SCG65-01 Room:201B Time:May 20 09:00-09:15

On the Concentration of Water in Arc Basalts: case study in Izu Oshima, Miyakejima, Fuji and some perspectives

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Genesis, transportation mechanism and distribution of water in subduction system is very important to understand various geological phenomena in subduction zones. Origin of subduction zone magma is thought be deeply connected with dehydration of subducting slabs. Because water degassed from magma prior to or during volcanic eruption, concentration of water in arc magma is not well constrained. In this study, we show evidences that basalt magma in volcanic front generally contains several weight percent of water. This is in contrast with previous view on lateral variation of water in Japanese Quaternary volcanoes (Sakuyama, 1979; Aoki et al, 1981). It also contradicts with estimated geographical variation of fluid components in Japanese Quaternary volcanoes by Nakamura et al.(2008) and Nakamura & Iwamori (2010).

Based on high-pressure melting experiments on primitive basalt of Izu-Oshima volcano, Hamada & Fujii (2007) concluded that presence of 3 to 6 wt% of water is necessary in order to explain very calcic (˜An90) plagioclase phenocryst. Phase relation of primitive basalt from Ofunato stage of Miyakejima volcano has been studied experimentally (Ushioda et al, 2011) and it is found that about 3 wt% of water is necessary in order to explain its phenocryst assemblage (ol + pl) and the calcic plagioclase composition (An90-94). Moreover, Hamada et al. (2011) has established a new method to estimate pre-degassing water content of magma using hydrogen concentration in plagioclase phenocryst. Using this new technique, water content in main magma chamber of Izu-Oshima volcano prior to 1986 eruption was estimated be ˜5 wt%.

Presence of large amount of water in basalt magma is also supported from explosive volcanic eruption style of Fuji volcano (e.g. Hoei sub-plinian eruption of 1707). According to Machida (1977), amount of volcanic ash (tephra) from Fuji volcano may be equal or greater than its volcanic edifice. This indicates that the explosive erption style of Fuji volcano continued through time and therefore high water content in its basalt magma is a continuous feature.

Basalt magma is less abundant in the volcanoes on Honshu Arc due to the extensive fractionation, magma mixing and crustal melting. Precise estimate of water content in their primitive basalt magma is therefore difficult. However, presence of very high modal amount of plagioclase phenocryst in basalt and basaltic andesite (usually 30˜40 vol%), is a good indication of the presence of large amount of water in these mafic magmas. This is because, degassing of hydrous basalt at shallow magma chamber invariably accompanies crystallization of large amount of plagioclase(e.g., Hamada & Fujii, 2008).

We therefore propose that basalt magma in volcanic front of Izu Mariana Arc (e.g., Fuji, Izu-Oshima, Miyakejima) and those of North Honshu Arc are all wet, may be typically containing 5 wt% of water or even higher. This view strongly contradicts with previous works; 1) lateral variation of water content similar to potassium (Sakuyama, 1979; Aoki et al, 1981); 2) nearly anhydrous magma genesis model by Tatsumi et al.(1983) at the volcanic front, and 3) recent estimation of fluid component in magma based on systematics in Nd and Pb isotopes (e.g. Nakamura & Iwamori, 2010). Our model, however, is not inconsistent with a model proposed by Kimura et al.(2010). We will discuss origin of the discrepancy between our model and previous works. We will also emphasize the importance of the large water flux released by hydrous basalt magma at the volcanic front in considering circulation of water in subduction zone.

Keywords: magma, water content, basalt, island arc, volcano

SCG65-02 Room:201B Time:May 20 09:15-09:30

Volatile behaviors in an immature subduction zone inferred from boninitic melt inclusions

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Recent study suggests that boninites formed at the immature stage of subduction zone, whereas related arc tholeiites erupted 0-7 Ma after boninite formations (Ishizuka et al., 2011, EPSL, v306, p229-240). In order to constrain volatile behaviors of an immature subduction zone, we have analyzed major, volatile contents and sulfur isotopic ratios (34S/32S) of melt inclusions in Cr-spinel from fore-arc volcanic rocks in Bonin Islands and in Guam. All Cr-spinels are collected at volcanic sand beaches and purified for this study. Boninitic melt inclusions occur in Muko-jima, Chichi-jima and tholeiitic melt inclusions occur in Mukoo-jima and Guam. Cr-spinels in boninite are high in Cr# (mostly 80-90) and low in TiO2 ($<$ 0.1wt%), indicating highly depleted source. Whereas Cr-spinels in tholeiite vary in Cr# (45-80) and in TiO2 (0.1-1 wt%). Compositions of melt inclusions fully cover compositional range of whole-rock. Some melt inclusions of boninites have MgO higher than 20 wt%, showing that they are very primitive magmas. H2O and CO2 contents of melt inclusions of Muko-jima boninite are high (up to 4 wt%) and low ($<$ 50 ppm), respectively whereas those of Mukoo-jima tholeiite are lower (H2O mostly ˜1 wt%) and higher (CO2 up to ˜1000ppm). Except H2O, volatiles of boninitic melt inclusions (F $<$20ppm; Cl $<$500ppm; S ˜100ppm) are considerably lower than those in tholeiites (F up to 400ppm; Cl up to 3000ppm; S up to 3000ppm). High S content of tholeiitic melt inclusions may indicate high oxygen fugacity of the magmas. Sulfur isotope data of melt inclusions from boninites show the lightest value that reported from igneous rocks (d ^{34}S$_{VCDT}$ = -5 to -10), whereas those of tholeiites (d^{34}S$_{VCDT}$=+2 to +5) are comparable to reported arc tholeiite data. S source of tholeiite should be mixture of seawater-derived hydrothermal sulfites and mantle sulfide. Whereas S source of boninite can be seawater derived pyrite which precipitated in mantle, inorganically, because of reduced condition caused by water-mantle reaction. As source of boninite is hydrated hertzbergite, sulfur in the source before the hydration may be neglible. Therefore, all sulfur of boninite may be secondary origin. Assuming open system isotope fractionation, d^{34}S$_{VCDT}$ difference between seawater sulfate (20 permil) and pyrite (-5 to -10 permil) can be explained by pyrite precipitation at ˜200^{o}C, which is consistent temperature of serpentinization at subduction zone. Boninite may be formed by melting of this serpentinite at an immature stage. Further contaminations by fluid led higher oxygen fugacity at mantle wedge, forming arc tholeiites.

