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

SIT002-01 Room:301B Time:May 27 08:30-09:00

Concordant and discordant podiform chromitites: their origins revisited

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Podiform chromitites, commonly found in harzburgite-dominant peridotite complexes including ophiolites, and have been classified into two types, concordant and discordant chromities in terms of attitude in the surrouding peridotites (Cassard et al., 1981). Their textural and structural differences are considered to be due to the difference in the degree of deformation: the concordant chromitites are older and more deformed that the discordant ones. As Ahmed and Arai (2002) stated the two types are sometimes different in spinel chemistry, PGE content, and presence/absence of hydrous mineral inclusions in spinel. In addition, the PGE pattern and PGM species are systematically different between the two types of chromitites: IPGE/PPGE ratio is higher in the discordant chromitite than the concordant one, and PGE sulfides are predominant in the former whereas PGE alloys are predominant in the latter. This clearly indicates the two types are completely different in origin: subsolidus deformation cannot produce such differences. There are two possible interpretations; (1) the melt composition involved in chromitite formation was different, e.g., MORB for the concordant chromitite and island-arc magmas such as boninites for the discordant one as Ahmed and Arai (2002) stated: or (2) the concordant chromitite is a deep recycled material (cf. Arai, 2010) whereas the discordant one is a shallow cumulate as Arai and Yurimoto interpreted (1994).

Keywords: podiform chromitite, ophiolite

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SIT002-02 Room:301B Time:May 27 09:00-09:15

Redistribution of platinum-group elements in the lithosphere: hindrance to the estimation of abnudances in the mantle

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Platinum-group elements (PGE) in the Earth's mantle are key tracers for understanding the chemical differentiation history of the Earth's interior. In particular, PGE abundances in the primitive mantle are important indices to reveal detailed differentiation processes in the early Earth. The PGE abundances in the primitive mantle are generally estimated from PGE concentrations in natural peridotite samples, most of which derived from oceanic and continental lithosphere. However, it is difficult to estimate the PGE concentrations in a relatively undifferentiated mantle from PGE concentration data of natural peridotites, because PGE concentrations in natural peridotites are quite heterogeneous and don't seem to correlate with other chemical indices. Recent studies on PGE in natural peridotites have revealed that PGE in peridotite are mainly distributed in micrometer-scale platinum-group minerals as well as in 10- to 100-micrometer-scale base metal sulfides (e.g., Lorand et al., 2008, 2010; Kogiso et al., 2008). These studies also demonstrated that PGE in natural peridotites have been remobilized by sulfur-bearing aqueous fluid or silicate melt, although it is not clear where and when such remobilization processes occurred. In any case, it is highly probable that many of the natural peridotites that were used to determine PGE abundances in the mantle had experienced remobilization of PGE. Thus, it is not appropriate to estimate the PGE abundances in the primitive mantle using correlation of PGE with any indices that are thought to reflect "degree of melting" of peridotite. To know the original concentrations of PGE in peridotite samples, it is necessary to reveal the details of the processes that are responsible for redistribution of PGE in the lithosphere.

Rererences:

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Keywords: platinum-group element, mantle heterogeneity, metasomatism

Japan Geoscience Union Meeting 2011
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SIT002-03 Room:301B Time:May 27 09:15-09:30

Plume-ridge interaction beneath the central Gulf of Aden: Sr, Nd, Pb and Hf isotopic evidence from dredged basalts

