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

SVC051-01 Room:301B Time:May 22 14:15-14:30

Volcanic activity and tectonics in the NE Honshu arc, Japan

Takeyoshi Yoshida[1*]

[1]Graduate School of Science, Tohoku Univ.

The NE Honshu arc was formed by several volcano-tectonic events resulting from late Cenozoic continental margin volcanism, sea-floor basaltic lava flows and subsequent bimodal volcanism assompanied by back-arc rifting, and felsic volcanism related to island-arc uplift and the latest andesitic volcanism. The eruption volumes of volcanic rocks have gradually decreased of basaltic lava flows in the back-arc spreading stage, to baimodal hyaloclastites in the back-arc rift stage, and felsic pumice eruption in the island-arc stage (Yoshida, 2009; Yamada and Yoshida, 2011). During late Miocene-Pliocene, bimodal products were mainly erupted from along-arc and NE-SW-aligned and elongated calderas. The deformation pattern mostly consisted of N-S dextral faults and subordinate NE-SW extensional structures produced by NE-SW compression. During Quaternary, a larger amount of andesite was erupted from along-arc and E-W-aligned stratovolcanoes. The deformation pattern mostly consisted of N-S thrust faults and subordinate E-W extensional structure at the shallowest depth, produced by E-W compression (Acocella et al., 2008). Interactions between the NE Honshu arc and the surrounding plates and the related magmatism appear to have been the main controls on the tectonic evolution including transition of the regional stress field and the subsidence history of the sedimentary basin of the NE Honshu arc.

Keywords: volcanic activity, tectonics, NE Honshu, magma, regional stress field

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

SVC051-02 Room:301B Time:May 22 14:30-14:45

Evolution of Cenozoic upper mantle beneath back arc region in NE Asia

Tetsuya Sakuyama[1*], Takashi Miyazaki[1], Qing Chang[1], Toshiro Takahashi[1], Yuka Hirahara[1], Ryoko Senda[1], David Tian[2], Jun-Ichi Kimura[1]

[1]JAMSTEC, [2]Peking Univ.

Back-arc region, an area away from a place where surface of a slab subducting below is at a depth of ˜300km, is characterized by high surface heat flow, slow upper mantle velocity, and continual sporadic volcanism. These lines of evidence suggest that the upper mantle beneath not only subduction zone but also back-arc region is influenced by the subducting and stagnant slab. In order to understand material recycling process by subduction of the oceanic lithosphere, it is, therefore, necessary for us to understand upper mantle dynamics beneath not only subduction zone but also back-arc region.

Eastern margin of the Eurasian Plate is a region where Cenozoic back-arc volcanism extensively and sporadically occur over back-arc width of $>$1000km. Despite numbers of geophysical and geochemical investigations on the upper mantle and rocks in this region, a number of analysis combining phase petrology and geochemistry on volcanic rocks is quite limited. Evolution of thermal structure of the back-arc upper mantle during the Cenozoic and their relationship with volcanism are, therefore, still poorly understood.

Alkaline basaltic volcanism sporadically occurred in Shandong area, center of eastern China, from late Palaeogene to Quaternary. High resolution seismic tomography studies have revealed that there is a slab stagnating beneath eastern China and the western edge of the slab locates beneath around Shandong area. We made systematic petrological and geochemical investigations on Cenozoic volcanism in Shandong area in order to address the issue above.

Most basaltic samples are aphyric ($<$5 vol%) and have olivine phenocryst and minor amount of clinopyroxene and plagioclase microphenocrysts. Several samples contain peridotite xenoliths and olivine crystals with kink band, but there is no lines of petrographic evidence which suggests magma mixing and contamination of crustal material. Basalts in Shandong area are concentrated in K_2O (0.7-2.5 wt%), Na_2O (3-5 wt%), FeO$*$ (11-13 wt%), and incompatible trace elements (30-120 ppm in Nb; 150-400 ppm in Zr, 15-28 ppm in Y; 30-90 ppm in La), poor in SiO_2 content (40-46 wt%), and show relatively undifferentiated chemical composition (7.5-14 wt% in MgO; 100-450 ppm in NiO; 0.9-1.5 in FeO$*$/MgO ratio). Primitive mantle normalized trace element pattern is strongly enriched in LREE and Nb without depletion of high field strength elements relative to large ion lithophile elements or Eu anomaly. Strontium and Nd isotope compositions of the basalts are within the range in epsiron, and $^{87}Sr/^{86}Sr$, from 0 to +6 and from 0.7031 to 0.7045, respectively.

