Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SIT06-P01 Room:Convention Hall Time:May 22 18:15-19:30

Electrical resistivity heterogeneity between the trench and fore-arc area in NE Japan arc

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We discussed 2-D resistivity distributions around the rupture zone of the 2011 Tohoku earthquake (M9.0) along latitude 38 degrees north and 39 degrees north in order to clarify structural properties and fluid distribution. Magnetotelluric (MT) impedances were obtained mainly in the ocean using ocean bottom electro-magnetometers (OBEMs). Long period land MT data also obtained near the coastline. Based on these data, we carried out 2-D resistivity inversion after the evaluation of 3-D bathymetric effect. The inverted resistivity model in the survey line of latitude 38 degrees entirely consists of conductive surface layer ($<$ 3 ohm-m) and subsequence resistive area ($>$ 1000 ohm-m). The thickness of surface conductor is a few km at landside of trench axis. On the other hand, the conductor distributes from surface to about 10 km deep in the Pacific plate and thus seems to correspond to the oceanic crust. The oceanic crust conductor can be recognized after the subduction, however, is disappeared at the about 20 west of the trench axis. It implies fluid dehydration from fluid rich oceanic crust soon after the subduction. In the presentation, resistivity distribution in the cross section along latitude 39 degrees will be discussed.

Keywords: Geofluid, electrical resistivity structure, OBEM, NE Japan arc, 2011 Tohoku-oki earthquake, Japan Trench

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P-wave velocity structure in the subducting crust of the Pacific plate beneath northeast Japan

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It is considered that the low-velocity oceanic crust exists at the uppermost part of the oceanic lithosphere. Water produced by dehydration reactions of hydrous minerals is considered to weaken the strength of faults by increasing pore-fluid pressure and facilitate seismic activity in the oceanic crust. Therefore, it is important to reveal the spatial variation in seismic velocity to understand where fluids are trapped and where dehydration reactions occur in the oceanic crust. However, it is generally difficult to obtain the detailed velocity variation in the oceanic crust, because the direct P- and S-waves from intraslab earthquakes tend to propagate in a short distance in the crust.

It is known that P-to-S converted phases at the plate interface are often observed in seismograms of intraslab earthquakes. Matsuzawa et al. (1986) examined arrival times and amplitudes of PS-converted phases, and suggested the existence of a low-velocity layer at the top of the slab down to a depth of at least 150 km. Here, we follow the strategy of Matsuzawa et al. (1986), and estimate the spatial variation in P-wave velocity in the oceanic crust beneath northeastern (NE) Japan using arrival times of PS-converted waves.

At first, we identified PS-converted waves in seismograms of intraslab earthquakes and obtained 2,798 arrival times of PS converted waves from 305 earthquakes. Before estimating P-wave velocity structure in the oceanic crust, we applied tomographic inversion method of Zhao et al. (1992) to arrival-time data of the direct P and S waves, and estimated 3D seismic velocity structures beneath the entire region of NE Japan. We then relocated earthquakes with the obtained 3D velocity model and determined P-wave velocity in the oceanic crust using arrival-time data of PS-converted waves.

The obtained results show that P-wave velocity in the oceanic crust varies across the arc, with Vp of 6.5-7.5 km/s in the fore arc and 7.5-8.5 km/s in the back arc. P-wave velocity at depths of $<$ 100 km is much lower than the values derived from MORB model beneath NE Japan (Hacker et al., 2003), suggesting the existence of aqueous fluids in the oceanic crust. High seismic activity at depths of 70-90 km (Kita et al., 2006) is located in areas of abundant aqueous fluids. The enhanced pore-fluid pressures and the resultant reduced effective normal stress weaken the strength of the faults sufficiently to bring the system into the brittle regime. Fluid-related embrittlement is probably working for the genesis of crustal earthquakes. Another important observation to be noticed here is that the observed P-wave velocity is almost consistent with the prediction of MORB model at depths of $>$100 km. This suggests that aqueous fluids in the crust should be released to surroundings at depth of ˜100 km, and the fluids thus liberated may contribute to metamorphic reactions in the overlying mantle wedge.

