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

SVC007-01 Room:301B Time:May 27 14:15-14:45

The Shatsky Rise Supervolcano

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Oceanic plateaus are enormous igneous mountains that apparently form from rapid, massive eruptions and emplacements of basalt and related igneous rocks. Because they are hidden beneath the sea and in remote parts of the globe, the structure and evolution of these mountains are poorly known. Shatsky Rise is an oceanic plateau, located ˜1500 km east of Japan, that formed during the Late Jurassic and Early Cretacous (˜145-125 Ma) near a triple junction of spreading ridges. It consists of three large volcanic massifs and a narrow volcanic ridge. It is inferred that eruptions began with the largest massif (Tamu Massif) and waned through time through the formation of the other massifs. Tamu Massif is a supervolcano, meaning that it appears to be a single volcanic edifice, like a seamount, but much bigger. It has an area similar to that of Olympus Mons on Mars, the largest volcano in the solar system. Geophysical data (bathymetry and seismic reflection profiles) show that Tamu Massif is elongated SW-NE, has a central summit, and a shape that is symmetric across its axis. Volcanic slopes are low, implying long lava flows with low viscosity. The cross-axis profile of the volcano is consistent with eruptions that flow outward from the axis region. Seismic profiles in some locations over these axes, especially near the summit, show normal faulting and grabens which imply that the volcanic axes are rift zones. Coring on Integrated Ocean Drilling Program (IODP) Expedition 324 recovered basalt flows of two general types: pillows and massive flows. The first type is indicative of normal seamount volcanism at low effusion rates whereas the second type implies high volume lava flows and high effusion rates. Massive flows are typical of continental flood basalts and are also found on other large plateaus. On Shatsky Rise, thick massive flows are found on Tamu Massif, whereas pillows and thin massive flows characterize the other massifs. This trend supports the idea that Tamu Massif was formed in an initial massive eruptive event and afterwards the volcanism waned as the other massifs were erupted. The fact that the cored lava flow sections on Tamu Massif appear similar to those cored by the Ocean Drilling Program from Ontong Java Plateau implies that these plateaus formed in similar fashion. Shallow water fossils and depth-diagnostic rocks and sediments indicate that the summits of Shatsky Rise massifs were near sea level at the time of formation. Expedition 324 cores also recovered hyaloclastites and volcanic sedimentary rocks which imply that explosive volcanism was significant near the volcano summit. Heavy alteration of rocks from the shallower parts of the Shatsky Rise volcanoes implies that fluids, perhaps driven by volcanic heat, flowed through the volcano summit rocks. In sum, the structure and evolution of Tamu Massif appears much like that of a typical seamount, except that it is much bigger and had correspondingly larger and widespread eruptions.

Keywords: large igneous province, oceanic plateau, volcanology, Integrated Ocean Drilling Program, seamount, Pacific Ocean

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SVC007-02 Room:301B Time:May 27 14:45-15:15

Preliminary Results from IODP Expedition 330: Louisville Seamount Trail and its Relation to the Ontong Java Plateau

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Integrated Ocean Drilling Program (IODP) Expedition 330 drilled five different guyots in the Louisville Seamount Trail ranging in age between 80 and 50 Ma. The primary goals of this expedition were to drill a sufficiently large number of in situ lava flows at each seamount for high-quality estimates of their paleolatitudes using paleomagnetic measurements, for improving the overall age progression using high-precision 40Ar/39Ar geochronology, and for detailed geochemical studies of the volcanic evolution of these seamounts. With these data we can provide the unique record of the paleolatitude shift (or lack thereof) of the Louisville mantle plume and compare it with the ˜15 degrees paleolatitude shift observed for seamounts in the Hawaiian-Emperor Seamount Trail over the same time period. It also allows us to directly compare the geochemical evolution of a typical Louisville seamount with seamounts in Hawaii and to test the apparent long-lived homogeneous geochemical character of the Louisville mantle source. These comparisons are of fundamental importance to determine whether these two primary hotspots have moved coherently or not, and to understand the nature of hotspots and convection in the Earth's mantle. Finally, the paleolatitude, age and geochemical data together will provide the ultimate test of whether the oldest Louisville seamounts were formed close to the 18-28 degrees south (with an average of 24 degrees) paleolatitude determined from basalt drilled on the Ontong Java Plateau during ODP Leg 192 and whether this Large Igneous Province (LIP) was genetically linked to the Louisville hotspot. If so, this would allow for the possibility that indeed the preceding plume head of the Louisville mantle upwelling caused the massive LIP volcanism forming the Ontong Java Plateau around 120 Ma.

