The earliest stage of Izu rear arc volcanism revealed by drilled cores at Site U1437, IODP Expedition 350

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The present Izu arc system consists of three types of volcanic structures, which are (1) the Quaternary volcanic front, (2) the rear-arc seamount chains and (3) bimodal rift-type volcanoes in a back-arc knoll zone and an active rift area, situated between the volcanic front and the rear-arc seamount chains. Ishizuka et al. (2003) show that the Izu rear arc volcanism migrated from eastward after the cessation of the Shikoku Basin opening (25-15 Ma; Okino et al., 1999). The rear-arc seamount chains volcanism began at 17 Ma and continued until 3 Ma, and was followed by rift type volcanism from 2.8 Ma to present (Ishizuka et al., 2003).

IODP Expedition 350 Site U1437 is located in the boundary area of the back-arc knoll zone and rear-arc seamount chains and drilled between the Enpo and Manji rear-arc chains. The first complete sequence of rear-arc rocks dated <15 Ma (Schmitt et al., in preparation) were recovered at this Site (Tamura et al., 2015), and develop over Unit I (top) to Unit VII (bottom).

The major and trace element compositions collected from the deepest parts of the Hole (Unit V and VII) show different types of magmatism. The lowermost Unit VII (~15 Ma) shows rift-type magmatism which have a relatively flat REE patterns, and Unit V (8 Ma) shows rear-arc seamount chains type with LREE-enriched patterns. This suggests that the area around Site U1437 used to be an extensional zone following the Shikoku Basin opening. At 17-8 Ma, volcanism in the Izu back-arc side occurred only in the western part of the seamount chains (Ishizuka et al., 2003) and in the eastern part of the Shikoku Basin (e.g. Kinan Escarpment; Ishizuka et al., 2009). Simultaneously rift-type volcanism occurred in the eastern part of the present seamount chains region.

The difference between the Unit VII and V indicates the temporal change of the subduction components with time. It is suggested that the subducting slab below Site U1437 had deepened with time.

Reconstruction of proto-arc basalt lava emplacement at the Amami Sankaku Basin

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How forearc oceanic crust was developed is a key to investigate evolution of the subduction system. However, few proto-arc oceanic crust is exposed below the modern oceanic arc and it is a problem for study how the arc was grown up. IODP Exp. 351 successfully recovered a proto-arc oceanic crust at the Amami Sankaku Basin which have similar geochemical feature to forearc basalts (FABs) of the Izu-Bonin-Mariana Arc which lacks geochemical evidence of subduction-recycled components (Arculus et al., 2015, Nature Geoscience).
Exp. 351 cored a 1611-m-long cores composed of 1461 m thick sediments (Unit I-IV) and 150 m thick basement rocks (Unit 1) at Site U1438, just west of Kyushu-Palau Ridge. Based on the biostratigraphy and paleomagnetism of sediments, the age of the basement is estimated to Eocene (e.g. Brandl et al., 2017, EPSL). The Unit 1 is built up with mostly sheet flows with sparsely vesicular tholeiitic basalts. The lower half of Unit 1 is composed of thin sheet flow of sparsely olivine (Ol)-plagioclase (Pl)-clinopyroxene (Cpx) phyric basalt, while the upper Unit 1 consists of thick sheet flows containing Ol and Pl phenocrysts up to 3 mm in maximum. The top 12 m of Unit 1 consist of moderately vesicular, Ol-Cpx phyric basalt sheet flows. Top surface crust of Unit 1 is conformably covered with umber-like dark mudstone of Unit IV. Limestone and tuff layers in the lower part indicate that the intermittent volcanism or the site U1438 was located at a basin in the early phase. Homogenized geochemistry of the lower half suggests that they were emplaced in an axial summit trough and on the spreading ridge. Upper half of the Unit 1 may be emplaced off ridge by flood of voluminous lava flows. Top basalt flows may be derived from a relatively high-Mg magma at ~3 km off ridge.

キーワード：Subduction initiation、forearc magmatism、U1438、Izu-Bonin-Mariana Arc
Keywords: Subduction initiation, forearc magmatism, U1438, Izu-Bonin-Mariana Arc

Forward modeling of the magma genesis for the deepest lithostratigraphic unit at Site U1437, IODP Expedition 350

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Site U1437 is located in the Izu rear-arc region, approximately 330 km west of the Izu-Bonin Trench axis and about 90 km west of the submarine Myojinsho volcano, 2117 meters below the sea level (mbsl). The stratigraphic Units VI and VII of this site, 1320–1806.5 meters below the seafloor (mbsf), contain volcaniclastics and hyaloclastites with coarse lava clasts. One of the research objectives of the IODP Expedition 350 is the analysis of the geochemical characteristics of Izu rear-arc magmas, which are not accessible by dredging (Tamura et al., 2015).

