Japan Geoscience Union Meeting 2015
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SIT03-P01 Room:Convention Hall Time:May 26 18:15-19:30

Continuous measurements of electrical conductivity of synthetic peridotite under changing temperature: Melting effect

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Transport properties of the mantle (ex. electrical conductivity, viscosity, and seismic attenuation) sharply changes during ascend of the mantle especially at around mantle solidus. Electrical conductivity is considered to be the most sensitive property to the presence of partial melt. To understand how partial melting changes the conductivity of ascending mantle (ex. mid-ocean ridge), we measured the electrical conductivity of synthesized peridotite samples, which have different manners of melting with temperature, during slow increases and decreases in temperature under atmospheric pressure.

Three types of samples, forsterite (80%) + diopside (20%), forsterite (95%) + diopside (5%) and forsterite (50%) + enstatite (40%) + diopside (10%) with addition of 0.5% spinel, were synthesized from $Mg(OH)_2$, SiO_2, $CaCO_3$ and $MgAl_2O_4$ powders with particle size of $<$50 nm. We continuously measured the electrical conductivity of these samples at temperature range from 1100 ℃ to 1400 ℃. Microstructures of the samples quenched from above solidus were observed by scanning electron microscopy (SEM) in order to measure the melt fraction.

The electrical conductivity at well below ($>$50 ℃) solidus of the forsterite + diopside samples exhibited a linear distribution in their Arrhenius plots indicating that a single mechanism controls. Such linear relationship was no longer observed at higher temperature regime exhibiting its exponential increase until the temperature reached to produce a phase assembly of forsterite + melt. In addition, the grain size dependence on electrical conductivity disappeared at temperature between 1350 ℃ and 1360 ℃, indicating that the effective conductive path changed from grain boundary to other path. The result indicates that there is a phase assembly of forsterite + diopside + melt phase at around 1360 ℃ which has not been appeared in the previously reported phase diagram (Kushiro and Schairer, 1963).

Monotonic increase of electrical conductivity was observed above solidus of the forsterite + enstatite + diopside + spinel sample, and such increment is considered to be strongly related melt fraction changing with temperature, which is supported from SEM observation.

Keywords: electrical conductivity, peridotite, partial melting, melt fraction

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SIT03-P02 Room:Convention Hall Time:May 26 18:15-19:30

Measurement of single crystal elasticity of Gold (Au) under high temperature and high pressure

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Single crystal elasticity of gold (Au) has been measure by inelastic X ray scattering method under high pressure. A few tens micrometer Au single crystal was prepared from a large commercial crystal by using FIB technique. The small crystal was placed inside a gasket hole of DAC apparatus. We succeeded to measure single crystal elasticity at 0.8 GPa and 3.2 GPa; the pressures were determined by the Ruby scale. ˜100 peaks were observed at each pressure, and used to constrain the three independent constants of C_{11}, C_{12}, and C_{44}. The resulted elastic constants are consistent with the previous data at ambient pressure.

We observed that C_{11} and C_{44} increase with increasing pressure, and C_{12} decreases with increasing pressure. We will expand the pressure range and temperature range of the measurement to establish the equation of state of gold with unprecedented accuracy.

Keywords: Gold, single crystal, elasticity, high pressure

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SIT03-P03 Room:Convention Hall Time:May 26 18:15-19:30

High temperature generation using semiconductor diamond heater at high pressure

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Melting relations of the Earth materials are information essentially important to clarify the early differentiation and evolution of the Earth. Nevertheless melting experiments using the Kawai-type apparatus under mid mantle conditions are impossible because of limited temperature generation. Following Shatsky et al. (2009), we have tried to generate temperatures higher than 3500 K adopting B-doped semiconductor diamond heater. In order to carry out melting experiments at higher than 50 GPa, we adopt sintered diamond anvils. Temperature (T) is estimated by extrapolating a T-W (power) curve constructed up to 2600 C based on the W/re thermocouple measurement. Our T-generation reached ca. 4700 C at 55GPa.