Keywords: Mantle Plume Motion, Primary Hotspots, Seamounts, Guyots, Mantle Geodynamics, Pacfic Plate

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SVC007-03 Room:301B Time:May 27 15:15-15:30

Deep structural images of the Ontong Java Plateau deduced from an active source seismic experiment

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The Ontong Java Plateau (OJP) is one of the large igneous provinces (LIPs) located on the western rim of the Pacific Ocean and is colliding with the Solomon Island Arc. The OJP is a shallow oceanic plateau outlined primarily by the 4000-m isobath (Mahoney et al., 2001), and its area is one-third that of the contiguous United States (Coffin and Eldholm, 1994). Shallow bathymetry suggests that OJP crust is thicker than that of normal oceanic crust. However, how the plateau formed is still under debate, with three primary models proposed: plume, bolide impact, and fast spreading ridge. Moreover, the OJP seems to have formed in a deep marine environment, which is not clearly explained. To understand the formation mechanism of the OJP, an active source seismic experiment was conducted over the central OJP by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) in February/March 2010. The active seismic source was a 7800 cu. in. tuned airgun array aiming to penetrate the OJP′s entire crustal thickness down to the Moho. A 444-channel hydrophone streamer was towed to acquire multi-channel reflection seismic reflection (MCS) data. One hundred ocean bottom seismographs (OBS) were also deployed on the OJP′s seafloor to acquire wide-angle reflection and refraction data. The new MCS data show clear sedimentary sequences in the shallow part of the OJP about 1 s thick in two-way travel time (TWT), and unnamed seamounts penetrate the sedimentary sequences suggesting magmatism following the main construction of the OJP. The MCS data also show a deep reflection event at about 11-12 s in TWT indicating a major acoustic impedance contrast such as the Moho. OBS data show a prominent refraction event with an apparent velocity of 7 km/s, which indicates a thick lower crust. No clear refraction events from the uppermost mantle are identified except at the northern edge of the OJP′s main body. From these observations, we will discuss models for the formation of the OJP and LIPs.

Keywords: LIPs, OJP, MCS, OBS

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SVC007-04 Room:301B Time:May 27 15:30-15:45

What triggered the Early Cretaceous Oceanic Anoxic Event 1a? The Platinum Group Element perspective

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The Early Cretaceous oceanic anoxic event, OAE1a, is represented by a global marine deposition of organic-rich sediments attributed to several causes: 1) the release of gas hydrates from continental margin sediments due to warming; 2) the increased cycling of 12C due to increased flux of nutrients and high productivity; and 3) the emplacement of large igneous provinces (LIPs) due to their temporal coincidences with many of these OAEs. Os isotope data for the organic-rich sedimentary sequence at Gorgo a Cerbara, central Italy containing the Selli Level horizon that represents the OAE1a, indicate a causal link between this event and the contemporaneous emplacement of the Ontong Java Plateau (OJP), an oceanic LIP in the Pacific. However, there is still a standing controversy regarding the cause of such emplacement. Two competing hypotheses are considered capable for the emplacement of a large igneous province in an oceanic setting: the mantle plume model and the bolide impact model. The Os isotope signature alone is not an unequivocal evidence to discriminate between the two models. The PGE elements, specifically Ir, in sedimentary sequences are best tracers for extraterrestrial input into the terrestrial and marine environments. Thus, if the OJP emplacement were caused by a bolide impact, the event is expected to leave a record on the sediments being deposited at the same time, such as the Selli Level horizon. The present study looks at the platinum group elements (PGE) composition across the Selli Level horizon at Gorgo a Cerbara, central Italy which were previously analyzed for Os isotopes to investigate further whether the OAE1a event represented by these sediments and the contemporaneous emplacement of the OJP was triggered by a mantle plume or a bolide impact. The results show that PGE abundances and inter-element ratios do not support the bolide impact model for the origin of the OJP, consistent with the Os isotope evidence that massive volcanism resulting in the emplacement of the OJP triggered the Early Cretaceous oceanic anoxic event.