The geochemical characteristics of the Unit VII volcaniclastics (1459.8–1806.5 mbsf) are expected to reflect the mantle source of the magmatism soon after the opening of the Shikoku Basin, which occurred between 24–15 Ma (Okino et al., 1994). Major-element and trace-element compositions of the Unit VII lava clasts differ from those of the Neogene rear-arc seamounts or Quaternary arc-front volcanoes. Most lava clasts from Unit VII have trace-element characteristics indicating weak influences from the slab (fluid or melt) (Sato et al., in preparation). Sr-Nd-Pb-Hf isotope ratios of the same samples are consistent with the trace-element characteristics.

In this study, ABS4 (Arc Basalt Simulator version 4) by Kimura et al. (2014) and PRIMACALC2 (Primary Magma Calculator version 2) by Kimura and Ariskin (2014) were used to model the source conditions of the magma genesis based on the major and trace elements, and Sr-Nd-Pb-Hf isotope compositions. Compositions of the primary magmas were estimated using PRIMACALC2 for one lapilli-tuff sample from the upper part of Unit VII and two volcaniclastic samples from the lower part of Unit VII. The forward modelling using ABS4 was performed on the primary magma compositions.

The model results suggest that the slab flux (fluid/melt) were derived from mixtures of the liquids from altered oceanic crust layer (50–52 %), sediment layer (18–32 %), and mantle-wedge base peridotite layer (17–32 %). These slab liquids were generated at depth of 3.7–4.5 GPa with slab surface temperature 775–804 °C. The conditions of fluxed melting of the mantle wedge showed large differences between the lower part (F = 1.4–4.2 %) and the upper part (F = 25 %) of Unit VII, but the melting depth is limited within the depth range 1.5–1.8 GPa. The flux fraction of the slab-derived liquid also differs between the lower part (0.4–0.6 %) and the upper part (2.5 %) of Unit VII.

Using the previously published Quaternary basalt compositions from the volcanic front, active rift, back-arc knoll, and rear-arc settings, source conditions were compared with that of the Unit VII. The Unit VII magmas were generated from the conditions similar with those in the active rift, back-arc knoll, and rear-arc environments, except for their higher degrees of melting with higher flux rate of the slab liquids. These characterize the source conditions of the upper part of Unit VII.

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Tamura et al., 2015. Proceedings of the International Ocean Discovery Program Volume 350, pp. 142

キーワード：Arc Basalt Simulator、 Izu rear-arc 、magma genesis
Keywords: Arc Basalt Simulator, Izu rear-arc , magma genesis

Asthenospheric contribution to magmatism at the active rift zone in the northern Izu-Bonin arc

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The active rift zone lies just behind the Quaternary volcanic front in the northern Izu-Bonin arc. Volcanism at the active rift zone has been active since ca. 2 Ma, and late Quaternary basaltic lavas (< 0.1 Ma) and hydrothermal activity occur along the central axis of the rifts (Taylor, 1992; Ishizuka et al., 2003). The southern part of the active rift zone has greater subsidence of the basement than the northern part (Ishizukda et al. 2002). In this paper we present new Sr, Nd, and Hf isotope and trace element data for the basalts erupted in the active rift zone, composed of northern Aogashima rift, Myojin rift, and southern Sumisu rift. Three geochemical groups can be identified within the active rift basalts: Low-Zr basalts (LZB), Mid-Zr basalts (MZB) and High-Zr basalts (HZB). The MZB and LZB occur at all rifts, whereas the HZB only at the Sumisu rift. The MZB has higher Zr/Yb and Nb/Yb, lower Ba/Nb than the LZB. The HZB has the highest Zr/Yb, and exhibits a similar Nb/Yb and Ba/Nb to the LZB. The MZB from the Aogashima rift has higher Ba/Th and lower Th/Nb than the HZB and MZB from the Sumisu rift. The HZB and MZB from the Sumisu rift show a similar Ba/Th and Th/Nb to the western back-arc seamount chains. Depletion of Zr-Hf in the N-MORB-normalized spiderdiagram characterizes the MZB and LZB. The $^{176}Hf/^{177}Hf$ values are slightly lower in the HZB than in the MZB and LZB, decoupling of $^{176}Hf/^{177}Hf$ and $^{143}Nd/^{144}Nd$ values. ODP Leg126 site 788, 790, and 791 reached the basaltic basement of the Sumisu rift (Gill et al., 1992). The geochemical data and stratigraphic relations of the basement indicate that the HZB is younger than the MZB. Estimated primary magma compositions suggest that segregation depth of primary magma for the basalts at the Sumisu rift exhibits 30 km (˜ 1.0 GPa), whereas that at the Aogashima and Myojin rifts more than 45 km (˜ 1.5 GPa). The correlation between Zr/Yb, Nb/Yb and Ba/Nb indicate that the MZB and LZB were produced by different degree of partial melting of a common source mantle. The MZB and LZB volcanism at the early stage of the back-arc rifting is best explained by a partial melting of subducted slab saturated with trace quantities of zircon under low-temperature condition in the mantle wedge. On the other hand, the HZB requires a partial melt of subducted slab accompanied by full dissolution of zircon under high-temperature condition in the mantle wedge. Spatial geochemical variation of the active rift zone basalts indicates that contribution of a slab melt component (high Th/Nb relative to Ba/Th) dominates in the Sumisu rift, whereas that of an aqueous fluid component dominates in the Aogashima rift. We propose that the back-arc rifting could have been caused by asthenospheric injection with high-temperature in the south during the syn stage.