Keywords: High temperature generation, Semiconductor diamond heater, Kawai-type apparatus, sintered diamond

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SIT03-P04 Room:Convention Hall Time:May 26 18:15-19:30

Numerical Simulation on Subduction of the Pacific Plate into Northeast China and the Seismogenic Mechanism of Earthquake

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The Pacific Plate is subducted into Northeast China up to 660km deep, leading to a series of deep earthquakes in Hunchun zones of Jilin province, which was noticed by seismologists in the past. As the only deep-earthquake belt in China, its occurrence-time, locations and magnitudes are closely associated with Japan trench earthquakes and shallow earthquakes in Northeast China. Until now, seismologists attached great importance to this phenomenon and researched it in various aspects. On the one hand, research results confirmed the above phenomenon. On the other hand, masses of important results were obtained including the structure of the Pacific subducting plate, lithosphere structure in Northeast China, the earthquake focal mechanism and the seismic dynamic mechanism about the deep and shallow earthquakes. But until now, there is seldom systematic research about the relationship among the Pacific plate, deep and shallow earthquakes using numerical simulation method. Therefore, this paper will study their relationships and furtherly explore the tectonic stress field and dynamics environment in Northeast China.

Based on the geology data and the seismic velocity structure in Northeast China, we built the 2D vertical model along the 45 degree latitude ranging from 104 to 144 degree longitude with 0-660km deep to simulate the Pacific plate subducting to Northeast China using finite element numerical simulation method. According to motion rate of the Pacific plate to the Eurasian plate, the boundary conditions are given. The model with the typical tectonic belts, such as Tanlu fault, can explain the earthquake mechanism and study the stress fields and displacement fields. Besides the relationship between fault belts and shallow earthquakes is discussed.Through numerical simulation and comprehensive analysis, some conclusions are obtained as follows:

(1) The Pacific plate subduction into Northeastern China is the main dynamic resource causing a series of deep-focal and shallow-focal earthquakes. The stress field shows that there are two main areas of stress concentration under the subduction of the Pacific plate. It can help us to explain the relationship about the seismogenic mechanism between deep and shallow earthquakes.

(2) The displacement field and deformation field are given. The results show the displacement field and deformation field are controlled by the Pacific plate subduction rates. Exist of low velocity medium in the middle crust layer is in favor of the occurrence of the shallow earthquakes.

Keywords: numerical simulation, subduction of the Pacific plate, deep and shallow earthquakes, Northeast China

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SIT03-P05 Room:Convention Hall Time:May 26 18:15-19:30

S-velocity structure of the crust and uppermost mantle of East Asia from ambient seismic noise

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We have collected continuous vertical-component broadband data from 1109 seismic stations in regional networks across China, Korea, and Japan for the year 2011, and we have measured over half a million Rayleigh wave group velocity dispersion curves from one-year stacks of station-pair ambient seismic noise cross-correlations. The Rayleigh wave group velocity dispersion curves are regionalized on a tessellated spherical shell grid in the period range 10 to 50 s to produce maps of Rayleigh wave group velocity distributions. Maps at 10 seconds period match well with geologic features at the surface. In particular, we observe low group velocities in the Songliao, Bohai Bay, Sichuan, Ordos, Tarim, and Junggar Basins in China, and the Ulleung and Yamato Basins in the East Sea (Sea of Japan). Higher group velocities are observed in regions with less sediment cover. At periods around 30 s, we observe group velocity decreases going from east to west in China, representing an overall trend of crustal thickening due to the collision between the Indian and Eurasian plates. The Ordos and Sichuan blocks show higher group velocities relative to the eastern margin of the Tibetan Plateau, possibly reflecting low temperatures in these cratons. Using the Rayleigh wave group velocity distributions, we have performed 1D linear inversions at each node on the spherical shell grid to retrieve S-velocity perturbations with respect to the reference model LITHO1.0 of Pasyanos *et al.* (2014). This has allowed us to construct a 3D model of the crust and uppermost mantle for East Asia. We observe large-scale lateral variation in the crust compared to the LITHO1.0 model. From 50 to 100 km depth, we observe a low-velocity mantle wedge underneath Japan and the Strait of Korea, and at 100 km depth we see a general trend of increasing S-velocities from east to west, possibly reflecting temperature/water content variations in the mantle.

Keywords: East Asia, tomography, ambient noise

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SIT03-P06 Room:Convention Hall Time:May 26 18:15-19:30

One-dimensional shear velocity structure beneath Okinawa trough inferred from surface wave phase velocity

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Structures beneath back-arc basins or marginal seas are as important as those just beneath island arcs to understand the whole systems of subduction zones. However number of studies on structure beneath back-arc basins is limited because of few seismic stations in back arc basin.