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Gulf of Aden is one of the ideal places to investigate processes of continental break-up and the interaction of plume with oceanic spreading ridge system. The Afar plume has strongly been affecting the formation and evolution of the Gulf of Aden and the Red Sea. Indeed, plume material flow could have played a role in the opening of the Gulf of Aden. Therefore, to evaluate the involvement of plume material in the source of basalts we measured Sr-Nd-Pb and Hf isotopic compositions of tholeiitic basalts dredged along the central Gulf of Aden ridge (45.5E-49E). Based on their contrasting spatial geochemical signatures, two groups (Group 1 and 2) of tholeiitic basalts are identified. Group 1 basalts, dredged from east of 46.20E, have relatively wide variations of 87Sr/86Sr (0.70278-0.70304) and 206Pb/204Pb (18.21-19.03) and limited range of 143Nd/144Nd (0.51301-0.51309) and 176Hf/177Hf (0.283224-0.283276; eHf=15.98-17.83); analogous to the geochemical signature of enriched (E) to depleted normal-type mid-oceanic ridge basalts (N-MORB). In contrast, Group 2 basalts, dredged between 45.6E and 46.2E, have limited ranges of 87Sr/86Sr (0.70323-0.70341), 206Pb/204Pb (19.33-19.49), and 143Nd/144Nd (0.51285-0.51292) and wide range of 176Hf/177Hf (0.283020-0.283155; eHf=8.77-13.54). The geochemical variations reflect the involvement of at least three components in their mantle source; these are (1) depleted MORB-type mantle, (2) plume matrix of the Afar plume, and (3) blobs in the plume matrix. Mixing between the first and second components would have produced Group 1 basalts, while mixing between the second and third components produced Group 2 basalts. The spatial variations in isotopic composition of the basalts suggest that the Afar plume head extends upto 48E along the Aden Ridge.

Keywords: Gulf of Aden, Afar plume, ridge-plume interaction, Sr-Nd-Pb-Hf isotopes

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SIT002-04 Room:301B Time:May 27 09:30-09:45

Generation and evolution of lithospheric mantle beneath Izu-Bonin-Mariana: Deduced from Ohmachi Seamount serpentinites

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At the base of western slope of the southern half of the Ohmachi Seamount, Izu-Bonin frontal arc, a large exposure of highly metamorphosed serpentinites has been well known (Yuasa et al., 1998; Niida et al., 2001, 2003; Ueda et al., 2004; Hirauchi et al., 2010). The serpentinite basement is divided into massive serpentinites and schistose serpentinites (antigorite schists) in association with a rare occurrence of eclogite (Ueda et al., 2004).

The massive serpentinites, carrying small amounts of primary mantle minerals, can be identified into three different peridotite types as their original lithologies. One is lherzolite, which represents a fertile, residual mantle peridotite (UMP) with primary olivine (Mg#=89~91) and spinel (Cr#=13~18). The second is dunite-chromitite, which represents an island-arc type magma channel sample (MCP), having a distinct mineralogy of olivine (Mg#=91.5~92.5) and spinel (Cr#=65~80) from the residual mantle lherzolite. The third type is cumulates (CUM: wehrlite ~ olivine clinopyroxenite ~ clinopyroxenite) composed of cumulus olivines and clinopyroxenes crystallized within a deep-seated magma chamber and/or magma conduit.

It is deduced from the above lithology and primary mineralogy that the Ohmachi Seamount serpentinite was originated as fertile mantle lherzolite, probably from the upper mantle beneath continental margin (Niida et al., 2001, 2003), before the opening of the West Philippine basin. Prior to the settlement into the the active Izu-Bonin arc system, the lithospheric mantle was modified by channeling of island-arc type magmas generated in Paleogene along old island-arc systems of the Ogasawara Ridge and the Kyushu-Palau Ridge. Then, the mantle peridotites were experienced in antigorite metamorphism of serpentine schist (Hirauchi et al., 2010) and in coupling with eclogite and amphibolite (Ueda et al., 2004) generated within a subduction channel.

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Keywords: Ohmachi Seamount, serpentinite, lherzolite, dunite, residual mantle peridotite, magma channel

Japan Geoscience Union Meeting 2011
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SIT002-05 Room:301B Time:May 27 09:45-10:00

Plagioclase-bearing harzburgite from the Mariana Trough: Evidence for melt impregnation in shallow mantle

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Upper mantle-derived plagioclase peridotite has been explained as a re-equilibrated mineral assemblage at the plagioclase stable P-T condition (Green and Ringwood 1967) and modified mantle peridotite by melt impregnation or melt-rock reaction (e.g. Dick et al., 2010). Here, we examine plagioclase-bearing samples from the Mariana Trough (JAMSTEC KR02-01: Arima et al., 2002) to understand modification through melt impregnation into the residual peridotites.

