Japan Geoscience Union Meeting 2015
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SVC12-P01 Room:Convention Hall Time:May 26 18:15-19:30

Atmospheric effect on infrasound detectablity at Chichi-jima from Nishino-shima assessed by a Monte Carlo phonon method

ICHIHARA, Mie[1] ; KIKUCHI, Junji[2*] ; LACANNA, Giorgio[3] ; KANNO, Yo[1] ; NISHIDA, Kiwamu[1]

[1]ERI, University of Tokyo, [2]Dept. Earth and Planetary Science, University of Tokyo, [3]University of Florence

Nishino-shima volcano in some 1000 km south of Tokyo is active since November, 2013. The new island keeps growing and is almost swallowing the original Nishino-shima island. We installed infrasonic stations to Chichi-jima, which is the closest inhabited island in 130 km to the east of Nishino-shima, and have been detecting clear infrasonic signals from Nishino-shima since May 2014. The detection of infrasound at such a distance obviously depends on the atmospheric structure. Here we present a simple method to evaluate the atmospheric effect, which is crucial for interpreting the infrasonic observation to the change of volcanic activity. The method is similar to the Monte Carlo phonon method proposed by Shearer and Earle (2004) to investigate seismic scattering wave fields.

A million phonon particles were transmitted from the ground to the atmosphere in random directions between zero and 90 degrees in the vertical plane cutting from Nishino-shima to Chichi-jima. Ray-tracing calculation (Tahira, 1982) was performed for each particles assuming one dimensional atmospheric structure with the effect of wind advection in the plane. We counted the number of the particles that reached Chichi-jima in the area of the infrasound stations spanning about 1 km, and regarded that the number represented the infrasound energy that reached the stations. Perfect reflection was assumed on the sea surface, but the particles that were trapped in the bottom layer thinner than the scale of the infrasonic wave length were eliminated. The calculation was performed for atmospheric structures from May to December 2014, using the data from radiosonde measurements twice a day by the Japan Meteorology Agency.

The calculated infrasonic energy arrivals were compared with the power of the signal from Nishino-shima detected by the infrasonic array at Chichi-jima. The calculation and the observation showed similar tendencies in general confirming that detection/non-detection of infrasound at Chichi-jima was controlled by atmospheric conditions. However, discrepancies were found in the beginning of May and in the end of June. The calculation shows infrasound was detectable, but it was not detected by the observation. These were the periods with low growth rates of the new island according to the satellite image analysis (Maeno et al., 2014). We conclude that in these periods the non-detection was due to the lack of the infrasonic source at Nishino-shima and not due to the propagation effect.

Although information for the atmospheric structure is limited, this simple method provides a first-order evaluation for the atmospheric effects and improves the interpretation of the infrasonic data at Chichi-jima for Nishino-shima activity.

Keywords: Volcano, Infrasound, Monitoring, Eruption, Wave propagation

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SVC12-P02 Room:Convention Hall Time:May 26 18:15-19:30

Characteristics of Eruptions Accompanied with Pyroclastic Flow at Sakurajima Volcano's Showa crater

TAMEGURI, Takeshi[1*] ; IGUCHI, Masato[1]

[1]Disaster Prevention Research Institute, Kyoto University

Sakurajima is a post-caldera cone situated on the southern rim of Aira caldera, south Kyushu, Japan. Vulcanian eruptions have occurred at the Minamidake crater at the summit since 1955. However, principal eruptive activity shifted to the Showa crater at the eastern flank of the summit in 2006. The eruptions at the Showa crater were phreatic in 2006-2007 and vulcanian eruptions started from 2008. Minor vulcanian eruptions occurred about 1,000 times per year in 2010-2013. Ash plume height of the eruptions sometimes reached to 3000-5000m from the crater after 2013. The eruptive activities at the Showa crater become active and are sometimes accompanied with small pyroclastic flows after 2008. The pyroclastic flow is dangerous volcanic phenomenon, it is important to understand the mechanism of generation of the pyroclastic flow for disaster prevention. In this study, we research ground deformation and precursory earthquakes patterns before eruptions accompanied with the pyroclastic flow.

Inflationary strain changes are observed by extensometers a few tens of minutes to several hours prior to the eruptions and are caused by pressure sources located at depths of 0-1.5 km. The inflation rates decrease or sometimes suspend about 30 minutes before the eruptions. Small earthquakes dominated by high frequency components (5-6 Hz) swarm when duration of inflation is longer than 1 hour. The hypocenters of the small earthquakes are located at a depth of 0.5 km beneath the crater and are close to depth of the pressure source. The earthquakes begin to occur a half hour to 1 hour after the start of the inflation. The amplitudes and number of the earthquakes further increase when the inflation rates decrease or suspend. Then, the occurrences of the earthquakes suddenly stop at the start of the eruptions. Inflation duration of the eruptions accompanied with pyroclastic flow is longer (more than 1.5 hours).

