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

SVC070-P01 Room:Convention Hall Time:May 23 16:15-18:45

Progress in new theory of volcanism with 2011 eruption of Shinmoe-dake as a trigger: birth of caldera chain tectonics

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[1]non

This is a sequel to the presentation on the shock-wave fracturing pipe model in this meeting (S-VC47). According the model the crater is laterally located to the magma reservoir (MR) as the vent is formed by laterally discharged shock wave with dome crush. The Shinmoe-dake erupted on the next day of the abstract submission. A few days later GSI released MR was estimated 10 km WNW to the Shinmoe-dake, that is concordant with the model. Further 5 km NW quake swarms (1968 Ebino quake etc.) occurred in the past. The MR underlies the focal region. It supplied magma to the secondary MR in vent.

MR is suspected below the quake swarm. The swarms in Matsushiro and the off-shore of east Izu Pen. are underlain by MRs for Mt. Asama and Izu-Oshima.

Then I noticed the epicenter distribution before and after the Unzen-dake eruption (Ohta, 1993; Jour. Geol. Soc. Japan, Fig.28) is consistent with the vent-forming model. The MR is estimated 15 km below the Chijiwa caldera. The MR for the Shinmoe-dake is also estimated below a caldera (Kakuto). Is this accidental?

According to the model, as the load on shallower dome is lighter, the shallow MR tends to grow large without crush. Assuming the magma is generated in the deep, it is natural that the huge MR is formed in the shallow part that is plugged by cooled and solidified vent top. The shallow MR grows with succeeding magma supply without eruption into a silent gigantic MR.

The lateral eruption with dome crush of big MR forms a collapse caldera. The sudden fall of pressure generates new magma in the deep. The caldera chain (CC) is formed by the repetitive process; dome crush, vent forming, eruption, shallow MR grow, and collapse caldera. Plural MRs are usually generated; most of them form normal volcanoes surrounding the caldera.

The depression called volcanic graben is CC. The typical one is Kagoshima Bay; Ata-south, Ata-north, and Aira calderas form a northward CC. The next may be the gravity low to NW of Aira caldera. CC is estimated from the off-shore of western Satsuma Pen. to the Chijiwa caldera; the next may be the gravity low in east off-shore of Shimabara Pen. In Kirishima area the Kobayashi and Kakuto calderas make CC; the next may be the gravity low in Makizono-cho. In Ohita pref. a complex CC is estimated; a forecasted next caldera is the gravity low in Beppu Bay. Intensive observation to three of the indicated gravity lows is required.

The CCs are seen in the Ogasawara, Mariana, and Okinawa troughs, Philippine Sea, Japan Sea, and the graben in western side of Japan Trench. The CC in ocean is larger than that in land. The land caldera eruptes large pyroclastic flow; in contrast the ocean one flows vast basalt. The North-Yamato bank is a rare case; a large MR was solidified without eruption with radial dykes; the SE half was lost by another CC.

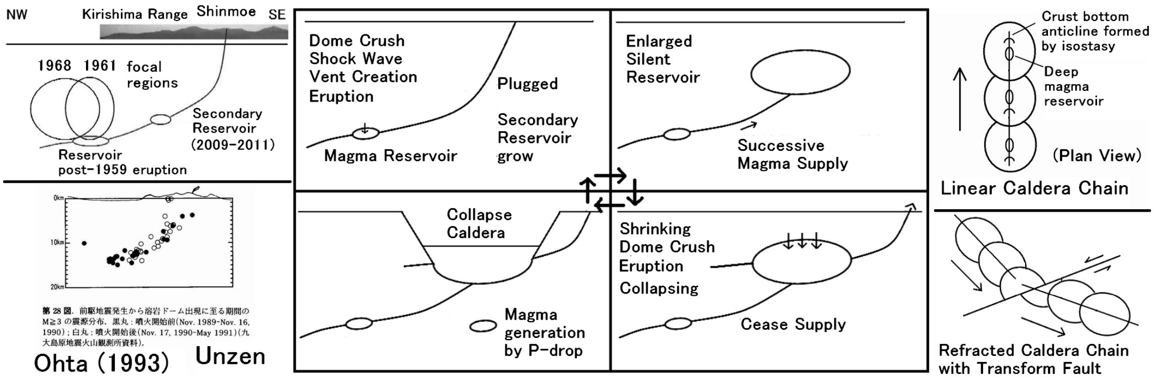
The CC has linearity. An anticline coincides with the center axis of calderas is formed in the crust bottom due to isostasy to make new MR place in same direction. The seamount chains are formed by CC. The uniform ocean crust keeps the high linearity. The CC is refracted by the transform fault.

The Columbia River plateau and the corridor to Yellowstone in the western US consist of CCs. The Basin and Range consists of many NS trending CCs.

The Rift Valley in the eastern Africa is CC. The Red Sea seems to spread after the CC passed. The CC is seen on the Atlantic Ocean coasts. As a continental cutter the CC migrated northward across the Pangaea. N-S trending CC seems common, but E-W may be dominant in equatorial region. This may be related to the tidal force and spin.

Surprisingly the Marineris canyon of Mars seems a CC. The North Polar Basin was formed by CC. The luna maria were formed by CC. The older is larger and the younger is smaller, as the MR deepened with moon cooling. NNW trending ray system of Tycho crater seems a CC; magma may be generated by meteorite impact.

I would like to express deep sympathy for victims of the disasters.



Keywords: volcanic graben, caldera chain, separation of continent, luna mare

Japan Geoscience Union Meeting 2011
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SVC070-P02 Room:Convention Hall Time:May 23 16:15-18:45

Subjects on teaching material development of volcanic eruption for science education: eruption of Shinmoedake, 2011

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Japanese abstract only.

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

SVC070-P03 Room:Convention Hall Time:May 23 16:15-18:45

Pre-historic activity of Shinmoedake in Kirishima volcanic complex

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Shinmoedake erupted on 19th January 2011; this eruption was followed by further explosive eruptions on the 26th and 27th of the same month. Since then, lava has been building up inside the Shinmoedake crater. We surveyed the volcanic geology at the flanks and crater rim of Shinmoedake in 2007. We found ash, pumice-fall deposits, and pyroclastic-flow deposits dating from A.D. 1716 to A.D. 1717, named Kyoho pumice (Sm-KP). This geological profile matches the historical records detailed by Imura and Kobayashi (1991). In addition, we found two lava flows above and one lava flow below the Maeyama pumice (MyP) fall deposits around the crater rim. It is known that MyP and Setao pumice volcanic deposits date to an event that occurred before the Sm-KP eruptions (Inoue, 1988; Okuno, 2002). We found typical outcrops of MyP on Shinyu forestry road, along the west flank of Shinmoedake. The thick pumice fall deposits within a pyroclastic flow deposit that covered the Sm-KP deposits and rode under the K-Ah tephra in this outcrop. We found the same depositional profile to the west of the crater rim. At the rim of the crater, the MyP comprises pyrolastic-fall deposits, thin pyroclastic-flow deposits, and 20-m-thick pyroclastic deposits. The MyP is distributed over the north-to-northwest part of the Shinmoedake volcano, and the tephra-fall volume in this region is calculated to be in the order of about 107 m3. In this study, we found two lava flows above MyP, named Ryobu lava flows (RyL-1, 2) originated mountain name of the historical records. RyL-1 is distributed on the southwest-to-south part of the crater rim and consists of Usagi-nomimi; the dikes of this lava flow can be observed on the south part of the crater, near the part of Usagi-nomimi. RyL-2 is distributed in the same area as RyL-1. Because the RyL-1 and RyL-2 lava flows covered the soil above the 2.2-ka Nakadake tephra, it can be concluded that the corresponding eruptions occurred at around the same time as the MyP eruptions. In addition, we observed another lava flow, named RyL-3, distributed from the southwest to southeast part of crater rim under the MyP. We found that the lava flow has covered the K-Ah tephra around the flank of the volcano. We thank the staff of the SABO Technical Center and Nippon Koei Co., Ltd.

Keywords: Shinmoedake, Kirishima volcanic complex, Maeyama pumice, lava flow, crater rim

Japan Geoscience Union Meeting 2011
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SVC070-P04 Room:Convention Hall Time:May 23 16:15-18:45

Reconsideration of the historical eruption dates of Shinmoedake, Kirishima volcano group: Meiwa and Bunsei eruptions

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It has been reported that the historical tephras of Shinmoedake are Kyoho pumice (Sm-KP: 1716-1717), Meiwa pumice (Sm-MP: 1771-1772), Bunsei pumice (Sm-BP: 1822), and Showa ash (Sm-SA: 1959) in ascending order (Imura and Kobayashi (1991). Howerer, our geologic survey proved that the two pumice beds (Sm-MP and Sm-BP) are one of the members of Sm-KP. Hence, we reconsidered the documentary records of eruptions. The results are, 1) the eruption of 1771-1772 occurred at the diffeent vent (Ohachi crater), and 2) the 1822 eruption occurred at Shinmoedake, but it was only a small phreatic erupton. The outline of the results are alredy reported in Tsutsui et al. (2005) and Tsutsui and Kobayashi (2008).

Keywords: Volcano, Eruption, Kirishima volcano group, Shinmoedake, historical eruption, documentary records

Japan Geoscience Union Meeting 2011
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SVC070-P05 Room:Convention Hall Time:May 23 16:15-18:45

Reconstruction of the sequence of the Kyoho Eruption of Shinmoedake Volcano based on the historical record

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Reconstruction of the eruptive sequence of the Kyoho Eruption (AD 1716 - 1717) of Shinmoedake of Kirishima Volcanones based on the historical record.

Keywords: Shinmoedake, Kirishima, Kyoho, 1716-1717, eruption, historical record

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

SVC070-P06 Room:Convention Hall Time:May 23 16:15-18:45

Precursory eruptions of the 2011 Shinmoedake eruption, Kirishima volcanoes, Japan

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The first precursory eruption, occurred at August 2008, was a phreatic one, which formed fissure vents and produced tephra of 0.2 million ton (Geshi et al., 2010). The next eruption occurred on March 30, 2010 and small ones happened successively on April 17, May 27, June 27 and 28, July 5 and 10. After a half year dormancy, another phase of eruption started on January 19, and main magmatic eruption continuously occurred on Jan. 26. We reported here the representatives of these precursory eruptions.

The eruption of March 30, was very small-scale phreatic one, and ejected only a few ten tons of ash. The eruption of May 27 was also a phreatic, but violent jet was taken by a video camera. The mass of tephra was estimated to be about 300 ton. Eruptions of June 27 and 28 happened at cloudy day, so they were not witnessed. The eruption of July 10 was taken by some cameras. The report by JMA suggested that a small scale pyroclastic surge happened there, but we think it was only drifted gas along the crater rim.

The January 19 eruption was reported as a small scale phreatic one in the JMA report, but the mass of tephra was estimated to be 60,000 ton, which is much larger than the previous phreatic eruptions. The tephra is generally fine grained, and its bulk density is less than 1.0 g/cubic cm, and it is reported that the tephra carried about 10 % of vesiculated pumice material. And a week later, main magmatic eruption started on January 26 which is still going on at the time of writing.

