Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P01 Room:Convention Hall Time:May 24 17:15-18:30

The nature of mantle xenoliths from three frontal volcanoes of the Kamchatka arc: toward a general view of the sub-front

ISHIMARU, Satoko[1*], ARAI, Shoji[2], TAMURA, Akihiro[2], Victor M. Okrugin[3], Vasily Shcherbakov[4], Pavel Plechov[4]

[1]Dept. of Earth Environ. Sci., Kumamoto Univ., [2]Dept. of Earth Sci., Kanazawa Univ., [3]IVS., FEB of Russian Acad. Sci., [4]Fac. of Geol., Moscow State Univ.

We have a large amount of data about petrological and geochemical features of upper mantle peridotites, but the nature of sub-arc mantle, especially beneath a volcanic front, has not been fully understood due to the scarcity of occurrences of mantle-derived materials there. Mantle-wedge peridotites are opened to the impact of fluids or melts released from downgoing slab. They induce magma production and modify the petrological and geochemical features of the mantle wedge. To identify the nature of sub-arc mantle and the metasomatic agents, peridotite xenoliths trapped in arc magma is one of the most useful tools. Kamchatka Peninsula is one of the active volcanic arcs, and peridotite xenoliths derived from the upper mantle beneath the volcanic front are obtained from 9 of its volcanoes (Erlich et al., 1979). Avachinsky (Avacha) volcano is the most famous of them because of its easy accessibility and high xenolith production. Peridotite xenoliths from Avacha record high degree of melting and multiple stages of metasomatism (e.g., Ishimaru et al., 2007; Ionov, 2010). Formation of secondary orthopyroxenes replacing olivine is one of characteristics of arc-derived peridotite xenoliths (e.g., Arai & Kida, 2000; McInnes et al., 2001). In addition, we found peculiar metasomatisms, e.g., Ni enrichment (e.g., Ishimaru and Arai, 2008), in the Avacha peridotite xenolith suite. We examined additional peridotite xenoliths suite from other two volcanoes of the volcanic front of Kamchatka arc, Shiveluch and Bezymyanny volcano, to obtain a more generalized view of the mantle-wedge process there.

We examined 2 harzburgite xenoliths from Bezymyanny and 13 xenoliths of pyroxenites with/without olivine and 3 xenoliths of peridotites (2 dunites and 1 metasomatized harzburgite) from Shiveluch. Both of them are brought up to the surface by calc-alkaline series andesite to dacite. To clarify the residual features of the mantle peridotites, we only dealt with 3 peridotites from Shiveluch, because most of Shiveluch pyroxenites show textures of cumulate and/or extensively modification by interaction with the host andesite. The mantle peridotites from both Bezymyanny and Shiveluch are composed of fine-grained minerals (cf. Arai and Kida, 2000), and occasionally contain hornblende and/or phlogopite. Almost all orthopyroxenes show irregular shapes and replace olivine, indicating a secondary origin. At the boundary between the harzburgite and host andesite, we observed hornblende and secondary orthopyroxenes. At the interior of the xenoliths, the Fo content of olivine in Bezymyanny and Shiveluch samples is 91-92 and 94, respectively, and the Cr# (= Cr/(Cr + Al) atomic ratio) of chromian spinel is high, 0.43-0.69 and 0.63-0.72, respectively, and the former decreases to 76 at the boundary with the host andesite although the Cr# is almost constant. These petrographical and geochemical features are shared with Avacha peridotite xenoliths (e.g., Ishimaru et al., 2007). Orthopyroxenes in the both peridotite suites do not show simple residual feature in REE pattern, but instead are LREE-enriched and MREE-depleted. These REE concentrations of orthopyroxene indicate the metasomatic agents, which formed olivine replacing orthopyroxene, for Bezymyanny and Shiveluch were strongly enriched in LREE and SiO_2-oversaturated melts or fluids (= evolved magma?).

We will make discussion about the nature of sub-frontal mantle peridotite and metasomatic events with additional geochemical data.

Keywords: arc mantle, peridotite xeloliths, volcanic front, metasomatism

©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P02 Room:Convention Hall Time:May 24 17:15-18:30

Petrological nature and origin of ultramafic complex in the basal part of the Salahi mantle section, the Oman ophiolite

NOMOTO, Yuki[1*], TAKAZAWA, Eiichi[1]

[1]Faculty of Science, Niigata University

The Salahi (Hilti) mantle section located in the northern Oman ophiolite is mainly composed of harzburgite and dunite, but the ultramafic complex in the southwestern part of the Salahi mantle section is mainly composed of dunite and pyroxenite. This study clarifies petrological nature of the ultramafic complex and examines the origin of this complex using their rock textures and mineral compositions.

Peridotites in the ultramafic complex in the basal part of the Salahi mantle section have the equigranular texture with coarse-grained to very coarse-grained (grain diameter greater than 1cm), and the grain boundary is intricate like a labyrinth.

The spinel Cr# of harzburgites in the basal part of the mantle section ranges from 55 to 72, and is most frequent in the range of 64-66, and then the second peak in the 70-72. Harzburgites with high Cr# spinel (Cr# greater than 70) are abundant in this area, so we speculate the presence of highly refractory zone (HRZ, hereafter) that has been reported from the northern Fizh block (Kanke and Takazawa, 2006). Also the spinel Cr# of dunites in this area ranges from 61 to 84, and is most frequent in the range of 76-82, so highly refractory dunites are also abundant as well as the harzburgites. This indicates that during oceanic thrusting stage a large volume of fluid infiltrated into the mantle section from the base, and then voluminous dunites were made by flux melting of residual harzburgite. Dunites with very coarse-grained texture also support this hypothesis.