Chiba et al. (2008) reported that the residual mantle peridotites beneath the Mariana Trough are lherzolite to lherzolitic harzburgite. These rocks attain 71% of 129 samples examined. The major element chemistry of the primary cores of olivine (Mg#=90.0-91.7, NiO=0.31-0.48 wt%), orthopyroxene (Mg#=90.2-91.5, Al_2O_3=2.76-4.58 wt%), clinopyroxene (Mg#=91.0-93.9, Al_2O_3=3.69-5.57 wt%), and spinel (Mg#=67.0-74.6, Cr#=24.0-42.5, TiO_2=0.06-0.22 wt%) indicates a residual mantle peridotite with a small to moderate degree of partial melting.

Interstitial plagioclase, 0.1-0.7 mm in size, have been found in 4 samples of the residual harzburgite, showing trails with small grains of secondary olivine, orthopyroxene, clinopyroxene and spinel among coarse protogranular grains of primary harzburgite minerals. The modal% of plagioclase is 0.3-0.7.

The coarse protogranular grains of primary olivine cores (Mg#=89.5-91.6, NiO=0.31-0.45 wt%), orthopyroxene cores (Mg#=89.2-91.7, Al_2O_3=1.94-5.73 wt%) and clinopyroxene cores (Mg#=90.1-93.8, Al_2O_3=2.27-6.30 wt%) have similar chemical compositions to those of the residual peridotite, whereas the small grains of secondary orthopyroxene (Mg#=90.3-91.6, Al_2O_3=1.30-2.56 wt%) and clinopyroxene (Mg#=91.8-94.0, Al_2O_3=1.79-4.43 wt%) have lower content in Al_2O_3. Characteristically, small grain of spinels have lower Mg# (43.8-64.5), higher Cr# (37.2-54.3), and higher content in TiO_2 (0.07-0.33 wt%).

Concludingly, the plagioclase harzburgite from the Mariana Trough can be explained as a modified residual peridotite by primary melt impregnation, generated in a shallow mantle. These harzburgite resembles 'P-type peridotite' of the Parece Vela (Ohara et al., 2003), 'plagioclase-bearing peridotite' of the southern Mariana Trench (Michibayashi et al., 2009), 'impregnated peridotite' of the Romanche Fracture Zone (Tartarotti et al., 2002) and 'plagioclase peridotite' of the Paleo-MAR (Dick et al., 2010). Such a modification by melt impregnation seems to be frequent in the back-arc lifting and the mid-ocean ridge systems.

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Keywords: Mariana Trough, plagioclase-bearing harzburgite, residual peridotite, back-arc basin, melt impregnation

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SIT002-06 Room:301B Time:May 27 10:00-10:15

Volcanic and tectonic activities shown by a high-resolution acoustic survey, the case of the Southern Mariana Trough

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Mariana Trough is one of back-arc basins which developed from 11N to 23N on south-east part of the Philippine Sea plate. There are 3 known hydrothermal sites on the Southern part of the Mariana Trough: the Snail site develops on spreading axis, the Archean site develops on the eastern foot of the spreading axis, and the Pika site develops on the top of off-axis seamount which stands on ~5 km SW from the spreading axis. The three hydrothermal sites seem in line. The water samples from the Snail site and the Pika site indicate an opposite features to these geological setting. To investigate geological background of these 3 hydrothermal sites, the detailed geophysical and hydrological survey using *AUV-Urashima* (JAMSTEC) followed by the eye observation using *Shinkai6500* was conducted on 2009 and 2010.

We obtained following results.