Keywords: boninite, arc tholeiite, sulfur isotope, volatiles, melt inclusion

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The redox states of volcanic glasses from Bonin islands, Japan, estimated by Fe-K edge micro XANES study

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The redox state of arc mantle is an important issue to understand processes of material cycle and generation of magma within mantle wedge. Previous studies on mantle xenoliths indicated that arc mantle is more oxidized relative to those of other tectonic settings and proposed that the oxidized nature is attributed to an influence of subduction-related fluid. However, it is unobvious that partially melted region within mantle wedge where arc magma is generated is actually oxidized because mantle xenoliths are fragments of cool, rigid, re-equilibrated lithospheric mantle. In addition, the role of subduction-related fluid on oxidization of arc mantle is still unclear.

Arc magmas might be a unique material having information about the redox state of their source mantle region. Among various arc magmas, we thought that boninite is the most suitable to examine both the redox state of arc mantle and the effect of subduction-related fluid on arc mantle. This is because boninite is undifferentiated rock quenched in seawater. They are expected to preserve information on redox state of sub-arc mantle. In addition, they were considered to be generated by partial melting of hydrous mantle which was highly influenced by subduction-related fluid. Therefore, the redox state of boninite is ecpected to give clue to above issues.

It is well known that valence state of Fe in silicate glass is a sensitive indicator of its oxygen fugacity (fO2). Recent advance in Fe-K edge micro-XANES (X-ray Absorption Near Edge Structure) study enables us to determine valence state of Fe in silicate glass with several microns order of special resolution. In this study, we investigated fO2 of quenched silicate glasses included in pillow lavas and hyaloclastites of boninite from Chichijima, Otojima, and Mukojima, Bonin islands, Japan. We also analyzed quenched basaltic glasses from Anejima and Hahajima for comparison. In addition, quenched glasses of AIST standard rock samples (JA-1a, JA-2, and JB-2) synthesized at fO2 near quartz-magnetite-fayalite (QMF) and Ni-NiO (NNO) buffers were analyzed to assess the reliability of this analytical method. We performed the measurements using Beam Line 4A in Photon Factory, KEK, which enables us micro analysis of XANES. The obtained spectra were analyzed using the method of Cottrell et al. (2009) to determine mole ratios of ferric to total iron, Fe3+/Fe. Oxygen fugacity of silicate glass was calculated from the Fe3+/Fe ratio using the method of Kress and Carmichael (1991). Reliability of our analyses is confirmed because controlled fO2 during synthesizing standard glasses is reproduced within standard deviation of 0.4 by the models of Cottrell et al. (2009) and Kress and Carmichael (1991).

The measured Fe3+/Fe ratios of quenched glasses are 0.17-0.24 for boninites from Chichijima, Otojima, and Mukojima. Basaltic glasses from Anejima and Hahajima are 0.20-0.22, which is identical to those of boninites. These values are larger than the average Fe3+/Fe value of MORB (ca.0.16). We estimated fO2 of the measured glasses is near NNO buffer based on obtained Fe3+/Fe ratios. Because the effects of crystallization of silicate minerals and dehydration during ascent on fO2 of silicate melt are thought to be small, the estimated fO2 of the glasses may inherit their genetic conditions. Our results suggest that (1) slab-derived fluid related to boninite genesis did not significantly affect the redox state of source mantle region and (2) the redox state of arc mantle was oxidized even at an initial stage of arc evolution. This is inconsistent with the results of Lee et al. (2005, 2010).

Keywords: XANES, Oxygen fugacity, arc mantle, volcanic glass, boninite, Bonin islands

SCG65-04 Room:201B Time:May 20 09:45-10:00

In-situ determination of Pb partition between aqueous fluids and haplogranite melts under HTHP conditions

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Using a micro-focused synchrotron x ray at Synchrotron SOLEIL (France), in-situ x-ray fluorescence (XRF) spectra of Pb, Rb, and Sr are obtained from aqueous fluids and haplogranite/jadeite melt at 0.3-1.3 GPa and 730-830C. Partition coefficients between aqueous fluids and melts are obtained for Pb, Sr and Rb (D $^{fluid/melt}$ $_{Pb}$, D $^{fluid/melt}$ $_{Rb}$, D $^{fluid/melt}$ $_{Sr}$) with and without Cl. As pressure increases, D $^{fluid/melt}$ $_{Pb}$, D $^{fluid/melt}$ $_{Rb}$, and D $^{fluid/melt}$ $_{Sr}$ increase. As salinity increases, D $^{fluid/melt}$ $_{Pb}$, D $^{fluid/melt}$ $_{Rb}$, and D $^{fluid/melt}$ $_{Sr}$ increase. D $^{fluid/melt}$ $_{Pb}$ are larger than unity in 5 M (Na, K)Cl bearing solution-haplogranite melt system. D $^{fluid/melt}$ $_{Rb}$ are larger than unity in 2.5 M NaCl bearing solution-jadeite melt system. Under the identical conditions, D $^{fluid/melt}$ $_{Sr}$ are smaller than 0.6 and 0.1, respectively. The present study confirms that saline fluids can transfer large ion lithophile elements such as Pb, Rb, and Sr from subducting oceanic lithosphere to the mantle wedge, whereas Cl-free aqueous fluids cannot.

Keywords: magma, aqueous fluid, elemental partition, high temperature and high pressure, synchrotron X-ray fluorescence, lead

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Development of a database of the electrical conductivity of H_2O-NaCl fluids: A molecular dynamics study

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Introduction: Fluids in the earth's crust would have large effects on the occurrence of earthquake and volcanic eruptions. To delineate distribution of the fluids in the earth's crust is requisite to understand the effects of the fluids on the earthquake and volcanic activities. The distribution of the fluids has been expected to be revealed by electromagnetic observation, e.g. magnetotellurics. Electrical conductivity distribution in the crust is considered to roughly correspond to the fluids distribution because of the high electrical conductivity of fluids relative to solids. To develop a plausible model of the fluids distribution to explain the electromagnetic observations, we have to construct a database of the electrical conductivities of fluids over the wide range of pressure (P), temperature (T), and electrolyte concentrations (c). The experimental approaches to measure the electrical conductivities of aqueous NaCl solution have been difficult at high P, T and c conditions and we can get only the data at $P < 4000$ bars, $T < 1100$ K and $c < 0.1$ m (mol/kg) [1]. Classical molecular dynamics (MD) simulations are useful to obtain the physical properties of fluids at high P, T and c conditions and to understand the underlying atomic-scale mechanism of the electrical conductivities. The phases of water and aqueous NaCl solutions at the P-T conditions of the Earth's crust are in liquid and supercritical states. The aims of this study are to make a reliable water model to simulate water in liquid and supercritical phases and to construct a database of electrical conductivity of aqueous NaCl solution at high temperature and pressure conditions.