Keywords: Shinmoedake, Presursory eruption, 2011, Kirishima volcano

Japan Geoscience Union Meeting 2011
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SVC070-P07 Room:Convention Hall Time:May 23 16:15-18:45

Petrology of the 2011 ejecta of Shinmoedake, Kirishima volcano

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We analyzed phase compositions and water contents of the ejecta of the 2011 eruption of Shinmoe-dake, Kirishima volcano, to elucidate the conditions of magmas and possible interaction of mafic and silicic magmas. Phenocryst of the ejecta (both the sub-Plinian pumice and Vulcanian blocks) consists of olivine and calcic plagioclase derived from high-temperature mafic magma and plagioclase, augite, orthopyroxene(sometimes olivine), magnetite, ilmenite coming from low-temperature felsic magma. Plagioclase compositions illustrates two trends in MgO versus #Ca (=Ca/(Ca+Na)) diagram; i.e., high MgO trend (#Ca=63-91) derived from high-temperature magma and low MgO trend (#Ca=53-85) derived from low-temperature magma. It is suggested that low MgO trend plagioclase have suffered from low-temperature reequilibration of MgO with the surrounding magma for more than 10 years at ca. 950 degree C. Idiomorphic olivine phenocryst have #Mg(=Mg/(Mg+Fe)) of 75-77, but some olivine inclusions in plagioclase or orthopyroxene phenocrysts have #Mg of 65-72. Magnetite are mostly unzoned with ulvospinel contents of 28-35. Only limited number of magnetite have thin rim of more ulvospinel content, suggesting that the very limited time of crystallization and diffusion after mixing of the magmas. The magma mixing may have taken place in the conduit, which is consistent with the heterogeneity and wide compositional range of the matrix glass of the ejected pumice. Equilibration temperature by contiguous magnetite and ilmenite gave temperature of 947-956 degreee C, whereas contiguous pairs of orthopyroxene and augite gave equilibration temperature of 902-933 degree C. We obtained water contents of the most silicic matrix glass to be 4.5-5.5 wt% at 200 MPa to have liquidus temperatures of 930-950 degree C using MELTS program (Ghiorso and Sack, 1995). This is the possible condition for the low-temperature felsic magma. Conditions of the high temperature magma is not well constrained at present. The GPS baseline measurement tells us the stretching at the same rate that took place for 1 year before the eruption, suggesting intrusion of high-temperature magma into the remnant magma chamber. If next eruption takes place at Shinmoe-dake in near future, we expect more high-temperate mafic magma. Bulk rock water contents of the sub-Plinian ejecta by Karl-Fisher titration gave 0.02-0.10wt% for dark clast, and 0.10-0.17 wt% for gray pumice. Taking into consideration of ca. 0.10 wt % of remnant undegassed water during heating of the sample, the water contents of the glass in the pumice (assuming anhydrous minerals) are calculated to be 0.25-0.35 wt%, corresponding water-saturation pressures of 0.4-0.8 MPa. The irregular nature of the vesicles of the pumice suggest possible degassing of water after fragmentation of the magma.

Keywords: Kirishima volcano, 2011 eruption of Shinmoedake, magma mixing, plagioclase, water content of glass

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SVC070-P08 Room:Convention Hall Time:May 23 16:15-18:45

Geochemistry of Shinmoe-dake 2011 eruption magma, Kirishima Volcano

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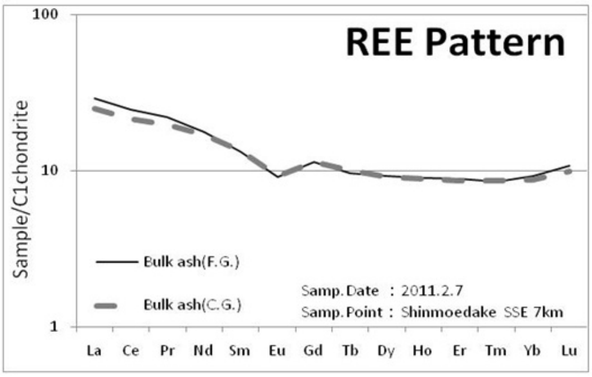
We analyzed major and trace elements (especially rare earth elements) in two volcanic ash samples of 2011 eruption which collected at 7 km south-southeast from Shinmoe-dake, Kirishima volcano using by XRF and LA-ICP-MS.

One is coarse grain (grain size 0.2 - 8 mm) , and another is fine grain (grain size> 0.2 mm). Chemical compositions of these two samples were quite similar.

Their major chemical compositions were SiO_2 53-56%, FeO 9-10%, MgO 7-8%, Na_2O 2.2-2.4% and K_2O 0.9-1.4%. Therefore these two samples were calk-alkaline basaltic andesite. REE pattern of these samples were very similar, Light rare earth elements contents are a little higher than heavy rare earth elements (see figure). This pattern are common for calk-alkaline basaltic andesite.

We will discuss more about chemical variations depend on the eruption period of 2011 activity and chemical difference between 1717 and 2011 eruption samples in this study.



Keywords: Chemical composition, Magma, 2011 eruption, Shinmoe-dake, Kirishima volcano

Japan Geoscience Union Meeting 2011
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SVC070-P09 Room:Convention Hall Time:May 23 16:15-18:45

Injection of hot mafic magma prior to the 2011 eruption of Shinmoedake, Kirishima volcano, Japan

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[1]GSJ, AIST

The 2011 eruption of Shinmoedake, Kirishima volcano, Japan, started at 19th January with an phreatomagmatic eruption. The climactic stage (as of 31st March) was the sub-Plinian eruptions on 26th to 27th January, followed by some Vulcanian eruptions (e.g., 1st and 14th February), accompanied by other small eruptions. Most of essential materials were mafic andesite with SiO_2 = 57 wt.%, whereas in the material by 26th to 27th January there were also silicic one with SiO_2 = 62-63 wt.% (Geshi et al., 2011). The mafic andesite is a mixture of the low-temperature silicic andesite (mushy magma) and a high- temperature basaltic magma with SiO_2 = 53-54 wt.%, deduced from the compositions of phenocrysts and melt inclusions (Saito et al., 2011). The injection of the basaltic magma perhaps affected the sequence and styles of the eruptions, and it is necessary to estimate when and how the mafic magma injected into the magma system.

In this study we mainly analyzed magnetite, which is appropriate to investigate magma processes with time scales between days to years because of its large diffusion coefficients. We analyzed minor components, as well as the major component (Usp; Ti concentration), especially Mg/Mn, which is sensitive to melt composition and a good indicator of magma mixing (e.g., Tomiya & Takahashi, 2005).

Deduced from chemical compositions and zoning profiles of magnetite (and ilmenite), the mafic injection occurred just prior to the 26th to 27th January sub-Plinian eruptions, but did not occurred prior to the Vulcanian eruptions in February. Furthermore, the mafic injections occurred both about 2 years and several tens of years or more before the 2011 eruption. Thus, mafic injection occurred repeatedly before the 2011 eruption, and the last one induced the climactic sub-Plinian eruptions.

Keywords: Shinmoedake, Kirishima, magma mixing, magnetite, time scale

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SVC070-P10 Room:Convention Hall Time:May 23 16:15-18:45

Preparation processes and evolution of the 2011 eruption of Shinmoe-dake -insights from volcanic ash

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[1]Earthq. Res. Inst., Univ. Tokyo, [2]NIED, [3]Fuji-Tokoha University

Analyses of ash are important in predicting future activities. We discuss temporal change of ash from Shinmoe-dake, for the periods a) from August 2008 to 26 January 2011 (sub-Plinian activity) and b) after the start of lava accumulation in crater on 28 January 2011. Increase of juvenile material was detected for ash from January 19, 2011 activity (reported to JMA in the noon of January 26). Ash particles were categorized into pumice, scoria, fresh lava, altered material, and crystal. Pumice and scoria include both of juvenile and slightly altered particles. Ratios of these ash components are based on particle number (250-500 micrometer).

August 2008 to June 2010 (2008/8/22, 2010/3/30, 2010/5/27, 2010/6/27): Eruptive activities are basically phreatic. Ratios of scoria and pumice particles are always less than 10%, and those pumice particles are less than 1% in most samples. Each of fresh lava and altered material accounts for 20-50%. All pumice particles are slightly altered, with change in color, adherence of finer altered material in vesicle and ablation of particle surface. A part of scoria particles after 27 May, 2010 have glaze, indicating a possibility of juvenile material. Particles of non-altered lava (gray, black, brownish-red and greenish gray) have variable crystallinity in groundmass. Even the lava particles with glassy groundmass are free from glaze, being different from those after February of 2011. Particles of altered material are either those with orange color or those with silicification accompanying sulfide minerals. Crystal particles are plagioclase, clinopyroxene, orthopyroxene and Fe-Ti oxides.

January 19, 2011: Eruptive activity shifted to phreatomagmatic. Pumice particles reach 8% and 95% of all are very fresh without alteration and adherence of finer altered material, which is remarkably different from previous period. The pumice particles have blocky surface with low vesicularity, implying the interaction of magma with aquifer. 20% of scoria particles (4% in total) have graze, implying a possibility of juvenile material.

After February 2011(2/2, 2/7-8, 2/18, 2/24, 3/13) : Changes from the previous two periods are 1) Increase of non-altered lava to 65-80%, 2) decrease of altered material to the range of 10 to ca. 2%, addition of olivine as crystal particle. Addition of particle from lava accumulated in Shinmoe crater led to the change 1). The non-altered lava particle in this period includes two types, A) glaze-free particles which had been always found in ash since August 2008, B) very fresh, glassy lava with remarkable glaze. The latter corresponds to lava newly accumulated in crater in 2011. The type B lava accounts for half of non-altered lava (ca. 65% in total) in February 2 ash. With time passage, type B lava changes in color from olive (2/2, 2/7-8) to greenish gray and becomes weak in glaze, which makes it difficult to distinguish it from type A lava. At least, Type B lava particle in February 2 and February 7-8 ash resembles in appearance to particles obtained artificially crushing February 1 volcanic bomb from the accumulated lava. Furthermore, phenocryst assemblages are the same between the type B lava and the bomb (plagioclase, clinopyroxene, orthopyroxene, olivine and Fe-Ti oxides). Ash of February 2 and February 7-8 include vesiculated glass particles with the same color (olive) as the type B lava. Ratio of the vesiculated glass in ash decreases from ca. 7% (2/2) to 1% (2/7-8). Most particles of scoria and pumice can be interpreted as juvenile. Pumice particle are always less than 2%. Ratio of scoria particle mostly increases with time, 0.2%(2/2), 3%(2/7-8), 6%(2/18), 15%(2/24), 8%(3/13). The scoria particles may be derived either from unsolidified part of the accumulated lava or deeper part of the magma plumbing system.

Acknowledgement: Japan Meteorogical Agency, Tetsuo Kobayashi, Yasuhisa Tajima, Ryusuke Imura, Hiroaki Sato and Masayuki Sakaue are thanked for supply of ash samples.

Keywords: Shinmoe-dake, volcanic ash, juvenile material, phreatic eruption, phreatomagmatic eruption, component

Japan Geoscience Union Meeting 2011
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SVC070-P11 Room:Convention Hall Time:May 23 16:15-18:45

Simplified estimation of preeruptive magma viscosity for the 2011 eruption at Shinmoedake, Kirishima volcano

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[1]CRIEPI

Magma viscosity is one of the most important physical properties to model eruption processes, because it controls timescale of magma movement. Although preeruptive magma viscosity can be estimated from petrological analysis of erupted materials, it is time-consuming to acquire petrological data required for magma viscosity estimate (melt composition, melt water content, temperature and phenocryst content). Takeuchi (2010, JPGU) has proposed a simplified method to estimate preeruptive magma viscosity by using only melt SiO_2 and phenocryst content data. In this study, the simplified method was applied for the magma erupted in 26-27 Jan, 2011, at Shinmoedake, Kirishima volcano, Japan.