Keywords: Ontong Java Plateau, Oceanic Anoxic Event 1a, Os isotopes, Platinum Group Elements, Large Igneous Provinces, Early Cretaceous

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SVC007-05 Room:301B Time:May 27 15:45-16:00

Seismic reflection images in the northern part of the Manihiki Plateau

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Manihiki Plateau, located in the central Pacific, is one of the Large Igneous Provinces in the Pacific Ocean. The formation and evolution of this plateau is deeply related with Ontong Java Plateau and Hikurangi Plateau, and study on this plateau is important not only to understand the nature of these plateaus but also to develop a new formation model of the oceanic plateau. In September 2010 we conducted a research cruise in and around the northern part of Manihiki Plateau to obtain new geology and geophysics data with R/V Hakuho-maru of Japan Agency for Marine-Earth Science and Technology. We present here preliminary results from multichannel reflection seismic (MCS) survey carried out during this cruise. The MCS data were obtained along 6 MCS survey lines running across the Northern Basin, Northern Plateau and troughs around them. Total length of the MCS lines is approximately 360 nautical miles. A GI-gun and a 1200 m-long streamer cable was used as the source and the receiver array, respectively. Preliminary near trace seismic profiles show the variability of trough-fill sediments in this area; deeper troughs in the south of the Northern Basin were covered with acoustically transparent sediments, which was not observed in the shallower troughs located in the southwest of the Northern Basin and those around the Northern Plateau. In the northwestern end of the Manihiki Plateau, trough sediment reflectors were disturbed by patchy dim spots, which may suggest later volcanic activity or intrusion in this area.

Keywords: Large Igneous Provinces, Manihiki Plateau, seismic reflection survey

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SVC007-06 Room:301B Time:May 27 16:00-16:15

Oceanic plateau accretion viewed from greenstones in the Permian and Jurassic accretionary complexes in Japan: A review

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Mode of occurrence of greenstones in the Jurassic accretionary complexes (Mino-Tamba Belt) includes two major types; melange type and basal type (Koizumi and Ishiwatari, 2006; Is. Arc, 15, 58-). The melange-type greenstones occur as small (1 to 100 m size) blocks in melanges, but the basal-type ones occur as a large stratum of about 1 km thick and more than 100 km long in the basal part of a nappe. These occurrences correspond to rock chemistry such that the melange type includes N-MORB and OIB while the basal type consists mostly of homogenous E-MORB. The mixed occurrence of N-MORB and OIB suggests subduction-accretion of the thin (N-MORB) oceanic crust spotted with seamounts (OIB), while the homogenous, large E-MORB slabs suggest accretion of a thick oceanic plateau (ibid.). The oceanic plateau origin of the basal greenstones are further supported by the occurrence of ultramafic volcanic rocks such as meimechite (HFSE-rich picrite; Ichiyama and Ishiwatari, 2005; CMP, 149, 373-) and ferropicrite (Ichiyama et al. 2006; Lithos, 89, 47-) as well as related high-Ti basaltic rocks rarely with olivine-spinifex texture (Ichiyama et al. 2007; Is. Arc, 16, 493-). The association of voluminous, low-Ti, E-MORB (LTS) and high-Ti mafic-ultramafic volcanic rocks of HIMU affinity (HTS) correspond to that in oceanic plateau, possibly formed by a deep-seated, large-scale mantle plume (superplume) (Ichiyama et al. 2008; Lithos, 100, 127-). Tatsumi et al. (2000) already postulated mantle plume-origin of Carboniferous greenstones in accretionary complexes in SW Japan, but the age of superplume magmatism may also be Permian and in some places Triassic. Tatsumi et al. (1998) postulated a mid-Cretaceous superplume from greenstones of the Sorachi Group in Hokkaido. However, Takashima et al. (2002) postulated Late Jurassic marginal basin environment for volcanism of the Sorachi Group (or their Horokanai Ophiolite). Ishiwatari and Ichiyama (2004) reviewed Jurassic greenstones in Russian Primorye and the adjacent Northeast China, and pointed out that the late Jurassic meimechites occurs in the Late Jurassic-Early Cretaceous accretionary complexes, suggesting that the superplume magmatism happened very near to the subduction zone. We envisage that the Permo-Carboniferous superplume activity recorded in the Japanese greenstones happened in the middle of a large ocean, but the Jurassic superplume activity may have taken place near the subduction zone.