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キーワード：背弧海盆、北部伊豆・小笠原弧、アクティブリフト帯、スラブ由来流体相
Keywords: back-arc basin, the northern Izu-Bonin arc, the active rift zone, slab-derived component

Discovery of low-Ca, high-Si boninites from the northern Zambales Ophiolite: Doubly-vergent subduction initiation along Philippine Sea Plate margins

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We report the discovery of low-Ca, high-Si boninite from the middle Eocene Zambales Ophiolite in Luzon Island, Philippines. Boninite occurs as lapilli fall deposit and pillow lava flows in the upper volcanic unit of the juvenile arc section (Acoje Block) in northern Zambales Ophiolite. Following the classification of Kanayama et al. (2013) and Reagan et al. (2015), high-Si and low-Si subtypes are recognized in the upper unit together with boninitic basalts of Hawkins and Evans (1983). This upper volcanic unit in turn overlies a lower volcanic unit consisting of basaltic andesite to andesitic lavas and explosive eruptives (subaqueous pahoehoe and lobate sheet flows, tuff breccia, agglutinate, scoria and spatter deposits) forming a low-Si boninite series. Zambales high-Si boninites, mostly of the aphyric type, consist of subhedral olivine microphenocrysts (Mg#=0.88-0.91), abundant elongate enstatite microphenocrysts (Mg#=0.86-0.87) with augite±pigeonite overgrowth and chromian spinel (Cr# =0.7-0.8) set in glassy groundmass with quench clinopyroxene. This assemblage corresponds to Type II and III of Umino (1985) in samples described from the boninite type locality. Enstatite microphenocrysts with spongy cores and reverse zoning, together with embayed quartz xenocrysts are also recognized. Whole-rock composition of Zambales high-Si boninite, with 55.9-58.5 wt% SiO_2, 0.25-0.35wt% TiO_2, 8.5-13.8 wt% MgO and FeO*/MgO ratios less than 1, is akin to that of a typical Ogasawara boninite. Ni and and Cr contents are remarkably high as well. MORB-normalized trace element pattern of Zambales high-Si boninites show enrichment in LILEs (Rb, Ba, Th, K, Pb, Sr) and depletion in HFSEs (Nb, Ta) with positive Hf anomaly relative to Sm and negative Ti anomaly relative to Y. In contrast with samples from Ogasawara, Zambales high-Si boninites exhibit spoon-shaped REE pattern with strong LREE depletion relative to less depleted HREEs. Trace element ratios also distinguish Zambales boninites, having lower Zr/Ti and higher Ba/Yb ratios than Ogasawara boninites and are comparable with samples from Troodos and Oman Ophiolite. The presence of boninite and boninite-series volcanics in Acoje Block (44 Ma) and protoarc basalt (PAB)-like transitional MORB in Coto Block (45 Ma) indicate that the distinct subduction initiation chemostratigraphy is present in Zambales Ophiolite, albeit supplied by separate magma plumbing systems with stratigraphic relationships obfuscated by post-emplacement tectonic deformation. The occurrence of a massive sulfide deposit in the lower volcanic unit and possibly up to lowermost section of the upper unit is consistent with massive sulfide-bearing horizons in Troodos and Oman as well as on the Bonin Ridge.
Unfolding of subducted slabs beneath southern Eurasia reveals that the Philippine Sea Plate at 44Ma is bordered by Cretaceous oceanic crust (the East Asian Plate of Wu et al., 2016) in its western margin. Coupled with available paleomagnetic data from Zambales and Luzon, we make the case for a subduction initiation origin of the Zambales Ophiolite in the western margin (leading edge) of the northwestward moving, clockwise rotating Philippine Sea Plate. In addition, the complementary nature of Cretaceous ophiolites in eastern Philippines and the Amami-Daito region implies a common history prior to the onset of spreading in the overriding plate.