Keywords: PS converted wave, oceanic crust, Pacific slab

SIT06-P03 Room:Convention Hall Time:May 22 18:15-19:30

3-D electrical conductivity structure in the mid mantle beneath Australia region

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The 3-D electrical concductivity in the mid and mostupper lower mantle beneath Australia was elucidated by inverting C response data at 8 observatories in Australia. We just used data obtained by Semenov and Kuvshinov (2012) estimating by using very long time series up to 51 years maximum. The period range used in this study is between 4 and 100 days by removing data with shorter period to avoid contamination of some irregular source effects such as auroral effects. By using this data under the assumption that the source is external dipole field in geomagnetic coordinate, the 3-D conductiviy map beneath Australia is inverted.

To invert data, we used the 3-D inverse code developed by Koyama (2002), in which integral equation method with modified IDM pre-conditionor is applied for forward calculation and the misfit function is minimized by quasi-Newton iterative method. By conducting a hundred of numerical tests, we found that the conductivity in the depth between 510-900 km is well resolved.

Mainly we detected a highly conductive body in the mid-mantle beneath eastern Australia, which is almost 1.0 S/m. This might indicate the existance of fluid and/or melt in the mid-mantle.

Keywords: electrical conductivity, mid mantle, Australia, inversion, C response

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SIT06-P04 Room:Convention Hall Time:May 22 18:15-19:30

Dissolution mechanisms of CO_2 in silicate melts

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Carbon dioxide is one of abundant volatile components in natural magmas. It is generally known to dissolve in silicate melts/glasses as molecular CO_2 and $CO_3{}^{2-}$ species, but how the latter group is incorporated and its effect on the silicate structure are less known. Recently, we started a comprehensive study on silicate glasses (quenched melts) using advanced solid-state NMR techniques combined with Raman spectroscopy and first-principles calculations to better understand this issue. Here we give a preliminary report of the results.

CO_2-bearing glasses (1 to 10 wt%, all undersaturated) were prepared by quenching melts at 1.0 to 1.5 GPa and 1400 to 1600 ^oC using a non-endloaded piston cylinder apparatus. ^{13}C-enriched carbonate ($CaCO_3$ or Na_2CO_3) was used as the $^{13}CO_2$ source. The starting material was sealed in Pt capsule, and Fe_2O_3 disk was placed near the capsule to avoid reduction of CO_2.

Three silicate compositions have been examined by NMR thus far: diopside ($CaMgSi_2O_6$), Ca-melilite ($Ca_{1.5}AlSi_2O_7$) and jadeite ($NaAlSi_2O_6$). The ^{13}C MAS NMR spectrum of the diopside glass contains a nearly symmetric peak near 167.2 ppm. That of the Ca-melilite glass exhibits a similarly narrow peak near 167.8 ppm with a tail to lower frequency. Both peaks are attributable to dissolved $CO_3{}^{2-}$ group. The ^{13}C MAS NMR spectrum of the jadeite glass contains a broader asymmetric peak near 164 ppm, a narrower peak near 125 ppm and another weak narrow peak near 185 ppm, resembling that reported previously. These peaks may be attributed to dissolved $CO_3{}^{2-}$, CO_2 and CO species, respectively. Thus for depolymerized diopside and Ca-melilite compositions, $CO_3{}^{2-}$ species is predominant, but for fully polymerized jadeite composition, $CO_3{}^{2-}$ and CO_2 species coexist, consistent with previous reports. The presence of CO molecules indicates somewhat reduced condition. Preliminary speculation on the environments of the $CO_3{}^{2-}$ groups may be made from the ^{13}C NMR spectra. The narrowness and closeness in peak position to crystalline $CaCO_3$(168.6 ppm) for the two depolymerized compositions may indicate that both are dominated by free $CO_3{}^{2-}$ species (i.e. linked only to network modifiers). Formation of free $CO_3{}^{2-}$ will polymerize the melt structure. The asymmetric peak shape for the Ca-melilite glass could be a sign for additional species. For this sample, ^{27}Al 3Q MAS NMR revealed small amounts of penta-coordinated and octahedral Al, in addition to tetrahedral Al. It is interesting to know whether these high-coordinated Al are related to $CO_3{}^{2-}$ speciation. The ^{13}C NMR peak of $CO_3{}^{2-}$ in the jadeite glass is much broader and more shifted from that of crystalline carbonate, suggesting that these species could be part of the aluminosilicate network. More definite peak assignment awaits further ^{29}Si-^{13}C and ^{27}Al-^{13}C double-resonance NMR measurements that can directly probe C-O-Si(Al) linkages. Raman spectroscopy will be also used to obtain information regarding symmetry of $CO_3{}^{2-}$ species. First-principles calculations are underway to gain better insights into the chemical shifts and J couplings for candidate local structures. The latest results will be presented at the meeting.