Moreover, two types of dunites can be classified on the basis of compositional relationship between harzburgite and dunite that are nearby each other in the field, that is increase or decrease in Fo of olivine with the increase of spinel Cr# from harzburgite to dunite. The distribution of these two types is separated clearly in the field. The former is found in the central part of the ultramafic complex, while the latter occurs in the periphery of the ultramafic complex. This indicates that a large amount of fluid infiltrated into the central part of the ultramafic complex, so flux melting caused dissolution of not only orthopyroxene but also a small amount of olivine forming dunites with high Fo olivine. On the other hand, dunites with low Fo olivine associated with pyroxenite may have formed by fractional crystallization of olivine and pyroxene from a partial melt in the periphery of the ultramafic complex.

The HRZ has been detected in the northern part of the Fizh mantle section, indicating a large volume of melt/fluid infiltrated into paleo-ridge segment end region during oceanic thrusting stage (Kanke and Takazawa, 2006). We consider that the ultramafic complex in the southwestern part of the Salahi mantle section is also a kind of HRZ. Moreover, the southern part of the Salahi block has been considered as a paleo-ridge segment end similar to the northern part of the Fizh block (Miyashita et al., 2003; Monnier et al., 2006). Our study suspects that highly refractory harzburgites was closely related to the segment end region during oceanic thrusting. Previous study showed that clinopyroxene-rich harzburgites or lherzolite tend to occur at the basal part of paleo-ridge segment end region (Takazawa et al., 2003; Monnier et al., 2006). Flux melting of such fertile peridotite produces relatively larger amount of partial melt resulted in a large porosity in residual peridotite. Large porosity can enhance further infiltration of fluid into residual peridotite. This positive feedback system may explain the formation of HRZ at a paleo-ridge segment end region.

Keywords: Oman ophiolite, mantle section, highly refractory zone, spinel, peridotite, pyroxenite

©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P03 Room:Convention Hall Time:May 24 17:15-18:30

Along-axis variations of ultramafic-mafic intrusions in the northern Oman ophiolite

KANEKO, Ryu[1*], ADACHI, Yoshiko[2], Takashi Sanpei[3], MIYASHITA, Sumio[4]

[1]Graduate school of Sci. & Tech., Niigata Univ., [2]Institute for Research Promotion, Niigata Univ., [3]Sumitomo Osaka Cement Co., [4]Dep. Geol., Fac. Sci., Niigata Univ.

The Oman ophiolite contains ubiquitous ultramafic-mafic intrusions (called as "wehrlite" intrusions). There are three different ideas for the genesis of these intrusions; 1) off-axis magmatism (Jousselin and Nicolas, 2000), 2) oceanic thrusting during V2 volcanism (Koepke et al., 2009), 3) mantle remelting due to mantle diapir in the sub-ocean ridge (Clenet et al., 2009). Although Jousselin and Nicolas (2000) claimed genesis of ocean ridge, Koepke et al. (2009) insisted island arc setting for the genesis of "wehrlite" intrusions. On the other hand, Adachi and Miyashita (2003) showed that there are two different types of ultramafic-mafic intrusions, common ubiquitous intrusions (genesis of ocean ridge; Geotimes unit) and plutonic equivalents of island arc magmatism (Alley unit). Ridge segment structure in the northern Oman ophiolite is shown by Miyashita et al. (2003) and Umino et al. (2003): Wadi Fizh area is northern margin, Wadi Thuqbah area is center, Wadi Hilti area is intermediate and Wadi Ahin area is southern margin of the second order ridge segment. We describe petrological features of the ultramafic-mafic intrusions and discuss with along-axis variations and these genesis.

Recently we have found a huge ultramafic-mafic intrusion (Barghah complex ; 10x2km) from the northern part of Salahi (Hilti) block (Wadi Barghah). The layering and foliation of the host layered gabbro are dragged by this intrusion to result an apparent anticline structure around the Barghah complex. This complex is mainly composed of Cpx (clinopyroxene) dunite, Cpx-Pl (plagioclase) dunite, wehrlite, Pl wehrlite and Cpx mela troctolite. The Moho transition zone of Wadi Barghah area is mainly composed of dunite, Pl dunite, Cpx-Pl dunite and Ol mela gabbro, and attains about 200m thick, indicating that this area corresponds to the ridge segment center.

"Wehrlite" intrusions at the Wadi Fizh area (segment margin) about a few tens to hundred m width, are mainly composed of Hbl (hornblende) mela Ol gabbro, Hbl mela troctolite and Hbl mela Ol gabbronorite. These rocks are characterized by abundant brown Hbl and Opx (orthopyroxene).

Fo contents of olivine and Cpx Mg# from Barghah complex ranges from 85 to 91, and 0.89 to 0.94. These compositions are primitive as similar to those of the Moho transition zone (Ol Fo=86~92,Cpx Mg#=0.88~0.93) in this area. Ti and Na contents of Cpx show wide compositional ranges, though the Cpx Mg# ranges are narrow, suggesting a melt-mantle reaction. These compositional features of Cpx are different from the differentiation trend of MORB. Cr# and TiO2 contents of Cr spinels ranges from 0.45 to 0.62, and 0.19 to 2.41 wt%, respectively, similar to MORB spinels and distinct from those of island arc magmatism (Alley unit).

Fo contents of olivine and Cpx Mg# from Wadi Fizh area ranges from 80 to 86, and 0.85 to 0.88. Apparently these compositions are considerably evolved than those of the Barghah complex. Cr# and TiO2 contents of Cr spinels ranges from 0.51 to 0.69, and 0.48 to 2.90 wt%, respectively, similar to MORB spinels and distinct from those of island arc magmatism (Alley unit).

Abundant appearance of Hbl and Opx indicates that the melts of Fizh "wehrlite" are rich in H2O. The origin of H2O may be ascribed to the penetration of sea water along the fracture at the ridge segment margin. On the other hand, ultramafic-mafic intrusions of Wadi Barghah are free from igneous amphiboles and have less evolved features, similar to the Moho transition zone in terms of lithology and mineral composition. This complex is rooted the Moho transition zone and intruded diapirically. Thus, ultramafic-mafic intrusions show signficant variations due to the location in the ridge segment.

