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

SCG63-P01 Room:Convention Hall Time:May 22 18:15-19:30

Spectroscopic properties of sub- and supercritical fluid(H_2O - (CO_2) - X)

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Physicochemical states of H2O are divided into three phases, solid, liquid and vapor. Especially, the vapor-liquid phase boundary is called the saturated steam pressure curve. The terminated point of this curve is called the critical point. Liquid density becomes equal to gas density at that point. The fluid's state above the critical point is called supercritical fluid (water). Supercritical fluids exist near the deep-sea hydrothermal vent or in the deep earth's crust.

Supercritical fluid has a characteristic property that chemical reactivity, solubility and/or ion product. It is very important for the understandings of fluid/crustal rocks interaction. Therefore, decision of supercritical point of crustal fluid and characterization of fluid's state is very important.

The fluid near the critical point has intense density fluctuation, so, it is considered that the optical transmissivity is very low.

In present study, spectroscopic measurements for pure H2O, CO2 and C2H5OH fluids under high temperatures and high pressures up to 400 ^{o}C/30 MPa were carried out by using visible-type autoclave. It was observed the state of the optical property of the fluid near the critical point. In addition, it was considered a method for the critical point determination of multicomponent fluid by the spectral measurement of the transmitted light through the fluid. On the critical point, intensity of transmitted light though each fluid became low drastically. The minimum intensity of transmitted light was corresponded to critical temperature and pressure of each fluid. Differences between experimentally determined critical temperature and reference data in literature of pure fluids were within about 1.6 ^{o}C, and pressure differences were less than 0.3 MPa. It is practically well coincide and it is possible to evaluate critical temperature and pressure of multicomponent geofluids by using spectroscopic measurement under hydrothermal conditions.

Intensity between about 940 and 960 nm of H2O and of C2H5OH was always dark through entire temperature range in both cases of heating and cooling stages. Those absorptions in near-infrared region were corresponded to a combination of fundamental vibrations of -OH. It indicates that spectral measurement of multicomponent fluid will also lead to a further understanding of the fluid composition and the molecular structure.

Keywords: critical point, supercritical fluid, spectroscopic measurement

SCG63-P02 Room:Convention Hall Time:May 22 18:15-19:30

Development of solubility measurement technique of rare earth element (Ce) in super critical aqueous fluids

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Mineral solubility in supercritical aqueous fluids has been determined mainly with "single crystal weight-loss method" (e.g. Manning, 1994). The detection limit of the weight loss (typically 10 micro gram) produces relatively large errors for nominally insoluble minerals (e.g. Antignano and Manning, 2008). In this study, we have been developing two different methods for measuring the solubility of Ce-monazite in aqueous fluids in the lower crustal conditions.

Firstly, synthetic fluid inclusion method was tested. We synthesized fluid inclusions in a gem-quality quartz single crystal at 0.8-1.2 GPa and 700-900 degC using a piston cylinder apparatus. The volume fractions of synthesized fluid inclusions were determined by using X-ray CT. The quartz crystals were dissolved with HF acid and the solution was analyzed with ICP-MS. The concentration of the fluid inclusion was then calculated by subtracting the amount of Ce in the background quartz.

Secondly, we conducted direct analyses of solute recovered from runs at 1 GPa and 800 degC. In order to separate the fluid from the starting material, we put $CePO_4$ powder with deionized distilled water into a gold inner capsule with one end welded shut and the crimped lightly. The fluid was expected to be equilibrated diffusively during the run duration (24 hours). The weight of water in the outer capsule was measured after quenching and the quenched crystals only in the outer capsule were dissolved with HNO_3 acid for ICP-MS analyses.

In the synthetic fluid inclusion method, solubility in the SiO_2-saturated system was determined, but the minimum Ce concentration that can be determined with this method is large due to small volume fraction of the synthetic fluid inclusions. The preliminary results obtained with the direct solute analyses method were consistent with the result reported by a previous study (Tropper et al., 2011).