Keywords: accretionary complex, greenstone, oceanic plateau, Permian, Jurassic

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SVC007-07 Room:301B Time:May 27 16:30-16:45

Early stage of Shatsky Rise formation: Isotope-geochemical characterization (Sr, Nd, Pb and Hf) of Site U1347A

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The submarine Shatsky Rise plateau, a unique large igneous province (LIP) in the northwest Pacific Ocean ca. 1500 km east of Japan, is the only large intraoceanic plateau worldwide, which formed during the Late Jurassic to Early Cretaceous. Numerous reversals of the Earth's magnetic field during this time period caused alternating magnetic lineation in the ocean floor, which allowed a detailed reconstruction of the original tectonic setting. Accordingly the three main volcanic edifices Tamu, Ori and Shirshov massif formed along a southwest - northeast trending, rapidly spreading triple junction. However, Shatsky Rise shows characteristics for both a ridge-controlled an a plume head origin. Therefore the main objective of IODP Expedition 324 was to test both hypotheses (plume head versus ridge-controlled) for the plateau genesis.

During Expedition 324 five sites on all three main volcanic edifices have been cored. We present here first isotope-geochemistry results from the southernmost site U1347A, situated on the upper flank east of the summit of Tamu massif. The analyzed volcanic rocks were sampled from a depth range of 160 m to 300 m mbsf, and comprise relatively fresh basaltic lava flows, which occur as packages of pillow basalt and massive inflation units.

We present new Sr-Nd and Pb and for the first time Hf isotope data from Shatsky Rise. The 176Hf/177Hf isotopic composition is fairly uniform throughout the entire hole and ranges between 0.283130 and 0.283160, showing no distinct MORB or intraplate (plume) affinity.

Keywords: Shatsky Rise plateau, geochemistry, isotope data, Hf, Sr, Nd, Pb

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SVC007-08 Room:301B Time:May 27 16:45-17:00

Uplift and subsidence of Shatsky Rise: inferred from volatiles in fresh volcanic glasses

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Shatsky Rise is a late Jurassic-early Cretaceous oceanic plateau located in the northwestern Pacific. It consists of three major massifs: Tamu, Ori and Shirshov Massifs from southwest to northeast. The Rise is 1000km x 200km, similar in size to Japan. Magnetic anomalies indicate that massifs are younger at northeast and formed along the trace of a triple junction of the mid oceanic ridge. IODP Expedition 324 drilled five sites on Shatsky Rise, two on Tamu Massif (Sites U1347 and U1348; east flank and north flank), two on Ori Massif (Sites U1349 and U1350; summit and east flank) and one on Shirshov Massif (Site U1346; summit). Drilling results show the following evidences for shallow marine (and/or possible subaerial) eruption of Shatsky Rise magma: (1) Basal sediments contain shallow-water bioclastic material at Sites U1346, U1347, U1348 and U1349, (2) Basal sediments contain benthic foraminifera characteristic of neritic and/or upper bathyal environments at Sites U1346, U1347 and U1348, (3) Some lava flows are highly vesicular up to 80% at Sites U1346, U1347 and U1349, (4) A possible paleosol is present and highly oxidized and possibly subaerial alteration is found at Site U1349. We examined the shallow marine eruption of Shatsky magma more quantitatively by volatiles in unaltered fresh volcanic glasses from Sites U1347, U1348 and U1350. CO2 content of all volcanic glasses (~50 samples) are lower than 40 ppm and H2O content are ranging from 0.2-0.6 wt%. The eruption (degassing) depths calculated by H2O-CO2 contents of volcanic glasses (Newman and Lowerstern, 2002) are all less than 1000m. The average eruption depths of U1347, U1348 and U1350 were 800 +- 200m (n=21), 390 +- 20m (n=2) and 710 +- 130m (n=21), respectively. Our data indicate initial uplift and post-eruption subsidence of Shatsky Rise and subsidence ratios agree well with normal oceanic lithosphere.

Keywords: eruption depth, volatile, volcanic glass, Shatsky Rise

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SVC007-09 Room:301B Time:May 27 17:00-17:15