Computational Methods: We have developed a flexible and polarizable water model based on our previous flexible model [2]. In our new model, the point charges are located on the hydrogen atoms and on the lone pairs of the oxygen atom. The point charges are fluctuated during the MD simulations. The MD simulations were performed using the code MXDORTO with some modifications.

Results and Discussion: Electrical conductivity of aqueous NaCl solution should depend on the density, viscosity, dielectric constant, and salt concentration (mol/kg) [1]. The density and salt concentration are the parameters of the number of ions per unit volume. In the atomic-scale view, the decrease of the viscosity corresponds to the increase of the ionic mobility. Since the viscosity sharply decreases with the increase of the temperature and shows no large dependence on P and T at $T > 600$ K, the density, salt concentration and dielectric constant are the most important parameters at $T > 600$ K. To construct a reliable water model for the supercritical phases, we should check the reproducibility of the physical properties compared with experimental results. Here we compared the structure, density, dielectric constants, and electrical conductivity of aqueous NaCl solutions in supercritical phases with some experiments. The radial distribution functions between atoms in the solution were good agreement with the experiments at 673 K and 3400 bar. The densities of 0.1 m NaCl solution and dielectric constants of water at T = 573 ˜ 973 K and P = 2000 ˜ 5000 bar were reasonable compared with the experiments. In this study, we explain the underlying mechanism of the change of the electrical conductivity of aqueous NaCl solution in the supercritical phase from atomistic view and try to construct the useful equations for the electrical conductivity of aqueous NaCl solution in the supercritical phase.

[1] Quist, A.S. and Marshall, W.L. (1968) JPC 72 684?703. [2] Kumagai, N., Kawamura, K. and Yokokawa, T. (1994) Mol. Simul. 12 177?186.

Keywords: dielectric constant, ion association, polarizable model, MD

SCG65-06 Room:201B Time:May 20 10:45-11:00

Spatial distribution of slab-related fluid in Japan - Relation to inland earthquakes -

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Recently, possibility that fluids are involved in earthquakes has been pointed out. Activity of the deep low frequency (DLF) earthquakes and the shallow inland microquakes in Japan have been precisely monitored by the Hi-net for the last decade. The DLF earthquakes are well-determined for hypocenter having feature of very deep (20-40km depth) and thought to be related with hydrothermal fluids. In this study, we show the spatial distribution of crustal fluid and discuss the role of fluids in the occurrences of the DLF earthquake and the inland microquake.

Saline waters found close to the hypocenter of the DLF events show characteristic isotopic composition and chemistry; 1) similar to magmatic water or Arima-type thermal water indicated by isotopic composition of water, 2) NaCl-CO_2-type, and 3) high Li/Cl ratio ($>$0.001 in wt. ratio). The flow rate of these saline waters were hydrologically investigated at 6 places in Kinki district to be 8.5 kgH_2O/sec in total. Calculated dehydration rate of subducting slabs given from literatures ranged from 4 to 36 kgH_2O/sec for the arc length of 100km (SW Japan), which corresponds to our observational results, indicating they are of slab dehydration origin. The fluid involved in DLF events is likely either a magmatic fluid released during solidification of a magma at lower crust or a slab fluid directly supplied by slab dehydration.

The spatial distribution of slab-related fluids also agree well with that of shallow microquake occurrences (depth $<$ 20km) or areas showing shallower D90 as well as that of DLF events. Upwelling of slab-related fluids seems to be one of the cause of shallow microquake activities. Fluids needs a path for upwelling such as a fissure existing at faults, and then the upwelling fluids will reduce the friction of fault planes. Furthermore, the recent large inland earthquakes (M $>$7) occurred close to the area of DLF events where the slab-related fluid exists. And some areas (a part of Chugoku district and the Abukuma granitic province), where no slab-related fluids are found, has relatively less earthquake activity. In conclusion, the NaCl-CO_2-type slab-related fluid widely exists but is localized in Japan, and play a role on inland earthquake activity.

Keywords: crustal fluid, slab-related, inland earthquake, deep low frequency event

SCG65-07 Room:201B Time:May 20 11:00-11:15

Groundwater database and its analysis utilizing the hot spring analysis table

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It is known that the role of water in the material circulation in subduction zones is important. Since 2009, Tanaka laboratory, has been collecting its own the table hot spring analysis in cooperation with each prefectural government, the health center. These tables are based on Paragraph 1 of Article 18 of the Act in hot spring law. Because, results of the analysis, public secondary raw data is difficult of personal property. Currently, the database of the Tanaka laboratory in Japan but some areas are missed, the data is already entered into the GIS 5,998 points.

In addition to the introduction of the above database, to announce the results of the analysis. It was of particular interest this time is the ratio Br / Cl and Li / Cl. Kaga and Toyama Plain are adjacent plain. But, Na-Cl type hot springs wich exist at coastal area, that characteristic of Li/Cl and Br/Cl ratio are different. Also examine other areas, you can find similar characteristics of Br/Cl and Li/Cl to the group of Toyama Plain's Na-Cl type hot springs, that overlap with the hot springs considered affected by Arima-type deep brine.

Keywords: Hot springs, Groundwater database, GIS, Arima-type deep brine, Br/Cl, Li/Cl

SCG65-08 Room:201B Time:May 20 11:15-11:30

Fluid inclusions with high Li/B ratio found from HP/LT type metasediments

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Recent studies invoked that the variation of peculiar fluid soluble light elements, such as Li, B and Cl, are capable of suggesting generation depths of fluid released in subduction zones (Scambelluri et al., 2004; Marschall et al., 2007). Crush-leached (CL) fluids extracted from quartz (Qz) veins intercalated with metabasites of the Sanbagawa metamorphic belt show high Li and B concentrations, whose Li/B ratios show a positive correlation with metamorphic grade of the host rocks, i.e., from 0.02 for pumpellyite-actinolite facies to 0.27 for eclogite facies (Sengen et al., 2009). Furthermore, CL fluids extracted from three samples of Qz veins (IR04, IR27 and IR28) intercalated with metasediments in proximal to the eclogite mass in the Besshi district show much higher Li/B ratio (0.36-1.99). Yoshida et al. (2011a) reported Li/B ratio of dehydrated fluids derived from tourmaline-free metasediments showing higher values than those expected from metabasites for the same grade, suggesting that Li/B ratio of dehydrated fluids was controlled by the rock types of host rocks.