Analyzed sample was a gray, pumicious lapilli sampled on 28 Jan at 9 km SE from the Shinmoedake crater. The resin-impregnated pumice sample was polished and analyzed by electron probe micro analyzer. The porosity and phenocryst modal composition were obtained from image analysis of back scattered electron images. Elemental mapping images for Mg, Ca and Fe were used for discrimination of phenocryst phases. The analyzed area was ca. 1.0 cm x 1.1 cm with 2 micron meter in spatial resolution. Broad beam with 20 micron meter in diameter was used for obtaining melt SiO_2 content of microlite-rich groundmass. As a result, the porosity, the phenocryst and melt SiO_2 contents were ca. 64 vol%, ca. 40 vol% and 63 wt%, respectively. Applying the simplified method for this melt SiO_2 content, preeruptive melt viscosity were estimated to be ca 10^3 Pas. Preeruptive magma viscosity of phenocryst-bearing magma was estimated to be ca 10^4 Pas, based on Einstein-Roscoe equation. This characteristic of preeruptive melt and magma viscosity is similar to the magmas of Sakurajima vulucanian activity, Asama 2004 eruption, precursory eruption of Hokkaido Komagatake 1929 and Pinatubo 1991.

Keywords: Kirishima volcano, Shinmoedake, 2011 eruption, preeruptive magma viscosity

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SVC070-P12 Room:Convention Hall Time:May 23 16:15-18:45

Magma mixing and ascent process of Shinmoedake 2011 eruption from phenocrysts, microlite, vesicle textures

Takashi Hoshide[1*], Atsushi Toramaru[1], Kei Ikehata[1], Yu Iriyama[1]

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Shinmoedake 2011 eruption which started on 26th January 2011 showed a characteristic transition of eruption styles.

Two sub-plinian eruptions from 15 h on 26th and from midnight of 27th produced a pumice deposit of 6 cm in thickness at 8 km from the vent. After the sub-plinian phase, the eruption style shifts to vulcanian type which majorly produced volcanic ash with emitting air shock, since an eruption at 15 h on 27th Jan. Among vulcanian eruptions exceeding 10 times until end of Feb, the most intensive eruption on 1st Feb ejected volcanic bombs of 1 m in diameter at 2 km from the vent.

In order to quantify the magma ascent and degassing processes and clarify the governing factors of such an eruption style transition, we carried out the textural and compositional analysis of pumices sampled at 8 km from the vent from 26 and 27, Jan and of bomb sampled at 2.6 km from vent from 1 Feb. We recognize three types of pumices by color: white, gray and brown. White pumices are generally well vesiculated, flake-shaped, 1 to 2 mm in length, and include relatively spherical bubbles (5 to 20 um in diameter) and platy plagioclase (10 to 100 um in length), equant, platy or acicular pyroxene (sub-micron to 10 um) and equant oxide (2 to 10 um) microlites. Gray pumices are generally moderately vesiculated, block-shaped, 2-20 mm in diameter, and include relatively irregular coalesced interconnected bubbles (10 to 100 um in typical scale) and platy plagioclase (10 to 50 um in length), equant, platy or acicular pyroxene (sub-micron to 10 um) and equant oxide (2 to 5 um) microlites. Bomb has a relatively vesiculated inner part (bulk density is 1700kg/m^3) with a rind. The inner part includes two types of vesicles: large irregular shaped (several mili meter in typical scale) and small spherical (10-30 um in diameter), whereas the rind has no small type of vesicle. The bomb includes plagioclase (0.2 to 3 mm in length), clinopyroxene (0.1 to 0.5 mm), orthopyroxene (0.1 to 0.5 mm), olivine (0.2 to 0.5 mm) and magnetite (0.2 to 0.5 mm) as phenocrysts and plagioclase (3 to 100 um in length), clinopyroxene, orthopyroxene (sub-micron to 40 um), and magnetite as microlites. Sulfide minerals of iron and copper are found in inclusion of phenocrysts and groundmass. Plagioclase phenocrysts are largely classified into two types: one has calcic core (An_{90}) with the normal zoning (An_{70} rim) (A-type), the other has sodic core (An_{50}-$_{75}$) with the reverse zoning (An_{70} rim) (B-type). Olivine pheocrysts coexist with A-type plagioclase phenocrysts whereas pyroxene and magnetite phenocrysts coexist with B-type plagioclase phenocrysts. Plagioclase microlites in the bomb are platy to acicular shaped and 10-150 um in length. Larger microlites show a characteristic stepwise zoning structure with calcic core (An_{70}) and sodic rim (An_{58}-$_{60}$). Microlite sodic rims include pyroxene microlites.

From the systematics of the mineral assemblage in glomeroporphyritic phenocrysts and the zoning pattern of two types of plagioclase phenocrysts, it is suggested that the magma mixing process occurred between a basaltic magma and a silicic magma. The chemical composition of An_{70} of plagioclase phenocryst rim and microlite core requires 3.5 wt% of water content in the mixed magma, which approximately corresponds to 1 kbar saturation pressure and 4 km depth. As a result, it is concluded that core of larger pl microlites and rim of pl phenocrysts crystallize under the pressure and water content. From the systematic change in microlite size of white pumice, gray pumice to bomb and the bubble size from white pumice to gray pumice, it is suggested that the decompression rate or water-exsolution rate systematically decrease from white pumice, gray pumice to bomb from the corresponding microlite number density and bubble number density. For more quantitative estimation, we have to develop the method to extract the original signature at the nucleation stage of bubble and microlite.

Keywords: Kirishimayama, magma mixing, eruption style, rock texture, magma ascent

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

SVC070-P13 Room:Convention Hall Time:May 23 16:15-18:45

CO2/H2O ratio of magmatic gas at Shinmoe-dake volcano, Japan, in 1994: Implication to the eruption in 2011

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The chemical composition of fumarolic gases brings us useful information on the volatile in magma, because fumarolic gases contain volatile components such as H2O and CO2 originating in a degassing magma. For example, CO2 degasses preferentially relative to H2O. Therefore, the CO2/H2O ratio of the degassed volatile is expected to decrease along the progress of magma degassing. The CO2/H2O ratio of magmatic component in fumarolic gas could be a key for the estimation of volatile content in magma. Since the magmatic eruption is driven by the volatile in magma, the CO2/H2O ratio of fumarolic gas will be used for the evaluation of eruptive potential.

In this study, the chemical and isotopic composition of fumarolic gases at Shinmoe-dake volcano in 1994 is re-evaluated in terms of magmatic CO2/H2O ratio. The ratio is compared with those of other volcanoes with variety in the activity in order to implicate the 2011 eruption at Shinmoe-dake volcano.

In 1994, two fumarolic gases were sampled within the summit crater and on the outside flank of crater. The discharge of gas was strongly discharging with large noise. However, the temperature of gas was 103C at most (Ohba et al., 1997). In general, a magmatic gas is mixed with cool groundwater resulting in the formation of a vapor and liquid phases. The vapor phase is thought to be represented by the fumarolic gas at surface. The above model for the generation of fumarolic gas applies to the fumarolic gas at Shinmoe-dake. Based on the correlation between CO2/H2O ratio and isotope ratio of H2O in fumarolic gas, the magmatic CO2/H2O ratio was estimated to be 0.03 for the fumarolic gas at Shinmoe-dake volcano.

The eruptive potential seems to be correlated with the CO2/H2O ratio of magmatic component. For example, the CO2/H2O ratio is 0.006 for the dormant volcanoes such as, Kusatsu-Shirane, Atosanupuri and Hakone. In 1989, the seismic activity at Iwate volcano increased. The CO2/H2O ratio of magmatic component in 1989 and 1999 was 0.008. After all Iwate volcano has failed to erupt. Meakan-dake volcano is located close to Atosanupuri. Meakan-dake erupted phreatically in 2006. The CO2/H2O ratio for Meakan-dake is 0.012. The CO2/H2O ratio for Kuchinoerabu volcano is 0.013 (Shinohra et al., 2001). The seismic activity and SO2 flux have increased recently. The CO2/H2O ratio for fumarolic gas at Unzen was 0.03 during the effusive magmatic eruption (Ohba et al., 2008). The ratio was decreased to 0.015 when the effusion of magma stopped. The CO2/H2O ratio of fumarolic gas at Izu-Ohsima was 0.04 just after the magmatic eruption in 1986 (Kazahaya et al., 1993). The CO2/H2O ratio of volcanic gas at Mt. Etna is 0.1 to 1.0 (Shinohara et al., 2008). The volcanic activity at Etna volcano is significantly intense.

Comparing the CO2/H2O ratio at Shinmoe-dake in 1994 with the above examples, the ratio is recognized to be high as same as the ratio at volcanoes during eruption or after eruption. Presently it is difficult to use the CO2/H2O ratio as the precursor of eruption because the CO2/H2O ratio at Shinmoe-dake just before the eruption in 2011 was not obtained. The CO2/H2O ratio of magmatic component may be used for the evaluation of eruptive potential in medium- and long-terms. One application is possible to Tatun volcanoes in Taiwan. The CO2/H2O ratio at Tatun volcanoes was 0.018 to 0.027 (Ohba et al., 2010). Although no historical eruption at Tatun volcanoes was recorded, an eruption younger than 20kBP has been estimated (Chen and Lin, 2002). The high CO2/H2O ratio at Tatun volcano may suggest the eruptive potential in future.

Keywords: Shinmoe-dake, magma, CO2, H2O, fumarolic gas

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

SVC070-P14 Room:Convention Hall Time:May 23 16:15-18:45

Sulfur dioxide flux of Shinmoedake 2011 eruption

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Shinmoedake at Kirishima volcanoes had a small eruption on Jan. 19, 2011 and the volcano started magmatic eruption from Jan. 26. From Jan. 27, 2011, we started sulfur dioxide flux measurements from the volcano using SO2 monitoring system based on a compact UV spectrometer (COMPUSS).

Sulfur dioxide flux measurements were carried out by traverse method. The sulfur dioxide amount in the cross-section of the volcanic plume was obtained by moving beneath the volcanic plume with the car equipped with the COMPUSS aiming the zenith. The sulfur dioxide flux was retrieved by multiplying the sulfur dioxide amount and the plume speed. For the plume speed, we used GPV wind speed data corresponding to the plume height. At the end of January, since the amount of ash and gas in the plume was so large, traverse measurements were carried out on the roads about 25km away from the volcano. After the emission of ash has decreased, the measurements were conducted on the roads about 7-10km away.

The sulfur dioxide fluxes of the first 10 days were huge and exceeded 10000 ton/day. Especially, on Jan. 28, when the lava dome was growing inside the summit crater, the observed flux recorded more than 40000 ton/day. This huge flux decreased more than an order of magnitude to several hundred ton/day by mid February. Although the flux sometimes increases to about 1000 ton/day, the flux is basically several hundred ton/day until present(the end of March). In the presentation, we will discuss the sulfur dioxide flux variation of the Shinmoedake 2011 eruption and report precursory flux decrease observed before the eruption occurred on Feb. 3.

Keywords: Kirishima Volcano, Shinmoedake, sulfur dioxide, volcanic gas, flux

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

SVC070-P15 Room:Convention Hall Time:May 23 16:15-18:45

Eruption Cloud Echo from Shinmoe-dake Volcano in 2011 Observed by Weather Radars

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We report on the eruption cloud echo from Shinmoe-dake volcano in 2011 detected by JMA's operational weather Doppler radars at Kagoshima airport, Tanegashima and Fukuoka.

Acknowledgements
We would like to thank Drs. Y. Tanaka, O. Suzuki and H. Yamauchi (MRI) for the use of their "Draft" radar analysis software.