Keywords: Oman ophiolite, wehrlite intrusion, ridge segmentation

©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P04 Room:Convention Hall Time:May 24 17:15-18:30

Petrology of Ol-Cpx layered units in the Higashi-Akaishi ultramafic body, SW Japan: Close affinity to high Ca boninite

HATTORI, Tatsuya[1*], MIZUKAMI, Tomoyuki[1], ARAI, Shoji[1], TAMURA, Akihiro[2]

[1]Natural Science, Kanazawa university, [2]Frontier Science Organization, Kanazawa university

The Higashi-akaishi ultramafic body (HA) in the Sanbagawa belt, SW Japan, is composed of dunite, wehrlite, olivine-clinopyroxenite and garnet-bearing rocks. The body is regarded as a piece of hanging wall mantle at the deeper part of oceanic-type subduction zone. Understanding of the petrological signature is important to gain insights into the formation of the mantle wedge. We present field and microtextural observations and mineral chemistry of a 250 m-thick section of compositional layering in the central part of the body and link them to the magmatic process and composition related to the formation of the HA body.

The layering in the section form a trend of compositional variation in centimeter to 10m-scales: dunite - wehrlite - olivine-clinopyroxenite. Fo and NiO in olivine and Cr/(Cr+Al) in spinel decrease in accord with this trend. These changes can be explained by fractional crystallization of Cpx following olivine and spinel. So, the dunite in the section can be regarded as a member of Ol-Cpx cumulate.

Olivine shows high Fo (up to 94) and high NiO content (- 0.33 wt%), and Cr-spinel is rich in Cr (Cr/(Cr+Al)=0.65-0.90) and poor in TiO2. Coarse porphyroclasts of Cpx in wehrlite and olivine-clinopyroxenite show highly depleted REE patterns (C1 normalized values of Ce and Yb are 0.1-0.8 and 0.3-2, respectively). The Cpx includes abundant Cr-spinel exsolutions and is most likely to preserve a primary composition crystallized from magma. Later alterations are identified by distinctive REE patterns of Cpx with microtextural features of recrystallization.

The primary chemical compositions of minerals and estimated melts in equilibrium with the Cpx overlap the ranges of high-Ca boninite (HCB); they are less depleted than low-Ca boninite and are more depleted than the Setouchi high Mg andesite. The crystallization of Ol and Cpx is also consistent with a HCB magma. Highly depleted but Ca-rich nature of HCB requires a cumulative partial melting of fertile lherzolite forming harzburgite. Experimental and natural evidence shows that it takes place in hot (close to 1300 oC) and moderately hydrous conditions. Therefore, the HA body can be regarded as a record of a high temperature phase in the Sanbagawa arc evolution.

Present activities of HCB lavas are found in oceanic arc systems (Bonin and Tonga) and in a site of arc-plume interaction (northern edge of Tonga arc). Considering that the HA body is located in the middle of the E-W elongation of the Sanbagawa metamorphic belt, it is likely that the HCB activity produced the cumulate occurred in an island arc system behind which hot asthenospheric mantle was upwelling. This can be related to the Mesozoic high temperature episode in the east Eurasian margin due to a replacement of continental lithosphere by fertile asthenospheric mantle.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P05 Room:Convention Hall Time:May 24 17:15-18:30

Petrological evidence of ancient mantle components beneath the Mid-Ocean Ridge? Results from a serpentine seamount along

MORISHITA, Tomoaki[1], MINOGUCHI, Kensei[1*], TAMURA, Akihiro[1], NAKAMURA, Kentaro[2], SATO, Hiroshi[3], HARIGANE, Yumiko[4], OKINO, Kyoko[5]

[1]Kanazawa Univ., [2]JAMSTEC, [3]Tokai Univ., [4]AIST, [5]Univ. Tokyo

We examined abyssal peridotites recovered from a small seamount along the Central Indian Ridge. Only gabbros and serpentine were recovered from the top of the seamount by dredge. Peridotite samples were classified into (1) dunite, (2) pyroxene-bearing peridotite (olivine $>$ pyroxene) and (3) pyroxene-rich peridotite (pyroxene $>$ olivine). We will show you our interpretation that some of these samples were formed in a diffent tectonic setting at ancient age.

Keywords: mid-ocean ridge, mantle

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P06 Room:Convention Hall Time:May 24 17:15-18:30

Geology of ophiolite and serpentinite melange around Mitsuishi Horai-san, Kamuikotan Zone, Hokkaido

UEDA, Hayato[1*], Mio Miura[1], Yu Kano[1]

[1]Hirosaki Univ.

Serpentinites containing high-P/T metamorphic rocks are expected to provide information on structure, physical properties, and dynamics inside subduction zone of upper mantle depths. Comparing with structural evolution of concurrent accretionary and subduction complexes and forearc basin, it could be a key to comprehensively understand the entire subduction zone dynamics. Based on this aspect of view, we have thus surveyed geology of serpentinite melange and related rocks exposed around Mitsuishi Horai-san in the Kamuikotan high-P/T zone in Hokkaido. This area is known to yield blocks of the most high-grade metamorphic rocks (garnet- and/or epidote amphibolite) in the Kamuikotan zone. However, isolated occurrence of serpentinite melange among Neogene deposits and poor exposure has obstructed to evaluate its significance on subduction zone evolution. To date, we have made a geological map of eastern half of the area, and obtained two new insights (A and B below) on geological components and structures, which will be here presented.

A: Constituent rock units

A geological body that has been wholly regarded as a "serpentinite melange" is composed of at least three components.

The first is a dismembered ophiolite (here named as "the Gunkan-yama ophiolite") as a pile of tectonic slices of ultramafic and mafic rocks without any signs of high-P/T metamorphism. The ultramafic rocks comprise a partly serpentinized harzburgite body and extensively serpentinized cumulate bodies (clinopyroxenite-wehrlite and dunite with trace gabbro). Mafic rocks are composites of gabbro (-diorite) and diabase, whose grain sizes considerably vary in each single body. Based on occasional intrusive boundaries, they probably comprise dike complexes intruded into cumulates.