Keywords: Zambales Ophiolite, boninite, Philippine Sea Plate, subduction initiation

マリアナ海溝の角閃岩とガーネッタイトとその地質学的位置づけ
Amphibolites and a garnetite: Geodynamic implications of crustal lithologies from the southeast Mariana fore-arc

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A transect of Shinkai 6500 dives in the Challenger segment of the Mariana fore-arc recovered samples mantle and crustal lithologies. One plutonic rock collected at 4900 meters depth has an age of 46.1 Ma and mingled boninitic to arc tholeiitic domains suggesting that it is a piece of the nascent IBM arc crust. Epidote amphibolites and a hornblende garnetite were retrieved from depths between 5938 and 6277 meters depth in an area dominated by peridotite. The amphibolites have trace element compositions similar to enriched MORB, whereas the garnetite appears to be the crystal cumulate of basalt fractionation or the residue after melting of deep crust at pressures of 1.2 GPa or higher and at temperatures exceeding 780°C. There is little evidence for the involvement of subducted fluids in the genesis of the amphibolites. The garnetite is enriched in fluid soluble elements, but this enrichment might have occurred during retrograde metamorphism. The amphibolites and garnetite have initial Hf, Nd, and Pb isotopic values suggesting that they represent metamorphosed fragments of Eocene to Cretaceous terranes akin to those at the north end of the Philippine plate. The high pressures achieved by the garnetite suggest that it represents a fragment of the delaminated root of one of these terranes. Coeval Sm-Nd, Lu-Hf, and 40Ar-39Ar ages of the garnetite indicate rapid ascent and cooling at 25 Ma. The amphibolites and garnetite were tectonically juxtaposed with peridotites by complex mantle dynamics in the S. Mariana Forearc associated with the opening of the Parece-Vela Basin and the collision of the Caroline Ridge.

キーワード：角閃岩、ガーネッタイト、マリアナ海溝
Keywords: Amphibolite, Ganetite, Mariana Trench

トランスフォーム断層からマントルに水が流入した岩石学的証拠：南西インド洋海嶺Prince Edward transform fault
Direct evidence of hydration into mantle during shearing below a transform fault: Prince Edward transform fault, Southwest Indian Ridge