Magma variety and stratigraphy of Ori Massif, Shatsky Rise

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In order to examine magma genesis and evolution of large igneous provinces (LIPs), Integrated Ocean Drilling Program Expedition 324 cored ~470 m of igneous basement at four holes on Shatsky Rise, located ~1500 km east of Japan. The four basement holes are distributed on three volcanic massifs of Shatsky Rise (they are called Tamu, Ori, and Shirshov massifs from southwest to northeast); two holes on Ori Massif (Hole U1349A and U1350A) and one each hole on Shirshov (Hole U1346A) and Tamu (Hole U1347A) massifs. Geochemistry of ~130 fresh glass samples from the basement holes has indicated that Shatsky magmas are divided into three groups (Shimizu et al., AGU 2010 Fall Meeting Abstract U51A-0019); normal, low-Ti, and high-Nb (K) groups. Chemical compositions of the normal group are similar to those of normal mid-ocean ridge basalt (N-MORB), but slightly enriched (e.g., higher La/Yb than N-MORB). The fresh glasses and fresh whole rocks (LOI <1 wt %) of the normal group show an obvious chemical trend, which can be explained by a fractional crystallization of three phenocryst phases (olivine, plagioclase and augite) under low pressure ($<<200$ MPa) and nearly dry (water, 0.2-0.6 wt %) conditions. The crystallization temperatures are estimated to be 1130-1210 degree C. The low-Ti group has slightly lower Ti, Fe, Mn, V, Sr and Zr concentrations at the same MgO. The high-Nb basalts are characterized by their distinctly higher concentrations of incompatible trace elements (e.g., K, Nb, REEs) than the normal basalts, indicating that they were likely affected by enriched components. Examinations of the rock chemistry show that the three groups are simply discriminated by Nb/Ti ratio; normal group has low Nb/Ti (less than 0.00058), low-Ti group has middle Nb/Ti (0.00058-0.00071), high-Nb has high Nb/Ti (more than 0.00071). The discrimination method has strong merit that can be applied to altered rocks because both Ti and Nb are highly resistant to alteration processes.

The longest basement section (~173 m) among the Expedition 324 holes was recovered from Hole U1350A on flank site of Ori Massif. All three geochemical groups are present in the hole. On the basis of the basement morphology, the thick section is divided into three units; pillow and massive flows (unit II), hyaloclastite and breccias (unit III), and pillow lavas set in a matrix intercalated micritic limestone (unit IV). Unit II is subdivided into three subunits; upper massive-flow dominant unit IIa, transitional unit IIb, and lower pillow dominant unit IIc. The Nb/Ti of ~100 basement basalts (fresh glasses, lava flows and breccias) indicates that the normal group is the most abundant and occupies 64% of Hole 1350A. The high-Nb group is the second abundant (28%) and constitutes middle portion of unit IIa and most part of unit IIb. The low-Ti group (8% of the basement section) often appears adjacent to the high-Nb, implying that the origins of the two groups are closely related. One important note is that unit IIb consists only high-Nb and low-Ti groups (normal group basalt is absent). The geochemical examination shows that about 1/3 of the basement section is composed of non-normal basalts (high-Nb and low-Ti groups), which may indicate that the involvement of enriched components are important factors to discuss magma genesis of Shatsky Rise.

Keywords: Large Igneous Province, Integrated Ocean Drilling Program, plume, plate, oceanic plateau, magma

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SVC007-10 Room:301B Time:May 27 17:15-17:30

Bearing of Cr-Spinel in Basalt from Shatsky Rise on Primitive Melt Composition and Temperature

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Basalt from two of six sites drilled on Shatsky Rise, a Jurassic ridge-centered oceanic plateau in the NW Pacific, contains Cr-spinel. The two sites, U1346 and U1349, were respectively drilled near the summits of Shirshov and Ori massifs during IODP Expedition 324 in 2009, and despite intense alteration the rocks geochemically are the most primitive and least differentiated from all the sites of Shatsky Rise. The spinel is usually enclosed in altered olivine, but by and large has itself escaped alteration. From it, a general idea of the compositions of primitive and near parental melt compositions as well as melt temperatures can be estimated. Spinel at each site analyzed by electron microprobe has a limited range in CrNo = 100*Cr/(Cr+Al) ~ 50 at Site U1346 and lower, ~20, at Site U1349, but at each site spinel MgNo = 100*Mg(Mg+Fe[sup]2+[/sup]) is variable. Comparison with other spinel and experimental data indicates that spinel from U1349 crystallized at a pressure of ~1GPa, but from a range of moderately to strongly differentiated liquids with MgO ~ 9 to 4%, and at potential temperatures (at 1 GPa) of ~1250C. Aluminous spinel with highest MgNo resembles some found in abyssal tholeiites from Siquiros Fracture Zone on the East Pacific Rise. Similar mixing occurred at U1346, but at lower pressure. The liquids at both sites had MORB-like TiO[sub]2[/sub] contents but a somewhat wider range of oxidation states, to both higher and lower Fe3No = 100*Fe3/(Fe3+Al+Cr) in the spinel. The final lavas to erupt at two places on Shatsky Rise thus had neither high (picritic-liquid) MgO contents nor high potential temperatures during the earliest stages of their crystallization histories.