To inspect other factors controlling Li/B ratio of dehydrated fluids, Qz fabric, microthermometry-Raman spectroscopy of fluid inclusions and hydrochemical facies of CL fluids were investigated for abovementioned three samples with high Li/B ratio.

Qz grains in the veins show foam microstructure with almost no intracrystalline deformation structures, suggesting that their fabrics are formed at high-T and low-differential stress conditions and that they have escaped from the later stage deformation during the exhumation stage of the metamorphic belt.

Each sample contains two or three kinds of fluid inclusion assemblage (FIA) indicating that they suffer multistage fluid activities in their P-T trajectory. IR04 has three kinds of FIA, FIA-04a, -04b and -04c. FIA-04a, composed of high saline aqueous fluid (7.0-8.7 mass% NaCl$_{eq}$) and CH$_4$ gas, are arranged at intragranular planes. Rare annular shaped fluid inclusions are observed within FIA-04a, suggesting that the host rock suffered compression after their entrapment. FIA-04b is arranged at intragranular planes, consisting of single/two phase inclusions of CH$_4$-CO$_2$-N$_2$-H$_2$ fluid. FIA-04c is two phase inclusions, composed of high saline aqueous fluid (8.7-9.5 mass% NaCl$_{eq}$) and CH$_4$-N$_2$ mixed gas. IR27 contains two kinds of FIA, FIA-27a and -27b, arranged at trans/intra granular planes, respectively. FIA-27a is composed of high saline aqueous fluid (5.7-10.5 mass% NaCl$_{eq}$) and CH4-N2 mixed gas. The occurrence of FIA-27b is restricted to the wall-adjacent Qz grains and their sizes are too small to determine the compositions, though part of them are considered to be aqueous fluid. IR28 has two kinds of FIA, FIA-28a and -28b. FIA-28a, arranged at intra/trans granular planes, is composed of CH$_4$-N$_2$ mixed gas and no water is detected. FIA-28b is characterized by the arrangement along intra/trans granular planes and composed of low-saline aqueous fluid (0.9-2.2 mass% NaCl$_{eq}$) and CH4-N2 mixed gas, showing irregular shapes with large size (up to ˜40 micron).

CL fluid of IR28 shows dominance of HCO3, which is known as the characteristics of pore fluid in near surface fracture of continental crust (Bucher and Stober, 2010), and is commonly observed in Qz veins showing strongly deformed fabric (Yoshida et al., 2011b). The low salinity of IR28 is also similar to that of later-stage veins (Okamoto et al., 2008), although the timing of entrapment of FIA-28a and 28b still remain unclear. However, textural observation shows FIA-04a was trapped during the prograde stage and FIA-04b, 04c, 27a, could have been trapped during peak stage or the early stage of the exhumation. CL fluids of IR04 and IR27 are dominant in Na-Cl type. These observations suggest that hydrochemcial facies of deep fluids and texture and Qz veins are potential signposts looking for the pristine deep fluids.

Keywords: fluid inclusion, Li/B ratio, subduction zone, Sanbagawa belt, Crush-Leach method, eclogite

SCG65-09 Room:201B Time:May 20 11:30-11:45

Effects of Al and Na on mineralogy of silica deposits from hydrothermal fluids

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Silica is one of the most dominant components in the Earth's crust, and is characterized by high solubility with respect to water that is sensitive to temperature. An ubiquitous occurrences of the quartz vein in seismogenic depth of the subduction zones implies the importance of the quartz precipitation in fractures on earthquake cycle. However, the mechanism of quartz vein formation is still poorly understood. One of the difficulties is arisen by the fact that silica can precipitate from hydrothermal fluids as metastable polymorphs such as opals. Hydrothermal fluid contains various minor elements derived from the crustal rocks: and thus it is possible that kinetics of silica precipitation is affected by these minor elements. Our previous study (Okamoto et al., 2010) revealed that the mineralogy of silica from pure Si solutions are different from that from impure solutions including minor amounts of Al, Na and K derived from granite .

In this study, we conducted the hydrothermal flow-through experiments at 430 C and 31 MPa to investigate the effect of Al and Na on precipitation of silica minerals. . We use a blank vessel for precipitation of silica minerals without rock/mineral substrates. The Si-supersaturated solutions (300-350 ppm, $C_{Si}/C_{Si,Qtz,eq}$ = 3-3.5) were prepared by dissolution of quartz at 350 C, and the concentration of Al and Na in the input solution was systematically changed by dissolution of albite at different temperatures. The concentrations of Al and Na in the input solutions range from 0 to 7 ppm, and the atomic ratio of Al and Na were unity that is same as the stoichiometry of albite.

With increasing Al and Na concentration in the input solutions, the dominant silica mineral systematically changes from amorphous silica, cristobalite to quartz. The atomic ratio of difference of Al and Na between input and output solutions, dC_{Al}/dC_{Na}, was 1.06. The modal abundances of individual silica minerals were estimated from XRD spectra by using the internal reference addition method. With increasing Al concentration in the input solution, the modal abundance of amorphous silica monotonically decreases from 100 to 15 wt.%, whereas that of quartz increases from 0 to 82 wt.%. Cristobalite becomes dominant at the intermediate Al concentration (1-3 ppm) in the input solutions. In the experiments with low Al concentrations ($C_{Al} < 3.0$ ppm) in the input solution, the contents of Al2O3 and Na2O of the products (amorphous silica and/or cristobalite) are less than 0.06 wt%, and no systematic relationship between Na and Al content. On the other hand, in the experiments with high Al solution ($C_{Al} > 3.0$ ppm), the products contains Al2O3 and Na2O are contained up to 0.36 wt.% and 0.25 wt.%, respectively. These lines of evidences suggest that Al^{3+} coupled with Na^{+} substituted for Si^{4+} in quartz in our experiments.