Whole variation of major element composition cannot be reproduced solely by crystal fractionation process. Provided mantle source lithology as peridotite and a certain amount of water in primary melt, mantle potential temperature is estimated to be 1400˜1500^{o}C. Variation of trace element compositions of primary melts cannot be reproduced by melting of primitive mantle or depleted MORB source mantle, but is reproducible by different degree of melting of a single source material of which composition is similar to that of a metasomatized spinel harzburgite xenolith reported from eastern Asia. As estimated melting pressure decreases, degree of melting increases.

By comparing estimated mantle temperature with those beneath surrounding area which includes whole eastern China, Korea, and southwestern Japan, uppermost mantle is the highest beneath Shandong area and mostly depleted in isotopic composition, while the lowest temperature regions are located in northeastern and southeastern China and in Chugoku district, southwestern Japan. This concentric zonation of mantle temperature and geochemical composition with an order of ˜1000km suggests existence of a thermal and chemical asthenospheric mantle anomaly associated with a stagnant slab.

Keywords: alkaline basalt, northeastern China, back arc, Cenozoic

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

SVC051-03 Room:301B Time:May 22 14:45-15:00

Chrome-spinel inclusions in olivine and plagioclase as a marker of phenocrysts in a differentiating magma system

Takashi Hoshide[1*], Masaaki Obata[2]

[1]Kyushu University, [2]Kyoto University

Crystal accumulation is an important process in magmatic differentiation. Although whether cumulus crystals were *intratelluric* phenocrysts or *newly-formed* crystals after magma emplacement is an important issue concerning mechanisms of magmatic differentiation, there has been no effective criteria for the judgement. We demonstrate, from a study of the Murotomisaki Gabbroic Intrusion, that Cr-spinel inclusions in silicates may be used as a useful marker to identify the intratelluric phenocrysts and also as a tracer to study the crystal redistribution in a differentiating magma body.

The Murotomisaki Gabbro is a sill-like layered mafic intrusion (~200 m thick) emplaced in Tertiary sediments in Shikoku, Japan. Several olivine-rich zones have been identified in a lower 100-m zone. Olivine and plagioclase phenocrysts in the chilled margin commonly contain tiny Cr-spinel inclusions, which are uniform in composition regardless of kind of the host mineral. Cr-spinels occur as olivine- or plagioclase-hosted inclusions in the lower 40-m cumulates (AC subzone), while there are no Cr-spinel crystals in the overlying cumulates (40-100 m; GR subzone). In the AC subzone, Cr-spinel contains more Fe^{3+} than that in the chilled margin. This tendency is more pronounced in olivine-hosted inclusions than in plagioclase-hosted ones. Within olivine crystals, closer the crystal margin, the more modified are the compositions of the spinel inclusions. From the above observations, we infer that all olivine- and plagioclase-hosted Cr-spinel inclusions from the AC subzone are originally of the same in compositions as those from the chilled margin, but their compositions have been modified in situ during solidification of magmas by diffusional exchange with the residual melt through the host minerals.

Keywords: crystal settling, intratelluric phenocryst, magmatic differentiation, Cr-spinel, diffusion, Murotomisaki Gabbroic Intrusion

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

SVC051-04 Room:301B Time:May 22 15:00-15:15

Magma chamber of Ofunato Stage, Miyakejima volcano based on high-pressure experiments

Masashi Ushioda[1*], Eiichi Takahashi[1], Toshihiro Suzuki[2], Morihisa Hamada[1]

[1]Earth and Planetaly Sciences, Tokyo Tech, [2]IFREE/JAMSTEC

Miyakejima is an active volcanic island located about 200km south of Tokyo in Izu-Mariana arc. Tsukui et al. (2001) divided the volcanic activity of the last 10000 years into four stages: 10000-7000 (Ofunato Stage), 4000-2500 (Tsubota Stage), 2500 y.B.P to AD1154 (Oyama Stage) since AD1469 (Shinmio Stage). We performed melting experiments of OFS scoria, which is one of the least fractionated Miyakejima basalt, in Ofunato stage. Experiments were performed in the temperature ranges of 1050-1200C at 1.0, 1.5, 2.0, 2.5kbar using IHPV at the Magma Factory, Tokyo Tech. Based on the experimental results and petrology of OFS, magma chamber in Ofunato Stage was reconstructed. The magma chamber was located at 5~6km depth (~1.5kbar) and water-rich (~3 wt.%) basalt magma crystallized olivine and calcic plagioclase (which is the typical phenocryst assemblage throughout Ofunato Stage) at ~1100C under NNO-buffer. Condition of the magma chamber was maintained almost constant for 3000 years. A series of crystallization trends were calculated using MELTS program (Ghiorso and Sack, 1995), and it is found that andesites erupted in Tsubota Stage can be formed by fractional crystallization of OFS basalt at 1.5kbar under NNO. Postulated water content in magma (~0.6 wt.%), however, is much lower than in Ofunato Stage (~3 wt.%). Accordingly it is suggested that magma chamber has been significantly degassed (0.6 wt.% H2O in magma) during the dormant period (4000~7000 y.B.P)