1. The *AUV-Urashima* detected backscattering signals in water column over the known (Snail site, Archean site, and Pika site) and also unknown hydrothermal sites. Eye-observation using *Shinkai6500* in 2010 indicate that one of the backscatter signals in water column detected undiscovered hydrothermal site. We named the new hydrothermal site as the "Urashima site". We also found dead chimneys ~10 m height and turbid water, at the other sites of ackscatter signals in water column except the known and the Urashima hydrothermal sites.

2. The Archean, Pika, and Urashima hydrothermal sites shows small topographic features. Combination of the detailed acoustic survey using *AUV-Urashima* and the eye observation using *Shinkai6500* indicate extent of the area of hydrothermal vents. The Archean site going trend along ridge-line of the hydrothermal mound. The Pika site is developed not only the center of the summit, but also over the top (center~western edge) of the off-axis seamount. The newly found hydrothermal site, the Urashima site, is developed from the northern foot of the off-axis seamount to the northern flat terrain, at least 150 m x 180 m area.

3. Snail site is not accompanied with small topographic features. It is difficult to decide the exact point of the snail site on 2-D mosaic map, but backscatter signals in water column help us. There are few faults and fissure around the Snail site. On the other hand, the other hydrothermal site named Yamanaka site, which is thought as a decadent hydrothermal site on the same spreading axis, is cut by clear fissures. There is no geological connection on seafloor between these two hydrothermal sites.

4. Several spots of ultra-low backscattering seafloor are found along spreading axis, between the Snail site and the Yamanaka site. Eye observation by *Shinkai6500* reveals that there are fragments of black-colored lava. Normally, we interpret low-backscatter areas as a thickly sedimented field, or such kind of an absorber material, covering seafloor. The rubble of lava on seafloor suggests that low-backscattered area may indicate fresh (non sedimented) lava field. We should reconsider interpretations of acoustic data sets over volcanic area.

5. Distribution of hydrothermal vents, length and distribution of linear features (fault and fissure), and distribution of newly looking lavas indicate a detailed position of active seafloor along spreading axis and around the off-axis seamount which holds the Pika and the Urashima sites.

Keywords: High-resolution acoustic survey, AUV, water column, ultra-low backscattering intensity, lava flow

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SIT002-07 Room:301B Time:May 27 10:15-10:30

Trace element distributions of the hydrothermal altered oceanic crust in the Oman ophiolite

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Hydrothermal alteration processes of oceanic crust at mid-ocean ridges cause significant changes in elemental budget and vertical distribution. Although previous studies have been reported chemical compositions of oceanic crustal rocks from dredged and/or drilled modern seafloor and ophiolite, available depth-successive data is still limited. In this study, concentrations of trace elements were determined for a complete section of oceanic crust in the Oman ophiolite in order to investigate elemental mobilization during hydrothermal alteration. Pillow basalts altered at low temperature ($<100^oC$) were highly enriched in B, As, Rb, Cs, Ba, U, and moderately enriched in Pb, suggesting that these elements were adsorbed onto and/or incorporated into secondary minerals, such as smectite and calcite. Mn and Zn were enriched in the transition zone between pillow lava and sheeted dike complex, and depleted in base of sheeted dike complex. On the other hand, Cu and Pb of the sheeted dikes were generally depleted. Dolerite dikes in gabbro altered at high temperature ($>300^oC$) showed enrichment of U, indicating addition of U to rock during high temperature alteration. In contrast to the previous views that both Li and B are leached from rocks during hydrothermal alteration at high temperatures, the lower oceanic crust altered $>300^oC$ (even at $>450^oC$) showed B-enrichment relative to fresh rocks. This suggests that the altered oceanic crust is a large sink of B and source of Li.

