waveforms including explosion earthquakes in early August 2013 when the ACROSS source was not operating. The outputs of this procedure were the errors of the Green function caused by the explosion earthquakes. In most cases, the errors distributed over the entire time window of the Green function. Depending on the timings of the eruptions, the errors concentrated on an earlier part of the Green function window for some eruptions, but for some other eruptions the errors concentrated on a later part, suggesting that averaging the errors for many eruptions would flatten the error distribution. Therefore the energy decrease localized to the 2-4 s window is difficult to explain by contaminations of volcanic earthquakes but is more likely a true temporal variation of the subsurface structure.

As a candidate explanation for this temporal variation, we may consider dynamic effects of volcanic earthquakes before and after eruptions on a medium beneath Showa crater, affecting the reflection amplitude of the Green function in that region. We would evaluate this and other candidate models in the future.

Keywords: ACROSS, Subsurface structure, Active seismic source, Sakurajima volcano, Volcano seismology, Volcano monitoring

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P38 Room:Convention Hall Time:May 27 18:15-19:30

Seismic velocity changes at Sakurajima detected by coda wave interferometry and seismic interferometry

HIROSE, Takashi[1] ; NAKAHARA, Hisashi[1*] ; NISHIMURA, Takeshi[1]

[1]Graduate School of Science, Tohoku University

Sakurajima is one of the most active volcanoes and is monitored by various kinds of geophysical and geological observations. Active seismic experiments have been repeated once a year since 2008. Applying coda-wave interferometry to seismic records at 6 Japan Meteorological Agency (JMA) stations from the active seismic experiments conducted in 2011, 2012, and 2013 (Tsutsui et al., 2012, 2013, and 2014), we detect significant seismic velocity increases at northern and eastern flanks of the volcano. The velocity change is at a maximum 0.40% around 4Hz, 0.15% around 8Hz, and 0.05% around 16Hz. We also apply seismic interferometry to ambient noise during 2012 and 2013 to continuously monitor velocity changes. From the vertical-vertical cross correlations in 1-2, 2-4, and 4-8 Hz bands, we find that seismic velocity increases and decreases with a period of several months for all the station pairs. The amplitude of the velocity change is at a maximum 2%, 1%, and 0.5% in 1-2Hz, 2-4Hz, and 4-8Hz, respectively. Results from seismic interferometry are consistent with those from coda-wave interferometry. The periodic change in seismic velocity shows a good correlation with records of an extensometer shown in CCPVE (2014): velocity increase for contraction while velocity decrease for extension. The strain change is attributed to a volcanic pressure source at a few kilometers beneath the summit (Iguchi et al., 2013). For station pairs between which the summit is located, short-term velocity changes seem to be associated with precipitation. This study shows that simultaneous use of seismic interferometry and coda-wave interferometry is useful to obtain reliable measurements of seismic velocity changes.

Acknowledgments: We used seismograms recorded by JMA. Active seismic experiments were conducted by DPRI, Kyoto University, other 8 Japanese universities, and JMA.

Keywords: seismic velocity change, Sakurajima, coda-wave interferometry, seismic interferometry

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P39 Room:Convention Hall Time:May 27 18:15-19:30

Ground Deformation around the Domestic Active Volcano using InSAR time series analysis

ANDO, Shinobu[1*] ; MIURA, Yuji[2] ; MATSUMORI, Toshiyuki[2]

[1]MRI, [2]JMA

ALOS has an L-band SAR (PALSAR), which is not affected by vegetation, and the interference is good even in mountainous areas. So these methods are effective for the crustal deformation observation of volcanic areas.

In previous studies, we have reported the analysis results about all domestic active volcanic areas, using D-InSAR of ALOS since 2007. Furthermore, in the last JPGU meeting, we have reported the analysis results about 11 active volcanoes in the Kunashiri and Etorofu islands, Soutern Kuril Islands using *StaMPS* software (Hooper *et al*., 2004).

We are promoting the analysis of ALOS/PALSAR data around the major domestic active volcano in Japan using a similar approach. As a result, we were detected a time series variation of the ground deformation caused by the volcanic activity in some of the active volcano. Note, in the northern volcano area, we analyzed except for the data captured in the winter in order to remove the effect of the snow. *StaMPS* software has the analysis methods to merge these results besides PS-InSAR and SBAS methods. We will report the merged results obtained by these analysis methods.

Some of PALSAR data were prepared by Japan Aerospace Exploration Agency (JAXA) via the Coordinating Committee for the Prediction of Volcanic Eruption (CCPVE) as part of the project “ALOS Domestic Demonstration on Disaster Management Application” of the Volcano Working Group. Also, we used some of PALSAR data that are shared within PALSAR Interferometry Consortium to Study our Evolving Land surface (PIXEL). PALSAR data belongs to Ministry of Economy, Trade and Industry (METI) and JAXA. In the process of the InSAR, we used Digital Ellipsoidal Height Model (DEHM) based on “the digital elevation map 10m-mesh” provided by GSI, and Generic Mapping Tools (P.Wessel and W.H.F.Smith, 1999) to prepare illustrations.