Keywords: weather radar, eruption cloud echo, Kirishima, Shinmoe-dake volcano, eruption, 2011

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

SVC070-P16 Room:Convention Hall Time:May 23 16:15-18:45

Image observation and satellite image analysis of eruption clouds at Kirishima-Shinmoedake volcano

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After small phreatic eruption at 01:27 on 19 Jan. 2011, continuous ejections of plumes were recorded on 22 and 25. Massive ejections of ash clouds started at 15:40 on 26 almost continuously mixed with eruptions until 27. These time variations can be seen by smooth interval records of a video camera with the NIR mode. Though the visibility condition was rather bad on 26 Jan. 2011, the upper parts of massive ash clouds could be seen in the visible camera records at 58 km SW from the volcano in Kagoshima city and also at 38 km north in Hitoyoshi basin. In addition to these fixed observation points, automatic recording cameras have been installed at near-by points in Kirishima city 9 and 11 km SSW from the volcano with visible and NIR modes.

Long distance observation has a merit to see the whole features of eruption clouds. Their advection and dispersion beyond the scope of ground observation can be studied by satellite images. Massive ash clouds on 26 and 27 Jan. 2011 could be recognized in NOAA-APT images with the scales 100-300 km extending over the sea. In the image data of MODIS on board of Terra and Aqua satellites obtained by the receivers of Tokyo University of Information Sciences, various dispersion images including a plume toward 750 km south-east were obtained [2]. In addition to visible and NIR images of satellite data in the daytime, thermal image data in the nighttime and their differences in the form of Aerosol Vapor Index enable to detect dispersed ash clouds over the sea. This method can be applied also to the MTSAT/VISSR data with frequent observation, to study time sequence of large scale dispersion of ash clouds. The behavior of ash dispersion depends on the meteorological conditions. Especially, the height dependence of the wind direction and speed is decisive, implying the importance of the ground observation of the ash clouds at the source volcano, as we are going to study further.

The understanding of volcanic topography is important to see the relation between an observation point and the volcano, to design plans to prevent volcanic hazards such as volcanic bombs, ash-fall, ash-mud flows, and educate people against the hazards. The SiPSE-3D satellite images of Kirishima volcanoes were prepared for these purposes.

The above results are displayed in the following web sites:

http://arist.edu.kagoshima-u.ac.jp/volc/kiri/kiri11/kiri11top.htm

http://es.educ.kumamoto-u.ac.jp/volc/shinmoe/index.htm

[1] K. Kinoshita et al., Image observations of volcanic clouds and Asian dusts and atmospheric environment in Kagoshima, Proc. Branch Meeting of Met. Soc. Japan, 2009, pp.7-8 (in Japanese).

[2] I. Harada et al., Analysis of explosive eruption of Kirishima- Shinmoedake volcano using MODIS and Simulcast Viewer, This Session, 2011.

Keywords: volcanic ash cloud, near-infrared image, interval record, NOAA-APT image, MODIS image, Aerosol Vapor Index

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

SVC070-P17 Room:Convention Hall Time:May 23 16:15-18:45

The relationship between the eruption condition and column height during the 2011 eruptions of Shinmoe-Dake volcano

Yujiro Suzuki[1*], Takehiro Koyaguchi[1], Minoru Takeo[1], Takao Ohminato[1], Mie Ichihara[1], Setsuya Nakada[1], Yuki Suzuki[1], Takayuki Kaneko[1]

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During an explosive volcanic eruption, an eruption cloud which is ejected from volcanic vent with a high temperature becomes buoyant to generate an eruption column. The heights of eruption column are key observable data for understanding the dynamics of eruption cloud and estimating the eruption conditions at the vent. Therefore, to clarify the relationship between the column height and eruption conditions has been one of the most important issues from the viewpoint of disaster prevention as well as volcanology. In Shinmoe-Dake, Kirishima volcanic group, some eruption columns which reached a height of several kilometers have been recognized since January, 2011. During these explosive eruptions, the column heights were observed by means of the weather radar system and other eruption conditions were estimated from different observations. In this study, in order to develop a model that can quantitatively predict the relationship between the column height and eruption conditions, we compare the predictions by the existing model with the observed data.

Woods [1988] proposed a steady vertical 1-D model of eruption column in which the column is assumed to be well-mixed horizontally. This model predicts the column height when the atmospheric condition, the magma properties (temperature and water content), and the eruption conditions (mass discharge rate and exit velocity) are given. However, because this model applies the entrainment hypothesis [Morton et al., 1956] to the process of turbulent mixing in eruption clouds, the efficiency of turbulent mixing (i.e., entrainment coefficient, k) should be empirically given.

Using the steady 1-D model, we calculate the column heights for three explosive eruptions on Jan. 26 and 27. The mid-latitude atmosphere is applied to the atmospheric condition. On the basis of the petrological data, the magma temperature and water content are assumed to be 950 degrees Celsius and 3 wt.%, respectively. The average mass discharge rate can be estimated to be 10^5-10^6 kg/s from the total amount of tephra fall deposits and the durations of the eruptions; the total amount of tephra fall deposits was deduced on the basis of the field works, the durations of the eruptions were obtained from the satellite images, infrasonic observations, and seismic observations. The exit velocity and the entrainment coefficient are treated as a free parameter. The calculation results indicate that the column height is mainly dependent of the assumed value of the entrainment coefficient. When the entrainment coefficient is set to be 0.05 ? 0.13, the column height ranges 12 ? 6 km. The column height observed by means of the weather radar [MRI JMA, 2011] was about 8 km and it roughly coincides with the model prediction for k=0.1.

In order to improve the steady 1-D model and to estimate the relationship between the column height and the eruption condition with a high accuracy, the adequate value of the entrainment coefficient should be given in the model. For this purpose, the observation of column height with a high spatial resolution and the theoretical works for the turbulent mixing are required. In particular, the dependency of entrainment coefficient on the wind should be studied on the basis of the 3-D numerical simulations.

Keywords: Shinmoe-Dake, eruption cloud, numerical model

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

SVC070-P18 Room:Convention Hall Time:May 23 16:15-18:45

Tephra fallout model and grain size distribution of Shinmoe-Dake tephra, 2011 eruption of Kirishima volcano.

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We report the result of our grain-size distribution analyses of Shinmoe-Dake tephra and show the result of tephra fallout modeling based on our tephra data. A total of 67 tephra samples were collected at stations located SE of Shinmoe-Dake, Kirishima volcano, mostly on January 28, 29 and February 1. They probably correspond to the major first eruption products of Shinmoe-Dake, which occurred between the morning of January 26 and the morning of January 28. Although several eruption episodes were reported during this period, we basically observed a single tephra unit, which is overlain by very thin light-grey colored fine ash. Everywhere, the deposit was reversely graded and characteristically coarse-grained for its thickness. Along the profile 6 km away from the vent, tephra measurements showd the thickest value at Miike elementary school. Abundant corse-grain pumice was found near Miike Miyazaki Nature House for Youth. The isopach map shows a very narrow band of tephra fallout area extending from the crater to southeast through most of Miyakonojo city to the coast of Nichinan city.

Modeling of the medial and distal deposit was performed using the Tephra2 computer code and numerical inversion methods. Input consisted of the thicknesses measured at the tephra sample stations. The inversion process, the downhill simplex method, searches for best-fit eruption parameters to explain observed variation in tephra thickness. We were able to obtain best fit using an eruption column height of approximately 8 km and eruption mass (medial and distal facies only) of approximately 5 x 10^9 kg. This volume does not include near-vent tephra, but only the tephra dispersed at distances $>$ 5 km from the vent, in the populated region SE of Kirishima. Volume estimates should be refined using more proximal data when the eruption subsides.

Our initial observations of the medial and distal zones suggests the bulk of the deposit was the product of a short-lived, relatively energetic eruption, producing a small volume of tephra fallout, with unusually large clast size and relatively high column height (approximately 8 km) during the most intensive phase of activity, given the thickness of the deposit and volume in medial and distal zones.

Keywords: Kirishima volcano, Shinmoedake, Tephra, eruption column, grain size distribution, downhill simplex method

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

SVC070-P19 Room:Convention Hall Time:May 23 16:15-18:45

Visual observation and ash fall sampling for the 2011 Eruptive activity of Shinmoe-dake, Kirishima volcano

Shin'ya Onizawa[1*], Keiichi Fukui[1], Toshiki Shimbori[1], Shinobu Ando[1], Kazuhiro Kimura[1], Fuyuki Hirose[1], Yasuhiro Yoshida[1], Kazuhiro Iwakiri[1], Tomohisa Yoshida[1], Tetsuya Yamamoto[2], Sumio Yoshikawa[1]

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Shinmoe-dake started magmatic eruptions on 26 January 2011. Meteorological Research Institute conducted visual observations of eruptive and fumarolic activities of Shinmoe-dake from the end of January to the end of March. Further, ash falls by the eruptive activities were sampled.

Visual observation was conducted to monitor eruptive and fumarolic activities and to estimate heat discharge rate from the crater of Shinmoe-dake. Video and infrared thermal cameras were installed about 8 km to the south of Shinmoe-dake. High-resolution images of discharges of volcanic ashes and vapor were obtained by the observation.

Ash fall sampling was conducted in order to understand tephra transport and to enhance tephra fall prediction. Ash traps were placed at fixed point to the southeast of Shinmoe-dake, and ash fall deposits were sampled every a few days. Moreover, for several eruptions, we directly sampled falling ashes to enhance temporal resolution of sampling data.

We will report results of these observations in the presentation.

Keywords: kirishima volcano, Shinmoe-dake, visual observation, ash fall sampling

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

SVC070-P20 Room:Convention Hall Time:May 23 16:15-18:45

Fallout tephra of the eruption of Shinmoedake in Kirishima Volcanoes after January 28th, 2011

Teruki Oikawa[1*], Ryuta FURUKAWA[1], Shun Nakano[1], Nobuo Geshi[1], Kuniaki Nishiki[1], Takahiro Miwa[2], Hiroshi Shinohara[1], Hideo Hoshizumi[1], Akihiko Tomiya[1], Akiko Tanaka[1]

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Fallout tephra of the eruption of Shinmoedake in Kirishima Volcanoes after January 28th, 2011

Keywords: Shinmoedake, Kirishima, Kyushu, eruption, tephra, volcanic ash

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

SVC070-P21 Room:Convention Hall Time:May 23 16:15-18:45

Distribution analysis of pyroclastic deposits on 2011 eruption of Shinmoedake Volcano, Kirishima Volcanic Group, using

Hisashi Sasaki[1*], Masayuki Sakagami[1], Takumi Sato[1], Shinya Fujiwara[1], Tomohiko Soga[1], Kenichi Honda[1], Masamichi Haraguchi[1], akiko kasuga[2], HIROKAZU MURAKI[2], Koichi Iribe[2]

[1]Kokusai Kogyo Co., Ltd., [2]ImageONE Co., Ltd.

In January 2011, a magmatic eruption occurred in Shinmoedake Volcano, one of members of the Kirishima volcanic group, located in Kyushu, Japan. In this study, we employed C-band SAR data acquired by RADARSAT-2 for the examination of ground surface changes due to the volcanic activities (ash fall and volcanic bombs). RADARSAT-2 images that were acquired with the Multi-look fine mode (8m resolution) and Fine Quad-Pol mode (12m resolution) were examined. By performing continuous monitoring, we generated a change detection image from the Multi-look fine mode data. On the other hand, we analysed the full polarimetric image and generated a Pauli color-coded image with the Fine Quad-Pol mode data. Change detection images showed differences of backscatter intensity between images before and after the eruption (Fig. 1). Red color indicates smoother features on the before eruption image, while blue color indicates rougher features on the same image. Change detection images revealed the regional and local changes, especially around the craters and southeast direction. We considered the ground surface changes around the crater detected in this study was deposited volcanic bombs and thick ash by the eruption. Pauli color-coded image was classified into bare ground area, forest area, and building area, using the differences of reflecting features (Fig. 2). Around the crater, while forest area is decreasing, bare ground area is increasing. We considered this change around the crater detected in this study was influenced by the volcanic ashes.