Keywords: Miyakejima, Magma chamber, High-pressure experiment, Ofunato Stage

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

SVC051-05 Room:301B Time:May 22 15:15-15:30

Roles of geodetic methods on volcanic activity forecasting

Makoto Murakami[1*]

[1]ISV, Hokkaido Univ.

Since the beginning of the GPS continuous measurements in mid 1990's, it has been demonstrating the usefulness in the volcanic activity monitoring. The most recent such example is a detection of deep source inflation preceding the 2011 January eruption of Shinmoe Crater of Kirishima volcanic complex.

Another example is prediction experiment of Asama Volcano. Asama volcano nested in the central part of Japan is a highly active volcano repeating eruptions since prehistoric period. The recent activity started in 2004 after 20 year long dormancy followed by further eruptions in 2008 and 2009. Distance change of a baseline spanning over the volcano edifice derived from GPS continuous measurements operated by the Geospatial Information Authority of Japan (GEONET) shows a series of repeating episodes of inflation and deflation. During the inflation period volcanic activities near the surface (seismicity, fumarole and SO2 emission, etc.) become culminating (Murakami, 2006). All the eruptions after 2004 are confirmed to have happened during inflation period. A suggested magmatic model is that episodic intrusions of magma from the depth to a shallow reservoir are driving volcanic activity near the surface. To the present no apparent periodicity is confirmed in the temporal evolution of the ground deformation. In this presentation, we discuss the possibility of prediction of the beggining of a new episode, based on a certain regularity of the deformation's temporal evolution. It is noteworthy that the temporal change of the baseline length is a chain of successive similar episodes. Each episode shares the similarity in shape but not in magnitude. More importantly the starting point of each episode drops on a single line suggesting a time-predictability following the same discussion in case of earthquake predictability. We see similar tendency also around Meakan Volcano, easetern Hokkaido.

In this presentation we discuss the roles of geodetic method in volcanic eruption prediction including the search of possible candidate sites of super eruption.

Keywords: Volcanic Eruption Prediction, GPS: Global Positioning System, Geodesy, Disaster Mitigation, Super Volcano

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

SVC051-06 Room:301B Time:May 22 15:30-15:45

Post-Eruptive Deformation of the 2006 Rabaul Volcano (PNG) Eruption Detected by ALOS-SAR Data

Suame Ampana[1*], Fumiaki Kimata[1]

[1]Nagoya University

Rabaul volcano is located at 4.271oS and 152.203oE on the eastern flank of the Bismarck Volcanic Arc on the northeastern end of the Island of New Britain in Papua New Guinea (PNG). It is a 9 x 14 km caldera complex. The volcanic arc is associated with the current subduction of the Solomon Sea Plate beneath the Bismarck Plate along the New Britain Trench. The most recent twin eruptions of VEI 6 occurred in September 1994 from two vents, Vulcan and Tavurvur, located roughly on the western and eastern margins of the caldera respectively, preceded by a deformational crisis ten years earlier. Leading up to and after the deformational crisis, intense monitoring was carried out anticipating an eruption in the near future.

After the 1994 eruption, Vulcan eruption ceased shortly thereafter while Tavurvur continued intermittently to end of 2010. An eruption of VEI 4 occurred on August 11, 2006 with vent and explosive eruptions. Lava flow and lava dome extrusion also occurred. Before the eruption, uplift was observed since February 2005 and amounted to 4 cm uplift at the time of eruption. At the eruption, ~25 cm of subsidence was detected by continuous GPS measurements. Habitants of Rabaul town were evacuated to safe locations.

Generally, it is agreed that the central up-doming of the caldera is being caused by one or two point sources at shallow levels within the caldera block, at depths ranging from 1 to 2.5 km. In contrast, the complexity of the observed deformation has also led to suggestion that more complex source may be involved other than a single (or two) point source. Moreover, the observed deformation may be the response of the caldera structure to the stresses from a 4- to 5- km deep magma source. Also, pressurization along ring faults, as delimited by seismic annulus, has been proposed to account for the observed deformation.