The second component is a serpentinite melange (here named as "the Horai-san serpentinite melange") with severely sheared matrices of foliated serpentinite. It lies on the southwest of the Gunkan-yama ophiolite, and contain blocks of amphibolites, antigorite serpentinite, minor metapelites, and of rocks common with the ophiolite such as massive serpentinite, ultramafic cumulate, gabbro and diabase.

The third component is a low-grade (blueschist facies) metabasite occurring on the northeast of the ophiolite. Based on lithological similarity, it is inferably an extension of a coherent metabasites in the main exposure of the Kamuikotan Zone to the northeast of the study area.

Rocks of the study area are therefore regarded as a full set of the fundamental elements of the Kamuikotan zone: an ophiolite, a serpentinite melange, and a low-grade metamorphic body. They seem to be arranged more regularly than previous view of entire mixed-up structure.

B: Relationships with surrounding sediments

It has been considered that the "basement rocks" now consisting of ophiolite, serpentinite melange, and metabasites were emplaced along with a fault crosscutting the surrounding Neogene deposits. However, our mapping revealed that they are unconformably overlain by the basal conglomerate of the Neogene deposits both on their NE and SW margins, with several observations of the contact on outcrops. The basement exposure is thus regarded as an inlier at the core of an anticline. This suggests that the basement rocks had been emplaced before the timing of the unconformity. Clasts of epidote-amphibolite and chromian spinel are contained in the Cretaceous forearc basin deposits to the northeast of the study area, and therefore, the emplacement might have basically completed until late Early Cretaceous (Albian).

Keywords: ophiolite, serpentinite melange, high-P/T metamorphic rocks, subduction zone

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P07 Room:Convention Hall Time:May 24 17:15-18:30

Hydration processes in the mantle wedge peridotite; an example from the Ust-Belaya ophiolite, Far East Russia

MACHI, Sumiaki[1*], ISHIWATARI, Akira[2], MORISHITA, Tomoaki[3], HAYASAKA, Yasutaka[4], LEDNEVA, Galina, V.[5], SOKOLOV, Sergei D.[5], BAZYLEV, Borys A.[5], PALANDZHYAN, Suren A.[5], ARAI, Shoji[6], TAMURA, Akihiro[3]

[1]Natural Sci & Tec., Kanazawa Univ., [2]NE Asia Center, Tohoku Univ., [3]FSO, Kanazawa Univ., [4]Earth & Planet. Sys. Sci., Hiroshima Univ., [5]Geol. Inst. Russia Academy of Science, [6]Earth Sci. Course, Kanazawa Univ.

The Ust'-Belaya ophiolite is exposed in the 80 km x 40 km area on the south of Ust'-Belaya (N65 30', E173 17'), Far East Russia (Sokolov et al., 2003 Geol. Soc. London, Spec. Publ. 218, 619-664). The associated limestone suggests Devonian or older age of this ophiolite. The ultramafic rocks of the Ust'-Belaya ophiolite are mainly composed of fertile lherzolite, lherzolite/harzburgite with small amount of dunite, pyroxenite and chromitite. Those are characterized by significant hydration, which caused formation of secondary minerals. Here we describe hydration process of the mantle peridotite.

Mantle peridotite of the Ust'-Belaya ophiolite is divided into hydrated peridotite and antigorite-bearing serpentinite based on mineral assemblage. In both types, primary spinel is often rimed by chlorite. In some cases, primary spinel completely breaks down to aggregate of chlorite and magnetite/ferritchromite. Hydrated peridotite is composed of olivine, amphibole, chlorite and/or talc and/or secondary clinopyroxene. Amphibole and talc occur as pseudomorph after primary pyroxenes. Antigorite-bearing serpentinite is composed of olivine, amphibole, and/or talc and/or secondary clinopyroxene. Olivine often shows apparent partings similar to cleavage, i.e., the so-called "cleavable olivine". Primary pyroxenes are basically replaced by aggregate of secondary olivine, amphibole and serpentine.

Olivine compositions in both mineral assemblages are often heterogeneous even in a single mineral grain and/or within sample because of chemical modification related to hydration events. Olivine along with amphibole shows low Fo (= 100 x Mg/[Mg+Fe] = 85~89) and poor in NiO (= 0.15~0.40 wt.%) if compared with primary olivine (Fo=90~92; NiO = 0.35~0.45 wt.%). Meanwhile olivine which is along with antigorite in antigorite-serpentinite also show low Fo contents (= ~90) but resemble to primary olivine in NiO content. This compositional modification suggests introduction of Fe during hydration.

Amphiboles show different compositional trend corresponding to the mineral assemblage. Amphiboles in hydrated peridotite are calcic amphiboles, showing a pargasite/edenite-tremolite trend, on the other hand amphiboles in antigorite-bearing serpentinite show a richterite-tremolite trend with some pargasite. Several amphiboles in antigorite-bearing serpentinite show zoning composed of pargasitic core, tremolitic mantle and richiteritic rim. This zoning indicates multiple stage addition of Na2O with Fluid. Trace element patterns of edenitic/pargasitic amphibole are similar to those of primary clinopyroxene. On the other hand, those of Na-rich tremolite and richteritic amphibole show low abundance with pronounced positive anomaly of Sr. These chemical data indicate introduction of Na and Sr during serpentinization. The reports of Na-rich tremolite and richterite in ultramafic rock are relatively rare and most of them are associated with antigorite. This may mean that formation of such amphibole requires a specific condition during antigorite formation.

The unsystematic spatial distribution of hydrated peridotite and antigorite-bearing serpentinite may mean that they represent effectively cooled part by hydrous fluids in the mantle wedge.