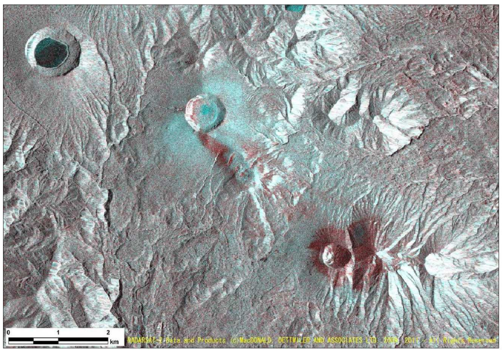
Fig. 1 Change Detection Image

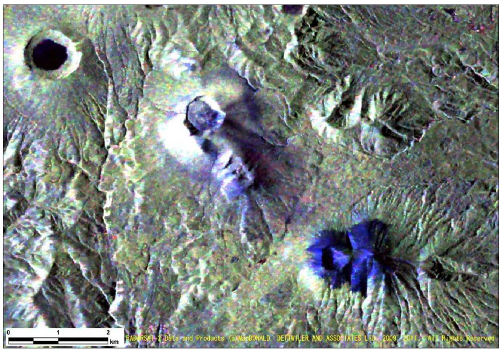
Fig. 2 Pauli color-coded image

Keywords: Shinmoedake, RADARSAT-2, SAR, volcanic eruption, pyroclastic deposit, monitoring

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

SVC070-P22 Room:Convention Hall Time:May 23 16:15-18:45

Simple approximation method for prompt recognition of ash fall distribution:A case study at Shinmoe-dake Volcano

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A series of eruption of Shinmoe-dake volcano commenced on Junuary 19,2011.For these eruption,we apply to a swift method for drawing isopachs.

Keywords: prompt recognition of ash fall distribution, isopachs, Shinmoe-dake

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

SVC070-P23 Room:Convention Hall Time:May 23 16:15-18:45

Analysis of explosive eruption of Kirishima-Shinmoedake volcano using MODIS and Simulcast Viewer

Ippei Harada[1*], Jonggeol Park[1], Xiangguang Zhang[1], Ichio Asanuma[1], Kisei Kinoshita[2]

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An explosive eruption occurred at Kirishima-Shinmoedake volcano on Japan's southern island of Kyushu on 26th January, 2011. The last explosive eruption of this volcano occurred 52 years ago. Intermittent ash eruptions of considerable magnitude have continued since the explosion, and an ash plume rose to a maximum altitude of 3,000 meters above the crater rim on 27th January and 2nd February (Japan Meteorological Agency 2011). Airborne volcanic ash has impacted farm production and the daily lives of residents downwind from the volcano, and heavy rainfalls may cause secondary disasters from mud flows. For these reasons, a time-series understanding of Kirishima-Shinmoedake eruptions is vital. Terra/MODIS and Aqua/MODIS (500m resolution) acquire data two or three times a day, while thermal infrared images (resolution 1km) can be acquired both day and night, and can be useful in understanding patterns of volcanic ash spread (Watson et al, 2002; Kinoshita et al, 2001, 2003). The objective of this study is to monitor the eruptive activity from Kirishima-Shinmoedake using Simulcast Viewer in real time and MODIS satellite images from three stations (Abashiri in eastern Hokkaido, Chiba in central Honshu, and Miyakojima in the southern Ryukyu Islands) operated by Tokyo University of Information Sciences.

MODIS is a key instrument aboard the Terra (EOS AM1) and Aqua (EOS PM1) satellites. Terra/MODIS and Aqua/MODIS view the entire Earth's surface every 2 to 3 days, acquiring data in 36 spectral bands. At the Chiba campus of Tokyo University of Information Sciences, located just east of Tokyo, MODIS data has been periodically acquired and archived since 2000. Since 2002, data from the Aqua satellite has been added to that of Terra, allowing acquisition several times daily. In addition, in 2009 antennas were established at the Abashiri and Miyakojima Island facilities.

In this study, geometric correction was implemented using MOD02 and MOD03 of Terra/MODIS and Aqua/MODIS acquired day and night from the start of the eruption on January 26 through February 4, 2011. Using bands 28, 29, 30, 31 and 32 of thermal infrared images, volcanic ash smoke can be detected by calculating Aerosol Vapor Index (AVI), allowing monitoring of eruptive activity both day and night (Kinoshita et al, 2001, 2003). In addition, the simulcast technology provided by NASA can be accessed at Tokyo University of Information Sciences, enabling monitoring of all East Asia. This system is being used to monitor changes of explosive eruptive activity at Kirishima-Shinmoedake. The scale of the volcanic eruption began to increase from about 15:30 JST on 26th January, and an ash plume rose to a maximum altitude of 2,000 meters above the crater rim about 19:00 JST drifted to the southeast (Japan Meteorological Agency 2011). By calculating AVI using thermal infrared images of Aqua/MODIS acquired at 22:00 JST on the 26th January, the volcanic ash smoke was confirmed to have diffused about 750 km to the southeast of the crater rim.

Acknowledgement

This research was supported, in part, by the Strategic Research Infrastructure Formation Project "Research project for sustainable development of economic and social structure dependent on the environment of the eastern coast of Asia (TUIS)" supporting by MEXT, and by a grant-in-aid for scientific research A (No. 20241009) of MEXT Japan.

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Keywords: Terra/MODIS, Aqua/MODIS, volcanic ash, Aerosol Vapor Index, monitoring

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

SVC070-P24 Room:Convention Hall Time:May 23 16:15-18:45

The range of volcanic deposit from the eruption of the 2011 eruption of Shinmoe - dake detected by satellite imagery

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At the time of volcanic eruption, it is well known pyroclastic deposit causes the post-eruption, such as secondary lahars. In order to predict and mitigate lahar disasters from volcanic eruptions, quick collect information following eruptions is important. However, gathering information in the proximity of response to erupting volcano is very dangerous and therefore extremely difficult. Thus, the effective use of satellite-based remote sensing technology provides a means of collecting information even in such situation. In this study, we tried to detect the range of volcanic ash time-series data taken through analysing satellite remote sensing data.

The satellite sensors of the images used in this study are the AVNIR-2 (Advanced Visible and Near Infrared Radiometer Type), PALSAR (Phased Array type L-band Synthetic Aperture Radar) aboard ALOS, and MODIS (Moderate Resolution Imaging Spectroradiometer) aboard Terra and Aqua.

The optical sensers, such as AVNIR-2 and MODIS, provided global and clear view of spatial distribution of pyroclastic materials. However, there were not very good images because of cloud or volcanic smoke. On the other hand, the SAR always provide cloud free images, which seem to show some changing areas by deposition of pyroclastic materials.

Keywords: Volcanic ash, Satellite, Synthetic Aperture Radar

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

SVC070-P25 Room:Convention Hall Time:May 23 16:15-18:45

Tephra fallout simulation of Kirishima Volcanoes, Shinmoedake using TEPHRA2

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The Shinmoedake, part of Kirishima volcanoes, has shown signs of volcanic activity after the date of January 26, 2011 and is sending ash over a wide range of southeastern part of Miyazaki prefecture. The effects are so severe that public transportations are disrupted and the evacuation of hundreds of residents is forced. On February 3, 2011, the Coordinating Committee for Prediction of Volcanic Eruptions (CCPVE) announced that they expected the hazardous eruptions of the Shinmoedake to continue. If the eruption persisted, further spreading of ash fall and volcanic mudflows could occur. Hence, it is necessary to predict the extent of damage in the different seasons, and also in the regions where the ash fall has not reached yet. Besides the key factor for the prediction is ”wind effect”.

In this report, we show the analytical result how the distribution of ash fall behaves under the same level of the eruption and the different wind profile by the simulation using TEPHRA 2.

We decided parameters by the information (erupted volume, eruption column height, etc.) released by several institutions like AIST, JMA and ERI, and also by the information of field research. We also use the JMA's wind profiles of Kagoshima-area near Kirishima volcanoes. We use 4 data sets of wind profile as below:

(Data set 1) The data as at 9 a.m. on January 26, 2011 when Shinmoedake erupted.

(Data set 2) The monthly average data as at 9 a.m. from 1991 to 2000

(Data set 3) The daily data on February for 9 a.m. and 3 p.m. from 1999 to 2010 (which consists of 1214 files)

(Data set 4) The daily data on August for 9 a.m. and 3 p.m. from 1999 to 2010 (which consists of 1302 files)

What this report shows are following: First, by using Data set 1, we checked the robustness of parameters, and found the reliable parameters to duplicate the Kirishima-explosion. Second, we calculated the distribution of ash fall by using Data set 2. Finally, we calculated the stochastic distribution of the amount of ash fall is derived from the repeated computation with the randomly chosen from wind profile form Data set 3 or 4 and different eruption-column level.

Keywords: Kirishima Volcanoes, Shinmoedake, tephra fallout, simulation, TEPHRA2

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

SVC070-P26 Room:Convention Hall Time:May 23 16:15-18:45

High Altitude airborne LiDAR at south east edge of Shinmoedake-crater in Kirishima Volcano,Japan

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1. Introduction

In general, it is important to measure the change in the amount of the gush of the ejecta to understand the transition of the volcanic eruption. About immediately outside on the edge of a crater and thickness piling up, there was no effective measurement means, and the state of the blank of data continued to the eruption in 2011 of new [mo] though the measurement was done from the lava volume and 2km in the crater by various organizations about the amount of fallout in the distance. The situation in which an explosive eruption that smoke reaches advanced several thousand m occurred at intervals of ˜ the tenth in several days, and the measurement of the sky of the crater of about 1000m in altitude of ground was extremely dangerous and impossible though was one of the best techniques for such a measurement of the purpose the Airlines laser measurement.

2. Measurement

The request of the Meteorological Agency was received and Asia Air Survey executed this measurement independently. The offer had been received from the Kagoshima Prefecture engineering works part about the geographical features data about the Ministry of Land, Infrastructure and Transport Miyazaki river national road office and Kagoshima Prefecture when attaching to Miyazaki Prefecture before it erupted for the comparison. We wish to express our gratitude for recording here.

The measurement condition is as follows.

Measurement time 10:39-10:41 on February 26, 2011

Flight altitude 5650m (18,532ft)

scanning angle +-25 degrees

flight speed 70m/s(136kt)

3. Result of a measurement

Pumice did the descent piling up by the eruption from January 26 to the 27th in the new [mo] eruption for the southeastward in the crater. In the orthophoto, the ground level within the range has changed into the discernment gray. The volcanic ash of the minute grain dark color by an explosive eruption afterwards piles up like covering on that. The axis of fallout has been biased to the north side a little. A lot of impact Craters are seen in the vicinity of the crater, and a gray spot with the scattering pumice can be made out to the surroundings. Moreover, signs of the secondary earth and sand movement can be made out in the valley muscle in the south of the shinmoe-dake (Kagoshima Prefecture side). There are remarkable the reflectivity of the laser a lot of points of the area that expands from the shinmoe-dake on the southeast side without the reflection at all from all sides 5m. The point where such reflection strength of the laser is low or the reflection was not able to be detected is roughly corresponding to the descent volcanic ash piling up region that has been clarified so far.