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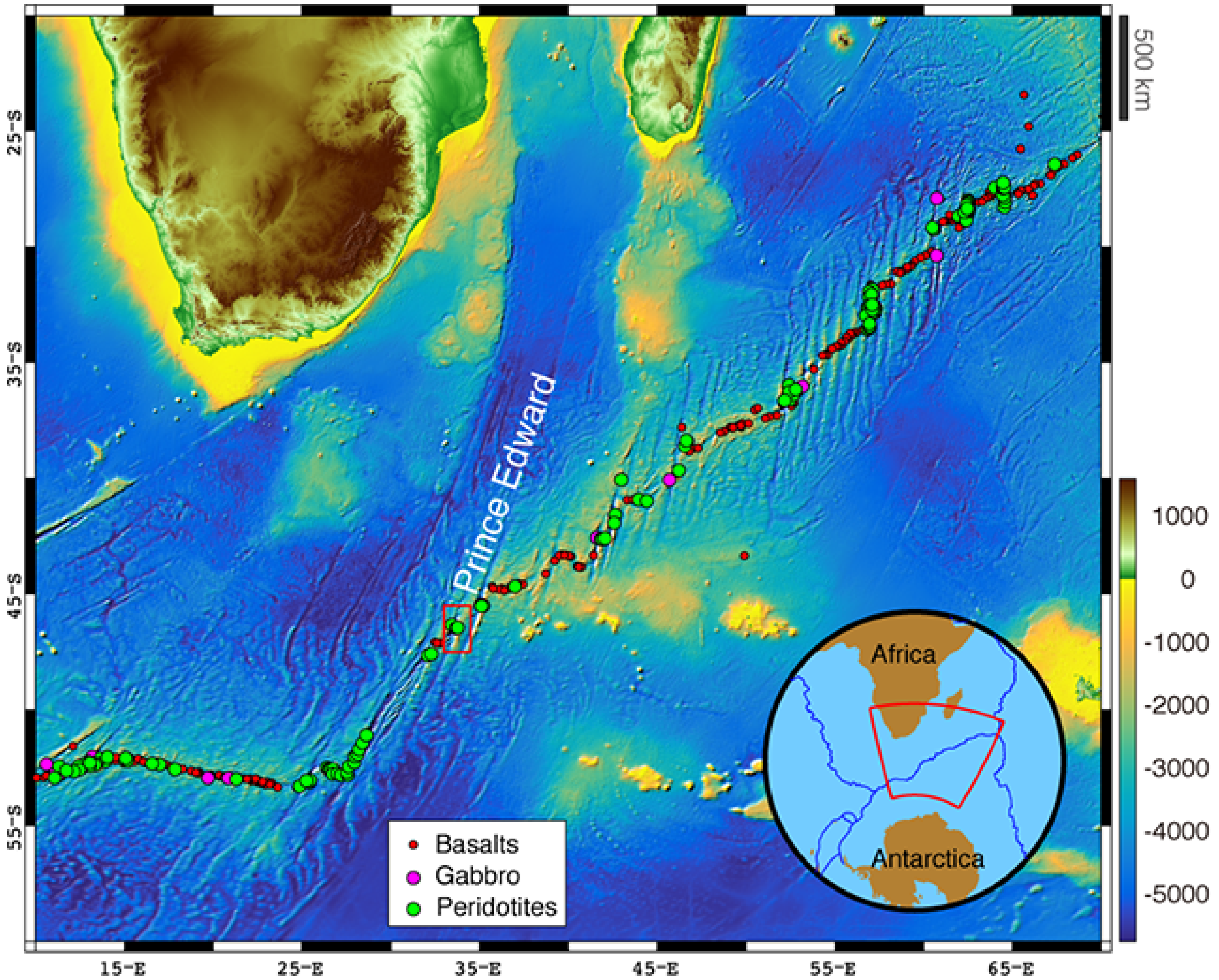
Southwest Indian Ridge (SWIR) is located to the southwest of Rodriguez Triple Junction, where three Indian ocean ridges meet (Zhou & Dick, 2013, Nature). SWIR is one of the slowest spreading ocean ridges in the world. In this study, we studied microstructural development of 21 peridotite samples obtained from Prince Edward transform fault of SWIR by PROTEA5 cruise in 1983. The peridotites consist dominantly of olivine, orthopyroxene and clinopyroxene with minor amounts of amphibole and plagioclase as well as secondary minerals such as serpentine and magnetite. The peridotites were classified into four groups based on their microstructures: 3 ultramylonites mostly consisting of extremely fine crystals (3-5 μm), 13 heterogeneous tectonites consisting of coarse-grained crystals and fine-grained matrix, 1 cataclasite and 4 intensely serpentinized peridotites. Olivine Mg# is 0.90-0.91 and spinel Cr# is 0.1-0.35. Amphibole crystals have chemical compositions of tremolite and magnesio-hornblende and they were intensely deformed within the ultramylonites and the heterogeneous tectonites, indicating that they have occurred before or during intense shearing in mantle. Moreover, extremely fine grain sizes of olivine and microboudin textures in both pyroxene and spinel crystals suggest that these peridotites have been sheared under high stress conditions. Furthermore, olivine crystal-fabrics within the amphibole bearing peridotites have B and E types that could be developed under hydrous conditions, whereas olivine fabrics within the other peridotites have A and D types that could be developed under anhydrous conditions (Karato et al., 2008, Annu. Rev. Earth Planet. Sci.). Consequently, the petrophysical characteristics of peridotites in this study indicate that the uppermost mantle below the Prince Edward transform fault has been locally but intensely hydrated during shearing due to transform movement.

キーワード：トランスフォーム断層、マントル、オリビンファブリック
Keywords: Transform fault, mantle, olivine fabrics



Prince Edward
500 km
Basalts
Gabbro
Peridotites
Africa
Antarctica
1000
0
-1000
-2000
-3000
-4000
-5000
25°S
35°S
45°S
55°S
15°E
25°E
35°E
45°E
55°E
65°E

M2Mハワイサイトの下のマントル不均質
Mantle heterogeneity under Hawaii site of M2M

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The project of MoHole to Mantle (M2M) has three candidates for the prospective drilling sites. North Arch of Hawaii is one of candidates, and the seismic site survey will be performed in the near future. Therefore, it is important to increase knowledge of the mantle materials under the Hawaii region. In this study, we discuss the chemical and petrological heterogeneity under the Hawaii region using the experimental data for physical properties of silica under high pressures and high temperatures.

We performed the high-pressure experiments using a multi-anvil high-pressure system combined with a synchrotron radiation source made it possible to acquire precise data from samples under high-pressure and high-temperature conditions. Experimental details have been described elsewhere [1,2]. The starting material was powdered silica to observe the phase transition from coesite to stishovite at around 10 GPa corresponding to ~300 km depth in the upper mantle.

The phase boundary between coesite and stishovite in SiO_2 was determined over the range of 1200–1700 K. The stability of each phase was determined by observing the powdered X-ray diffraction data. The transition boundary between the coesite and stishovite phases was found to occur at P (GPa) = 4.7 + 0.0031 x T (K). The phase transition determined in our study occurs at around 10 GPa at the normal mantle geotherm, coinciding with the seismic discontinuity around 300 km depth known as the X-discontinuity [3].