This study focuses on the structures beneath Okinawa trough. Philippine sea plate is subducting along the Ryukyu trench and the Ryukyu arc is an island arc of this subduction zone. Okinawa trough is located in backarc region of Ryukyu arc and is considered to be a region of backarc spreading. Crustal structure along the Okinawa trough has been investigated by the Japan Coast Guard (e.g. Horiuchi et al., 2011) and the Moho depth has been obtained. For the upper mantle structure, Nakamura et al. (2003) inferred three dimensional P and S-wave structure by body wave tomography and several studies inferred three dimensional S-wave tomography as a surrounding part of continent by surface wave tomography (e.g., Huang and Zhao, 2006). However, the mantle dynamics beneath the Okinawa trough has not been well imaged.

As the first step of investigation of the mantle dynamics beneath the Ryukyu arc and Okinawa trough, we inferred one-dimensional shear-wave velocity structure of crust and uppermost mantle beneath the Okinawa trough. We also inferred that beneath East China Sea continental shelf.

We measured phase velocities of Rayleigh and Love waves by two-station method and obtained dispersion curves. We used stations of F-net of National Research Institute for Earth Science and Disaster Prevention (NIED), China Digital Seismograph Network (CDSN), and Global Seismograph Network (GSN).

We then inferred one-dimensional shear-wave average structure along the path by genetic algorithm. We assumed radial anisotropy in uppermost mantle (Moho to 220 km) and isotropy in other layers.

Shear wave velocities just below the Moho beneath the Okinawa trough is significantly lower than that beneath the continental shelf. It may suggest partial melting due to upwelling beneath the Okinawa trough. However, the velocities around 220 km is higher than that beneath the continental shelf, suggesting that origin of the upwelling is not deep. The upwelling could be a passive flow like that beneath mid-ocean ridge. SV velocities beneath western part of the Okinawa trough is lower than SH velocities, while SV and SH velocities beneath eastern part are similar to each other. This radial anisotropy may be caused by the shape of the cracks of partial melt or preferred orientations of mantle minerals.

Keywords: Okinawa trough, backarc spreading, seismic structure, surface wave

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SIT03-P07 Room:Convention Hall Time:May 26 18:15-19:30

P-wave velocity anomalies of the plume beneath the French Polynesia

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The French Polynesian region is characterized by positive topographic anomalies of 700 m, a concentration of hotspot chains. Many seismic tomography results show a broad low-velocity anomaly in the lower mantle continued from the base of the mantle. These observations suggest that a large-scale mantle flow rises from the bottom of the mantle beneath the region. Joint Japanese-French broadband seismological observations were performed from 2001 to 2005 with 10 island stations from the Polynesian PLUME project (Barruol et al. 2002) and 10 broadband ocean bottom seismometers (BBOBSs) from the Polynesian BBOBS project (Suetsugu et al. 2005). A P-wave

tomography using the data from these projects revealed that large-scale low-velocity anomalies (on the order of 1000 km in diameter) from the bottom of the mantle become smaller-scale low-velocity anomalies (on the order of 100 km in diameter) at the depth of about 1000 km. However the connection of the small-scale low-velocity anomalies to the surface hotspots was not unrevealed because of the poor resolution in the upper mantle.

A new P-wave tomography with better resolution in the upper mantle was obtained by adding data from BBOSBSs around Society Islands deployed along the TIARES project during 2009 - 2010 (Suetsugu et al. 2012) and by taking the finite frequency effect into account for the frequency-depended differential travel times. The frequencydepended differential travel times were measured by multi-band cross correlating P waveforms. The new P-wave tomography shows strong low-velocity anomalies beneath the Society Islands and Pitcairn in the upper mantle although they do not extend to the 660-km discontinuity. This model also shows that small-scale low-velocity anomalies in the uppermost lower mantle. The low-velocity anomalies in the depth range about 550 - 900 km are smaller both in lateral area and amplitude than those in most of the upper mantle and the lower mantle. The velocity patterns are well correlated each other in the depth range but are not correlated with the patterns above and below, indicating the mantle beneath the French polynesia can be divided into 3 layers in terns of radial correlation.

Keywords: Tomography, Plume, Mantle, French Polynesia