Natural silica sinters, which form at shallow levels (< 1 km depth) of the crust, are composed mainly of opaline silica (amorphous silica and cristobalite) with lesser amounts of quartz. In contrast, the hydrothermal quartz veins do not contain the relic of other silica polymorphs, expect for chalcedony. Such contrasting mineralogy of silica deposits probably reflect the concentration of Al and Na in the solution. Because solubility and morphology of precipitates are quite different between quartz and amorphous silica, the minor amount of Al and Na in the hydrothermal fluids would affects the location and amount of silica deposits at the Earth's crust.

Keywords: Presipitation of silica minerals, Quartz, Aluminum, Sodium, Hydrothermal experiment

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Hydrothermal experiments on calcite precipitation via water-rock interaction

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Calcite veins are very common within crusts and accretionary prisms. For example, calcite + quartz veins occur ubiquitously in the Shimanto belt. The solubility of calcite decreased with temperature, that is the opposite trend of quartz; and thus how calcite precipitated in the conditions that quartz also occurs is puzzling. Also, the fluid inclusions in the Shimanto veins are composed of CH_4, with exception of CO_2-dominant inclusions found in the southern parts of the Muroto Peninsula, that belongs to the Tertiary Shimanto belt (Lewis, 2000). In spite of its importance, the experimental studies on the calcite precipitation are very limited. Most experiments are carried out under near room temperature and controlled by pH change or synthetic CO_2 saturated fluids (Lee & Morse, 1999), that are far from natural conditions of calcite-vein formation. To best of our knowledge, there are no experimental studies on calcite precipitation under hydrothermal conditions (>100?C).

The purpose of this study is to understand the controlling factors on calcite precipitation under conditions of calcite-vein formation (fluid compositions, P-T conditions, host rock types). The solubility of calcite increases with decreasing temperature or pH, with increasing fluid pressures, and with increasing concentration of NaCl (Ellis, 1963). What is the most controlling factor that enhances the calcite-vein formation at the conditions of the Shimanto belt is unknown. We conducted two types of hydrothermal flow-through experiments for calcite precipitation by (1) temperature change and (2) water-rock interaction at constant P-T. In both experiments, the P-T condition for calcite precipitation is 300 ?C and 30 MPa.

In the first experiments, the supersaturated solutions were prepared by dissolution of limestone sand (1-2 mm in size) in the distilled water at 100 ?C. In the precipitation vessel, seven limestone substrates (5x5x15 mm) were set along the flow-path. The limestone is composed of fine grained aggregate of calcite (<0.03 mm). The temperature of the precipitation vessel was set to be 300 ?C. The fluid flow rate was 2.5 ml/min. After the run of 240 h (10 days), the total increase of weight of limestone substrates was 0.051 g. Observations by SEM and by optical microscope reveal that epitaxial grwoth calcite from substrate crystals with size of 0.02-0.03 mm.

In the second experiment, we used $NaHCO_3$ solution (pH 8.4) as input solution. In the preparing vessel, sands of sandstone, mudstone or basalt from the Shimanto belt were set to dissolve Ca and other cations. In the second vessel, four limestone substrates as the same size as the first experiment. The measured fluid flow rate was 2.59 ml/min. After the run of 240 h, the total increase of weight of substrates was 0.037 g. Observation of the surface of the substrates by SEM and EDS reveal that calcite crystals with size of 0.01 mm precipitated together with clay minerals and apatite.

Our results suggest that calcite veins could be formed at high temperature around 300 ?C, in higher pH fluids, if fluids saturated with calcite by Ca from host rocks and CO_3^{2-} in the crustal fluids. The possibility of the formation of quartz and calcite vein is also suggested from the precipitation of silicate and calcite from natural rock samples at the same temperature. The source of Ca and CO_3^{2-} would be the host sedimentary or basaltic rocks in the Shimanto belt.

References: Lewis J. C., Byrne T. B., J.D.Pasteris, (2000), J. metamorphic Geol., 2000, 18, 319-333
Y. J. Lee, J. W. Morse, (1999), Chemical Geology, 156 (1999), 151-170
A. J. Ellis, (1963), American Journal of Science, 261, 1963, 259-267

Keywords: calcite precipitation, crustal fluid, CO2 storage, Shimanto belt

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SCG65-11 Room:201B Time:May 20 13:45-14:15

Thermal history of Earth and the evolution of oceans

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Our understanding of the thermal budget of Earth and its long-term evolution has been considerably improved in the last several years, owing to an unusual confluence of new theoretical developments and multi-disciplinary observations. In this contribution, I will present the latest summary on the thermal history of Earth during the last 4 billion years and discuss how it may be exploited to better understand the global water cycle and the evolution of oceans. To be consistent with the thermal evolution of Earth, the Archean oceans may have been twice as voluminous as the present-day oceans, and Earth's mantle is suggested to have been gradually hydrated by subduction. Net water exchange between the surface reservoir and the deep interior is likely to be essential for the stable operation of plate tectonics over Earth's history.

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SCG65-12 Room:201B Time:May 20 14:15-14:30

A seismic cluster at 155 km depth beneath Niigata: Implications for phase transformation from gabbro to eclogite

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Intermediate-depth earthquakes occur at depths of 60-300 km, forming the double Wadati-Benioff zone in subduction zones as a global prevalence (Brudzinski et al., 2007). Because of high pressures that prohibit brittle failure at such depths, the genesis of intermediate-depth earthquakes has been discussed in terms of dehydration embrittlement (Seno and Yamanaka, 1996; Peacock, 2001; Jung et al., 2004) or periodic shear heating (Kelemen and Hirth, 2007).

We find a tiny seismic cluster in the lower crust of the Pacific plate at a depth of 155 km and analyze it based on waveform similarity. The cluster consists of sub-clusters with similar waveforms, and earthquakes in each cluster lie on single fault plane with complementary rupture areas. This result suggests that earthquake occur as a reactivation of pre-existing hydrated faults. We also reveal that in the cluster, tensional faulting occurs closer to the top of the slab and compressional faulting is dominant away from the slab surface. Since regional stress around the cluster is compression, we interpret that shallow tensional faulting occurs as a result of a stretching deformation in the transformed crust underlain by untransformed crust. Our observations may reflect ongoing gabbro-eclogite transformation at a pressure of ˜5 GPa.