The silica minerals do not appear in normal mantle rocks, such as peridotite, under the upper mantle conditions. In contrast, it is known that the existence of silica minerals has been confirmed in the subducted oceanic crusts or sediments [4]. Previous studies of seismic observations inferred that the X-discontinuity was discovered under the Hawaii region [5]. According to these discussions, the compositional heterogeneity is necessary to explain the observations of the seismic X-discontinuity under the Hawaii region.

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キーワード：マントル掘削、マントル不均質、相転移、シリカ、Oceanic plate
Keywords: Mantle drilling, Mantle heterogeneity, Phase transition, Silica, Oceanic plate

北極海，超低速拡大ガッケル海嶺産かんらん岩の多様性
Petrological diversity of abyssal peridotites from the ultraslow-spreading Gakkel Ridge, Arctic Ocean

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The Gakkel Ridge is the world's slowest-spreading mid-ocean ridge varying from about 14 mm/year to 8 mm/year in full spreading rate (Cochran et al., 2003 JGR). It is widely accepted that the ultraslow-spreading ridge limits melting, leading to an idea that peridotites beneath the ultra-slow spreading ridges are relatively fertile in melt components. The ultraslow-spreading ridges, therefore, provide us unique opportunity to insight into original mantle heterogeneity before partial melting beneath the ocean ridge. Peridotite samples were recovered from the Gakkel Ridge during the international Arctic Mid-Ocean Ridge Expedition (AMORE) (Micael et al., 2003 Nature). Recently, D’Errico et al. (2016 GCA) reported a variety of peridotites corrected by the expedition. We also examined petrology and mineralogy of 12 abyssal peridotites from the Sparsely Magmatic Zones of the Gakkel Ridge. Our samples show a wide range of textures from protgranular to mylonitic textures. Based on trace element pattern of clinopyroxene, peridotites can be classified into three types: (Type-1: simple residue) systematic depletions in light rare earth elements (LREEs) from Heavy REEs (HREEs), (Type-2: residue after influx melting) concave-down REE pattern with highly enriched LREE, and (Type-3: unusual mantle) systematic depletions in LREEs from HREEs with no Zr negative anomaly. Type-1 peridotite can be explained as residue after partial melting and melt extraction, and are similar to other abyssal peridotites recovered from other mid-ocean ridges. Trace element pattern of clinopyroxene in Type-2 peridotite is similar trend to that in harzburgie sample of D’Errico et al. (2016). Type-2 peridotite can be explained as residue after influx melting in the melting column beneath the ridge. Type-3 peridotite has not been reported yet. We need further investing on origin of this sample: either reaction/influx melting with a Zr-rich fluid/melt or originally Zr-rich mantle source.

キーワード：超低速拡大海嶺下マントル、マントル不均質性、かんらん岩
Keywords: Mantle beneath the ultraslow-spreading ridge, Mantle heterogeneity, Peridotite

Petrological and geochemical diversity of mantle section revealed by comparison between northern and southern Oman ophiolite

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The Oman ophiolite is a former oceanic lithosphere formed at Neo-Tethyan oceanic ridge about 95 million years ago and is now distributed along the eastern border of Arabian peninsula over 500 km length. It is suitable for studying formation of oceanic lithosphere at spreading ridge and arc-related magmatism initiated by thrusting of oceanic lithosphere (Lippard et al., 1986; Nicolas, 1989). The volcanic rocks in the crustal section in the northern part of the Oman ophiolite record an evolution in tectonic setting from spreading ridge (N-MORB) to convergent margin (arc tholeiite and boninite) (Alabaster et al., 1982; Ishikawa et al., 2002; Kusano et al., 2013, 2014, 2016). The harzburgites and dunites in the mantle section of northern Oman ophiolite (Salahi and Fizh massifs) are highly refractory indicated by high Cr# (=Cr/[Cr+Al] atomic ratio) of spinel (Cr# >0.6) (Arai et al., 2006; Kanke et al., 2014). The spinel Cr# of harzburgites and dunites show positive correlation with the Ce/Yb ratio of clinopyroxenes. The increase of spinel Cr# accompanies the increase of Ce/Yb ratio of clinopyroxenes. In general, during partial melting of harzburgite in a closed system spinel Cr# increases with increasing the degree of melting (Dick and Bullen, 1984; Arai, 1994). At the same time the Ce/Yb ratio of residual clinopyroxene decreases (Johnson et al., 1990). On the other hand, when melt/rock ratio increase by reaction between exotic fluid/melt and harzburgite in an open system, the Cr# of spinel may forms a positive correlation with the Ce/Yb ratio of clinopyroxene. The plots of harzburgites and dunites produce the same positive trend although the Cr# of spinel and Ce/Yb ratio of clinopyroxene in dunites are greater than harzburgites. The dunites may have reacted with some fluid/melt with high Cr# spinel and clinopyroxene with high Ce/Yb ratio such as boninite. The reaction of harzburgite with boninitic melt may have produced dunites with high Cr# (>0.7) spinel and precipitated clinopyroxene with high Ce/Yb ratio. Although peridotite with high Cr# spinel is common in the northern massifs they are rare in the southern massifs such as Wadi Tayin massif in the southern Oman ophiolite. Similar to the northern massifs, the Cr# of spinel in the Wadi Tayin massif forms a positive correlation with the Ce/Yb ratio of clinopyroxene. Also the range of spinel Cr# for dunites tend to be greater than those of harzburgites. Thus in the Wadi Tayin massif the reaction of harzburgite with a light REE enriched fluid/melt increased melt mass resulted in the formation of dunite with high Cr# of spinel and high Ce/Yb ration of clinopyroxne. However, in the spinel Cr# vs Ce/Yb diagram the trend for the Wadi Tayin massif is sifted to lower Cr# side relative to that for the northern massifs. The high Cr# end of the trend for the Wadi Tayin massif does not coincide with boninite. Alternatively a possible end member is MORB or arc tholeiite that were active before boninite in the northern Oman ophiolite. Chondrite-normalized pattern for clinopyroxenes in the dunite with the highest Cr# of spinel and the highest Ce/Yb ratio of clinopyroxene is characterized by negative anomaly in the high field strength elements such as Nb, Ta, Zr and Hf. This may indicate that arc tholeiite is responsible for the formation of positive trend in the spinel Cr# vs Ce/Yb diagram for the peridotites from the Wadi Tayin massif in the southern Oman ophiolite. Further investigation is required to prove this hypothesis.