Keywords: silicate melt, carbon dioxide, melt structure, dissolution mechanism, NMR spectroscopy, Raman spectroscopy

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SIT06-P05 Room:Convention Hall Time:May 22 18:15-19:30

B isotopic variation of spring water in Japan

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Boron has two stable isotopes 10B and 11B with abundance of 18.98% and 81.02%, respectively. Natural isotopic variation of 11B/10B among geological samples is from -30 permil to +60 permil as delta-11B values, which is defined as relative deviations from an isotopic reference material (NIST-SRM 951) in parts par 1000. Boron isotope ratio is a powerful tracer in the fields of geochemistry, biochemistry, and environmental chemistry to trace the origin of materials.

Here B isotope ratios of spring water samples were precisely determined by ICP-MS with a multiple collector array. About 70 samples were selected among those collected from the whole area of Japan. Boron was extracted from the water samples of less than 1mL, and anion and cation ion-exchange chromatography was applied to separate B from matrix elements. Boron amount required was about 50 ng, and procedural B blank was typically around 100 pg.

Resultant delta-11B values had a very wide range from +40 permil to almost -10 permil. There was a decreasing tendency of delta-11B values from fore-arc to back-arc of Japan Island, which was consistent with the previously reported trend of delta-11B values observed in volcanic arc rocks. These results indicate that some kind of spring water has a B isotopic signature of fluids derived from continuous dehydration reaction within the slab, though interaction with granitic rocks during upwelling should be evaluated.

Keywords: Boron isotope, isotope ratio, ICP-MS

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SIT06-P06 Room:Convention Hall Time:May 22 18:15-19:30

Progress of serpentinization reactions and successive changes of mineralogical textures in Iwanai-dake ultramafic body

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We investigated successive change of serpentine textures accompanied with progress of serpentinization observed in serpentinized harzburgite and dunite samples from Iwanai-dake ultramafic body, Hokkaido, Japan. The change of serpentine textures shows serpentinization processes of harzburgite are different from dunite. Serpentine mesh texture of serpentinized harzburgite has two kinds of mesh rim types; type A rim is mixture of serpentine (Mg#97) and brucite (Mg#75), and type B rim consists of only serpentine (Mg#93). Type B rims are always accompanied with brucite-magnetite veins. The formation of type B rims and brucite-magnetite veins are observed concurrently with serpentinization of orthopyroxene. These observations suggest that two-stage reactions occurred during the serpentinization processes of harzburgite, and magnetite was formed by the later-stage reactions, which were triggered by supply of silica component from serpentinization of orthopyroxene. This is consistent with the higher magnetic susceptibility in moderately and highly serpentinized harzburgite than in less serpentinized ones. In case of serpentinized dunite, type A rim was dominantly observed and the amount of magnetite doesn't increase with the progress of serpentinization. These observations suggest that silica supply is a trigger of the later-stage serpentinization reactions, in which magnetite and hydrogen are generated.