Keywords: intermediate-depth earthquake, dehydration, weak fault

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SCG65-13 Room:201B Time:May 20 14:30-14:45

Insight into Amphibole-rich mafic-ultramafic rocks beneath island arc: an example from Shikano-shima, Kyusyu, Japan

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The role of amphibole in arc magma petrogenesis is not completely understood yet. Amphibole might be an important phase of crystallization at middle to lower crustal conditions in arc settings, and therefore might be an important role in the formation of arc magmas (Davidson et al., Geology, 2007). Amphibole-rich mafic and ultramafic rocks formed at the deeper part of arc setting are not studied well. Amphibole-rich rocks are commonly observed in the Ryoke belt, Japan, closely associated with granitic rocks (Kamei et al., Lithos, 2004; Yuhara & Kagami, Sci. Rep Fukuoka Univ., 2007). We examined petrological and mineralogical characteristics coupled with zircon chronology of amphibole-rich mafic rocks in the Shikano-shima granitic rocks of the Cretaceous age (Yuhara & Uto, Jour. Geol. Soc. Japan, 2008). We concluded that older (up to 20 Ma) amphibole-rich ultramafic rocks, which might be related to continental arc magmas, were assimilated by a mafic melt of high-Mg andesite affinity.

Keywords: fluid, amphibole, Island Arc

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SCG65-14 Room:201B Time:May 20 14:45-15:00

In-situ electrical conductivity measurement of serpentinite during shear deformation

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Electrical conductivity anomaly has been found in mantle wedge above subducting slab (Yamaguchi et al., 2009). The subducting slab re-leases most of the water to the mantle wedge by the dehydration reactions, and the expelled water reacts with mantle rocks, forming serpentinite and minor amount of magnetite at the plate interface. Stesky and Brace (1973) reported that some serpentinites have high conductivity of 10^{-2} S/m even at room tempera-ture, and that the others have low conductivity of 10^{-5} S/m. Microstructural observations indicated that the observed high conductivity is caused by the intercon-nection of magnetite (10^{4} S/m) grains, which are pro-duced during serpentinization. However, magnetite distribution and precipitatation mechanism should be considered to extrapolate laboratory conductivity data of a few millimeter sized sample to several kilometers geological scale (Watanabe, 2005). Then we inferred that the deformation controls interconnection and ori-entation of magnetite in serpentinites, because the mantle wedge rocks at the plate interface are subjected to noncoaxial stress and widely develop a strong alignment of constituent minerals. Therefore, we de-signed experimental cell for the electrical conductivity measurement of during shear deformation, and discuss here the influence of strain and magnetite volume frac-tion on connectivity of magnetite.

The electrical conductivity meas-urements of serpentinites with various amount of magnetite were conducted using an impedance analyz-er under high pressure generated by a cubic anvil ap-paratus. The electrical conductivity of serpentinites was investigated in the frequency range of $10^{?1}$-106 Hz and temperature range of 500-750 K at 1 GPa along the shear direction. Starting materials were powder mixture of serpentine and magnetite. The mixed sam-ples were sintered in a piston cylinder apparatus at 1GPa and 500?C. The sintered materials were prepared to be 2 - 3 mm length and 0.8mm^{2} of cross-section area. (2.0 mm by 0.4 mm). The serpentinite sample was sandwiched between alumina pistons which were cut at 45^{o} from the maximum compression direction. Ni electrodes for the electrical conductivity measurement were placed at each side of sample and played a role as strain marker to assess the strain from rotation of boundary between sample and Ni. In shear defor-mation experiment, deformation rate was fixed to be 200 micrometer per hour for 8 hours.

We measured the electrical conductivity during heating from 500 K to 750 K. The conductivity values of the serpentinite were 10^{-3} to 10^{-2} S/m. In all experiments, logarithmic conductivity linearly increased and decreased with increasing and decreasing reciprocal temperature, and we obtained systematic results against volume fraction of magnetite. During shear deformation, electrical conductivity increased with increasing strain. Activa-tion energy did not change each samples before and after deformation.

The result showed that only the data of 20 vol. % magnetite content reach into value of conductivity anomaly in mantle wedge. It is difficult to explain electrical conductivity anomaly by deformation of nat-ural serpentinite, because magnetite content of natural serpentinite is generally less than 5 vol. %. Therefore a presence of free aqueous fluid with seawater-like composition would be required to explain high con-ductivity anomaly observed in the mantle wedge.

Keywords: Electrical conductivity, Serpentinite, Subduction zone, in-situ measurement, Magnetite

SCG65-15 Room:201B Time:May 20 15:00-15:15

Seismic velocities of serpentinites - Influence of geometry of antigorite grains

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Serpentinites play key roles in subduction zone processes including transportation of water, seismogenesis, slab-mantle coupling, and exhumation of high-pressure rocks. Geophysical mapping of serpentinized regions leads to further understanding of these processes. Direct study of serpentinites is critical to the interpretation of indirect geophysical observations.

Determination of elastic constants of antigorite (Bezacier et al., 2010) has enabled us to calculate Voigt and Reuss bounds of seismic velocity in serpentinites. There is, however, considerable difference between two bounds due to strong elastic anisotropy of antigorite. Seismic velocity in serpentinites cannot be properly constrained by these bounds that consider mineral composition and orientation of crystal grains. Geometry of antigorite grains (thin plate), which is not considered in Voigt and Reuss bounds, should be taken into account for a better constraint (Watanabe et al., 2011).

We calculated seismic velocity in serpentinites by using a differential effective medium method (DEM). An antigorite grain is treated as a spheroidal inclusion, and embedded in a homogeneous matrix. Strain in the matrix are disturbed by introducing an inclusion, and evaluated by Eshelby's method. Elastic constants of the composite material can be calculated by differentiating the elastic energy with respect to strain. Nishizawa and Yoshino (2001) calculated seismic velocity in mica-rich rocks by embedding spheroidal inclusions with an identical orientation in an isotropic matrix. We modified their method and applied it to the case where spheroidal inclusions with different orientations are embedded in an anisotropic matrix.

Decreasing aspect ratio of an spheroidal inclusion, seismic velocity in serpentinites decreases and approaches to Reuss bound. When spheroidal inclusions are aligned, seismic anisotropy is enhanced with smaller aspect ratio. Seismic velocity calculated by using orientations of crystal grains reasonably reproduces that measured in laboratory. The velocity calculation considering the geometry of antigorite grains is promising for a good prediction of seismic velocity in serpentinites.

