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

SIT002-01 会場:301B 時間:5 月 27 日 08:30-09:00

調和性および非調和性ポディフォーム・クロミタイト：その成因の再考
Concordant and discordant podiform chromitites: their origins revisited

荒井 章司[1*], A.H. アハメド[2]
Shoji Arai[1*], A.H. Ahmed[2]

[1] 金沢大・理工・地球, [2] キングアブドラジズ大・地球
[1]Dept. Earth Sci., Kanazawa Univ., [2]Fac. Earth Sci., King Abdulaziz Univ.

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).

キーワード: ポディフォーム・クロミタイト, オフィオライト
Keywords: podiform chromitite, ophiolite

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

SIT002-02 会場:301B 時間:5 月 27 日 09:00-09:15

リソスフェアにおける白金族元素の再移動とマントル存在度推定の困難さ
Redistribution of platinum-group elements in the lithosphere: hindrance to the estimation of abnudances in the mantle

小木曽 哲 [1*]
Tetsu Kogiso[1*]

[1] 京都大学大学院人間・環境学研究科
[1]Human Environ. Std., Kyoto Univ.

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:

Kogiso, T. et al., Detecting micrometer-scale platinum-group minerals in mantle peridotite with microbeam synchrotron radiation X-ray fluorescence analysis. Geochem. Geophys. Geosyst. 9, 10.1029/2007GC001888 (2008).

Lorand, J.-P. et al., Abundance and distribution of platinum-group elements in orogenic lherzolites; a case study in a Fontete Rouge lherzolite (French Pyrenees). Chem. Geol. 248, 174 (2008).

Lorand, J.-P. et al., Platinum-group element micronuggets and referetilization process in Lherz orogenic peridotite (northeastern Pyrenees, France), Earth Planet. Sci. Lett., 289, 298 (2010).

キーワード: 白金族元素, マントル不均質, メタソマティズム
Keywords: platinum-group element, mantle heterogeneity, metasomatism

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

SIT002-03 会場:301B 時間:5 月 27 日 09:15-09:30

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

Meshesha Daniel[1*], 新城 竜一 [1], 折橋 裕二 [2], 原口 悟 [3], 玉木 賢策 [4]
Daniel Meshesha[1*], Ryuichi Shinjo[1], Yuji Orihashi[2], Satoru Haraguchi[3], Kensaku Tamaki[4]

[1]Department of Physics and Earth Sciences, [2]Earthquake Research Institute, Universit, [3]Atmosphere and Ocean Research Institute,, [4]Frontier Research Center for Energy and
[1]Department of Physics and Earth Sciences, [2]Earthquake Research Institute, Universit, [3]Atmosphere and Ocean Research Institute,, [4]Frontier Research Center for Energy and

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.

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

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

SIT002-04 会場:301B 時間:5 月 27 日 09:30-09:45

大町海山蛇紋岩から推定される IBM マントルの発生と進化
Generation and evolution of lithospheric mantle beneath Izu-Bonin-Mariana: Deduced from Ohmachi Seamount serpentinites

新井田 清信 [1*], 湯浅 真人 [2], 植田 勇人 [3], 平内 健一 [4]
Kiyoaki Niida[1*], Makoto Yuasa[2], Hayato Ueda[3], Ken-ichi Hirauchi[4]

[1] 北海道大学, [2] 産総研, [3] 弘前大学, [4] 広島大学
[1]Hokkaido Univ., [2]AIST, [3]Hirosaki Univ., [4]Hiroshima Univ.

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.

References:

Hirauchi, K., Michibayashi, K., Ueda, H. and Katayama, I., 2010, EPSL, 299, 196-206.
Niida, K., Izumino, T. and Yuasa, M., 2003, Chikyu Monthly Extra, 43: 90-100.
Niida, K., Yuasa, M., Nishimura, A., Fujiwara, T. and Watanabe, T., 2001, JAMSTEC J. Deep Sea Res., 19, 77-86.
Ueda, H., Usuki, T. and Kuramoto, Y., 2004, Geology 32, 849-852.
Yuasa, M., Nishimura, A., Niida, K. and Ishizuka, O., 1998, JAMSTEC Deep Sea Res., 14, 269-277.

キーワード: 大町海山, 蛇紋岩, レルゾライト, ダナイト, 残存マントルかんらん岩, マグマチャネル
Keywords: Ohmachi Seamount, serpentinite, lherzolite, dunite, residual mantle peridotite, magma channel

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

SIT002-05 会場:301B 時間:5 月 27 日 09:45-10:00

マリアナトラフの斜長石ハルツバージャイトに見られる melt impregnation の痕跡
Plagioclase-bearing harzburgite from the Mariana Trough: Evidence for melt impregnation in shallow mantle

千葉 恵美 [1*], 新井田 清信 [1]
Megumi Chiba[1*], Kiyoaki Niida[1]

[1] 北海道大学・理・自然史
[1]Natural History Science, Hokkaido Univ.