Keywords: serpentinite, serpentinization, mineralogical texture, magnetic susceptibility, water content, magnetite

SIT06-P07 Room:Convention Hall Time:May 22 18:15-19:30

Electrical conductivity measurement of albite-quartz-water system under high P/T conditions

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Magnetotelluric surverys have revealed that the high conductivity anomalies exist in the middle to lower crust. Electrical conductivity (EC) of dry crustal rocks are much lower than the high conductivity anomalies, suggesting the existence of conductive material in the crustal rocks that are stable only with the middle to lower crustal conditions. Aqueous fluids seem to be most likely candidate to explain the high conductivity anomalies. Quartz-water system has been investigated recently, but it cannot account for the high conductivity anomalies. Therefore, other ionic species, such as Na^+, in addition to silica phases dissolved in fluid is required to increase conductivity. In this study, albite was introduced to add the ionic species in the fluids. The electrical conductivities of albite- water and albite- quartz-water systems have been measured using an impedance analyzer at 1 GPa and 400-1100 K. Albite-water samples with water contents of 0.5, 1, 5, 9.3 wt.% were prepared by natural albite powder and mixture of $1Na_2SiO_3$, $5SiO_2$ and $2Al(OH)_3$ (mole ratio) in designed ratios. Albite-quartz-water samples with water contents of 0.34, 1.2, 5.6, 10 wt.% were prepared by natural albite powder and silicic acid ($SiO_2 0.5H_2O$) in designed ratios. EC and temperature relationship of all the other samples cannot be expressed by the Arrhenian formula except for the sample with 0.34 wt.% water content. The electrical conductivity of these samples decreased from highest designed temperature (e.g., 1000 K) during cooling, but the temperature dependence was getting weaker and weaker. EC, however, increased upon further cooling from 800 K until around 500 K. Then temperature dependence of EC was negligible. The tendency of EC changes with temperature indicates the concentration of electrical charge carrier changes with temperature assuming the charge carrier series will not change. The thermal dynamic calibration shows the total electric charge carriers (including H^+, OH^-, Na^+, AlO_2^- and $HSiO_3^-$) solved in water decreases with decreasing temperature from 908 to 773 K and then increases with decreasing temperature down to 573 K. The experimental result can be well explicated by the theoretical calibration. EC of the albite-quartz-water or albite-water systems are much higher than that of quartz-water system. We can well explain the high conductive anomalies in the crust even the temperatures are lower than the normal geotherm by dissolved albite in fluids.

Keywords: electrical conductivity, albite, quartz, water, fluids, high pressure

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Serpentinization and redox in various geologic environments

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In this study, serpentinization and simultaneous redox reactions in various geologic environments are described from a petrologic viewpoint with thermodynamic calculations for minerals and fluids. Serpentinization occurs at where geofluid and ultramafic rock interact. Sites of serpentinization spatially and temporally range and have physical, chemical, and biologic implications for the Earth's process.

Serpentinization in the present seafloor and deeper part of the oceanic plate is an entrance of water to deep mantle via subduction zone. Serpentinite has been found from the Mars surface suggesting that the existence of water and hydrothermal system in the early stage of the Mars history. It is known that the serpentinization of ultramafic rock simultaneously produces hydrogen by reduction of H_2O during the serpentinization. Hydrogen is one of the key elements to control the metabolism of the ecosystem, therefore the importance of serpentinization in biologic process has also been raised. Forearc mantle wedge is also the site of serpentinization in the present Earth.

Regarding the various site of serpentinization described above, phase diagrams for serpentinite in the model system CaO-MgO-FeO-Al_2O_3-SiO_2-O-H are calculated using internally consistent thermodynamic-dataset for the rock forming minerals and fluid. Using the diagrams, we discuss how the serpentinization and redox reactions depend on temperature, pressure, and bulk composition of the host rock and effect to redox of the geofluids.

Keywords: serpentinite, phase diagram, redox reaction, serpentinization

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Numerical simulation of subduction zone fluid processes: implications for global compositional anomaly

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Aqueous fluids released from subducting slabs are thought to transport incompatible elements from the slabs to the overlying wedge mantle, which consequently concentrates the incompatible elements in an arc magmas, and causes elemental differentiation.