Keywords: mantle wedge, hydration, metasomatism, serpentinization, antigorite, Ust'-Belaya ophiolite

©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P08 Room:Convention Hall Time:May 24 17:15-18:30

Preliminary results of geophysical survey in the middle Okinawa trough during GH11 cruise

SATO, Taichi[1*], ODA, Hirokuni[1], ISHIZUKA, Osamu[1], ARAI, Kohsaku[1]

[1]Institute of Geoscience, Geological Survey of Japan, AIST

Back-arc basins are extensional basins formed behind subduction zones by seafloor rifting or seafloor spreading. Back-arc seafloor spreading process is considered as similar to those of mid-ocean ridges. Likewise, back-arc rifting process is considered as similar to mid-ocean rifting but is not clear because there are few examples of the back-arc rifting in the present. The Okinawa Trough is a back-arc rifting basin of the Ryukyu arc, extending between the southwest Kyushu and north Taiwan. Several evidences of magmatic activity such as dike intrusions and/or oceanic crust, and hydrothermal activities were found in the trough, but it is still not clear when these magmatic activities were initiated and how they proceed during seafloor rifting.

We carried out marine geophysical survey in the Middle Okinawa Trough during GH11 cruise by R/V Hakurei maru No.2 from July 14 to August 15. Sea surface geophysical mapping (bathymetry, magnetics and gravity) was conducted during the survey. The survey area is largely divided into four area; northern area around Tokara Islands, continental shelf area around 27N. We present the preliminary results of the morphological and geophysical characteristics of the survey area and its implications as bellows;

1) In the Northern area around Tokara Islands, the present volcanic front, is located in the survey area. Several seamounts, sea knolls and lineaments trending N60E are vastly distributed west to the Tokara Islands. Positive magnetic anomalies up to 600nT are observed along Tokara Island and the northern part of the middle Okinawa trough where the seafloor is consisted of volcanic structures, suggesting the recent island-arc volcanism and back-arc volcanism by dike intrusions or initial emplacement of oceanic crust, respectively.

2) In spite of the depth deeper than 1000m, high amplitude magnetic anomalies of +-400nT are observed in the area of southern part of Iheya knolls and Izana knolls, also suggesting back-arc magmatic activity.

In combination with the previous geological and geophysical researches, these magmatic activities discovered are not related to so-called seafloor spreading. However, it is still not clear that how these magmatic activities can be interpreted as a whole picture of the magmatic activity in the Okinawa trough. In the presentation, we will integrate the new data with the previous geophysical data to reveal the magmatic activities of the whole Okinawa trough.

Keywords: Seafloor morphology, magnetics, gravity, Okinawa trough

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P09 Room:Convention Hall Time:May 24 17:15-18:30

Calculated phase diagrams for oceanic basalt compositions: insight into dehydration behavior of subducting oceanic crust

ENDO, Shunsuke[1*], Simon R. WALLIS[1]

[1]Nagoya University

The uppermost part of the oceanic lithosphere is variably hydrated by various processes such as high-T hydrothermal circulation at the mid-ocean ridge, low-T alteration on the seafloor, and seawater infiltration along fractures associated with normal faulting at the outer rise. Moreover, hydration due to fluid influx from sediments during incipient subduction stages can also be important. Heterogeneously hydrated oceanic crust and lithospheric mantle transport H_2O to great depths in subduction zones and can be released during prograde metamorphism. The flux of H_2O fluid through the slab-wedge mantle interface depends primarily on the thermal structure of the subduction zone, initial water budget of the slab, reaction kinetics, and compositions and volumes of slab constituent rocks. The complex nature of the initial water distribution and the large chemical system required to adequately describe crustal rocks are two of the major difficulties when trying to model the water release process. Nevertheless, calculation of H_2O-saturated phase assemblage diagrams (pseudosections) for given rock compositions can be used to predict the change of mineral assemblage and the amount of structurally-bound H_2O along a specific P-T path. Recent significant advances in calibrating mixing properties of complex solid-solution minerals (e.g. amphibole and clinopyroxene) allow us to calculate pseudosections for mafic rocks with some precision and accuracy. In this study, we present calculated pseudosections in the chemical system K_2O-Na_2O-CaO-FeO-Fe_2O_3-MgO-Al_2O_3-SiO_2-H_2O for normal mid-ocean ridge basalt (N-MORB) compositions. To account for the variation in the input MORB compositions in modern subduction zones of SW- and NE-Japan, pseudosections were calculated for four representative MORB compositions taken from samples from the Shikoku Basin (DSDP Leg 58 Site 442; Wood et al. 1980), Nankai Trough basement (ODP Leg 131 Site 808; Siena et al. 1993), and the Cretaceous (133-130 Ma) northwestern Pacific Ocean floor (DSDP Leg 32 Sites 303 and 304; Janney and Castillo 1997). Among many hydrous minerals predicted in these rock compositions, important dehydration reactions at forearc mantle levels involve stilpnomelane, lawsonite and chlorite. Stilpnomelane and related hydrous sheet silicates may be important H_2O carriers in cold subduction zones but reliable thermodynamic models for these minerals are not yet available. High water content (~6 wt. %) is required to form H_2O-saturated equilibrium phase assemblages in MORB compositions at very low-T conditions (<450 deg.C at 2.0 GPa). Accordingly, cold subduction zones are not associated with the release of significant amounts of water in the forearc region. However, recent subduction-zone thermal models that incorporate a stress- and temperature-dependent mantle rheology predict a substantial temperature rise at the depth where the slab-mantle interface becomes mechanically strongly coupled. A review of worldwide subduction zones suggests this depth is ~80 km irrespective of the subduction zone (Wada and Wang, 2009). Modelling suggests that below this strong coupling depth there is a steep temperature gradient between the top and base of the slab crust at depth. Our modeling predicts that the presence of such a steep temperature gradient in cold subduction zones such as NE Japan results in the release of substantial amounts of H_2O fluid from the uppermost part of oceanic crust at the depth where strong coupling begins. In the case of warm and hot subduction zones such as SW Japan and Cascadia, substantial dehydration of the slab is expected even at the uppermost mantle levels mainly due to breakdown of lawsonite (~370 deg.C at 1.0 GPa) and chlorite (~470 deg.C at 1.0 GPa). The predicted P-T conditions and substantial fluid release are compatible with the high fluid pressure regions inferred from high Vp/Vs ratios observed in the plate interface of warm subduction zones such as SW Japan and Cascadia.