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.

References

Arima et al., 2002, KR02-01 Northern Mariana Trough 2002 Cruise Onboard Report, JAMSTEC, p.216.
Chiba et al., 2008, Japan geoscience union meeting 2008, S147-024.
Dick et al., 2010, Journal of Petrology, 51, 425-467.
Green and Ringwood, 1967, Earth and Planetary Science Letters 3, 151-160.
Michibayashi et al., 2009, Geochemistry Geophysics Geosystems 4, doi:10.1029/2008GC002197.
Ohara et al., 2003, Geochemistry Geophysics Geosystems 4, doi:10.1029/2002GC000469.
Tartarotti et al., 2002, Lithos, 63, 125-149.

キーワード: マリアナトラフ, 斜長石ハルツバージャイト, 融け残りかんらん岩, 背弧海盆, メルトインプレグネーション
Keywords: Mariana Trough, plagioclase-bearing harzburgite, residual peridotite, back-arc basin, melt impregnation

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

SIT002-06 会場:301B 時間:5 月 27 日 10:00-10:15

AUV 高精度音響調査が捉えた海底面近傍の活動の様子＝南部マリアナトラフ熱水噴出孔周辺の調査を一例にして＝
Volcanic and tectonic activities shown by a high-resolution acoustic survey, the case of the Southern Mariana Trough

浅田 美穂 [1], 中村 謙太郎 [1*], 望月 伸竜 [2], 野木 義史 [3], 宮崎 淳一 [1], 小島 茂明 [4], 渡部 裕美 [1], 沖野 郷子 [4]
Miho Asada[1], Kentaro Nakamura[1*], Nobutatsu Mochizuki[2], Yoshifumi Nogi[3], Junichi Miyazaki[1], Shigeaki Kojima[4], Hiromi Watanabe[1], Kyoko Okino[4]

[1]（独）海洋研究開発機構, [2] 熊本大学大学院先導機構, [3] 国立極地研究所, [4] 東京大学大気海洋研究所
[1]JAMSTEC, [2]Kumamoto University, [3]National Institute of Polar Research, [4]Atomosphere and Ocean Research Institute

マリアナトラフは太平洋プレートに東側から沈み込まれるフィリピン海プレートの南西縁で現在中速程度の海洋底拡大がある背弧拡大系である。南部マリアナトラフには活発な熱水噴出孔の存在が、拡大軸から火山弧へ至る直線 5 km 程度の間に少なくとも３つ知られている。３つの熱水噴出孔はそれぞれ、蒲鉾形に盛り上がった拡大軸上の「スネイルサイト」、拡大軸東側麓部「アーキアンサイト」、拡大軸からおよそ 5 km 南西へ離れた位置の火山体頂部「ピカサイト」と呼ばれている。三点は直線上に並んで配置しているように見えて、かつそれぞれの熱水から吹き出す成分は、ピカサイトで拡大軸的特徴が、スネイルサイトで火山弧的特徴が報告されている。これら三点の熱水活動を支配する地質学的背景を探して、AUV うらしまを用いて音響による地形・地質探査、地磁気による地下構造探査、採水や現場水質観測など、多分野にわたる熱水噴出孔周辺の精査が 2009 年夏に行われた。同じ海域内で引き続き 2010 年にしんかい６５００による潜航調査が持たれ、二年間の調査結果を合わせて以下の結果が得られた。