Keywords: seismic velocity, serpentinite, serpentine, antigorite, water, subduction

SCG65-16 Room:201B Time:May 20 15:30-15:45

Microseismic-based detection of fluid flow in deep seated rock and its application to geothermal development

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In the hydraulic stimulation, massive fluid is injected into subsurface rock through drilled wells. Then a number of microseismic events are commonly observed. By analyzing those data of microseismic events, we can estimate the orientation, i.e. dip and strike, of the fracture which slips to induce microseismic event. From the estimated fracture orientation, taking into account the in situ stresses and the Mohr-coulomb criterion to describe the critical condition of fracture slipping, we can estimate the pore pressure at the location of slipping fracture and at the time when the slipping occurs, in other words, when the microseismic event occurs. The estimated values of pore pressure are sorted in a certain manner for each equally divided spatial region, i.e. block, to give spatial distribution of pore pressure and its variation with time during hydraulic stimulation. We applied this method to the microseismic data observed during the hydraulic stimulation performed in November 2003 at the HDR development site of Cooper Basin in Australia, and we succeeded in showing the pressure propagation through the rock formation during the test.

Keywords: Fluid flow, Microseismicity, Coulomb criteria, Inverse problem, Hydraulic fracturing, Geothermal development

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SCG65-17 Room:201B Time:May 20 15:45-16:00

Hydrothermal alteration in the Caleta Coloso fault core zone of the Atacama Fault System, Chile

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The Atacama Fault System (AFS) is a trench-parallel large-scale structure developed within mesozoic rocks of the present-day Coastal Cordillera in northern Chile (Cembrano et al., 2005). Its well-documented left-lateral activity has been interpreted as the result of the SE-ward oblique subduction of the Aluk (Phoenix) oceanic plate between 190 and 110 Ma (e.g., Schuber and Gonzalez, 1999). Recent activity of the AFS has been documented mainly as extensional and interpreted as a reactivation of the system in response to mega-thrust earthquakes (e.g., Gonzalez et al., 2006).

The Caleta Coloso Fault of the AFS is represented as a N-S to NNW-SSE west-ward concave-shape sinistral strike-slip fault showing a left-lateral displacement of about 3 km and a subvertical dip (Cembrano et al., 2005). The fault cuts through crystalline rocks of predominantly granodioritic composition (Gonzalez and Niemeyer, 2005) and its fault core currently displays hydrothermally altered cataclastic rocks (Olivares, 2004).

Two types of hydrothermal alteration, chloritization and propylitization, can be observed in the Caleta Coloso fault core zone. The former is characterized by the replacement of hornblende and biotite by chlorite, epidote mineralization and compositional changes in rims of plagioclase to albite-rich ones, while the latter by the intense plagioclase albitization and mineralization of chlorite, epidote and calcite. XRF analyses and density measurements of the rock revealed that contents of Al and Ca decrease with increasing Si, while Na increases and K, Fe and Mg are stable. The data suggest that the changes in the bulk chemical composition during alterations were mostly due to the plagioclase albitization. Hence, it can be concluded that the propylitization occurred later than the chloritization.

Faulkner et al. (2006) reported that the density of microfractures shown as fluid inclusion planes (FIPs) in quartz of the host rocks of the Caleta Coloso fault increases towards the fault core. Fujita et al. (2010) also noted that the FIPs in the rocks close to the fault tend to orientate along the shear planes (Y and P planes and between T and X planes of the fault). Those evidences indicate that the microfractures were formed during faulting and healed by mineral precipitation from fluids passing through the fractures and that the fluids have been preserved as the fluid inclusions in FIPs (Fujita et al., 2010).

The fluid inclusions in the chloritized rocks show a wide range in homogenization temperatures from 140 to 270 C with variable salinities of 6 - 18 wt.% NaCleq., while the temperatures of those in the propylitized rocks are low as 150 - 190 C (av. = 170 C) with high salinities as 12 - 18 wt.% (av. = 15 wt.%). Therefore, the fluid inclusions trapped in the both alterations stages are probably included in the chloritized rocks partly overprinted by the later propylitization. However, since the fluid inclusions of only low-homogenization temperatures with high salinities can be seen in the highly propylitized rocks, the most propylitization might completely alter the chloritized rocks with the intense albitization, resulting in removal of older fluid inclusions trapped during the earlier chloritization. Hence, it is supposed that the fluids of high-homogenization temperatures (ca. 250 C) and low salinities (ca. 9 wt.%) caused the chloritization, while those of low-homogenization temperatures (ca. 170 C) and high salinities (ca. 15 wt.%) did the propylitization.

Chemical compositions of chlorite coexisting with quartz indicate the chloritization temperature as around 330 C. A pressure at 330 C on an isochore for the 9 wt.% NaCl solution projected from the homogenization temperature of 250 C is about 1.1 kb, representing the chloritization pressure. Therefore, the propylitization temperature might be around 220 C if the propylitization occurred at the same depth with the chloritization.

Keywords: fault, fluid inclusion, hydrothermal alteration, chloritization, propylitization

SCG65-18 Room:201B Time:May 20 16:00-16:15

The physicochemical reaction during the coseismic-interseismic period of the fault gouge of the MTL, Japan

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Frictional heating during coseismic slip induces transient fluid-rock interaction and fluid transfer. It is crucial to understand these physicochemical process and mechanism because these fluids strongly influence the dynamic behavior and rupture propagation of earthquakes. In order to understand these reactions, we investigated the Median Tectonic Line (MTL), which runs through Nagano prefecture and is newly exposed around the Anko outcrop. We performed geochemical analyses of major- and minor-element concentrations, Sr isotope ratio and semi-quantitative clay mineral composition. Using the fluid-mobile trace element spectrum, which is sensitive to fluid-rock interaction at high temperatures, we estimated that the black gouge experienced frictional heating of approximately 150-200 degree Celsius. The clay collected from this black gouge show a distinctly low XRD pattern compared to the surrounding gouge, which may suggest amorphusization of clay minerals related to the shear slip. So the temperature signal probably indicates that frictional heating have occurred in the gouge together with high amount of coseismic fluid transfer.