Seismic energy releases of the precursory earthquakes accelerate before the eruptions, although there are all kinds of large and small seismic energy releases. The precursory earthquake may be generated by release of excess pressure accumulated by inflation of the pressure source. The accelerations of the seismic energy releases before eruptions with the pyroclastic flow tend to be larger than those with normal events. We could be possible to predict generation of the pyroclastic flow from monitoring of the inflation duration and the seismic energy release of precursory earthquakes.

Keywords: Sakurajima volcano, pyroclastic flow, explosive eruption

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SVC12-P03 Room:Convention Hall Time:May 26 18:15-19:30

Recent seismic volcanic activity at Deception Island volcano (Shetland Islands, Antarctica).

SERRANO, Inmaculada[1*] ; CARMONA, Enrique[1] ; TORCAL, Federico[2] ; DIAZ, Alejandro[1] ; JIMENEZ, Vanessa[1] ; LORENZO, Francisco[1] ; ALMENDROS, Francisco javier[1]

[1]Andalusian Institute of Geophysics, Granada University, Spain, [2]Pablo Olavide University, Seville, Spain

Deception Island is the most active volcano in the South Shetland Islands region, having erupted at least 6 times since it was first visited 160 years ago. The 15-km-diameter island is horseshoe-shaped and has a flooded caldera (Port Foster) measuring about 6 x 10 km and a maximum depth of 190 m. All historical eruptions have been relatively small in volume. Evidence for present-day volcanic activity at Deception Island includes fumaroles and hydrothermal activity, resurgence of the floor of Port Foster, and seismicity. Seismic monitoring has been going on since 1986 during austral summer surveys, in which volcano-tectonic earthquakes (VT), long-period events (LP) and volcanic tremors, among others, have been recorded with a local network and seismic arrays.

In this work we analyze the results of the last two Antarctic campaigns conducted by the Spanish research team (2013-2014 and 2014-2015). Although seismic volcanic activity remained at relatively low levels in the 2013-2014 campaign, a notable increase has been observed in the current campaign (the highest number of LP/VT events in one day is 1500/100). In this paper we will be discussing the initial results obtained from our analysis of the data, focusing our attention on particular periods of intense LP and VT activity.

These variations may be related to alterations in the shallow hydrothermal system of Deception Island. In some periods VT distributions are temporally and spatially homogeneous, with a generally low level of seismicity in certain specific particular areas. These patterns may be caused by different processes, involving regional stresses and local tectonic destabilization induced by volcanic activity. We investigated how these events may have influenced volcano dynamics. Overall, this study suggests that there has been a significant reactivation of the volcano since the 2013-2014 Antarctic campaign.

Keywords: seismic array, seismic network, volcano seismology, Shetland Islands, Antarctica

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The sixth round of the repetitive seismic experiment in Sakurajima Volcano, Japan. The experiment 2014.

TSUTSUI, Tomoki[1*] ; IGUCHI, Masato[2] ; NAKAMICHI, Haruhisa[2] ; TAMEGURI, Takeshi[2] ; IKEDA, Keiji[3] ; OSHIMA, Hiromitsu[4] ; YAMAMOTO, Mare[5] ; NOGAMI, Kenji[6] ; OHMINATO, Takao[7] ; KOYAMA, Takao[7] ; MAEDA, Yuta[8] ; OHKURA, Takahiro[2] ; SHIMIZU, Hiroshi[9] ; YAKIWARA, Hiroshi[10] ; KOBAYASHI, Reiji[10] ; MAEKAWA, Tokumitsu[4] ; HIRAHARA, Satoshi[5] ; WATANABE, Atsushi[7] ; HORIKAWA, Shinichiro[8] ; MATSUHIRO, Kenjiro[8] ; YOSHIKAWA, Shin[2] ; SONODA, Tadaomi[2] ; SEKI, Kenjiro[2] ; HIRANO, Shuichiro[10] ; HIRAMATSU, Hideyuki[3] ; TORIYAMA, Naofumi[3] ; KONO, Taisuke[3]

[1]Akita University, [2]Kyoto University, [3]Japan Meteorological Agency, [4]Hokkaido University, [5]Tohoku University, [6]Tokyo Institute of Technology, [7]University of Tokyo, [8]Nagoya University, [9]Kyushu University, [10]Kagoshima University

The sixth round of the repetitive seismic reflection experiment is presented, whose purpose is detection of structurel evolution associated with underground magma movement in Sakurajima Volcano.

Seismic experiments have been performed every December since 2009 with same field design in the same geometry in the northern part of Sakurajima. Two major lines are routinely included in these experiments and comprised with 14 shot points and 225 stations every year. Total stations vary depends on state of the year. Uniform instruments, LS-8200SD by Hakusan Industory and Vertical motion 4.5Hz sensor, and 20kg size chemical explosions are used. 263 stations were deployed in this round, 2014.

In addition to the routine style observation, another type charge, slurry explosive, was tested and accelerations were measured for all shots. These experiment and observations were performed at the shot point KOME, S07. Four accelerationmeter were deployed ranging 10 to 70m. The nearest station was the force-balancing type triaxial accelerometer, model TSA-100 by Metrozet, which installed at c.a. 10m from the shot holes. Other three station were the verdumping type triaxial accelerometer, model JEP-6A3 by Akashi Mitsutoyo, which wereinstalled at 30m and at adjacent of routine stations. Accelerogram were recorded by the recorders, SC-ADL1000 or SC-ADH10KP, at each station. In order to compare seismograms along the lines, 20kg of slurry explosives were detoneted at 15m from the dymanaite shot.