We processed ALOS PALSAR Data using InSAR technique for images obtained on February 27, July 15 and October 15 of 2007, October 17 of 2008, and September 4 and December 6 of 2009. This period corresponds to post-eruption deformation. Few centimeter subsidence are detected in the northeastern part of the caldera around Tavurvur volcano in the periods February ? July and July ? October in 2007 and September ? December in 2009. InSAR detected deformation estimates are consistent with vertical deformations of GPS processing by Rabaul Volcano Observatory for the corresponding periods. Subsidence of ~30 cm was observed in the caldera by continuous GPS measurements for 2 years until 2009. Small deformations are also detected around Vulcan.

A spherical deflation source at a depth of 2 km in the Greet Harbor provides a reasonable fit to the data using Mogi (1958) solution. We attributed the subsidence to decrease in the source volume as part of it recedes back into the magma chamber further beneath.

Keywords: Post-eruptive deformation, Rabaul volcano, ALOS PALSAR image, InSAR, subsidence, spherical source

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

SVC051-07 Room:301B Time:May 22 15:45-16:00

Recent transitions of seismicity in and around the Ontake volcano

Fumihito Yamazaki[1*], Yoshiko Yamanaka[1], Toshiki Watanabe[1], Haruhisa Nakamichi[1], Toshiko Terakawa[1], Takashi OKUDA[1], Shinichiro Horikawa[1], Ikumi Kuroda[1], Yuriko Shibayama[1]

[1]Res Ctr Seismol. Volcanol., Nagoya Univ.

The swarm activity in the southeastern foot of the Ontake volcano since February of 1976 succeeds until now for long period. At the time of the volcanic eruption of the Ontake volcano in 1979 and the succeeding small eruption in 1991 and 2007, no swarm seismicity change occurred and it seems that there is no relation between the swarm and the volcanic activities in this area. But, it is certain that these seismic and volcanic activities are the same proceedings of a crustal activity in the geological time scale that suggests the magmatic and/or the certain fluid activity caused the swarm and the volcanic activities. In this report, we show recent characteristic seismic events in and around the Ontake volcano.

We established the dense online seismic stations in and around the Ontake volcano. In the seasons of summer and autumn in 2009 and in 2010, we deployed temporal seismic network with 11 stations surrounding the summit of the Ontake volcano to investigate the seismic activity of the shallow volcanic events just beneath the summit. These volcanic events occurred within the depth of 0-3 km. The activity and also uppermost depth of these shallow earthquakes ups and downs and it indicates the volcanic activity of the Ontake volcano. It is found that the hypocenter area of these shallow volcanic events is restricted within the very narrow column. On the other hand, the extent of the seismic swarm activity expands towards east and north, but no earthquakes occurred in the surrounding area of the summit with 7-9 km in diameter.

Keywords: Ontake volcano, earthquake swarm, volcanic earthquake, seismicity

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

SVC051-08 Room:301B Time:May 22 16:00-16:15

Collapse caldera shape caused by a single sphere magma chamber in anisotropic homogeneous regional stress field

Shigekazu Kusumoto[1*], Toshiyasu Nagao[2]

[1]Grad. Sch. Sci. and Eng. Univ. Toyama, [2]EPRC, Inst. Ocean. Res. Dev. Tokai Univ.

We derived a fundamental solution giving caldera shape caused by a single magma chamber in an isotropic or anisotropic homogeneous regional stress field of which stress ratio between horizontal maximum and minimum principal stresses is constant.

In nature, many calderas are elliptical in shape and lie in extensional and compressive regional tectonic settings (e.g., Taupo, Taal, Valles, Long Valley, Campi Flegrei). As reasons which calderas have elliptical, we can cite (1) horizontally elongated magma body due to regional stresses in the crust, (2) the effects of far-field stresses, and (3) overlap of several collapse structures, each of which is related to an individual collapse event and possibly also associated with a discrete magma chamber. In this study, we attempted to investigate the effects of far-field stresses in caldera formation by analytical method. In order to simplify mathematical treatment of the problems, we assumed that the magma chamber is a small sphere, and approximated the collapse of the chamber to contraction (volume change).

The fundamental solution giving caldera shape caused by a single magma chamber in regional stress field was derived by evaluating the surface stress field due to volume change of magma chamber and the regional stress field by the Coulomb failure criteria. We estimated the shape of caldera by solving the derived equation numerically, because it was difficult to solve the equation algebraically.