Keywords: weight loss method, synthetic fluid inclusion method, solute trap method

SCG63-P03 Room:Convention Hall Time:May 22 18:15-19:30

Evolution of aperture distribution and permeability change during fracture sealing by silica minerals

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Fractures are dominant fluid pathways in the upper crusts. Ubiquitous occurrences of quartz veins suggest that precipitation of quartz provides significant effects on the hydrological and mechanical properties of crustal environments. For example, a model has been proposed that fracture sealing processes control the change of pore fluid pressure and thus earthquake cycle. Previous studies on quartz veins have focused on the P-T conditions, stress and strain fields and fluid compositions; however, details of dynamics of fluid flow and how fractures are sealed during vein formation are still unclear. In this study, we carried out the hydrothermal experiments to synthesis quartz veins, and observed the aperture structures by using X-ray CT. The purpose of this study is to clarify how aperture structures evolve by quartz precipitation in fractures and to understand the behavior of permeability evolution during vein formation.

We conducted the hydrothermal flow-through experiments for quartz precipitation from Si-supersaturated solutions at 430C and 30 MPa (supercritical region). The experimental apparatus consists of two vessels for preparation of the Si-supersaturated solution and for precipitation, respectively. The precipitation vessel has double-structure: the main flow path was the inner alumina tube, and the outer SUS tube was filled with static solutions connected with the flow path. A granite core (Westerly granite, diameter=3.6mm, length=50mm) with a slit of 300 micro-meter width was placed in the alumina tube. Inner and outer pressure of the inner tube was almost same (31MPa). Precipitation occurred preferentially within the alumina tube (mainly in the slit of granite), and alumina tube was broken when fracture was sealed and upstream fluid pressure was raised toward ˜35 MPa. The fluid pressure was recorded by the second to calculate the change of the permeability during run. The advantage of this system is that we can take out the non-destructive sample. We observed the aperture sizes of fractures before and after of run by computer tomography.

The mineralogy and aperture structures changes systematically along the fluid flow path. Near the inlet of the precipitation vessel, only amorphous silica precipitated predominantly. From the inlet to 35mm of fracture, nucleation and growth of quartz predominantly occurred, regardless of vein wall minerals. In this region, precipitation of quartz occurred preferentially on top wall rather than bottom wall, indicating the effects of the gravity on the density fluctuation of supercritical water. From 35mm to outlet of fracture, silica precipitates occurred as epitaxial overgrowth from quartz crystal. The wavelength of aperture structures is controlled by distribution and grain size of quartz of the host granite. Accordingly, fractures are not sealed homogeneously, but complex 3D flow pathways are evolved during vein formation.

Keywords: Hydrothermal experiments, Quartz vein, aperture

Japan Geoscience Union Meeting 2013
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SCG63-P04 Room:Convention Hall Time:May 22 18:15-19:30

Distribution of C-H-O fluids deduced from fluid inclusions from the Shimanto belt in the Muroto area,SW Japan

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Geofluids have compositions in C-H-O system, mainly composed of H2O, CO2 and CH4, and the compositional variation of fluids within the Earth's interior is of special importance for understanding the global carbon cycle. In this study, we characterized the C-H-O fluids in the ancient subduction zone, that were trapped in mineral veins as fluid inclusions within the accretionary complex, Shimanto belt, SW Japan. Although calcite-bearing veins commonly occur in the Shimanto belt, it is known that fluid inclusions were mainly composed of H2O and CH4; therefore it is unclear why calcite precipitated from the fluids in absence of CO2.

The Muroto Peninsula belongs to the Tertiary (Paleogene and Neogene system) Shimanto belt, and it is mainly composed of sandstones, mudstones and conglomerates with small amount of basalt. The ages of accretion become younger toward the south, and maximal temperature evaluated from the vitrinite reflectance increased from north(214C) to south(278C) in this area (DiTullio, 1993). Mineral veins were mainly composed of quartz, with small amount of calcite. We collected the mineral veins from the 9 outcrops along the coast, W1 to W5 in the western side, and E1 to E4 from the eastern side from Paleogene system. Lewis (2000) reported the fluid inclusions of CH4 and CO2 mixture at the locality W5, but the regional distribution of CO2 fluids is not clear.