Element transportation by slab-derived fluids has an important role on global material differentiation; however this process is not constrained well due to its complexity such as dehydration reaction, fluid migration, fluid-solid reaction, and melting. In this study, we try to induce the transportation and reaction of trace element during these complex processes in the solid-melt-water system. Based on numerical simulation with generation and migration of water by the relevant phase relationships, we construct numerical model for solid-fluid-melt flow beneath the NE Japan arc in order to estimate the influence of subduction process on chemical compositions of the each constituent phases.

As a result, we have successfully estimated trace element distributions in the solid, melt, and aqueous fluid and their migration in subduction zones. For instance, melts is distributed 80km˜150km above the Wadati-Benioff Zone, which is consistent with volcanic distribution in NE Japan. Based on the obtained elemental mapping over the subduction zone, we have also found a high Rb/Sr and Th/Pb layer above the subducting slab along the bottom of the mantle wedge. This layer subducts to the deeper mantle, which may contribute to a source region with high 87Sr/86Sr and 208Pb/204Pb ratios deep in the mantle: if they are accumulated, e.g., beneath a supercontinent associated with focused subduction towards it, such a source region can explain Dupal anomaly (Hart, 1984) or ”Mantle Eastern Hemisphere” (Iwamori and Nakamura, 2012), in which the mantle-derived basalts show isotopic anomaly over the region.

Keywords: subduction, simulation, trace element, isotopic anomaly, material recycling, slab

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Oxidation of slab mantle due to dehydration of serpentinite

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The oxygen fugacity in subduction zones controls the speciation of C-O-H-bearing fluids and phase equilibria in metamorphic processes. It is therefore important to quantify the oxidation states in the Earth's interior. This study used X-ray absorption near edge structure (XANES) spectroscopy to investigate changes in redox state that accompany the dehydration of serpentinite. A run product (Atg02) of our previous deformation experiment (Shimizu et al., 2011) was used for the analysis.

The starting material of the experiment was dark-green natural serpentinite (from Oeyama, Kyoto Prefecture, Japan) consisting mainly of antigorite and accessory wustite. A cylindrical sample of serpentinite (diameter 10 mm, height 15 mm) was enclosed in Ni and Ag sheets, and was set in confining mediums of talc and pyrophyllite. High-pressure and high-temperature deformation experiments were conducted with a piston-cylinder type apparatus. The confining pressure was kept at 800 MPa during the experiments. A graphite furnace was used to heat the sample to 700^{o}C. After the constant strain-rate experiment, the color of the sample had changed to pink or red, and forsterite and talc had grown in the antigorite matrix. Small particles of hematite were identified in the matrix by optical microscope and micro-Raman spectroscopy.

The oxidation state of the serpentinite before and after the experiments was investigated by the Fe-K edge XANES spectra acquired at BL9A, Photon Factory, KEK (Tsukuba, Japan), using Fe standards of FeS_2, fayalite, magnetite (Fe_3O_4), FeO, a-FeOOH, and a-Fe_2O_3. Following Wilke et al. (2001), the ratio $X(Fe^{3+}) = Fe^{3+}/(Fe^{2+} + Fe^{3+})$ was calculated from the Fe-K pre-edge centroid positions. The results show that $X(Fe^{3+})$ increased from 7% of the original sample to 23% in the reacted sample. It is probable that the oxidation state of the sample was buffered by a large amount of free water liberated by the following dehydration reaction: antigorite => forsterite + talc + H_2O.

The mechanical data of the antigorite-serpentinite showed drastic dehydration weakening. This result supports the hypothesis that intermediate-depth earthquakes in subduction slabs are triggered by the dehydration instability of serpentinite. If this hypotheses holds true, then the subducting slab mantle must be largely serpentinized.