We first estimated the shape of caldera without any regional stress field. As a result, caldera was formed as circular shape. This supports the existing results given by many analogue experiments and numerical simulations (e.g., Komuro et al., 1984; Komuro, 1987; Marti et al., 1994; Gudmundsson et al., 1997; Acocella et al., 2000; Roche et al., 2000; Kusumoto and Takemura, 2003). Under the condition that the regional stress field was isotropic compression, caldera was formed as circular shape, but its radius is smaller than radius of caldera without the regional stress field. On the other hand, under the anisotropic compressive stress field, caldera was formed as elliptical shape elongating to the direction of the maximum compressive stress axis. Under the anisotropic extension stress field, caldera was formed as elliptical shape elongating to the direction of the maximum extension stress axis. This supports the results given in analogue experiments by Holohan et al. (2005).

Not only elastic and strength constants of the crust but depth and volume change of the magma chamber and information (stress ratio and magnitude of the horizontal maximum principal stress regional stress field) on regional stress fields were included explicitly in the fundamental equation. We evaluated effects that these factors would give the shape of caldera, and it was found that the stress ratio and the magnitude of the horizontal maximum principal stress would play an important role in determination of caldera shape in the anisotropic homogeneous regional stress field.

[Acknowledgement]
This study was supported by Science and Technology Research Partnership for Sustainable Development, "Enhancement of Earthquake and Volcano Monitoring and Effective Utilization of Disaster Mitigation Information in the Philippines" of Japan Science and Technology Agency.

[References]
Acocella et al., 2000, JVGR; Gudmundsson et al., 1997, GRL; Holohan et al. 2005, JVGR; Komuro et al., 1984, BV; Komuro, 1987, JVGR; Kusumoto and Takemura, 2003, GRL; Marti et al., 1994, JGS; Roche et al., 2000, JGR.

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

SVC051-09 Room:301B Time:May 22 16:30-16:45

Fundamental structures of collapse caldera and their variations

Nobuo Geshi[1*]

[1]Geological Survey of Japan, AIST

Collapse caldera is a volcanic structure formed by the collapse of the roof rock into a decompressed magma chamber. Evacuation of magma from the chamber causes the drop of magmatic pressure inside the chamber and induces the collapse of roof rock into the chamber. Most of collapse calderas, particularly in silicic system, are formed by the eruption of magma to the surface. The calderas of Tambora 1815AD, Krakatau 1883AD, and Pinatubo 1991AD were formed by the large pyroclastic eruptions. In the case of mafic volcanoes, large lateral intrusion sometimes becomes a trigger of collapse (example Galapagos 1968AD, Miyakejima 2000AD and Piton de la Fournaise 2007AD).

We have rare chances to make direct observation of internal structure of natural collapse caldera and this prevents our further understanding about caldera forming process. Pyroclastic deposits produced during the caldera-forming eruption cover the caldera floor and hide the deformation structure on the caldera floor. In the case of calderas formed during the geological age, the original structure has been modified by the erosion, tectonic deformation and post-caldera volcanism.

During the last decade, the internal structure and collapse process of calderas are intensively discussed with analogue and numerical experiments. These results indicate that the development of caldera structure is controlled by the formation of ring faults propagate from the roof of magma chamber. In the shallow depth, the ring faults blanch to inner-reverse fault and outer normal fault and as result a double ring structure is formed. Developments of ring faults are controlled by the roof-aspect ratio. As increase the depth of magma chamber, deformation style sift from a coherent collapse to piecemeal. Some numerical simulations also show that the concentration of displacement to a specific faults with the progress of collapse and the block surrounded by the active ring fault(s) subside as a coherent block.

Comparison between the natural calderas and the experimental results indicates that the natural calderas without pyroclastic eruptions have very similar structures such as double ring faults and funnel-like cross section. This indicates that the fundamental structure of collapse caldera is a collapse of coherent or piecemealed block surrounded by ring faults. Existence of caldera-fill deposits produced during the ignimbrite eruptions and gravitational collapse of caldera wall modify the original collapse structure. Mechanical erosion by explosive activities also modifies the original caldera structure.

Keywords: volcano, eruption, magma, caldera, structure

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

SVC051-10 Room:301B Time:May 22 16:45-17:00

Tectonics of the Izu Peninsula region deduced from GPS data -Izu microplate and back-arc spreading of the Izu arc-

Takuya Nishimura[1*]

[1]GSI of Japan

Various tectonic processes proceed around the Izu Peninsula. They include a collision of the Izu arc to the Honshu arc, subduction along the Sagami and the Suruga Troughs, and volcanic activities of Izu-oshima and Izu-Tobu volcanoes. Many models for regional tectonics are proposed there. We modeled the regional deformation observed by GPS using a block-fault model and estimated block motion of the Izu microplate and spreading rate in the Izu back-arc rift zone. We present these results focusing on the regional tectonics in and around the Izu region.