The mole fraction of CH4 and CO2 gasses in the two-phase fluid inclusions in quartz veins and carbonic(one-phase) fluid inclusions in quartz and calcite were measured by the Laser Raman Spectroscopy (HoloLab, KAISER OPTICAL SYSTEMS Co.) with thin sections of veins. Homogenization temperatures of water-rich inclusions were measured by microthermometric techniques.

Two-phase fluid inclusions in the mineral veins in the Muroto area show the following features: (1) The gas phase of fluid inclusions are composed of pure CH4, or CO2-CH4 mixture, with various XCO2(=nCO2/nCO2+nCH4) values ranging from 0 to 0.8. Fluid inclusions with pure CH4 gas were found in the northern parts of the Muroto area (W1 - W4 and E1 - E3). (2) The average XCO2 values increased toward south, and the most southern points W5 and E4 shows XCO2 of 0.3˜0.8. (3) The XCO2 values are various within individual veins; fluids including CO2 (XCO2 > 0) were located only close to vein walls, whereas gas phase of fluid inclusions composed only CH4 were located in the center of the vein. Even in a single quartz crystals in mineral vein, the XCO2 values are scattered, 0.18˜0.88.

One-phase carbonic fluid inclusions were composed of CH4. Calcite veins also contain this type of CH4 one-phase inclusion. Primary fluid inclusions were composed of CO2 and CH4 mixture as mentioned above, but gas phase of secondary inclusions were all composed of only CH4 in the whole Muroto area. The average homogenization temperature of W1 and W5, are 216 C at W1, and 226 C at W5, respectively.

The increase of CO2 gas with increasing temperature (W1 to W5) and occurrence of CO2-bearing inclusions near vein wall imply that CO2 fluids were generated by diagenetic processes of carboniferous materials in host rocks. We will discuss the timing and controlling factor to produce variation in C-H-O fluid inclusions both in regional and local scales.

Referances:DiTullio L., Laughland M. M., Byrne T., Thermal maturity and constraints on deformation from illite crystallinity and vitrinite reflectance in the shallow levels of an accretionary prism: Eocene-Oligocene Shimanto Belt, southwest Japan, Geological Society of America, special paper (1993), 273, 63-82

Lewis J. C., Byrne T. B., J.D.Pasteris, (2000) Early Tertiary fluid flow and pressure-temperature conditions in the Shimanto accretionary complex of south-west Japan: constraints from fluid inclusions, J. metamorphic Geol., 2000, 18, 319-333

Keywords: fluid inclusions, calcite, accretinary complex, mineral veins

SCG63-P05 Room:Convention Hall Time:May 22 18:15-19:30

In-situ observation of dehydration and incongruent dissolution of antigorite into aqueous fluids

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It is considered that dehydration of serpentine in slab or mantle wedge causes seismicity (Yamasaki and Seno(2003 J. Geophys. Res.)). We performed an in situ observation of serpentine dehydration using Basset-type externally heated diamond anvil cell (W.A.Bassett et al. 1993 Rev. Sci. Instrum.).

We placed antigorite($Mg_{48}Si_{34}O_{85}(OH)_{62}$) in water along with an air babble in the cell. Before the heating, we confirmed there was no forsterite in the cell by Raman spectroscopic investigation. With Raman spectrum data of antigorite, we compared with Enami(2006 Gansekikoubutsukagagu in Japanese). On the heating, we observed, when antigorite dehydrate in water, antigorite melted in water and then forsterite formed and separated from water at 550-600 C and 0.2-0.7 GPa. The forsterite grew to about 30micrometer size in an hour.

The stability of antigorite suspected from this experiment isn't in contradiction Evans et al. (1976 Schweiz. Mineral. Petrogr. Mitt.).