In general, the oxygen fugacity of peridotites is equilibrated near the fayalite-magnetite-quartz (FMQ) buffer at the top of the upper mantle, and decreases with increasing depth (Frost and McCammon, 2008). However, if large parts of the slab mantle are serpentinized and if free water is released by the breaking down of antigorite, the reaction front of antigorite would be highly oxidized. The redox states in the subducting oceanic crust and the wedge mantle would be also influenced by water supplied from the slab mantle.

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Keywords: serpentine, dehydration reaction, redox state, X-ray absorption near-edge structure (XANES), high-PT experiment, subduction zone

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Exhumation stage fluid migration recorded in Na-rich phengite in Sanbagawa metamorphic rocks

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High-pressure metamorphic rocks and corresponding fluid inclusions are excellent natural laboratories to study deep fluid activities in subduction-zone processes. However, they usually suffer multi-stage fluid activities during subduction and exhumation stages.

A metasediment sample (IR04), collected from the Western Iratsu body, central Shikoku, has suffered eclogite facies metamorphism (550-650 C, 1.5-2.0 GPa). IR04 mainly consists of hornblende, phengite and garnet with minor amount of chlorite and other accessory/retrograde minerals. Yoshida and Hirajima (2012) found three types of fluid inclusions from the foliation-parallel quartz vein corresponding to IR04 and reported their trapping timing based on the textural observation as follows: (1) prograde P-increasing stage; (2) P-increasing or near-peak stage; (3) exhumation stage. Thus IR04 is thought to have suffered at least three stages of fluid activity. However, exact entrapment conditions of these fluid inclusions have not been determined yet.

Phengites contained in IR04 have Na-rich composition (paragonite component up to 20 mol%) and show composition modification along deformation parts and grain boundaries, with the direction crosscutting the cleavages. That modification is not derived from the retrograde element re-distribution with adjacent minerals because of their occurrence at the grain boundaries between phengites. Unmodified part (Na-rich core) have the composition with X_{Na} = Na/(Na+K) = 0.16-0.20 and Mg# = Mg/(Mg+Fe) = 0.68-0.72 while the modified part (Na-poor rim) have X_{Na} $<$0.04 and Mg# = 0.62-0.68. The boundaries between Na-rich core and Na-poor rim are very clear and have composition gaps.

In order to estimate the timing of Na-poor rim formation, we performed the forward modeling of exhumation and H_2O-fluid migration, i.e. we calculated the $X$$H_2O$-$P$($T$) phase diagram along the exhumation P-T trajectory from the peak stage of 650 C and 2.0 GPa to 400 C and 0.3 GPa, using the bulk composition of IR04. The result shows that Mg# of phengite does not account for the P and T deceasing but decreases with the increasing of total amount of H_2O of the system. On the other hand, X_{Na} of phengite shows decreasing with cooling and decompression, but almost constant value with H_2O content of the system. Assuming the effective bulk composition accounting for the Na-poor rim forming water-rock interaction can be approximated as the bulk composition of IR04, composition modification from Na-rich core to Na-poor rim, i.e. X_{Na} decreasing from 0.2 to $<$0.04 and Mg# decreasing from 0.7 to 0.62, can be explained by the increase of H_2O content at the temperature below 450 C. As Na-poor rim has compositional gap with the Na-rich core, that during exhumation, continuous water supply did not exist but H_2O increase should have taken place after water-unsaturated decompression and cooling to $<$450 C. Compared to the fluid inclusion stages of the corresponding quartz vein, the H_2O-fluid observed here is probably closely associated with the above-mentioned (3) exhumation stage fluid inclusions.

Additional two metapelites (IR27 and IR28), collected from the northern proximal to the Iratsu body and ca. 3km far from IR04 locality, show very similar composition modification of Na-rich phengite. Those metapelites belong to the biotite zone of the Sanbagawa metamorphic belt and have peak metamorphic conditions lower than IR04 (IR27 = ca. 600 C and 1.0 GPa; IR28 = 550 C and 0.8 GPa). The biotite zone of the Sanbagawa metamorphic belt is thought to have incorporated with higher grade Iratsu body at the depth of 25-30 km and to have exhumed together along the same P-T trajectory. The estimated conditions of H_2O-fluid migration ($<$450 C) correspond to the stage subsequent to the incorporation of the biotite zone and the Iratsu body, suggest that H_2O-fluid migration took place over the relatively wide area around the Iratsu body, at that stage of the exhumation.