In some previous studies, regional deformation by geodetic measurements is modeled by a kinematic block-fault model, in which surface displacements are expressed by the sum of rigid block rotations and elastic deformation near boundary faults. Nishimura et al. (2007) has applied this model to GPS velocity for 1996-2000 in the Izu region. We revised their model using new block configurations and GPS data for 2007-2009. We assumed 6 distinct blocks, that is the Kanto block, the Chubu block, the Izu microplate, the Philippine Sea plate, the Izu Arc block (a Izu Islands part of the conventional Philippine Sea plate), and the Pacific plate. Four-point inflation sources represent volcanic deformation for the Mount Fuji, O-shima, Kozu-shima, and Miyake-jima volcanoes. The unknowns estimated from the GPS velocity are 42 slip-deficit rates, 18 parameters of 6 Euler vectors, and 12 parameters of 4 point sources. Inversion results suggest the Izu microplate rotates rapidly clockwise with respect to the Kanto region. The block boundary between the Izu microplate and the Izu Arc block locates between the Izu Peninsula and Izu-oshima, extending from north to south. It passes near Kozu-shima and Nii-jma toward southeast. This boundary accommodates left-lateral strike slip with a long-term slip rate of 28 mm/yr. The dike intrusion events of the Izu-Tobu volcanoes in 1997, 1998 and 2006 accompanied the largest earthquakes (M5.8-5.9) whose focal mechanisms are left-lateral strike slip with north-south strike. They are attributed to the relative block movements. The pattern of the observed GPS velocity clearly suggests this lateral movement.

The GPS data supports back-arc spreading of the Izu arc suggested by the geological and geomorphological studies. Our analysis confirms that the forearc of the Izu Islands arc has an independent motion on a rigid part of the Philippine Sea plate. The relative Euler pole is estimated to locate west of Haha-jima. The model predicts 7 and 9 mm/yr of opening west of Aoga-shima and Miyake-jima across the Izu back-arc rift zone, respectively. Slip vectors of interplate earthquakes along the Sagami Trough imply that the active spreading may extend to the Izu Peninsula region. Our result supports a hypothesis that volcanism of Izu-Tobu is related with back-arc rift of the Izu arc (Takahashi, 2004).

Keywords: Izu Peninsula, Izu microplate, back-arc spreading, GPS, block-fault model

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

SVC051-11 Room:301B Time:May 22 17:00-17:15

Seismic velocity structure around Izu-Oshima volcano

Yuichi Morita[1*], Izu-Oshima seismic exploration group[1]

[1]ERI Univ. of Tokyo

Izu-Oshima volcano is one of active volcanoes in Japan, where inflations of volcanic edifice followed by small deflations are observed every two or three years. It shows that magma is stored beneath the volcanoes intermittently. It is important to reveal the effect of seismic velocity structure on the magma storage process, because the upwelling of the magma should be controlled by the underground density structure. Around Izu-Oshima volcano, seismic explorations were carried out in 1999 along NNW-SSE directed survey line. In 2009, the same kind of exploration was carried out along the WSW-ENE directed survey line. The survey lines of the explorations are perpendicular each other and the joint analysis of the both data will be expected to reveal detailed velocity structure beneath the volcano. The data processing of the exploration in 1999 has been completed. In this presentation, we explain the preliminary results from the 2009 exploration.

In the 2009 exploration, we deploy 39 ocean bottom seismometers (OBS) at the interval of around two kilometers along the survey line. The line passes through Izu-Oshima island and the central summit of the volcano. On the island, we also deploy around 300 seismometers with spacing of around 50m. Total length of the survey line is approximately 60km. We explode dynamites of 300kg weight at 9 points along the survey line below sea level. In addition, we also use pressure source (air-gun: capacity 50 litters) around the coast of the Izu-Oshima island and along the survey line. The shot interval is approximately 80m.

In the first step, the velocity is the estimated from onset times of refracted waves generated by pressure source. The spacing of the pressure source is very dense, and the velocity structure can be estimated until the depth of 3km in high resolution. The alignment of the whole survey line is aligned almost linearly, we can safely assume that the data processing based on 2D is valid in our case. Using the 2D ray tracing code by Zelt and Smith (1992), we estimate the P wave velocities in the layers and the top depth of each layer. From the analysis, the velocity in the first layers can be estimated as 1.7-2.0km/s, the second is 2.5-3.2km/s, and the third is 4.0-4.8km/s. In the second step, we estimate the deeper structure using the travel times of refracted waves from the dynamite shots. Here, the shallow structure is fixed one estimated in the previous step. The we can get the velocity of the basement is 5.8-6.2km/s, and the profile of the boundary.