4. Amount of geographical features change

The closeup in the vicinity of the center part of the difference calculation results with the geographical features data before it erupted was made. In this data, the time laser measurement is DSM data after it erupts of the DEM data of doing processing that the tree is removed before it erupts at most that contains the tree etc. Because about one point and the measurement density are low, it is difficult in 5m to remove the data of the tree.

However, when the value of 1m or more in amount of the geographical features change is taken within the range not covered with before it erupts, after it erupts, and vegetation, it considers the geomorphic change by this eruption and is unquestionable.

As a result, about 10m(12m or less) was requested 4m in the shinmoe-dake edge south for the crater edge east. A theoretical measurement error is +- about 50cm.

Keywords: Airbone LiDAR, volumetry, Laser, airfall

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

SVC070-P27 Room:Convention Hall Time:May 23 16:15-18:45

Secondary sediment movement phenomena observed after the 2011 eruption of Mt. Kirishima

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The 2011 eruption of Mt. Kirishima provides volcanic ash deposit mainly in the south-east direction from the Shinmoe peak. The southern slope of the Takachiho peak is also covered by thick volcanic ash deposit. After several rainfalls, thin black marks were found through the helicopter survey on the southern slope. The field surveys were conducted and revealed that they are a kind of debris flow deposit, but they didn't reach to the downstream and stopped at the point nearly 1,000 m a.s.l.

Keywords: debris flow, volcanic ash

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

SVC070-P28 Room:Convention Hall Time:May 23 16:15-18:45

SAR data analysis for 2011 Kirishima-yama (Shinmoe-dake) eruption

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Volcanic eruption of Shinmoe-dake, Kirishima-yama, began in January 2011. To investigate volcanic activity of Kirishima-yama, we analyzed satellite synthetic aperture radar (SAR). First, we investigated temporal change of the crater from SAR images. PALSAR image of January 27 showed that the crater lake had disappeared, and lava was identified in PALSAR data of January 29. It rapidly grew until January 31, its extrusion rate was estimated to 7.7*10ˆ6 mˆ3/day. After that, it seems that volume change of lava was negligible but that surface configuration of lava changed associated with eruptions. Next, we investigated crustal deformation applying Interferometric SAR technique (InSAR). Slant-range shortening indicating the inflation in the west of Kirishima-yama was detected from ascending and descending interferograms for pre-eruption period, and it changed to slant-range extension indicating deflation in the co-eruption period. Their results corresponded to results of GPS observations. After February 1, significant deformation was not detected. In the ascending interferogram generated from 2008/2/12 and 2011/2/20 PALSAR data, 12cm slant-range shortening was found in the southeast of Shinmoe-dake. Its area corresponds to the area where volcanic ash accumulated thickly. So we assume that its slant-range change was due to accumulation of volcanic ash, and we estimate its thickness. Estimated thickness was in good agreement with result of field investigation of volcanic ash by NIED and ERI, the University of Tokyo.

Keywords: SAR, Kirishima-yama, eruption, lava, deformation, volcanic ash

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

SVC070-P29 Room:Convention Hall Time:May 23 16:15-18:45

The Eruption Activity in 2011 at Kirishimayama Sinmoedake volcano revealed by ALOS

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[1]MRI, [2]Volc,JMA

On January 19th in 2011, a minor phreatomagmatic eruption occurred at Shinmoedake in Kirishimayama volcanoes group, located along the border between Miyazaki and Kagoshima prefectures. This eruption moved into the essential magma eruption in the afternoon on the 26th January. At 18:00, alert level was raised from 2 to 3, transitioning the volcano into a period of possible high activity (Target area had changed from the area around the crater to non-residential areas near the crater). In the morning on the 28th January, a lava dome in the summit crater was confirmed by aerial survey over Shinmoedake. Volcanic activity has been continuing since then, and alert area has been extended to 4-kms radius from the summit (as of March, 1st).

ALOS has the L-band SAR (PALSAR), which is not affected by plume and cloud, and is independent of day and night. In general, when eruptive activity becomes active, we cannot see craters by smoke and/or plume directly. ALOS/PALSAR penetrates cloud and/or plume and can grasp the state inside the crater. As a result, it is one of the most available methods to grasp the changes caused by volcanic activity.

Meteorological Research Institute analyzed amplitude images at Shinmoedake before and after eruptions. Results by ascending orbit revealed the existence of lava fragments inside the summit crater on the night of 27th January. We detected that the maximum size of lava fragments at this point measured 100m wide, and that it grew up to an approximately 500m diameter on the night of 29th January. Also, results by descending orbit confirmed that lava fragments kept almost the same size in the morning on the 30th January. After that, the state of lava fragments inside the crater has remained unchanged through several explosive eruptions. We also are going to report some analyses by optics sensor.

Some of PALSAR data used in this report were prepared by ALOS 'Daichi' Domestic Demonstration on Disaster Management Application that CCPVE. Also, some of PALSAR data were prepared by PIXEL (PALSAR Interferometry Consortium to Study our Evolving Land surface). PALSAR DATA belongs to JAXA/METI (Japan Aerospace Exploration agency/Ministry of Economy Trade and Industry). We would like to thank Dr. Shimada (JAXA) for the use of his SIGMA-SAR software. In the process of the InSAR, we used 'the digital elevation map 50m mesh' provided by GSI (Geological Survey Institute) and some figures were made using GMT (P.Wessel and W.H.F.Smith, 1999). We are also grateful to Dr. Okuyama (HVO) and Dr. Miyagi (JAXA) for the advice of drawing method by GMT.

Keywords: ALOS, Kirishima Shinmoedake, SAR, PALSAR, AVNIR-2

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

SVC070-P30 Room:Convention Hall Time:May 23 16:15-18:45

Elevation change detected with Levellings at Mt. Kirisimayama between 1968 and 2011

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In Feburuary of this year, a remeasurement was made at the levelling route established by ERI of Tokyo university at the northern slope of Mt. Kirishimayama in 1968. The levelling route at Ebino-Kogen area was also remeasured after twenty years since 1991. As the former route is passing near the deep pressure source estimated by the GPS and SAR observations, the effect of the deep pressure source is supposed to be observed.

At the former route, only three bench marks were found. They are the last benchmark (KVO001) of the route at KVO and the first two benchmarks (KVO010 and KVO009) of the route in Ebino city area. As the results of the levellings, KVO001 subsided 12.8cm against KVO009 in the 43 years.

The measured subsidence at KVO001 is quite larger than the estimated subsidence by the model formed by GPS and SAR results.

At the latter route in the twenty years, the more it goes toward the east, the more subsidence is observed. This trend is opposite to the deformation suggested by the model formed by GPS and SAR observations. It suspects another shallow source existence.

The eruptic activity of Mt. Kirisimayama is supposed to be continued for a while, so we would like to carry out levellings recurrently in those times.

Keywords: Mt. Kirishimayama, levelling, ground deformation, 2011

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

SVC070-P31 Room:Convention Hall Time:May 23 16:15-18:45

Source model for crustal deformation of Kirishima volcano based on GPS Integrated Analysis in Volcanic Region

Kirishima Volcano Observation and Analysis Group[1], Tetsuro Imakiire[1*]

[1]GSI of Japan

Geospatial Information Authority of Japan (GSI) is monitoring the crustal deformation of Kirishima volcano, using GPS observation data of GEONET and GPS observation sites of Japan Meteorological Agency (JMA) and National Institute of Earth Science and Disaster Prevention (NIED). We found the baselines surrounding Kirishima, those are Ebino to Makizono, Makizono to Miyakonojo-2, Miyakonojo-2 to Ebino, started to extend from December 2009. As we recognized this phenomenon means the inflation of the volcano, we submitted a observation results and source models, based on the observation data, to Coordinating Committee for Prediction of Volcanic Eruption on June and October, 2010.

Adding the observation data from JMA sites and NIED sites, and using the for the integrated analysis combining with GEONET data, the source model became more sophisticated. A deep source at the northwest of Karakunidake and a shallow source under Shinmoedake are estimated for the crustal deformation before January 2011. Rapid deflation is observed after the magma eruption from January 26. Although this deflation stage continued until February 1, the shortening of the baseline length was less than the extension for one year before the eruption. The estimated deflated volume of the source is also smaller than the inflated volume before the eruption. In-SAR images from DAICHI, PALSAR show the crustal deformation patterns, which are consistent to GPS observation data and source models. GSI installed an additional GPS observation sites in Kirishima area to monitor the crustal deformation. We have found the baselines surrounding Kirishima is extending in the same rate as that before the eruption, based on the observation date until the middle of March 2011. This means the magma is being supplied into the deep source, constantly.

Acknowledgement

We would like to express our thanks to JMA and NIED who kindly provide us the GPS observation data for this study. The Ministry of Economy, Trade and Industry (METI) and the Japan Aerospace Exploration Agency (JAXA) retain ownership of ALOS/PALSAR data. We would like to express our thanks METI and JAXA providing data for this study.

Keywords: Kirishima volcano, 2011 eruption, crustal deformation, GPS observation, source modeling, integrated analysis

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

SVC070-P32 Room:Convention Hall Time:May 23 16:15-18:45

Crustal deformation after eruption of Shinmoedake, Kirishima and Continuous GPS Observation

Shigeru Nakao[1*], Yuichi Morita[2], Kazuhiko Goto[1], Hiroshi Yakiwara[1], Shuichirou Hirano[1], Jun Oikawa[2], Hideki Ueda[3], Tomofumi Kozono[3], Yasuhiro Hirata[2], Hiroaki Takahashi[4], Yusaku Ohta[5], Takeshi Matsushima[6], Masato Iguchi[7]

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Blast eruption of Shinmoedake, Kirishima, Japan occurred on January 27, 2011. Before eruption there are four continuous GPS observation sites with three GEONET sites of GSI, two sites of NIED and a site of DPRI, Kyoto University. In order to clarify crustal deformation around Shinmoedake, a GPS site (MNZS) occupied on January 29, two sites (TKCH, KRNO) on Janurary 31, KRYK on February 8. GPS data at four sites set up after the eruption send to ERI, University of Tokyo and/or Kagoshima University through mobile phone once a day. Automatic GPS analysis is carried out by using Bernese GPS Software with Ultra rapid ephemerides once a day. After estimating coordinates of each GPS site, baseline lengths between GPS sites are calculated and then presented on the Web page automatically.

Nakao et al. (2011) estimated the source of crustal deformation before the blast eruption which is located about 4 km WNW from Karakunidake with depth 9.7 km. We compare change rate of baseline length before and after eruption. We estimated rate of baseline length by least squared method in the periods from December 1, 2010 to January 25, 2011 and from February 1 to March 28, 2011. Rates of baseline length, which is bookended the deformation source, do not decrease after the eruption. They are still high rates, say 4 to 5 cm/year and change rates do not decrease after the eruption. Rates of baseline length composed of newly occupied GPS site are also high, 4 to 6 cm/yr, which is bookended the deformation source.

We conclude that it seems that activity of Shinmoedake does not become low. We have to check the crustal deformation associated with magmatic activity.

Keywords: Shinmoedake, GPS

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

SVC070-P33 Room:Convention Hall Time:May 23 16:15-18:45

The preparation stage of the Mt. Shinmoe eruption implied by crustal deformation

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Crustal deformations accompanying with the eruptions of Shinmoe volcano on January 26 and 27, 2011, were recorded by extensometers at Isa (Yoshimatsu) observatory of Disaster Prevention Research Institute, Kyoto University. We analyzed the short timespan records of crustal deformation before three sub-plinian eruptions. The records of crustal deformation after the eruptions are explained by contractions of a magma chamber beneath the Shinmoe volcano. Our results indicate the contraction duration of this magma chamber had been shorten by each eruption, implying that magma releases have become easier by each eruption. In addtion, we also found the crustal deformation of the preparation stage of every large eruption. The deformation has started approximately 10 hours before each eruption. These records possibly indicate contractions of a deeper magma chamber before eruptions.