Keywords: Sanbagawa metamorphic belt, retrograde fluid, pseudosection, fluid-rock interaction

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S-wave attenuation structure around the western part of Nankai subduction zone

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Seismic imaging of lithospheric structure is crucially important to investigate spatial distribution of geofluid and its role in dynamics of the Earth's interior. Even though Vp and Vs structures are widely imaged in various regions in the world, these structures cannot explain complex and broadened seismic waves at higher frequency (>1Hz). Such complex wave trains can be described by considering wave scattering and attenuation due to random inhomogeneities and inelasticity of the medium [e.g., Sato & Fehler, 1992]. It can be expected that medium containing fluid-filled cracks is one of the possible causes of S-wave scattering and attenuation. Therefore, medium inhomogeneities and inelasticity are also important to elucidate geofluid distribution. In Nankai subduction zone, we have estimated the 3D distribution of random inhomogeneities [Takahashi et al. submitted to JGR]. This study estimated the spatial distribution of 1/Q of S-wave around the western part of the Nankai trough. In Kyushu and Shikoku regions, most of the medium shows weak attenuation ($1/Q < 1/1500$ at 8-16Hz). Volcanic area in Kyushu region shows strong attenuation (1/Q = 1/600 ˜ 1/300 at 8-16Hz). Beneath west Shikoku, slightly strong attenuation (1/Q=1/1000˜1/800 at 8-16Hz) are imaged at 20-40km depth. This anomaly is approximately located in or above the non-volcanic tremor zones [e.g., Obara et al. 2010]. If we compare the random inhomogeneities and 1/Q, there are clear differences of medium properties in volcanic area and tremor zone. This difference suggests that random inhomogeneities and attenuation may reflect fluid properties (magma or aqueous fluid) or amounts of geofluid in medium.

Keywords: Nankai trough, random media, scattering, attenuation

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Interaction of sinking slabs of the lowermost mantle

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Mantle plumes that rise from the lowermost mantle generate the most hotspots. The lowermost mantle has complex seismic structure that consist long-wavelength seismic low- and high-velocity anomalies. These seismic anomalies are anticipated to correspond with respectively. In addition, the margins of Large Low Shear Velocity Provinces (LLSVPs) under the African and Pacific areas are related to hotspots, and have a sharp seismic discontinuity. In this study, we investigate roles of post-perovskite (PPV) phase transition and compositional stratification in the generation of observed heterogeneity of the lowermost mantle and the upwelling plume. We construct a 2-D integrated model of the mantle convection with a sinking slab.

The PPV phase covers over the whole area of the CMB when the compositional layering is not introduced. In the models with high-density stratification, the structure of the lowermost mantle and the plume generation change significantly. The sinking slab pushes the high-density layer so that the high-density layer is piled up in the outside of the subduction area. This is more distinct in the case with lower density contrast of the chemical layering. The PPV phases in the high-density layer distribute very locally. On the other hand, the PPV phase is stably maintained beneath the subduction zone. The top of the phase boundary reaches about 300 km above the CMB. The PPV phase boundary becomes vertical at the location where the slab contacts with the high-density layer. This is expected to form the steep seismic discontinuity at the margin of the LLSVPs.

The slab also produces disturbances of thermal boundary layer, which causes the plume generation. The plumes grow more rapidly in the case with the PPV phase than that without it. Although the high temperature anomaly is generated at the margin of the high-density layer, the upwelling plume is not generated because the slab climbs up above high-density layer. Thicker pile of the chemical layer with the lower density contrast used in our study may be required to generate plumes at the margin of LLSVPs.

Keywords: plume, slab, high-density layer, LLSVPs, post-perovskite phase transition