From the above analysis, we can estimate the velocity profile beneath and around Izu-Oshima volcano. The features of the profile are listed below.

1) The subduction of the Philippine Sea plate at Sagami trough can be clearly imaged by the data acquired in the east end of the survey line. The dip angle of the subducting plate is around 20 degrees.

2) The depth of the basement layer with the velocity of around 6km/s is gradually inclined from 4km to 2.5 km in the west side of Izu-Oshima volcano and declined rapidly from 2.5km to 4.5 km in the east side. The convex profile of the basement is common feature beneath the volcanoes.

3) The velocity structure inside of the Izu-Oshima estimated here is almost coincide with the result of the 1999 exploration..

And we will move to process the later phases observed at the station inside of the Izu-Oshima island.

4) The SxP waves reflected at the depth of 8 to 10 kilometers are probably observed at focal distance of around 10 kilometers. More systematic analysis is needed to estimate the precise depth of the reflector.

5) The area of high attenuation of seismic waves is located around central summit of the volcano. And scattered waves are dominant in high frequency components at the stations located inside of caldera region. It shows that the structure beneath the caldera is very heterogeneous.

Keywords: Izu-Oshima Volcano, seismic velocity structure, structure beneath volcanic edfice

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

SVC051-12 Room:301B Time:May 22 17:15-17:30

Long-distance lateral magma transport in intra-oceanic arc volcanoes

Osamu Ishizuka[1*], Nobuo Geshi[1], Yoshihisa Kawanabe[1], Ogitsu Itaru[1], Taqumi TuZino[1], Shun Nakano[1], Kohsaku Arai[1], Kouya Sano[2], Toshikazu Yamamoto[2], Izumi Sakamoto[2], Rex N. Taylor[3]

[1]GSJ/AIST, [2]Tokai University, [3]NOCS

Recent geophysical observations in the Izu-Bonin intra-oceanic island arc indicate that magma is transported long distances laterally from the main basaltic composite volcano. When Miyakejima volcano erupted in 2000, seismic activity began beneath the volcano and migrated about 30km northwestward (Geshi et al., 2002). This event is interpreted to reflect northwestward dike injection from Miyakejima, transporting magma at a depth range between 12 and 20km (Kodaira et al., 2002). We demonstrated that long-distance lateral magma transport also occurred at Nishiyama volcano on Hachijojima Island using petrological, geochemical and structural studies of submarine and subaerial satellite vents (Ishizuka et al., 2008). Nishiyama provided evidence for two types of magma transport. In the first type, primitive magma moved laterally NNW for at least 20km in the middle to lower crust (10-20km deep) and is marked on the seabed as a series of submarine subparallel-aligning volcanic ridges. The other type is characterized by magmas that have experienced differentiation in a shallow magma chamber beneath Nishiyama and have been transported short distances (<5km). This latter type generates radially-distributing satellite cones. The long-distance magma transport seems to be controlled by a regional extensional stress regime, while short distance transport may be controlled by local stress regime affected by load of main volcanic edifice.

In this contribution, we report on recent investigations into the magma plumbing of Izu-Oshima volcano; an active basaltic volcano with extensive fissure eruption system. Cruise NT0906 accomplished 16 ROV dives in 2009. The dive areas were 1) NW of Izu-Oshima island, where the volcanism is expressed by NW-SE trending ridges, chains of volcanic edifices (NW chains) and the Higashi-Izu-Oki monogenetic volcanoes (HIMV) 2) SE of the island where NW-SE trending chains of volcanic edifices are also recognized (SE chains).

A bathymetric survey revealed that the subparallel NW-SE trending volcanic ridges extend up to 22 km to the NW and SE from the summit of Izu-Oshima volcano. The diving survey revealed that: 1) NW-SE trending ridges are eruption fissures, which erupted basaltic spatter and lava flows. 2) Basaltic effusives are petrographically similar among each ridge, while there are noticeable differences among the chains. 3) The NW chains are petrographically distinct from the HIMV in the same area. 4) Most of the NW-SE trending ridges have little sediment cover, implying that these eruption fissures are very recent.