１． AUV うらしまにより、スネイルサイト・アーキアンサイト・ピカサイト直上および熱水噴出孔は知られていない海域の水中に、音波が異常散乱する様子を捉えた。有人潜水船しんかい 6500 で当該箇所を再訪したところ、AUV の音響観測機器が水中に異常散乱を捉えた一カ所でこれまで知られていなかった熱水噴出孔を発見し、「うらしまサイト」と名付けた。うらしまサイトは熱水性生物の伝播の可能性を考える上で重要な位置を占めるかも知れない。うらしまサイト以外の水中異常散乱箇所には活動的熱水噴出孔を発見できなかったものの、高さ十m程度のデッドチムニーや、水中の濁りがある場所を新たに発見した。これにより高精度の音響探査は活発な熱水そのものを水中に検知できることが分かった。
２． 活動的熱水噴出孔のうち地形的特徴を伴う、アーキアン・ピカ・うらしま各サイトでは、AUV 音響探査による微地形および音圧分布図に基づいて、しんかい６５００を用いる海底の視認観察を行ったことで、各熱水噴出孔の空間的拡がりを議論することが可能になった。アーキアンサイトは拡大軸麓部のマウンド稜線に集中して存在する。ピカサイトはブラックスモーカー活動箇所として知られていた山体頂部中央付近のみならず、山体頂部から西方に延びる尾根線の上全体にデッドチムニーが林立している可能性が高い。うらしまサイトはピカサイトが乗る山体の北側裾野から北方の比較的平らな場所にかけて、150m × 180m の範囲に広がっていると考えられる。
３． スネイルサイトで活動的な熱水噴出孔はアーキアンサイトやピカサイトと異なり地形的特徴に乏しいので、音響画像を緯度経度上に落とした二次元画像から場所を決めることが難しいが、上述水中の音波異常散乱箇所から特定できる。スネイルサイトの周辺には断層や開口割れ目の密度が小さい。一方で衰退した熱水活動があると考えられている同じ拡大軸上の「ヤマナカサイト」は近傍に明らかな亀裂が発達している。スネイルサイトとヤマナカサイトを繋ぐ地質構造は、少なくとも海底面には露出していない。
４． スネイルサイトとヤマナカサイトの間の海底面には音波の後方散乱強度が低い場所が複数箇所に現れる。しんかい６５００で視認したところ、当該箇所には瓦礫様の溶岩が分布していた。海底面における後方散乱強度が低い場所は堆積物など音波を吸収する性質をもつものに覆われているとする解釈が一般的であるところ、今回の海底視認は、新鮮な溶岩でも表面形態によっては後方散乱強度が低い可能性を示した。このことは広域かつ高精度の海底音響探査を行った場合に得る音響画像解釈において、年代が若い溶岩流の分布等を考察し直す必要を迫る。
５． 活動的熱水噴出孔の場所と分布、断層・開口割れ目の大きさと分布、かつ比較的新しい溶岩の流域と分布を検討した結果、拡大軸上およびピカサイトがある火山帯で活動的な場所の絞り込みが可能になった。

キーワード: 高精度音響調査, AUV, 水中の音波異常散乱, 後方散乱強度, 溶岩
Keywords: High-resolution acoustic survey, AUV, water column, ultra-low backscattering intensity, lava flow

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

SIT002-07 会場:301B 時間:5 月 27 日 10:15-10:30

オマーンオフィオライト海洋地殻の熱水変質に伴う微量元素組成の変化
Trace element distributions of the hydrothermal altered oceanic crust in the Oman ophiolite

山岡 香子 [1*], 石川 剛志 [2], 川幡 穂高 [1]
Kyoko Yamaoka[1*], Tsuyoshi Ishikawa[2], hodaka kawahata[1]

[1] 東京大学大気海洋研究所, [2] 海洋研究開発機構高知コア研究所
[1]AORI, Univ. of Tokyo, [2]Kochi Core Center, JAMSTEC

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 ($<100^{o}$C) 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 ($>300^{o}$C) 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 $>300^{o}$C (even at $>450^{o}$C) showed B-enrichment relative to fresh rocks. This suggests that the altered oceanic crust is a large sink of B and source of Li.

キーワード: 海洋地殻, 熱水変質, 微量元素
Keywords: oceanic crust, hydrothermal alteration, trace element

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

SIT002-08 会場:301B 時間:5 月 27 日 10:45-11:00

アウターライズにおける沈み込む海洋プレートの構造変化
Structural changes within the subducting oceanic plate around the outer rise region

藤江 剛 [1*], 野口 直人 [1], 佐藤 壮 [1], 高橋 努 [1], 小平 秀一 [1]
Gou Fujie[1*], Naoto Noguchi[1], Takeshi Sato[1], Tsutomu Takahashi[1], Shuichi Kodaira[1]

[1] 海洋研究開発機構
[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.