The detonation for the sixth round experiment was done on the night 4th December 2014, and that for an additional line was the afternoon of 3rd December. 98.5% of all stations were completed schedule and seimograms upto 17Gbytes were obtained through the experiment. Data suggest that reflectivity under northeast part of Sakurajima have recovered as the same level as an average during 2009 to 2011.

On the slurry shot, 80% of peak acceleration was obserbed in near field and its waveform differs less significantly than that by dynamite. Because RMS amplitudes were the same in the routine stations with those from dynamite, it is possible to use slurry explosives sustainably as alternative of dynamite in our experiment.

This study was supported by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan, under its Earthquake and Volcano Hazards Observation and Research Program, also supported by Japan meteorological Agency and DPRI, Kyoto University. The instruments for routine experiment are provided by Earthquale Research Institute, University of Tokyo. The sensors and recorders were provided by Prof. Tomotaka Iwata, Kyoto University and SCIMOLEX co. The field operation was supported by Kagoshima Meteorological office, JMA.

Keywords: Sakurajima Volcano, Repetitive seismic experiment, Reflection seismology, Structure evolution, Volcanic structure, Magma

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Spatial and temporal analysis of stress fields inferred from crack distributions in the Mt. Fuji volcanic area

ARARAGI, Kohtaro[1*] ; SAVAGE, Martha[2] ; BRENGUIER, Florent[3] ; OHMINATO, Takao[1] ; AOKI, Yosuke[1]

[1]Earthquake Research Institute, University of Tokyo, [2]Victoria University of Wellington, Institute of Geophysics, [3]Institut des Sciences de la Terre, University Joseph Fourier

Understanding stress fields is an important topic to interpret geologic processes in volcanoes. After 2011 Tohoku-Oki earthquake, a Mw5.9 event occurred in the area on 15th March 2011. Therefore, this area is assumed to be affected by static and dynamic stress changes recently. We attempted to interpret those stresses from viewpoints of microcrack distribution by measurement of shear wave splitting and seismic interferometry by using seismic data from 24 seismic stations maintained by ERI, JMA and NIED in the Mt. Fuji volcanic region.

We measure shear wave splitting by upper crustal seismic event data from 2009 to 2012. In our measurement, fast polarization directions near the summit show radial pattern from the summit while those at stations far from the summit direct to the NW-SE. The pattern of fast polarization directions far from the summit is consistent with the direction of regional stresses.

From previous studies(e.g. Nakamura, 1977; Acocella and Neri, 2009) about dike, fissure eruption patterns and stresses in volcanic regions, we assumed that interaction of gravitational effect of the volcanic edifice and the regional stress can results in the crack distribution near Mt. Fuji. We conducted forward modeling of stress fields around Mt. Fuji to test the hypothesis of the influence of stresses on the contrast of the two patterns of splitting. We could reproduce the pattern of fast polarization directions as directions of maximum horizontal compressions.

Owing to the limitation of the time resolution of shear wave splitting measurement, we could not obtain significant temporal changes before and after the 2011 Tohoku-Oki earthquake and the Mw5.9 event. In order to interpret possible subtle changes of microcracks during the period, we attempted seismic interferometry in our data. Our preliminary results by vertical channels show consistent velocity drop with the results of Brenguier et al. (2014). In Brenguier et al. (2014), they used stations 15 km away from the summit of Mt. Fuji. In this research, we will increase the temporal and spatial resolution of change of seismic velocity by using 3 components of seismic data within the 15km of the volcanic edifice in addition to Hi-net stations.

Keywords: Mt. Fuji, Shear wave splitting, Seismic interferometry, microcrack, Tohoku-Oki Earthquake, seismic anisotropy

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Ground deformation associated with the eruption of Lumpur Sidoarjo mud volcano, east Java, Indonesia

AOKI, Yosuke[1*] ; SIDIQ, Teguh purmana[2]

[1]Earthquake Research Institute, University of Tokyo, [2]Institute of Technology Bandung

Ground deformation associated with the eruption of Lumpur Sidoarjo mud volcano between 2006 and 2011 has been investigated from Synthetic Aperture Radar images. Marked subsidence has been observed to the west of, as well as around, the vent. Line-of-sight changes in the both areas decayed since the middle of 2008 with a time constant of 1.5?2.5 years, implying that the ongoing eruption won't last long. This uniform decay time indicates that the western part is connected to the eruption center since the middle of 2008 to form a system with station- ary geometry. Our observation that the decay started later to the west than around the vent suggests that the sub- sidence to the west has been triggered by the mud eruption. A simple modeling suggests that 1) the conduit needs to be narrower at depth than at the surface, 2) the effective rigidity of the mud needs to be lower than that estimated from the drilled sample, or both to explain the observed decay constant of the deformation.

Keywords: Mud volcano, Ground deformation, Synthetic Aperture Radar, Time-series analysis