Most of SE chains are petrographically and geochemically similar to the central and subaerial vents in the latest stage of activity of this volcano (last 2000 years), while NW chains are similar to the older subaerial satellite cones. Geochemical similarity between the submarine and subaerial chains on its extension implies that each volcanic chain represents an episode of lateral magma transport away from the main Izu-Oshima edifice. This scenario also explains the overlapping distribution of HIMV and NW chains which have clearly distinct sources. HIMV appears to be fed by "in-situ" source, while NW chains are fed by magma plumbing system of Izu-Oshima volcano by lateral magma transport.

Magma transport at Izu-Oshima volcano, however, seems to be distinct from those at Hachijojima-Nishiyama volcano. Izu-Oshima system does not show compositional variation along the volcanic chain, and no primitive magma occurs in the chain. Long distance magma transport at the Izu-Oshima volcano seems to occur from shallow crustal magma chamber where extensive crystal fractionation and plagioclase accumulation take place.

Long-distance lateral magma transport in oceanic island arc volcanoes could be common phenomena where regional stress regime is favorable and important factor for construction of volcanic edifice and eruption system.

Keywords: Izu-Oshima volcano, intra-oceanic island arc, dyke, long-distance lateral magma transport

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

SVC051-13 Room:301B Time:May 22 17:30-17:45

Fissure eruptions of Fuji Volcano during the last 2300 years: Eruptive fissure and style of Eruption

Akira Takada[1*], Takahiro Yamamoto[1], Yoshihiro Ishizuka[1], Shun Nakano[1]

[1]AIST, Geological Survey of Japan

Fuji Volcano, central Japan, caused various fissure eruptions during the last 2300 years. The volcano is a good example to understand both the effect of regional and local stress field, and the effect of explosivity. Both explosive eruptions and un-explosive ones occurred at fissure eruptions with a short eruptive fissure of less than a few km long. The examples for explosive eruptions are Obuchi scoria and Hoei eruption. On the other hand, long-fissure eruptions come from un-explosive eruptions. Especially, their explosivity tends to decrease toward the lower termination. Some un-explosive eruptions may have been originated form magma drain-back system near the summit. The model is supported by the evidece of the high-level fissure eruption sites just beneath the summit crater bottom, and the existence of fumarole activities which were reported by historical documents. We examine the analog experiments on gelatin to collaborate the stress effect with the explosive effect with vesiculation.

Keywords: Fuji Volcano, Magma plumbing System, Fissure eruption, Style of eruption, Drain back, Stress field

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

SVC051-14 Room:301B Time:May 22 17:45-18:00

Clustering of dike orientations for paleostress analysis

Atsushi Yamaji[1*], Katsushi Sato[1]

[1]Div. Earth Planet. Sci., Kyoto Univ.

We propose a clustering method for dike orientations to infer paleostresses from the groups of dike orientations. Such inference has been done with the assumption that the orientations make a cluster or a girdle on a stereogram, which can be recognized on a stereogram by eyes. It was also assumed that all dikes were formed under a state of stress. Therefore, it was difficult to apply this method to dikes formed under polyphase stress history.

To solve this problem, we developed a numerical method of adapting a mixed Bingham distribution to the orientations of the dikes that could be affected by different stress states. Given a set of orientations, a mixture distribution is determined by the EM algorithm, and stress axes and stress ratios are obtained from each of the optimal Bingham components. The method determines the number of the components as well via Bayesian information criterion.

We tested the method using the artificial data sets that were generated with assumed stress states. The method successfully detected the stress states and the number of groups. Applying the method to the dikes at the western flank of the Miocene Ishizuchi Cauldron in Shikoku, Japan, we obtained two stress states. One of the stresses was consistent with the extensional tectonics accompanied by the Japan Sea opening. The other one was consistent with the volcano-tectonics of the area at the time of the dike formation.

Keywords: dike, orientation statistics, cluster analysis, stress, Japan Sea opening

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

SVC051-15 Room:301B Time:May 22 18:00-18:15

Structural geology of volcano deformation: Its utility and future issues

Daisuke MIURA[1*]

[1]CRIEPI

We have reviewed recent development in the study of volcano structure and deformation by use of the geological sciences. There are several approaches that can be applied in the study of volcano deformation. Geological sciences can be used to reveal history of volcanic eruptions and evolution of volcano structures. Material sciences can deal with both hot magma and its consolidated rocks. Geophysical sciences can deal with migration of magma before/during eruption events. While the geology has the great advantage to measure eruption magnitude, style, and those variations in the past events, it shows another aspect as just a record in the historic science. This aspect of geology might become an incompatible factor to the physics and chemistry methods. We hence encourage that a use of structure approach plays a key role to develop the physical understanding of eruption in long-term volcanism.

Keywords: structural geology, volcano, deformation, tectonics