Takahashi et al. (2011 J. Geophys. Res.) suggests dehydration of antigorite causes strengthening and embrittlement of the gouge by shear-sliding test. We got the result of supporting this suggestion. We didn't observe talc after the heating, so we considered that talc melted in water.

Keywords: antigorite, dehydration, in situ observation, high temperature and high pressure, sesmicity, incongruent dissolution

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

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In situ X-ray diffraction analysis of the experimental dehydration of chlorite at high pressure

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1. Introduction

Water in hydrous minerals is transported to deep Earth by subducting slab, which dehydrate at certain pressure and temperature. Exist of deep Earth's water affect the physical properties of Earth's minerals such as melting point, viscosity, elastic velocity, and so on. Therefore it is important to study the effect of water for the subducting slab materials. Moreover determination of the stability region of hydrous minerals is important to understand the mechanism of transport of water.

Serpentine ($Mg_6Si_4O_{10}(OH)_8$) is major hydrous mineral in subducting slab. There are many experimental reports for serpentine under high pressure. The stability field has already determined by in situ X-ray diffraction experiments. Chlorite ($(Mg,Al)_6(Si,Al)_4O_{10}(OH)_8$) should be also an important hydrous mineral in the subducted slab, because Al is included in slab materials. However there are few experimental reports for chlorite under high pressure.

So in this study, the dehydration reactions of chlorite have been studied by time-resolved X-ray diffraction analysis under high pressure and temperature.

2. Experimental

Time-resolved dehydration experiments of chlorite were conduced by in situ X-ray diffraction using the high-pressure apparatus MAX80 at PF-AR, KEK. Natural chlorite was used as a starting material, and sealed by Au caps plus diamond sleeve. Temperature was measured by W-Re thermocouple, and pressure was calculated by equation of state of NaCl and Au. Experiments were conduced between 3 to 8 GPa and up to 900 deg C. Time-resolved X-ray diffraction was measured at intervals of 50 deg C with checking diffraction change. When dehydration occurred at each pressure, it kept a few hours, and quenched. The quenched sample was analyzed by scanning electron microscope.

3. Results and discussion

In all experiments, chlorite was quickly dehydrated to forsterite + pyrope + fluid within 1 hour. Dehydration boundaries of chlorite were determined at 3 to 8 GPa, with compared with the previous works. The boundary has negative P/T slope at 5 to 8 GPa. Chlorite was stable at ˜ 800 deg C below 4 GPa. The dehydration boundary in the present study is consistent with previous phase equilibrium boundary by quench experiment. This means that, chlorite become to equilibrium state rapidly when slab cross the dehydration boundary.

The dehydration boundaries of chlorite and serpentine are compared. Pressure range of dehydration of chlorite is narrower than that of serpentine, which means that dehydration depth of chlorite does not change so much compared to serpentine by temperature profile of slab.

Keywords: Chlorite, Dehydration, High pressure phase relation, In situ X-ray diffraction

SCG63-P07 Room:Convention Hall Time:May 22 18:15-19:30

Elastic-wave velocity of serpentinites under high pore-fluid pressure

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Serpentine is one of the candidates to explain low-velocity anomaly and high Poisson ratio in subduction zones. However, extremely high Poisson ratio found beneath Kanto and southwest Japan requires the presence of aqueous fluid in addition to the serpentinites. In this study, we investigated the effect of pore fluid pressure on elastic-wave velocity of antigorite using intra-vessel apparatus at Pc = 10-200 MPa, Pp = 10-100 MPa and room temperature. Compressional and shear-wave velocities under dry condition increase with increasing confining pressure, and Vp/Vs increases slightly. At wet conditions, elastic velocities decrease with increasing pore fluid pressure, and Vp/Vs increases slightly. However, the effect of pore pressure is rather weak, in which Vp/Vs = 1.804 at Pp = 10 MPa shifted to Vp/Vs = 1.811 at Pp = 100 MPa. This indicates that the relatively low-porosity serpentinites can not explain the observed high Poisson ratio, even in high fluid pressure; consequently, much higher porosity due to fracturing is required to increase Poisson ratio at the plate boundary.