Keywords: Mt. Shinmoe, crustal deformation, preparation stage, contraction duration

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

SVC070-P34 Room:Convention Hall Time:May 23 16:15-18:45

Locating magma chambers during the 2011 eruptions of Kirishima volcano, southwest Japan, by using strain data obtained i

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[1]DPRI, Kyoto Univ.

Disaster Prevention Research Institute, Kyoto University, has been observing crustal deformation by using invar extensiometers and water-tube tiltmeters in a vault at Isa Station in Kagoshima Prefecture. This station is placed approximately 18 km away from Shinmoe-dake (Kirishima volcano group), which has made several major eruptions since 26th January, 2011. Data at Isa station show clear variations in strains accompanying with the series of eruptions. By assuming a negative pressure source in a homogeneous crust (i.e., Mogi model), we can estimate the direction along which the source locates. First, horizontal direction to the source is determined from a principal axis of the strain tensor. Then transverse strain to radial strain provides information on the dip angle from the horizontal plane to the source. We apply this procedure to data obtained during three eruptions occurred on May 26th and 27th, 2011. We will present the results of estimation, together with the latest data which will have been obtained until the 2011 JpGU meeting.

Keywords: extensometer, observation in vaults, Shinmoe-dake, Kirishima Volcano, eruption, Mogi model

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

SVC070-P35 Room:Convention Hall Time:May 23 16:15-18:45

Estimation of magma flux during the 2011 eruption of Shinmoedake volcano based on tilt data

Tomofumi Kozono[1*], Hideki Ueda[1], Taku Ozawa[1], Eisuke Fujita[1], Motoo Ukawa[1], Toshikazu Tanada[1]

[1]NIED

Magma flux of volcanic eruption is a key parameter which controls the type of the eruption (explosive/effusive) and eruption intensity such as eruption column heights. During the 2011 eruption of Shinmoedake volcano, the type and the intensity of the eruption drastically changed within a week: several sub-Plinian eruptions on January 26 and 27, and a continuous lava effusion from January 28 to 31. In response to this eruption sequence, borehole tilt measurements by NIED showed a deflation of magma chamber caused by magma outflux to the surface. In this study we investigated how the magma flux changed during the eruption of Shinmoedake volcano on the basis of the tilt data.

Analyses of the tilt data revealed that a spherical deflation source, which is inferred to be a magma chamber, is located at the northwest of Shinmoedake volcano with a depth of about 7 km. The tilt data shows a linear deflation during the eruptions: three rapid deflations on January 26 and 27 during the sub-Plinian eruptions, and a slow deflation from January 28 to 31 during the continuous lava effusion. On the basis of the tilt data, we estimated an average deflation rate for each deflation event. Results show that the deflation rate of each sub-Plinian phase is about 6 to 10 times higher than that of the lava effusion phase. Here, the magma flux during the lava effusion phase is well constrained from the observations of the lava growth inside the crater such as by SAR analysis (about 50-80 m^3/s). Multiplying this magma flux by the ratio of the deflation rates of the sub-Plinian phase to the lava effusion phase, we can calculate the magma flux during the sub-Plinian phase: the estimated fluxes are about 330-480, 570-820 and 450-650 m^3/s for the three deflation events.

Comparison of the estimated flux with compilations of magma flux data for various types of eruptions in the world shows that the magma flux of the sub-Plinian phase in the Shinmoedake eruption is around the minimum of the flux range for sub-Plinian or Plinian eruptions, wheras the flux of the lava effusion phase is around the maximum of the flux range for lava dome eruptions. This implies that the Shinmoedake eruption was a critical state for the transition between explosive and effusive eruptions.

Keywords: Shinmoedake volcano, magma flux, tilt data, eruption style, magma chamber

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

SVC070-P36 Room:Convention Hall Time:May 23 16:15-18:45

Tilt change preceding the eruption at Shinmoedake Volcano

Koji Kato[1*], Kazuya Kokubo[2], Yoshiaki Fujiwara[2], Shin'ichi Matsusue[1]

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The eruptive activity at Shinmoedake volcano began on January 19, 2011, and shifted magma eruption on January 26. Preceding these eruptions, characteristic tilt changes were detected by tilt-meters about 3km from crater. We report the character of tilt change preceding eruption at Shinmoedake volcano.

Tilt changes preceding eruptions showed the sense of ground-up toward the north-west side of the station located SW flank of volcano and the sense of ground-up toward the north side of the station located SSE flank of volcano. These tilt changes started several minutes-10 hours before eruptions and the amount of tilt changes were 0.04-0.14 maicro radian.

Keywords: Shinmoedake, Tilt Change

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

SVC070-P37 Room:Convention Hall Time:May 23 16:15-18:45

The 2011 Volcanic Activity of Mt. Shinmoe inferred from seismic and tilt data

Haruhisa Nakamichi[1], Toshiko Terakawa[1*], Yoshiko Yamanaka[1], Masahiro Yoshimoto[1], Hideki Ueda[2], Yuhki Kohno[2], Toshikazu Tanada[2], Takeshi Matsushima[3], Takanori Matsuzawa[2], Fumito Yamazaki[1], Takashi Okuda[1], Shinichiro Horikawa[1]

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We have monitored the 2011 volcanic activity of Mt. Shinmoe using data recorded by seismometers and tiltmeters. First we deployed a dense seismic array at 5 km in the direction of N255E to Mt. Shinmoe to monitor its volcanic activity. We applied the zero-lag cross-correlation method (Frankel et al., 1997) to waveforms of vertical components of the array. We estimated that the apparent velocities and back-azimuths of seismic waves excited by the volcanic eruptions are 4-6 km/s and N280E, respectively. We also detected continuous seismic waves with apparent velocities of 1.8-2.4 km/s and back-azimuths of N270E - N285E from February 1 to 7. It indicates that continuous weak volcanic tremors which ware not detected by JMA had occurred at Mt. Shinmoe for the 7days. However, we cannot detect such continuous seismic waves since February 8. We also examined characteristics of spectra and duration times of seismic waves associated with sub Plinian eruptions on January 26 and Vulcanian eruptions after the day.

Keywords: Mt. Shinmoe, volcanic tremor, Array analysis

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

SVC070-P38 Room:Convention Hall Time:May 23 16:15-18:45

Characteristics of eruption and volcanic tremorin Shin-moe crater, Kirishima volcano, Japan based on seismic array

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Shin-moe dake crater has started eruption in middle of January, 2011. One of the strongest vulcanian eruptions on February 1st hit the surrounding residential area by strong atmospheric pressure waves. Seismic array deployed at 3km away from the crater recorded this explosion. The direct P wave, surface wave and the sonic waves associated with the eruption arrived at the array on the expected lapse time from the origin time estimated from travel time of the sonic waves. In addition, phases with small amplitude prior to the eruption were observed. We performed MUSIC spectrum analysis for the observed seismic array data to determine slowness vector of waves approaching to the array. The slowness of the precursor phases is the same as that of the waves at the main eruption. This implied that the phases were generated at the shallow part of the conduit the volcano.

Volcanic tremors associated with the activity of Shin-moe dake that has started since middle of January, 2011, which have been observed by the array. Based on MUSIC analysis, We found two different sources of the tremor. One is located at shallow part around the shin-moe dake crater. Another is found out at deeper position NW away from the crater. The deeper source could be identical with the position of the pressure source inferred from geodetic observations. The both tremors from two sources are generated at similar time range. The result suggests that the two magma conduits/chamber have some interaction between them.

Keywords: Kirishima volcano, seismic array, eruption, volcanic tremor

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

SVC070-P39 Room:Convention Hall Time:May 23 16:15-18:45

Source locations of explosion events and tremor associated with eruptive activity at Kirishima volcanic complex

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[1]NIED

We used a source location method using high-frequency seismic amplitudes to locate sources of explosion events and tremor associated with eruptive activity at Kirishima volcanic complex. Source locations of explosion events were determined at depths down to about 5 km below sea level. We found that the sources of tremor were located just beneath the Shinmoe-dake summit crater as well as at depths of about 8 km beneath the crater. The estimated source depths were similar to those determined for explosion events at Tungurahua volcano, Ecuador, but deeper than those of explosion events at Sakurajima volcano, Japan. Tiltmeter observation indicated a pressure source located NW of the summit crater at a depth of 10 km, which was interpreted as a magma chamber. The explosion events and tremor at Kirishima may have been generated by magma vesiculation and fragmentation processes in a deeper portion of a conduit connected to the magma chamber.

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

SVC070-P40 Room:Convention Hall Time:May 23 16:15-18:45

Infrasonic wave and seismic tremors recorded during Shinmoe-dake (Kirishima) eruption

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Following the blast eruption of Shinmoe-dake (Kirishima volcano group) on January 26th, 2011, Institute of Seismology and Volcanology (SEVO), Kyushu University equipped two temporal observation stations Shinyu (KRSY, 3km WSW from the crater) and Onamiike-tozando (KRON, 4km WNW) in order to detect movement of magma from the chamber to the active crater. We set two broadband seismometers, an infrasonic wave vibrograph (KRSY), and a tiltmeter (KRON). These real-time data were transmitted to SEVO using a mobile phone data terminal.

During eruption activity of Shinmoe-dake in January to February, there were 12 big-blast eruptions were detected by JMA, and infrasonic waves were observed also by our vibrograph clearly. Especially a blast eruption in the morning in February 1st was so big that many glass windows hotels and houses within 10km from the crater were broken by the infrasonic wave. Our vibrograph recorded more than 1500 Pa, though the instrument was uncalibrated within this large value area. Onset waveform of this infrasonic wave is less narrow than other infrasonic blast data.

From January 31st, we several times observed harmonic tremors with peak frequency of 1–2 Hz using the broadband seismometers. And also our infrasonic wave vibrograph recorded almost similar waveform as broad -band seismometer. More aculeate analysis we found time lag between two signals have time rag of about 6.2 second and 1.7 second at Shinmoe-kita (SMN, 750m NW from the crater). This fact shows that the vibration source of the harmonic tremor was very sallow just under the active crater, and radiates the tremor and infrasonic wave simultaneously. Furthermore, we found the dominant frequency of the harmonic tremor is different every time, so that the size of vibration sources also changed every time.

Keywords: Kirishima Volcano, Shinmoedake, Air blast, broadband seismic stations, harmonic tremor, infrasonic wave

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

SVC070-P41 Room:Convention Hall Time:May 23 16:15-18:45

Preliminary report for a dense seismic array observation for a short period in the western area at Kirishima Volcanoes

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Dense seismic array observation composed of 97 temporary seismic stations was carried out in the western wide area at Kirishima Volcanoes in a period from March 7 to March 13, 2011. This observation aims to observe the volcanic events such as volcanic earthquakes, tremors and local earthquakes occurred in and around the volcanoes, in order to try to estimate the spatial locations of these events, to try to detect the temporal change of the event locations, and to obtain the basic velocity structure beneath the volcanoes.

The array consisted of three profiles, A-profile, B-profile and C-profile. Each profile has 46, 25 and 26 temporary seismic stations equipped with a 4.5Hz UD-component seismometer and LS-8200SD recorders, respectively. A spatial interval between the stations along the profiles is about 100m. At each station, it was scheduled to record continuously seismic waves every about 3 hours.