キーワード：オマーンオフィオライト、マントル、かんらん岩、海洋リソスフェア、沈み込み帯、くさび形マントル

Keywords: Oman ophiolite, mantle, peridotite, oceanic lithosphere, subduction zone, mantle wedge

Geochemistry of Wadi Tayin mantle section in the southern Oman mantle section with special reference to suprasubduction zone magmatism

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The Oman ophiolite is the fragment of oceanic lithosphere that was produced by Neo-Tethyan oceanic spreading ridge systems. This oceanic mantle lithosphere has been modified by arc-related magmatism during oceanic thrusting prior to obduction onto the Arabian continent.
The northern Oman ophiolite contains a large amount of volcanic sequence and dykes that show signature of subduction zone setting. On the other hand, in the southern massifs most of volcanic sequence has been eroded out during emplacement. In fact volcanic rocks with arc signature has not been found from the southern massifs. So it is important to study geochemical features of peridotites from the mantle section to clarify whether arc signature is present in the southern massifs.
In this study, we report the mineral compositions of peridotites from the Wadi Tayin massif in the southern Oman ophiolite to investigate the influence of arc magmatism and modification of oceanic lithospheric during oceanic thrusting. We systematically corrected harzburgites and dunites along wadis to cover the mantle section from the boundary between lower crust and uppermost mantle (namely "Moho") to the basal thrust.
Spinel Cr# [=Cr/(Cr+Al) atomic ratio] of harzburgite varies from 0.22 to 0.58. It tends to elevate from the basal thrust to the Moho. Spinel Cr# of dunite has a peak of frequency at 0.55 - 0.60, and the number of spinels with Cr# greater than 0.6 decline significantly. In addition, the spinels with Cr# greater than 0.6 occur either in the basal part of the mantle section or along NW-SE striking shear zone. The relationship between concordant and discordant dunites (Arai et al., 2006) is often observed. Spinel Cr# of concordant dunites is in a range of 0.38-0.40 whereas that of discordant dunites is in a range of 0.52-0.54. Similar to the previous study the spinels in the discordant dunites are tend to have greater Cr# than those in the concordant dunites (Arai et al., 2006).
Abundances of trace elements in clinopyroxenes were analyzed by LA-ICP-MS and were normalized to those of C1 condrites (Sun and McDonough, 1989). The chondrite-normalized patterns show that clinopyroxenes are depleted in LREE relative to HREE although abundance of LREE is more variable than that of HREE. Harzburgite with lowest spinel Cr# of 0.28 is strongly depleted in LREE whereas harzburgite with moderate spinel Cr# of 0.45-0.55 is more enriched in LREE relative to the former. Clinopyroxenes in dunites (spinel Cr# 0.40-0.68) also tend to be more enriched in MREE to LREE with increase of spinel Cr#. Particularly dunite with the highest spinel Cr# of 0.68 from the shear zone is the most enriched in MREE to LREE relative to other dunites. The chondrite-normalized trace element patterns for clinopyroxenes from this dunite show negative anomaly in high field strength (HFS) elements such as Nb, Ta, Zr and Hf indicating affinity to arc magma.
A positive correlation is observed in the diagram of spinel Cr# vs Ce/Yb ratio for clinopyroxene from dunites thereby indicating a reaction trend formed by flux-melting of harzburgite. Because the dunite with the highest spinel Cr# shows negative anomaly in the HFS elements, fluid that caused flux-melting in the mantle section might be carried from metamorphic sole due to dehydration of oceanic crust during