Keywords: Elastic-wave velocity, pore-fluid pressure, Vp/Vs, serpentinite

Japan Geoscience Union Meeting 2013
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Dihedral angle of garnet-H2O fluid in eclogite: Implication for low S-wave velocity regions at lowermost upper mantle

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Seismology have observed low shear-wave velocity region at depth of 300-400km in some of wedge mantle, where mantle rock is considered to contain small amount of aqueous fluid (or hydrous melt) in the grain boundary of minerals [e.g., 1]. Seismic behavior of fluid bearing system is highly influenced by a connectivity of fluid [e.g., 2]. The connectivity of aqueous fluid in a rock under mantle conditions is controlled by dihedral angle (= h), what is defined by the solid-liquid interfacial energy. A small amount of fluid can connect in grain boundaries and migrate if a value of h is less than 60 degree. To investigate connectivity of aqueous fluid in garnet-rich rocks, we measure the h for the garnet-aqueous fluid in eclogite bulk composition at upper mantle condition, and then, discuss the behavior of aqueous fluid in wedge mantle.

The target composition of starting material was MORB + 3.5 wt% of H2O, which prepared by mixing of JB-2 and Mg(OH)2. High-pressure experiments were performed using the multi-anvil apparatus (ORANGE1000) at pressure of 4 to 13 GPa at constant temperature of 1000 degree C. Run duration was 24 hour. Au/Pt double capsule was used as sample containers to eliminate the Fe-loss. To control oxygen fugacity, NiO + Ni + Ni(OH)2 powder was stuffed the space between Au and Pt capsules. Dihedral angle measurements were made from secondary-electron images at $>$5000$\ast$ taken by field emission scanning electron microscope (FE-SEM). In a large population of over 200, measurements were carried out for each sample in the random cross section, using Scion Image software of NIH. A true dihedral angle was adopted as the median of apparent angles on the polished section. Mineral chemistry was analyzed by using scanning electron microscope with energy dispersive spectrometer (SEM-EDS).

At lower pressure (4-8 GPa), there are garnet, pyroxene, coesite, and rutile. At high pressure (10-13 GPa), majorite component in garnet increase with increasing pressure, and modal composition of pyroxene amount decrease. More than 10 GPa, FeTi-hydroxide is observed instead of rutile. In all run products, we observed quench crystal, quench glass and pore at garnet grain boundaries. Below 8 GPa, part of fluid separate from coexisting minerals to high temperature side in sample capsule. The fluid form connected network at garnet rich part. This connected network cannot observe pyroxene-pyroxene grain boundary. Therefore we regard as h $>$ 60 degree at pyroxene-H2O fluid. Over 10 GPa, fluid does not separate in sample capsule. It suggests that fluid network does not connect in the higher pressure. It has possibility that the fluid contains silicate components because it was observed large amount of quench crystal. The h of garnet-fluid is 45 degree at 4 GPa. It increases with increasing pressure, and is maximum (h = ˜66 degree) at about 10 GPa. It suggested that garnet rich rocks are possible to trap fluid in a rock at ˜10 GPa (= ˜300 km in deep). We also pointed out that the dihedral angle of clinopyroxene should be larger than garnet. Therefore we conclude that shear wave velocity possible to decrease and attenuate at lowermost upper mantle, if garnet and pyroxene rich rocks exist at there.