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SCG65-19 Room:201B Time:May 20 16:15-16:30

Detection of deep fluid using lithium isotope of waters along the Atotsugawa fault system, central Japan

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The Atotsugawa fault system, central Japan is one of the active faults located in the Niigata-Kobe tectonic zone (strain-concentration zone) which detected dense GPS observation network (Sagiya et al., 2000). Along this fault system, active microearthquakes and possible fault creep has been detected from seismic observations and EDM/GPS survey, respectively (Tada, 1998; Ohzono et al., 2011). However, mechanism for strain concentration along this zone is still open question. Iio et al. (2002) speculated that the dehydrated fluid (water) from the Philippine Sea plate and the Pacific plate may weaken the lower crust beneath the Niigata-Kobe tectonic zone. Recent geophysical observations revealed existence of low resistivity and low velocity bodies beneath the zone (Yoshimura et al., 2009; Nakajima et al., 2010) which is consistent with Iio et al. (2002). Nevertheless, there is no direct evidence to represent existence of water (H_2O), and details about fluids such as origin are still unknown. On the other hand, geochemical signal of ground water can be a reliable evidence for detection of deep fluids if they come up to the shallow portion of the crust. Lithium (Li) is a fluid-mobile element having two stable isotopes, ^{7}Li/^{6}Li. Amount of Li leached from rock to fluid drastically increases with the temperature, and once leached Li is kept in fluid while decreasing temperature (cooling). These features indicate that Li has a great potential for tracer of deep fluid provide information on the origin and nature of fluid circulation. We thus collected water along the fault system (especially for the water leaking from fault zone), river water and spring water nearby the fault system, and analyzed their chemistry and isotope.

The results show that the several water samples collected from the fault zone have high concentration of Li and significantly lower value of ^{7}Li/^{6}Li whereas the river water and spring water shows low Li concentration and high ^{7}Li/^{6}Li value. These results suggest that the deep-crustal fluid which has peculiar chemical properties exists beneath the Atotsugawa fault system, and upwelling to the ground along the fault zones.

[References]
Iio et al., 2002, Earth planet Sci. Lett., 203, 245-253.
Nakajima et al., 2010, Earth Planets Space, 62, 555-566.
Nishio et al., 2010, Earth planet Sci. Lett., 297, 567-576.
Ohzono et al., 2011, Geophys. J. Int., doi:10.1111/j.1365-246X.2010.04876.x.
Sagiya et al., 2000, PAGEOPH, 157, 2303-2322.
Tada, 1998, Chikyu, 20, 142-148.(in Japanese)
Wada et al, 2007, Disaster Prevention Research Institute annuals, 50, 313-320.(in Japanese)
Yoshimura et al., 2009, Geophys. Res. Lett., 36, L20311, doi:10.1029/2009GL040016.

Keywords: Atotsugawa fault, Niigata-Kobe Tectonic Zone, geofluid, lithium isotope, fault fluid, Intraplate earthquake

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SCG65-20 Room:201B Time:May 20 16:30-16:45

Trace elements and isotopic variations along Sunda arc, Java island, Indonesia: an evaluation of slab fluid contribution

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A geochemical dataset of lavas from Java island, Sunda arc is compiled for trace elements and isotopic variations, in order to understand along-arc variation of the contribution of slab-derived fluid to arc magmas. We divided the island into western, central and eastern sections in terms of volcanism and tectonics. Based on volcano distribution, the western section is subdivided into North-West Java (NWJ) and Central-West Java (CWJ) chains. The NWJ chain is considered to be tectonically affected by bending subduction structure that marks the transition from Sumatra arc to Sunda arc.

In general, lavas from this island are distinguished by enriched LILE and LREE, negative anomalies of Nb and Ti, and low Mg, Ni and Cr. We observed along-arc variation of subduction slab imprint including both sediment (SED) and altered oceanic crust (AOC) by examining fluid-mobile elements against HFSE ratios (e.g. B/Nb, B/Zr, Ba/La). We also evaluate depletion of Nb which characterizes arc magmas, by using Nb/HFSE (e.g. Nb/Ta, Nb/Zr) ratios, along this island. Radiogenic Sr-Nd isotopes were determined to examine contribution of SED and AOC to arc magma source. Then we combine these to find differences between western, central and eastern sections.

Nb/HFSE ratios are evenly low along western, central and eastern sections. However, these ratios increase from volcanic front toward back arc in central and eastern sections. In contrast, they are uniformly low across the western section, with little deviation in NWJ chain. The B/HFSE and Ba/HFSE ratios decrease from volcanic front toward back arc in the central and eastern sections. Whereas, they decrease but slightly across the western section. They are observed highest in lavas from central section compared to others. Isotopic ratios from all sections are shifted from Indian Ocean MORB field toward higher ^{87}Sr/^{86}Sr and lower ^{143}Nd/^{144}Nd ratios. Back-arc lavas from central section overlap with mantle array and exhibit the lowest ^{87}Sr/^{86}Sr in a wide range of ^{143}Nd/^{144}Nd ratios, whereas the volcanic-front samples overlap with compositions of Indian Ocean sediment. Back arc lavas from eastern section are displaced toward sediment composition, while the volcanic front is placed closer to MORB.

This increasing trend of Nb/HFSE from volcanic front toward back arc in central and eastern sections implies more enriched mantle source in the back arc. This back arc source enrichment is then confirmed by isotopic ratios. Despite the little deviation in NWJ chain, the general flat trend as observed in western section indicates similar mantle source across this section. Positive correlation between incompatible elements ratio and the depth of Wadati-Benioff zone denotes an identifiable influence of subducted slab along this island. The sharp decreasing trends of B/HFSE and Ba/HFSE in central and eastern sections suggest a definite reduced slab-fluid influence from volcanic front toward back arc. Compared to these sections, the western section is less pronounced in terms of subduction components enrichment. The greatest enrichment of subduction components in central section implies strongest slab fluid imprint in this section. The Sr-Nd isotopic pattern justifies the involvement of slab fluid in all sections. However, this pattern confirms the strongest subducted sediment-fluid contribution in volcanic front of central section. The more enriched mantle source in back arc compared to volcanic front is observed in eastern section. This evidence corroborates mantle source enrichment towards the back arc, in central and eastern sections.

Keywords: sunda arc, along arc variation, slab fluid, fluid-mobile element, isotope