suprasubduction stage. According to the distribution of dunites that contain spinels with high Cr# (>0.6), the fluid might have been locally migrated both in the basal part and along shear zone. However, dunite that contains spinel with high Cr# (>0.6) is rare and not abundant unlike Fizh and Salahi mantle section in the northern Oman ophiolite.

キーワード：オフィオライト、マントル、中央海嶺、島弧、マントル-メルト反応
Keywords: ophiolite, mantle, mid-ocean ridge, suprasubduction zone, mantle-melt reaction

Arc magma-induced mantle refertalization: a case study of plagioclase peridotite in the Mineoka-Setogawa Belt, central Japan

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The Mineoka-Setogawa Belt, a Paleogene accretionary complex, is distrusted in the northern surroundings of the Izu Peninsula, central Japan. This belt contains ophiolitic mélange composed of serpentinized peridotite, mafic to felsic plutons and mafic volcanics. The serpentinized peridotite consists mainly of harzburgite, with a trace amount of lherzolite and dunite (Arai, 1991). In particular, the Mineoka-Setogawa harzburgite is characterized by containing calcic plagioclase (Takasawa, 1976; Arai and Takahashi. 1988). The Mineoka-Setogawa peridotite is sometimes intruded by the various sizes of hornblende gabbro dikes and veins. In the boundary between peridotite host and gabbro dike/vein, orthopyroxene (or sometimes anthophyllite) walls formed. In the case of thin gabbroic veins (<1 cm), HFSE-rich phases, such as zircon, ilmenite, rutile, and apatite, crystallized in the veins and wall minerals. These HFSE-rich phases could have formed through the interaction between magma and mantle. The above characteristics of the Mineoka-Setogawa peridotite are well similar to those of refertilization observed in abyssal peridotite from spreading axes (e.g., Dick et al., 2010; Morishita et al., 2004). The formation of the orthopyroxene walls as reaction products in the Mineoka-Setogawa peridotite indicates that the reactant magma could have been hydrous and Si-rich arc-related magma.

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Role of plutonics in the generation of felsic magmas at ocean island volcanoes —Oki Dozen and Ascension Island

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Ocean island volcanoes have the potential to erupt both effusively and explosively, with magmatic compositions ranging from basalt to rhyolite, similar to ocean islands such as the Canaries[I] and the Azores [II]. The generation of highly-evolved magmas in thin oceanic crust remains enigmatic with various islands preserving evidence for open-system magmatic processes, and generation by partial melting of oceanic crust[III]. The eruption of felsic magmas can also greatly increase the hazards they pose, and thus the more that can be understood about the processes leading to the generation of these evolved-magma compositions, the more we can hope to understand any potential future activity. Plutonic xenoliths represent the crystallized remains of magma storage regions, and can yield significant insights into the nature of magmatic processes, which may not be otherwise determined from looking at volcanic products alone. This contribution addresses the mechanisms for the production and eruption of evolved magma compositions at two contrasting ocean island volcanoes of Ascension Island in the Atlantic and at Oki Dozen in the Sea of Japan. While Oki Dozen is now extinct - K-Ar dating reveals the majority of activity occurred between 7.4 Ma and 5.4Ma[IV]-, recent Ar-Ar dating of Ascension Island has shown subaerial eruptions began around 1094 ka[V] with the most recent eruption to have occurred in the last 1000 years[VI] thus making future eruptions likely, and the importance of understanding the nature of the magmatic plumbing system even more vital.
We present whole rock XRF analyses, FTIR analyses of melt inclusions -and major and trace element concentrations within their host crystals- and textural information from BSE and CL images of crystal from the plutonic rocks from both Ascension Island and Oki Dozen. Our new data reveals that while the plutonic rocks from Ascension Island are generally more-evolved that the exposed volcanics, they still show no evidence for magma mixing or repeated use of a single storage region. While plutonics from Oki Dozen are of similar composition to the volcanic products, again there is no evidence for magma mixing in crystal textures, which is very different from the felsic magmas of the Canaries or Iceland[I,III]. Our data is used to highlight the importance of fractional crystallisation in the production of evolved magmas in ocean island volcanoes not directly related to any plate tectonic boundary, and reveals the importance of a pre-established crustal structure in the evolution of magmas in relatively thin oceanic crust.

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