Keywords: dehydration, MORB, pseudosection, subduction zone

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P10 Room:Convention Hall Time:May 24 17:15-18:30

A New Geothermometer Using Crystal Size Variations of the Sheeted Dikes: Insight Into the Thermal Structure of The Upper

UMINO, Susumu[1*], OKUGAWA, Ayumi[1]

[1]Department of Earth Sciences, Kanazawa University

Elucidation of hydrothermal system beneath the mid-ocean ridges is critical to understand cooling of lithosphere and physico-chemical evolution of the earth's surface and interior, and migration of deep bioshpere. Hydrothermal fluids are driven by thermal gradient which plays a fundamental role in hydrothermal circulation and thermo-chemical evolution of the oceanic crust.

Thermal structure of the upper oceanic crust has been estimated by numerical modeling and metamorphic temperatures based on equilibrium mineral assemblages and homogenization temperatures of fluid inclusions. However, metamorphic temperatures may not always represent the ambient temperatures of the host rocks as they are in equilibrium with the fluids that supply or remove heat from the host [1].

We present a new method of estimating the thermal structure of the ancient upper crust formed at the Oman paleospreading axis on the basis of the crystal size variations of the sheeted dike complex. A numerical simulation of crystallization in a dike (Rc) shows that the ambient wall rock temperature (Twall) is correlated with logarithm of crystal size in the center of a dike [2]. This enables us to estimate the wall rock temperatures at the time of the dike intrusion using the crystal size variations in the dike:

Twall =Tm [logRc - logRc(0)]/0.44 + Twall(0)

Tm is the liquidus temperature. A variable with (0) means a reference value.

Because dike intrusion is limited to a narrow volcanically active zone (less than 1 km in width) beneath the fast-spreading ridge axes, the groundmass crystal sizes of the sheeted dikes represent the thermal structure of the upper crust at the ridge axis. A well exposed and preserved paleoridge segment in the Oman Ophiolite [3, 4] provides ideal sites for the crystal-size geothermometry.

Application of the crystal-size geothermometry demonstrates that the estimated geotherm through the dikes at a paleoridge segment end along Wadi Fizh shows constantly low-temperatures in the upper dikes and remarkable high gradient 1.1degC/m in the lower dikes toward the gabbros. In contrast, the estimated geotherm along Wadi Hayl is consistently higher than that along Wadi Fizh and does not show any stratigraphic variation but remains in a limited range from 540 to 790degC, which is higher than any observed fluid temperatures on the present ridge axes. The thermal structure along Wadi Fizh indicates advective heat transfer by hydrothermal circulation of cold seawater in the upper dikes and conductive heat transfer in the lower dikes. However, the high geotherm in the segment center cannot be reconciled with heating by hydrothermal fluids but requires high heat supply by repeated dike intrusions.

References:
[1] Coogan (2008) Geochem. Geophys. Geosyst., Q02013, doi:10.1029/2007GC001787.
[2] Spohn et al. (1988) J.G.R., 93, 4880-4894.
[3] Miyashita et al. (2003) Geochem. Geophys. Geosyst., 8618, doi:10.1029/ 2001GC000235.
[4] Umino et al. (2003) Geochem. Geophys. Geosyst., 8618, doi:10.1029/ 2001GC000233.

Keywords: Mid-ocean ridges, Oceanic crust, Oman Ophiolite, Sheeted dikes, Crystal size, Thermal structure

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P11 Room:Convention Hall Time:May 24 17:15-18:30

Chromite-hosted sulfide inclusions in the Southwest Indian Ridge (SWIR) podiform chromitites

PAYOT, Betchaida[1*], ARAI, Shoji[1], Henry Dick[2], ABE, Natsue[3]

[1]Department of Earth Sciences, Kanazawa University, Kakuma, Kanazawa, Ishikawa 920-1192, Japan, [2]Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543, USA, [3]Japan Agency for Marine-Earth Science and Technology, 2-15 Natsushima-cho, Yokosuka 237-0061, Japan

Small pods of chromitites occur within dunites in Dredge 62 of the Knorr Cruise 162 Leg 9 from the Southwest Indian Ridge. The size of the pods varies from a few mm to 2 cm in width. Dunites hosting the chromitite pods are chromite-poor and dominantly composed of olivine which had been severely serpentinized. Small relics of olivine are very rare within dunites. These olivines are forsteritic (Fo content=90-91) with NiO wt%=0.31-0.35. The chromitite pods are composed solely of large chromite grains usually rimmed by chlorite. Chromites have very low Cr# (=0.22-0.23) and TiO2 content is 0.13-0.17 wt%. Except for a few sulfide inclusions, the chromites are totally free of hydrous and silicate inclusions which are reportedly common in podiform chromitites. The euhedral sulfide inclusions (<10 um in size) occur away from cracks or lamella within the chromites and are believed to be primary in occurrence. Hydrous and silicate phases and rutile have been noted as mineral inclusions within the chromites in the East Pacific Rise and Mid-Atlantic Ridge podiform chromitites (Arai and Matsukage, 1998; Abe, 2011). This work reports for the first time the occurrence of sulfide inclusions within chromites in podiform chromitites in the abyssal setting. These sulfide inclusions possibly represent the melt responsible for chromite crystallization and may provide important information on the mechanisms for the formation of podiform chromitites in the current oceanic floor.