[1]Revenaugh & Sipkin(1994), Nature , 369, 9
[2]Takei(2005), JGR, 110
[3]Yoshino et al. (2007), EPSL,256, 466
[4]Mibe et al. (2003), JGR,108
[5]Ono et al. (2002), EPSL,203, 895

Keywords: Dihedral angle, H2O-fluid, seismic low velocity zone, garnet, wedge mantle, connectivity

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

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Determination of the reaction boundary $MgCO_3$ + SiO_2 = $MgSiO_3$ + CO_3 in the upper mantle conditions

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Subducting slab consists of three layers; marine sediment, MORB and peridotite. The carbonates exist marine sediment, which transport CO_2 to Earth interior. It is important to clarify the stability and decarbonation conditions of carbonates under high pressure. Previous studies indicate that magnesite is only stable carbonate mineral in the mantle above ˜5 GPa, because the following reactions should occur with increasing pressure, $2CaCO_3 + 2MgSiO_3 = CaMg[CO_3]_2 + CaMg[SiO_3]_2$, and then $CaMg[CO_3]_2 + MgSiO_3 + MgCO_3 + CaMg[SiO_3]_2$. Still more, Isshiki et al. (2003) determined that magnesite would be stable in the mantle up to core-mantle boundary condition. However, there are few studies for the reaction of carbonate and silicate under high pressure. Here, we determined the reaction boundary; $MgCO_3$ (magnesite) + SiO_2 (coesite) = $MgSiO_3$ (enstatite) + CO_2 between 4-9 GPa. This reaction indicates that carbon is transported by slab in carbonate minerals. On the other hand, magnesite reacts with coesite in the ascending hot plume at upper mantle conditions. The details of the experimental results will be presented.

Keywords: magnesite, decarbonation, carbon cycle, deep Earth

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Development of ”Geofluid Map” in the Naruko district, NE Japan

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We recently address the development of the ”Geofluid Map” that represents fluid distribution in the crust of Japan arc. In this presentation, we present the method of the development of the map about Naruko district, NE Japan.

Presumption of rock type from seismic tomography

First, we selected possible rock types by review of geologic maps and crustal sections deduced from studies of mantle xenolith (e.g., Takahashi, 1978). Measurement data of elastic wave velocity of these rock types in high temperature and pressure (e.g., Kern et al., 2002; Wang et al., 2005) were plotted on the Vp-poisson’s ratio diagram. In NE Japan, rock types on the diagram can be divide into 3 groups mainly by the difference of Vp (C1: Granitic rocks, C2: Gabbroic rocks & Amphibolites, M1: Peridotites & Pyroxenites). By plotting recent data of seismic tomography in Naruko district (Okada et al., inpress) on the diagram, we deduced the distribution of rock types in crustal section of Naruko district.

Estimation of fluid distribution in crust

There are some studies about estimation of fluid content and distribution in crust (Ueshima, 2005; Mishina, 2006). Effective electrical conductivities of natural rocks depend on kind of rocks, content of fluid, connection of pore fluid and salt concentration in pore fluid. In consideration of the distribution of rock types deduced above, we estimated fluid content and distribution in crustal section of Naruko district using the recent data of electrical conductivity obtained by magnetotelluric observation in this area (Ogawa, personal communication).

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

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Water distribution in the upper mantle beneath Kyushu, Japan, as derived from receiver function analyses

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The Kyushu district, Japan, where the Philippine Sea (PHS) plate subducts, has several active volcanoes. In Kyushu, volcanoes are not distributed at regular intervals on the volcanic front and volcanic rocks have various chemical properties. To reveal the causes of the distribution of volcanoes and the chemical variation in volcanic rocks and to understand the process of magma genesis, we should reveal the water transportation by the PHS slab.

We investigated the seismic velocity discontinuities in the upper mantle beneath Kyushu, with seismic waveform data from stations of Hi-net, which are established by National Research Institute for Earth Science and Disaster Prevention, and stations of the J-array, which are established by Japan Meteorological Agency, Kyushu University, Kagoshima University and Kyoto University. We used receiver function analyses developed especially for discontinuities with high dipping angles (Abe et al., 2011, GJI). We obtained the geometry and velocity contrasts of the continental Moho, the oceanic Moho, and the upper boundary of the PHS slab.

We detected a discontinuity corresponding to the oceanic Moho and interpreted that the oceanic crust of the PHS slab has a low S-wave velocity and is hydrated down to 70 km beneath south Kyushu, down to 80-90 km beneath central Kyushu, and down to less than 50 km beneath north Kyushu.