キーワード: 海洋地殻, アウターライズ, 異方性, 地震波速度構造, 海底地震計, 構造探査
Keywords: oceanic plate, outer rise, anisotropy, seismic velocity structure, Ocean Bottom Seismometer, wide-angle seismic survey

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

SIT002-09 会場:301B 時間:5 月 27 日 11:00-11:15

北西太平洋海洋リソスフェア構造から推定された高速拡大軸における能動的マントル上昇
Active mantle upwelling at fast-spreading ridge deduced from seismic images of old oceanic lithosphere in the NW Pacific

小平 秀一[1*], 藤江　剛[1], 野口　直人[1], 山下　幹也[1], 佐藤　壮[1], 高橋　努[1], 海宝　由佳[1], 山本　揚二朗[1], 高橋　成実[1], 西浦　大輔[1], 阪口　秀[1]
Shuichi Kodaira[1*], Gou Fujie[1], Naoto Noguchi[1], Mikiya Yamashita[1], Takeshi Sato[1], Tsutomu Takahashi[1], Yuka Kaiho[1], Yujiro Yamamoto[1], Narumi Takahashi[1], Daisuke Nishiura[1], HIde Sakaguchi[1]

[1] 海洋研究開発機構
[1]JAMSTEC

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.

キーワード: 海洋リソスフェア, 地震探査, 地殻, マントル, 異方向性
Keywords: Oceanic lithosphere, Seismic imaging, Crust, Mantle, Anisotropy

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

SIT002-10 会場:301B 時間:5 月 27 日 11:15-11:30

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

Ban-Yuan Kuo[1*], Yen-Ting Ko[1]
Ban-Yuan Kuo[1*], Yen-Ting Ko[1]

[1]Inst Earth Sciences, Academia Sinica
[1]Inst Earth Sciences, Academia Sinica

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.

キーワード: mantle wedge, attenuation, anisotropy, mantle flow
Keywords: mantle wedge, attenuation, anisotropy, mantle flow

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

SIT002-11 会場:301B 時間:5 月 27 日 11:30-11:45

Anisotropic Mantle Lid in Young Subducted Slab underplating Central Mexico
Anisotropic Mantle Lid in Young Subducted Slab underplating Central Mexico

Tehru Alex Song[1*], YoungHee Kim[2]
Tehru Alex Song[1*], YoungHee Kim[2]

[1]IFREE, JAMSTEC, [2]Seismo Lab, Caltech
[1]IFREE, JAMSTEC, [2]Seismo Lab, Caltech

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.

キーワード: Anisotropy, Converted wave, subduction, spreading rate, Craton, Archean
Keywords: Anisotropy, Converted wave, subduction, spreading rate, Craton, Archean

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

SIT002-12 会場:301B 時間:5 月 27 日 11:45-12:00

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

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

針金 由美子[1*], 水上 知行[2], 森下 知晃[2], 道林 克禎[3], 阿部 なつ江[4], 平野 直人[5]
Yumiko Harigane[1*], Tomoyuki Mizukami[2], Tomoaki Morishita[2], Katsuyoshi Michibayashi[3], Natsue Abe[4], Naoto Hirano[5]

[1]University of Houston, [2] 金沢大学, [3] 静岡大学, [4]JAMSTEC, IFREE, [5] 東北大学
[1]University of Houston, [2]Kanazawa University, [3]Shizuoka University, [4]JAMSTEC, IFREE, [5]Tohoku University

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.

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

SIT002-13 会場:301B 時間:5 月 27 日 12:00-12:30

アセノスフェアの新しいモデル
A new model of the asthenosphere

唐戸 俊一郎 [1*]
Shun-ichiro Karato[1*]

[1] イェール大学
[1]Yale University

アセノスフェアの特徴は、（１）地球化学的に「枯渇」していて、その組成がほぼ均質であること、（２）地球物理学的には地震波の速度が遅く、減衰が大きく、電気伝導度が高いことがあげられる。この古くから知られている観測の他に、最近（１）リソスフェア-アセノスフェア境界での速度変化が大きくかつシャープであること、（２）上部マントル深部にも比較的シャープで速度変化の大きな低速度層がほぼグローバルに存在することが分かって来た。今回は、これらの観察事実を統一的に説明するモデルを提出する。このモデルでは、上部マントルは遷移層直上での部分溶融の溶け残りとして出来たと考える。もし、遷移層直上で部分溶融が起これば、その上の上部マントルの全て（リソスフェアを除き）でも部分溶融が起こらねばならない。このモデルで上部マントルの水素などの非適合元素の分布やその量（その均一性も含め）が説明できる。ただし、部分溶融の地球物理的観測への効果は上部マントル浅部ではそれほど大きくない。液は少量しかなく、完全には粒界を濡らさないからである。ところが、上部マントル深部では液が完全に粒界を濡らす可能性が高い。上部マントル深部の低速度層は液が完全に粒界を濡らした結果として説明できる。

キーワード: アセノスフェア, 水, 部分融解, 地震波速度, 電気伝導度
Keywords: asthenosphere, water, partial melting, seismic wave velocities, electrical conductivity