Keywords: sulfide, inclusion, chromite, podiform chromitites, abyssal

©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P12 Room:Convention Hall Time:May 24 17:15-18:30

A plagioclase fabric database: Characterization of CPO and seismic properties in the oceanic lower crust

SATSUKAWA, Takako[1*], ILDEFONSE, Benoit[2], MAINPRICE, David[2], MICHIBAYASHI, Katsuyoshi[1]

[1]Center for Integrated Research and Education of Natural Hazards, Shizuoka University, [2]Geosciences Montpellier, Universite Montpellier II, [3]Geosciences Montpellier, Universite Montpellier II

This study presents a unique database of almost 200 plagioclase Crystallographic Preferred Orientations (CPOs) of variously deformed gabbroic rocks. Plagioclase is the dominant mineral phase in most of the studied samples. The CPOs characteristics as a function of deformation regime (magmatic and crystal-plastic) are outlined and discussed. CPOs of principal mineral phases are also used to calculate the seismic properties of variously deformed gabbroic rocks from the oceanic lithosphere. The studied samples are from slow- and fast-spread present-day ocean crust, as well as ophiolites. Plagioclase CPO is grouped in three main categories: type B is a strong alignment of (010) with a girdle distribution of [100], type A is a strong point maximum concentration of [100] with parallel girdle distributions of (010) and (001), and type P is point maxima of [100], (010), and (001). A majority of CPO patterns are type B as well as type P, in which both magmatic and crystal-plastic deformation textures occur. Type A CPOs are less common; they represent 24 % of the samples deformed by crystal-plastic flow. Calculated seismic properties (P-wave and S-wave velocities and anisotropies) show that anisotropy (up to 10% for P-wave and 15% for S-wave) tends to increase as a function of fabric strength. Despite of a large variation of fabric patterns and geodynamic setting, seismic properties of plagioclase-rich rocks have similar anisotropies in magnitude. The J-index does not show any consistent variation as a function of the CPO patterns. However, the [100] concentration has an influence on the seismic anisotropies in crystal-plastic deformed samples, whereas the (010) plane alignment has a strong influence on seismic anisotropies in samples deformed by magmatic flow.

Keywords: plagioclase, fabric, seismic anisotropy, oceanic crust, lower crust, gabbro

©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P13 Room:Convention Hall Time:May 24 17:15-18:30

Differentiation processes of Shatsky Rise magmas, NE Pacific plate: constraints from clinopyroxene chemistry

YAZAKI, Mai[1*], HIRANO, Naoto[2], SANO, Takashi[3]

[1]Graduate School of Sicience, Tohoku University, [2]Center for NE-Asian Studies, Tohoku University, [3]National Museum of Nature and Science

Shatsky Rise is the large igneous provinces on the northwestern Pacific Plate. Previous geophysical and geochemical studies suggest two hypotheses about Shatsky Rise formation. One is mantle plume head model, the other is decompression melting model. Shatsky Rise formed at the Pacific-Izanagi-Farallon triple junction during the latest Jurassic to Early Cretaceous. Although some geological studies of lavas have attempted to explain the origin of Shatsky Rise (e.g. Mahoney et. al., 2005), we do not still have the answer about this question because the lavas are obtained from limited sampling sites, and are covered with thick pelagic sediments.

IODP Expedition 324 cruise was carried out by the research vessel, JOIDES Resolution in 2009, at Tamu , Ori and Shirshov massifs of Shatsky Rise. In this study, clinopyroxene phenocrysts of obtained massive, pillow and subaerial lavas are analyzed by electron microprobe analysis. It would be possible to discuss about the origin of Shatsky Rise based on the trend of magma differentiation in clinopyroxene phenocrysts.

Phenocryst compositions of clinopyroxene from Tamu Massif show the data along the MORB trend. The compositions from Ori Massif, on the other hands, plot the data along the trend of OIB-tholeiite. The magma source of Shatsky Rise, therefore, changed from MORB-like to OIB-like materials during the passage of a mantle plume and the Pacific Plate beneath Shatsky Rise. Thus, it is difficult to explain that Shatsky Rise occurs from single origin in the mantle.

This research was supported by IODP After Cruise Research Program, JAMSTEC.

Keywords: Shatsky Rise, LIPs, Pacific Plate, clinopyroxene, tholeiite

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P14 Room:Convention Hall Time:May 24 17:15-18:30

Microstructural analysis of peridotites obtained from the Izu-Ogasawara forearc region

HARIGANE, Yumiko[1*], MICHIBAYASHI, Katsuyoshi[2], MORISHITA, Tomoaki[3], TANI, Kenichiro[4], ISHIZUKA, Osamu[1]

[1]Institute of Geology and Geoinformation, AIST, [2]Institute of Geosciences, Shizuoka University, [3]FSO, Kanazawa University, [4]IFREE, JAMSTEC

Forearc locates a frontal side of volcanic front in an island arc, where provides a key information for the initiation of magmatic and subduction process in island arc formation. However, there are a few studies discussed geological interpretations of the upper mantle structure in the forearc region, although there are many studies for understanding the evolution of crustal structures of the island arc. Here, we report microstructural results of five harzburgites sampled from the landward slope of the Izu-Ogasawara Trench (dredge site KH07-02-D31 and dive site KR08-07-7K417). Morishita et al. (2011) have already reported a major and trace element compositions of the harzburgite samples in this study; they show high forsterite (91.7-92.1) and NiO (0.4 wt%) contents of olivine, high Cr# [Cr/(Cr + Al) atomic ratio; 0.65-0.73] of spinel and low Al2O3 (<1.5 wt%), Na2O (<0.04 wt%) contents of pyroxene, suggesting a refractory origin. The harzburgites are characterized by coarse granular textures consisting of coarse olivine grains and elongated orthopyroxene grains. The olivine and orthopyroxene grains show intracrystalline deformations such as wavy extinction. Crystallographic preferred orientations (CPOs) of olivine show mainly a [100](001) pattern, which has a strong alignment of [100] axis to the lineation and [001]-axis concentration perpendicular to the foliation. All olivine CPOs studied have much higher intensities than those of Mariana forearc region (e.g. Michibayashi et al., 2007). The CPOs of orthopyroxene shows a [001](100) pattern with [001] parallel to the lineation and (100) normal to foliation. Since these harzburgite samples are refractory origin associated with boninitic melting during initiation of subduction (e.g. Morishita et al., 2011), their deformation characteristics could be possibly related to the initiation of subduction in the Izu-Ogaswara forearc region.