Keywords: InSAR time series analysis, Ground deformation, ALOS/PALSAR,, Domestic Active volcano

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P40 Room:Convention Hall Time:May 27 18:15-19:30

Ground Deformation of Mayon Volcano Revealed by GPS Campaign Survey 2005 - 2015

TAKAGI, Akimichi[1*] ; FUJIWARA, Kenji[2] ; OHKURA, Takahiro[3] ; C. LUIS, Jr, artemio[4] ; V. BALOLOY, Alejo[4] ; ANDO, Shinobu[1] ; LAGUERTA, Eduardo[4] ; V. BORNAS, Ma. antonia[4]

[1]Meteorological Research Institute, [2]Japan Meteorological Agency, [3]Aso Volcanological Laboratory, Institute for Geothermal Sciences, Graduate School of Science, Kyoto, [4]PHIVOLCS

Geodetic observations such as GPS and gravity surveys conducted regarding the Mayon volcano (Jentzsch et al., 2001) detected no fine changes in deformation accompanying the 1993 eruption. To detect temporal changes in pressure sources caused by magma accumulation and discharge, we have installed a GPS survey network consisting of over ten sites around the Mayon volcano since 2005, detected changes in deformation accompanying the 2009 Mayon eruption.

The GPS campaign network, operating since 2005, consists of five survey lines arrayed radially from the volcanic summit. The survey has been repeated 2 or 3 times a year from May 2005 to June 2014, numbering 24 over the ensuing decade. An MG-2110 all-in-one single-frequency receiver (Furuno Electric Co., Ltd.) was used for its advantage such as a low power consumption of 0.5 W and its 1.5 kg weight. Such high-mobility devices make surveys efficient. Static observation was conducted 1 to 4 days using 30-second sampling. We estimated relative positions bihourly for individual stations in relation to a reference site using Bernese GPS software Ver. 5.0, then averaged bihourly positions as the final position for each survey.

No baseline has changes exceeding 4 cm in the last 10 years, but several had rapid contractions of 2 to 3 cm from 2009 to 2010. A lava flow eruption occurred at the Mayon volcano in December 2009, and we assumed that the volcanic edifice was deflated when magma associated with the 2009 eruption was discharged. We thus estimated the position and volume change of the reduced pressure source accompanying the 2009 eruption using ground deformation from August 2009 to February 2010. We applied the Mogi model (Mogi, 1958) to estimate a spherical source consisting of only four unknown parameters. Optimal parameters of the deflation pressure source were estimated to be at a depth of 8.5 km beneath the summit (latitude 13.2425deg., 123.6914deg.) and the amount of volume change -13 x $10^6 m^3$.

Although the survey frequency is low before the 2009 eruption, some baselines seem to have extended slightly. This probably means that the GPS survey recorded magma accumulating before the 2009 eruption.

New lava dome approximately 30m-50m high appeared a on the summit crater in August 2014 (PHIVOLCS, 2014). It was difficult, however, to detect the temporal change by GPS observation. The total amount of magma discharged was too small to deflate the volcano edifice.

Acknowledgements

The authors thank the Volcano Monitoring and Eruption Prediction Division and Mayon Volcano Observatory of PHIVOLCS for dedicated their cooperation in our surveys and for the maintenance of the network for continuous GPS observation.

This study was supported by the Japan International Corporation Agency (JICA) and the Japan Science and Technology Agency (JST) within the framework of the Science and Technology Research Partnership for Sustainable Development (SATREPS).

Keywords: Mayon Volcano, GPS, Ground Deformation, Pressure Source, Magma

©2015. Japan Geoscience Union. All Rights Reserved.

SVC45-P41 Room:Convention Hall Time:May 27 18:15-19:30

Improvement of REGMOS (Remote GNSS Monitoring System)

FURUYA, Yukiko[1*] ; UESHIBA, Haruka[1] ; YOSHIOKA, Mitsugu[1] ; NARITA, Tsugunori[1] ; MURAYAMA, Shigeyuki[2] ; TAKEYAMA, Minenori[2] ; FUKUMORI, Hideaki[2]

[1]GSI of Japan, [2]Techno Vanguard Corporation

GSI of Japan has developed Remote GNSS Monitoring System (REGMOS) and observed crustal movement around volcanoes with REGMOS. REGMOS is autonomous system which can work in the area where there is neither ordinary electricity nor telephone services.

REGMOS has GNSS receiver and antenna, thermometer, tiltmeter, network camera, etc. The data of these equipment are transferred to server in GSI once every hour.

In 2013~2014, we have improved REGMOS's functions. First, we introduced Multi-GNSS observation. Second, we introduced the terrestrial mobile communication system. Third, we increased the frequency of camera shooting and data transfer.

We will report these improvements of REGMOS and its effects.

Keywords: Remote GNSS Monitoring System, REGMOS, Volcano, Crustal Deformation