Keywords: oceanic crust, hydrothermal alteration, trace element

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SIT002-08 Room:301B Time:May 27 10:45-11:00

Structural changes within the subducting oceanic plate around the outer rise region

Gou Fujie[1*], Naoto Noguchi[1], Takeshi Sato[1], Tsutomu Takahashi[1], Shuichi Kodaira[1]

[1]JAMSTEC/IFREE

The subducting oceanic plate and the water within it play important roles in seismic and volcanic activities in the island arc. Bending related faulting in the outer rise region is considered to be one of the major mechanisms of the water penetration and hydration of the incoming plate. However, detailed structural changes in the outer rise region have been not well resolved.

In 2009, for revealing seismic structure and its variation around the outer rise, we conducted a reflection and refraction seismic survey along a 500-km long survey line (A2) in the northwestern Pacific region, which is perpendicular to the Kuril trench. The Vp (P-wave velocity) and Vs (S-wave velocity) structure models along line A2 clearly show that the seismic velocities within the oceanic crust gradually decrease toward the trench axis beneath the outer rise and Vp/Vs within the upper crust becomes higher near the trench axis, suggesting high water content within the upper part of oceanic crust. These structural changes begins just at the south end of the outer rise, implying that the bending related faulting at the outer rise is responsible for the variation in the seismic velocity and water content within the incoming plate.

In 2010, for confirming these structural features and revealing the seismic anisotropy, we conducted another reflection and refraction seismic survey along two trench parallel survey lines, R1 and P1. R1 is located at the outer slope of the Kuril trench and P1 is located at the south of the outer rise. Both lines perpendicularly cross the line A2. We deployed 45 OBSs along R1 and P1 at a spacing of 6km, and fired a 7800 cu. in. tuned airgun array of R/V Kairei at a regular spacing of 0.2km. During the airgun shots, we towed a 444-channel, 6km long, hydrophone streamer cable and obtained multi-channel seismic (MCS) reflection data. The quality of the OBS and MCS seismic record section is good. We can observe clear refractions from the oceanic mantle (Pn) with apparent velocity of about 8.0km/sec, which is significantly lower than that of line A2.

We modelled Vp and Vs structure models by using both OBS and MCS traveltimes. Above the oceanic Moho, seismic velocity models of the trench parallel lines R1 and P1 are well consistent with that of A2, supporting the structural features observed along line A2. On the other hand, just below the oceanic Moho, we observed remarkable seismic velocity difference between the trench parallel direction and perpendicular direction, indicating that the significant anisotropy within the oceanic mantle.

Keywords: oceanic plate, outer rise, anisotropy, seismic velocity structure, Ocean Bottom Seismometer, wide-angle seismic survey

Japan Geoscience Union Meeting 2011
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SIT002-09 Room:301B Time:May 27 11:00-11:15

Active mantle upwelling at fast-spreading ridge deduced from seismic images of old oceanic lithosphere in the NW Pacific

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One of long-standing questions about the mantle flow, which governs an accretion process of oceanic lithosphere, at the mid-oceanic ridges has been whether the mantle upwelling is active or passive. Although there are lines of geological and geophysical evidences which support dominantly passive upwelling at the mid-oceanic ridges in a sense of the global plate tectonics, it is also possible that, when decompression melting occurs, low density melt is preserved in the mantle to create local buoyancy which forms mantle convection near the spreading axis. A few study about ophiolite and gravity anomalies in the East Pacific Rise demonstrated a possible active upwelling diapirs at the ridges, but yet no seismological evidence which directly indicates the active upwelling has been observed. Here, from seismic data acquired at the old Pacific plate (120 ? 130 Ma) off the Kuril trench, we show very high P-wave velocity (Vp = 8.6 km/s) and strong anisotropy (7 %) in the uppermost mantle immediately below the oceanic crust having lower crustal reflectors (LCRs) dipping toward the paleo-ridge with dominantly uniform spacing and dipping. Similar LCRs have been reported by previous seismic studies in the northwestern and eastern Pacific. Based on geometry and distribution of the LCRs, there has been much debate about an origin of the LCR. For example, thermal and chemical modeling predicted that the LCRs were lithological layering formed by downward and outward flow from an axial magma chamber due to passive upwelling of mantle. On the other hand, based on ophiolite studies, it is proposed that ridge-ward lower crustal fabrics may be formed by a basal shear at the crust due to the active mantle upwelling. Our new observations present the first direct seismological evidence indicating strong basal share of the oceanic crust due to the active upwelling of mantle at the mid-oceanic ridge.