Keywords: harzburgite, olivine, orthopyroxene, crystallographic preferred orientation, Izu-Ogasawara forearc region

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P15 Room:Convention Hall Time:May 24 17:15-18:30

Fabric and petrological characteristics of peridotiites derived from Mariana serpentinite seamounts

KONDO, Yosuke[1*], MICHIBAYASHI, Katsuyoshi[1], Teruaki Ishii[2], Patricia Fryer[3]

[1]Institute of Geosciences, Shizuoka Univeristy, [2]Fukada Geological Institute, [3]University of Hawaii

Serpentinite seamounts are unique seamounts that have only been in the Izu-Bonin-Mariana arc. The Pan-lid seamount is located at the northernmost Mariana arc, whereas the Deep Blue seamount is located at southernmost part. This study envestigated serpentinized peridotites derived from the eight seamounts (Pan-lid, Conical, Packman, Twin peaks, Big Blue, Celestial, South Chamorro, Deep Blue seamounts). Samples from these seamounts are mantle-derived peridotite. These samples were analyzed by EBSD and EPMA. As a result, olivine crystal preferred orientations (CPOs) were divided into three types: A-type AG-type and D-type. The northern seamounts are characterized by A-type and/or AG-type, whereas the southern seamounts consist dominantly of D-type. Only South Chamorro seamount has both AG-type and D-type. The compositions (Cr#-Mg#) of spinel vary among the seamounts. Only Cr# of spinel in South Chamorro and Deep Blue Seamounts exceeded value of 0.6. But no clear relationship between partial melting process and CPO development has been found. These suggest that the northern Mariana arc have a complex and heterogeneous structure.

Keywords: peridotite, Mariana Trench, Serpentinite seamount

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
©2012. Japan Geoscience Union. All Rights Reserved.

MIS31-P16 Room:Convention Hall Time:May 24 17:15-18:30

Fluid migration and boninite formation in incipient subarc mantle inferred from dunites in the Oman ophiolite

Anna SUETAKE[1], TAKAZAWA, Eiichi[2*]

[1]Graduate School of Science and Technology, Niigata University, [2]Faculty of Science, Niigata University

The Oman ophiolite has experienced a flux melting of residual peridotites during oceanic thrusting subsequent to the formation at Neo-Tethys mid-ocean ridge. We studied spatial variability of spinel Cr# (=Cr/[Cr+Al]x100 mol%) and REE abundances of clinopyroxene in dunites from the Fizh mantle section, the northern Oman ophiolite. These data are used to understand fluid infiltration from the base of ophiolite and flux melting of residual harzburgite during oceanic thrusting.

Rock texture of dunite in the Fizh block is classified into six subgroup such as very-coarse granular, coarse granular, fine granular, planer, porphyroclastic and mylonitic textures. Rock texture of dunite is similar to the wallrock harzburgite in the upper half of Fizh mantle section. However, in the lower half of Fizh mantle section dunite becomes very coarse granular with olivine grain size greater than 1 cm although porphyroclastic or mylonitic textures is common in wallrock harzburgite.

Spinel Cr# in dunites from the Fizh mantle section varies from 45 to 80 and is the most frequent in 65-70 while spinel Cr# in harzburgites is the most frequent in 55-60 that is lower than that for dunite. Moreover, harzburgites with spinel Cr# greater than 70 is limited in the highly refractory zone located in the nothern Fizh mantle section while dunites with Cr# greater than 70 distribute over much wider area. In the area where dunite has low Cr# spinel less than 60 wallrock harzburgite tends to have spinel Cr# lower than 40.

Chondrite-normalized REE patterns of clinopyroxene in dunites are variable especially in LREE. Chondrite-normalized patterns of hypothetical melts in equilibrium with clinopyroxenes in dunites from the basal part show spoon-like shape with depletion in MREE relative to HREE and enrichment in LREE relative to MREE. Chondrite-normalized patterns of such melts are similar to those of boninites from the Fizh crustal section although some melts are more depleted in LREE to MREE relative to the boninite.

Spinel Cr# within a thick dunite layer (5 m thick) is the highest in the center (Cr# 71). Fluid flow and reaction may have been enhanced in the center by higher porosity resulted in the high Cr# spinel and formation of thick dunite. Because abundance of REE in clinopyroxene is uniform over dunite and wallrock harzburgite the migration of fluid and melt was comprehensive along with focused flow in the center of dunite layer.

High Cr# spinel frequently occur in harzburgite and dunite in the northern Fizh mantle section indicating that large volume of fluid flew through dunite and caused flux melting of wallrock harzburgite. Dunites with low Cr# spinel also occur in the northern Fizh mantle section indicating that fluid flux was limited in this region. In the southern Fizh mantle section dunite tends to have high Cr# spinel while harzburgite has spinel Cr# around 60 indicating fluid flux was low so that the extent of flux melting of wallrock harzburgite was limited.

The basal part of the Fizh mantle section is characterized by high Cr# spinel greater than 60 that is similar to subarc mantle, by dunites with very coarse granular texture, by dunite clinopyroxenes enriched in LREE. We consider that the dunites in the Fizh mantle section was reacted with boninitic melt formed by flux melting of harzburgites with addition of fluid from the base due to thermal metamorphism of altered oceanic crust during oceanic thrusting of the ophiolite. Variability in REE patterns for dunite clinopyroxene requires addition of fluid as much as 8% and as low as 0.1% being variable depending on the region. These results indicate that the fluid infiltration from the base of ophiolite and migration of boninitic melt after flux melting of harzburgite was not uniform over the Fizh mantle section. Reactive infiltration instability may have developed regional variability in porosity in the Fizh mantle section forming finger-like shape of fluid and melt migration.

Keywords: Oman ophioilte, mantle section, dunite, mid-ocean ridge, subduction zone, spinel