We revealed from the detected velocity contrast at the continental Moho that the forearc mantle beneath central Kyushu has a low velocity region (Vs=2.8-3.5 km/s) that can be composed of hydrated materials and free aqueous fluid. Such a low velocity forearc mantle does not exist beneath north and south Kyushu. Beneath north Kyushu, the oceanic crust would not convey much water to the mantle wedge. Beneath south Kyushu, water dehydrated from the slab would move to the backarc side and cause arc volcanism, while it would move to the forearc side and cause a gap in volcanism and serpentinization of the forearc mantle. The low velocity forearc mantle exists only near the edge of the mantle wedge beneath the southern part of central Kyushu while it spreads more widely beneath the northern part of central Kyushu. Geochemical studies indicated that volcanic rocks that were and were not influenced by slab-derived fluid coexist in north Kyushu and the northern part of central Kyushu (Kita et al., 2001, JVGR; Miyoshi et al., 2008, JVGR). Wide distribution of the hydrated materials in the forearc mantle and mantle upwelling may cause such coexistence.

Keywords: Kyushu, Philippine Sea slab, receiver function, subduction zone, water transportatio, volcanism

Japan Geoscience Union Meeting 2013
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Detectability of crustal change accompanied with shallower slow earthquakes

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Owing to developing dense network of inland seismic observations, deeper slow earthquakes have been observed at the depth of about 30 km in southwestern Japan [e.g., Obara, 2002, Science]. More recently, shallower slow earthquakes have been also confirmed by ocean-seafloor seismograms [Sugioka et al., 2012, Nature Geosci.]. Since the shallower slow earthquakes have been also observed around the source region of the 2011 Tohoku earthquake [Matsuzawa et al., 2012, SSJ-FM], it is important for us to robustly detect shallower slow earthquake from seismic and geodetic observations in order to estimate the spatial distribution of seismic coupling for megathrust earthquake [Ariyoshi et al. 2012, SSJ-FM].

From August 2011, Dense Ocean-floor Network system for Earthquake and Tsunamis (DONET) has been operating steadily until now. The DONET has observation cable extending from land-based Owase city to the trench off Kumano-nada, which covers shallower part of source region of the Tonankai earthquake. Since shor-term slow slip events accompanied with tremor episodes have been observed by tiltmeters in deeper part of subduction zones [e.g., Hirose and Obara, 2006, GRL], crustal deformation driven by shallower slow earthquake is expected to be detected by ocean-floor hydraulic gauges. In the Japan subduction zone, episodic slow slip events had been observed by hydraulic gauge before the 2011 Tohoku-Oki earthquake [Ito et al., 2013, Tectonophys., in press]. In this study, we try to investigate the detectability from an earthquake cycle simulation based on rate- and state-dependent friction law.

As a study of modeling shallower slow earthquakes, Ariyoshi et al. [2012, SSJ-FM] reproduced shallower slow earthquake by assuming frictional property similar to deeper one, which occurs along-strike migration only for deeper slow earthquake with shallower slow earthquake inactive in inter-seismic stage of megathrust earthquake. In this study, we estimate crustal deformation at DONET observation points by applying the reproduced model to the Tonankai area.

In the pre-seismic stage, numerical simulation shows that the rate of vertical displacement is increased and enough to be detectable by hydraulic gauges because of higher rate of moment release for the shallower slow earthquakes. In addition, since the shallower slow earthquake becomes more active in pre-seismic stage, these results indicate that slip events detectable by DONET is expected to be more frequent toward the occurrence of megathrust earthquakes. On the other hand, DONET could not detect the shallower slow earthquakes because of lower rate of moment release.

These results suggest that monitoring slow earthquake by ocean-floor hydraulic gauges in addition to seismometers is expected to play an important role in detecting the generation process of megathrust earthquakes.

Keywords: slow earthquake, ocean-floor network observation, hydraulic pressure, megathrust earthquake cycle simulation, role of geofluid in subduction plate, friction law