During the whole observation period, one eruption occurred on 02h50m, March 8. Because the 10 minutes interruption scheduled between the continuous recording periods unfortunately overlapped the eruption time, we have no seismic data accompanied by the eruption. In addition, the main shock and many big aftershocks of the 2011 Off the Pacific Coast of Tohoku Earthquake occurred on March 11 strongly disturbed weak signals produced in the volcanic area. However, we could successfully obtain other seismic data derived from local earthquakes and volcanic events.

Keywords: array, volcano, Kirishima

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

SVC070-P42 Room:Convention Hall Time:May 23 16:15-18:45

Seismicity in and around Kirishima Volcanic Group for recent 10 years and temporary seismic observation

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Extensive magmatic eruption started at Shinmoe-dake on January 26, 2011. No remarkable VT earthquake beneath Kirishima Volcanic Group was observed before and after the eruption. We therefore conclude that the activity of the VT earthquake was quite low. The same seismic characteristic was also recognized at the previous small-ash eruptions which occurred on August, 2008 and/or during 2011. It is interesting that the low activity of VT earthquakes has been observed during the inflation of the volcano edifice (JMA, 2008) has been continued. On the other hand, episodic tectonic earthquakes were located beneath the north-east and east flank of the volcanic group. Shallow crustal earthquakes in and around Ogiri Area (Ida et al., 1986) were occasionally observed during the period. Morita and Ohminato (2005) suggested a classification of VT earthquake as follows: 1) VT earthquakes are caused by slipping on the pre-existing fault, and so on. 2) The earthquakes are caused by simple volcanic processes like magma intrusion. We investigated the above mentioned VT earthquakes in and around the volcanic group to clarify whether the type of the earthquakes is 2) or not. It is important that we discuss the cause of VT earthquakes, and that we mention the quite low seismicity of the VT earthquakes beneath the volcanic edifices.

Nansei-Toko Observatory for Earthquakes and Volcanoes, Kagoshima University (NOEV) has been located tectonic earthquakes in and around south Kyushu, Japan, for about 20 years by use of the seismic data of the observatory, JMA, and Hi-net. After 2001, the seismic network has been able to locate the crustal micro-earthquakes larger than M0.5-1.0 (Mori, 2001). Therefore, we can describe the temporal change of the seismicity on the constant quality of the hypocenter list having the constant quality. The ability of the location however is extensive low for the very small BL and BH earthquakes just beneath the active crater of Shinmoe-dake and Ohachi. Therefore, we limit our discussion on the regional earthquakes in and around Kirishima Volcanic Group. We installed 5 temporary short-period seismic stations at the volcanic group after the extensive eruption to intense seismic observation.

The characteristics of the VT earthquakes larger than or equal to M1.5 are summarized as follows. The number of the VT earthquakes was only 47. The maximum magnitude was 4.1. No earthquake whose magnitude from 2.5 to 4.0 was occurred. The depths of the earthquakes were limited the range shallower than 3.5km below sea level. On the other hand, there are two areas that the seismicity became active in the recent years: A) the seismicity beneath the east flank of the volcanic group became obviously active in 2006. B) it is interesting that the crustal seismicity (M1-2) locates between Kirishima Volcanoes and Aira Caldera remarkably active after 2009. In this presentation, we show the details and characteristics of the VT earthquakes in and around Kirishima Volcanic Group. We also discuss the distribution and temporal changes of principal stress axis of the focal mechanisms.

Keywords: Kirishima Volcanic Group, Shinmoe-dake, Volcano-Tectonic earthquakes

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

SVC070-P43 Room:Convention Hall Time:May 23 16:15-18:45

Detected infrasound signals in Isumi, Japan - the Eruption of Shinmoe-dake -

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The infrasound observation system is installed in Isumi, Chiba-prefecture (approximately 60 km SE of Tokyo) as a component of the International Monitoring System for CTBT's verification scheme. It is an array observation site and is comprised of six elements. It had been deployed on November 2004. Until now, many interesting infrasound signals were observed.

The infrasound signals generated by the volcanic explosions of Minamidake, Sakura-jima might be the typical examples. Signal made by the large explosions of Sakura-jima were sometimes detected and we are trying to discuss propagation characteristics of infrasound signals by using them, which include dispersion, attenuation, etc.

Shinmoe-dake had minor eruption on 19th of January 2011 and is erupting actively since 26th of January. Furthermore the large explosions occurred several times, whose waveforms at JMA's nearest microphone station had more than 100[Pa]. The observation system detected successive infrasound signals which came from the direction of Shinmoe-dake since 26th of January, and also detected a series of infrasound signals as often as large explosion had occurred. The distance between Shinmoe-dake and the observation site is approximately 950 km. Travel time of infrasound waves was estimated approximately fifty minutes. According to estimated sound speed profile along the propagation path, duct might be established within the troposphere, and a series of infrasound signal seemed to show a tendency of dispersion.

Keywords: infrasound, volcanic explosion, pressure wave, microbarometer

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

SVC070-P44 Room:Convention Hall Time:May 23 16:15-18:45

Numerical Analysis of Shock Propagation in Eruption of Mt. Shinmoe

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The eruption of Mt. Shinmoe caused the damage of breaking windows several kilometers away from the volcano, and the word "Air vibration" came to be recognized by the general public. We can know the approximate scale of the eruption by measuring a peak pressure of air vibration. Because the pressure wave may take different profile depending on the condition of the eruption, information of the eruption is included in the waveform. Therefore, there is a possibility that the characteristics of the eruption could be understood. The objective of the present study is to simulate the shock wave propagating from the eruptive crater numerically, and to investigate the characteristics of the pressure history which is observed at far field of the volcano.

The eruption was numerically simulated with a three-dimensional flow solver. This study assumes that gases are inviscid and follow the equation of state for perfect gases. The weighted average flux (WAF) scheme is used to solve the conservation laws of mass, momentum, and energy. The scheme is one of the extended Godunov schemes with second-order accuracy both in time and space. It is constructed as a finite-volume method using the integral form of the basic equations. The HLLC approximate Riemann solver with a TVD-limiter function is utilized for inter-cell flux evaluation.

Numerical domain of 5km x 5km x 3000m around Mt. Shinmoe was given by using 10m grid of digital map published by Geospatial Information Authority of Japan. The eruptive energy is set to 7.3×10^5 MJ, which the eruptive energy is equivalent to when the peak pressure of 1500Pa is observed at 3km away from the eruptive crater. Numerical calculations are carried out with following two eruptive models.

1.Pressurized container model: An imaginary gas container filled with high pressure air is placed over the eruptive crater. Blast waves or atmospheric vibrations are simulated by suddenly removing the container wall. In this study, the diameter of the container is arbitrarily set to 50m and placed 60m above the crater. The filling pressure and the temperature are 558kPa and 1000K, respectively.

2.Shock tube model: Volcanic vent is modeled as a long tube. The bottom part of the tube is separated by a diaphragm and is filled with high pressure air. When the diaphragm is removed, the high pressure air pushes the air in the rest of the tube, generating a shock wave and high speed air flow is induced behind the wave. The shock wave and the jet flow simulate the volcanic eruption. In this study, the cross section and the length of the tube are assumed to be 100m x 100m and 150m. The diaphragm is placed at the position where the volume of the high pressure section becomes the same as that in the pressurized container model. The initial filling pressure and the temperature are also the same as that in the previous case.

Curves in Fig.1a are the pressure histories at 1km south from the crater computed using these two different eruption models. It is observed that the negative over-pressure is less pronounced and its duration time is longer in the shock tube model compared to those in the pressurized container model. Figure 1b shows a typical over pressure history actually measured at 1km from the Mt. Shinmoe's crater[1]. Although it is only qualitative at this moment, it is seen that the curve for the shock tube model in Fig1a resembles the pressure history in Fig1b.

It is expected that valuable information regarding the eruption such as how and how much of energy is released is obtained by carrying out simulations for different combinations of numerical parameters.

In this study, comparisons are made between numerical results obtained with and without taking the terrain into consideration. The effect of the terrain is also discussed.

Reference

[1] Coordinating Committee for the Prediction of Volcanic Eruption, Observation of air vibration caused by Kirishima Shinmoedake eruption, The University of Tokyo Earthquake Research Institute, 2011

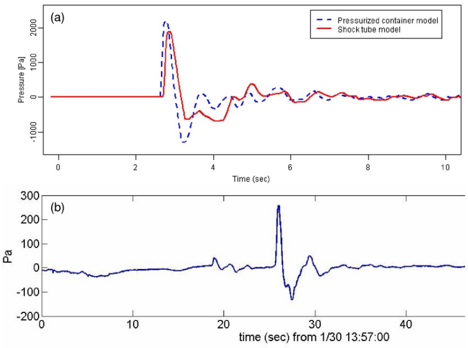

Fig. 1

Keywords: Mt. Shinmoe, CFD, Shock wave

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

SVC070-P45 Room:Convention Hall Time:May 23 16:15-18:45

Mt.Shinmoe eruption:Air-shock waveforms widely observed in Japan

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Infrasonic signals which are accompanied with explosive eruptions and continuous eruptions at Mt.Shinmoedake in 2011 were widely observed by some microphones in central Japan. We will report the characteristics of amplitude, comparison between other examples such as Asamayama 2004, and multiple raypath related to meteorological condition.

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

SVC070-P46 Room:Convention Hall Time:May 23 16:15-18:45

Magnetotelluric survey at Kirishima volcanoes in 2010 and 2011 (Preliminary report)

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We conducted broadband magnetotelluric (MT) survey at Kirishima volcanoes in 2010 and 2011 to elucidate the electrical resistivity structure. From July to September 2010, we made MT measurements at 17 sites around Mt. Shinmoe. ADU07s of Metronix were used for measurements and measurement term was almost three weeks at each site. By preliminary results, directions of induction vectors go to north of Mt. Shinmoe, around Mt. Karakuni in and below the periods of 1 seconds, and tend to go to north-west of Mt. Shimoe, westward of Mt. Karakuni around 100 seconds. This may indicate that a shallow low resistive body exists at a few km depth of the north position of Mt. Shinmoe and a deep low resistive body exists at tens km depth of the north-west position of Mt. Shimoe.

From 26 January 2011, it occured the active eruptoins of Mt. Shinmoe. GPS measurements found that the position of 6km apart from Mt. Shimoe in north-west direciotion is the source of stress at 10 km depth, that is, a magma chamber. Thus the induction vectors may point at a deep main magma chamber and a shallow sub magma chamber.

After the eruption mentioned above, we are going to conduct MT survey at another 12 sites from March to April 2011 around the postion of the magma chamber, and aim to detect main, sub magma chambers and its path.

Keywords: Mt. Shinmoe, MT, resistivity

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

SVC070-P47 Room:Convention Hall Time:May 23 16:15-18:45

Geomagnetic total intensity monitoring before the 2011 summit eruption at Shinmoe-dake crater in Kirishima volcano

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At Shinmoe-dake crater in Kirishima volcano, a weak summit eruption occurred in 22th, Aug., 2008. Since then, 3 weak eruptions took place in 2010, and intense magmatic activities with generation of lava dome and explosive summit eruptions have started since 26th Jan., 2011. 52 years have passed since the last explosive summit eruptions occurred at the crater in 1959. Since moderate volcanic activities in 1991-1992, we have performed continuous monitoring of geomagnetic total intensities at several sites in the vicinity of the Shinmoe-dake crater, aiming at detecting temporal variation due to thermal magnetic effect or piezo-magnetic effect before and during the main eruptions. Since all the observation sites just near the summit were damaged by the intense volcanic activities from 26th Jan., 2011, we will present temporal variation before the recent eruption and discuss on source of the changes.

Keywords: Shinmoe-dake crater, Kirishima, 2011 summit eruption, geomagnetic total intensity, thermal magnetic effect