Keywords: Oceanic lithosphere, Seismic imaging, Crust, Mantle, Anisotropy

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SIT002-10 Room:301B Time:May 27 11:15-11:30

Attenuation and anisotropy structure at the lateral edge of the Okinawa trough

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The Ryukyu subduction zone and its associated back-arc basin, the Okinawa trough, terminate laterally against the Eurasian lithosphere at northeast Taiwan. The mantle wedge shows a factor of 10 increase in Q values from the segment with significant rifting to NE Taiwan where rifting has just begun. The high Q values beneath central northern Taiwan are probably affiliated to the colder Eurasian lithosphere, but the lithospheres eastern boundary is unknown. Shear-wave splitting pattern helps to resolve this issue. We found a rotation of the polarization direction of the fast split wave from nearly NS (trench normal) at the southwest OT to roughly EW beneath northern Taiwan in alignment with the orogenic structure. Because the lateral edge of the mantle wedge is blocked by the thick Eurasian lithosphere, trench-parallel flow is suppressed and the trench-normal flow dominates. The western boundary of the trench-normal fast direction is used to mark the western boundary of the mantle wedge, which can be drawn roughly at 121.8E. If this is the boundary, the attenuation pattern suggests that the mantle wedge against the Eurasian lithosphere is cooled by 100-200 degrees.

Keywords: mantle wedge, attenuation, anisotropy, mantle flow

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SIT002-11 Room:301B Time:May 27 11:30-11:45

Anisotropic Mantle Lid in Young Subducted Slab underplating Central Mexico

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Modern plate tectonics involves several important ingredients such as seafloor spreading at mid-ocean ridges, generations of island arcs and subductions of plates. Although it is not clear exactly when plate tectonics started, seismic investigations of some of the oldest stable continental crust, the Slave craton and the Superior craton in North America, revealed multiple localized dipping anisotropic layers in the sub-cratonic lithospheric mantle that point towards the possibility of several shallow subduction episodes from late Archean (~2.6 Ga) to early Proterozoic (~ 1.8 Ga), which may form sub-cratonic lithospheric mantle by successive accretions and stacking. However, such seismic features have never been observed in modern subduction setting and it is extremely difficult to infer the state of plate tectonics such as plate velocities and spreading rates in early Earth. Here we model local converted S-to-P waves and teleseismic P-to-S converted waves to interrogate the interior of the young subducted Cocos plate beneath Central Mexico. We find a strong peak-to-peak P-wave (10 percent) and S-wave anisotropy (10 percent) localized within the topmost 2-6 km of the subducting oceanic mantle, with a fast symmetric axis dipping at about 40 degrees away from the East-Pacific Rise and orienting at about 30 degrees clockwise from the north, which is consistent with local plate motion direction. Such an anisotropic mantle lid is probably composed of dunites and depleted harzburgites assemblages that were originally synthesized and strained at the East Pacific Rise and later subducted. This provides a strong case that processes generating dipping anisotropic layers beneath the Slave craton and other ancient continents can be analogous to modern seafloor spreading at mid-ocean ridges, except they operate under a different thermal state of the mantle in the Earth's history. The analogy established here allows direct inferences of seafloor spreading rates back to the Archean, which has profound implications on the evolution of global heat flux and carbon cycle.

Keywords: Anisotropy, Converted wave, subduction, spreading rate, Craton, Archean

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SIT002-12 Room:301B Time:May 27 11:45-12:00

Direct evidence for upper mantle structure in the NW Pacific Plate: microstructural analysis of a petit-spot peridotite

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Petit-spots are the late Miocene alkali basaltic volcanoes on the Early Cretaceous NW Pacific Plate, originate at the base of the lithosphere. Petrological studies reveal that the alkali basaltic volcanoes have their roots at the base of the NW Pacific lithosphere (Hirano et al., 2006, 2008), and that essentially unaltered pieces of oceanic lithosphere (tholeiitic basalt, dolerite, gabbro, and mantle peridotite) were caught up in the ascending magma as mafic and ultramafic xenoliths (Abe et al., 2006; Hirano et al., 2004; Yamamoto et al., 2009). Therefore, the petit-spots provide a unique window into the entire section of subducting oceanic lithosphere. We present here the first direct observations on the deep structure of the Pacific lithosphere using microstructural analyses of a petit-spot peridotite xenolith. The petit-spot peridotite xenolith (6K880R2O) which was obtained during the cruise YK05-06, R/V Yokosuka and the submersible Shinkai 6500 from a dive site 6K#880 at the eastern fault escarpment of a petit-spot volcano in the Japan Trench is a lherzolite that consists mainly of coarse- and medium-grained olivine, orthopyroxene, and clinopyroxene, as well as fine-grained aggregates of spinel and orthopyroxene. The bulk trace-element patterns of the aggregates are similar to those of pyrope-rich garnet and the associated clinopyroxene shows a signature typically seen in those equilibrated under conditions of the garnet-lherzolite stability field (Abe et al., 2006). The equilibrium conditions of this sample applied to a two-pyroxene geothermometer (Wells, 1977) and a univariant curve for the garnet-spinel facies transition (O'Neill, 1981; Klemme and O'Neill, 2000), indicating that was determined to be 1100+-50 oC at a pressure of 16-20 kbar as reported by Abe et al. (2006) and Yamamoto et al. (2009). This conditions correspond to a depth of ~60 km below the seafloor (Abe et al., 2006; Yamamoto et al., 2009). A strong deformational fabric is marked by a parallel alignment of millimeter-sized elongate minerals and their crystallographic preferred orientation. The olivine displays a [010] fiber pattern with a girdle of [100] axes and a maximum of [010] perpendicular to the foliation, a pattern which is consistent with a transpressional deformation in high temperature conditions at the base of oceanic lithosphere. Our microstructural observations and seismic data indicate that the lower part of the NW Pacific lithosphere possess an early stage structure of mantle flow at the asthenosphere. A discrepancy between the weak anisotropy in the petit-spot peridotite and the strong azimuthal anisotropy from the seismic data in the NW Pacific plate implies the existence of a highly anisotropic component in the deep oceanic lithosphere.

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A new model of the asthenosphere

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Asthenosphere is characterized by (i) homogeneous depletion of incompatible elements, and (ii) some geophysical ”anomalies” including low velocities, high attenuation of seismic waves and high electrical conductivity. In addition to these well-known features, some new observations have been reported including (i) a sharp and large velocity drop at the lithosphere-asthenosphere boundary and (ii) the nearly global presence of a low velocity layer above the ”410”. In this presentation, I will propose a new model to explain these features. A key element of this model is partial melting just above the ”410” discontinuity, and the upper mantle is considered, in this model, to be a residue of this partial melting. This provides a natural explanation for the homogeneously depleted composition of the upper mantle. Once one accepts partial melting at 410, then one must have partial melting in all parts of the upper mantle (except for the lithosphere). However, the influence of partial melting on geophysical parameters is not large in the shallow upper mantle because (i) the melt fraction is low ($<$0.1 %) and (ii) melt does not well grain-boundaries. However, the situation is different in the deep upper mantle, where melt is expected completely wet grain-boundaries. The low velocity layer above the 410-km discontinuity is likely caused by the complete wetting by a small amount of melt.

Keywords: asthenosphere, water, partial melting, seismic wave velocities, electrical conductivity