Keywords: oceanic plateau, chromian spinel, basalt, temperature, parental composition

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SVC007-11 Room:301B Time:May 27 17:30-17:45

Highly siderophile element geochemistry of high-Mg basalts from Pacific large igneous provinces

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Highly siderophile elements (HSEs: Re, Au, Ir, Os, Ru, Rh, Pt, Pd) and the Re-Os isotope system embedded within these elements are recognized as unique geochemical tools for assessing causal mechanism of large igneous provinces (LIPs), because they are potentially effective tracers of core-mantle interaction. HSE-rich signatures in some of the Ontong Java Plateau (OJP) basalts have been previously attributed to the involvement of outer core material in accordance with the plume-head model. However, the model is not universally accepted because other explanations, such as meteoritic contamination in the context of bolide impact model, cannot be rejected. Furthermore, the HSE enrichment could be simply explained by their high degrees of partial melting and be shared by other hot-spot volcanism and continental LIPs hosting major platinum-group mineral deposits. To date, geochemical behaviors of HSEs during magma genesis and evolution of oceanic LIPs are poorly constrained largely due to lack of comprehensive datasets.

In this study, we have developed a renewed analytical protocol that is suitable for small amount of basaltic sample powders (<2 g), with the aim of obtaining accurate $^{187}Os/^{188}Os$ ratios and HSE concentrations (except for mono-isotopic Rh and Au) for oceanic LIP basalts recovered by drilling program. The method includes the regular inverse aqua regia attack at 240 degree C in carius tubes followed by a desilicification step with HF in order to liberate HSEs contained in residual silicates. The effectiveness of our method, which includes the significance of the desilicification step, will be demonstrated by results of replicate analyses of basaltic reference materials BIR-1 and TDB-1 through the comparison of dissolutions with and without HF. We will discuss the possible causes of HSE variations in oceanic LIP magmas based on the data for (1) the high-Mg basalts from Hole U1349A on summit site of Ori massif of the Shatsky Rise (IODP Expedition 324) and (2) Kroenke-type basalts from the OJP (ODP Leg 192).

Keywords: Large Igneous Province, Integrated Ocean Drilling Program, oceanic plateau, plume, highly siderophile elements, Re-Os isotopes

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Boron and Chlorine contents of Shatsky Rise, North Pacific, and their implications for the alteration of oceanic plateau

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Oceanic crust is a large reservoir of Boron (B), Chlorine (Cl) and the other fluid-mobile elements. Investigation of these element contents of oceanic crust is necessary for clarifying the material circulation in the Earth and the alteration mechanism. Sea mount chain and oceanic plateau probably supply large amount of fluid to the mantle in plate convergent zones. However, little is known about the concentrations of B and Cl within the Sea mount and oceanic plateau. We therefore measured the B and Cl contents of the thick altered basalt sequences and fresh glasses in Shatsky Rise.

The B-Cl-K data show that low-temperature submarine alteration was dominant on altered rocks from Shatsky Rise, especially Site U1349 samples, as described below. The altered rocks have extensively higher B (up to 130 ppm) and B/K (up to 0.07) than fresh glasses (up to 5 ppm and 0.002, respectively). The high B contents in the altered rocks are most likely caused by the uptake of boron into secondary minerals in equilibrium with seawater at low temperature ($<$150 degree C). On the other hand, Cl contents of the altered rocks (33-1760 ppm) are nearly identical to those of fresh glasses (90-1100 ppm). The Cl data show that hydrothermal alteration was negligibly small on upper Shatsky Rise, because high Cl concentration of altered oceanic crust would be achieved during hydrothermal alteration at high temperature conditions (~400 degree C).

The extensive low-temperature alteration is also proposed by descriptions of secondary minerals in the altered rocks from the Shatsky Rise (Sager et al., 2010, Proceedings of IODP Expedition 324). The main secondary minerals are calcite and clay minerals, which can be candidates of high B contaminant of Shatsky altered rocks. Calcite (126 ppm in B) would not be main contaminant, because B/K of calcite ($>$0.7) is distinctly higher than that of contaminant ($<$0.07) that estimated by B/K of the Shatsky altered rocks. Thus clay minerals would be the main contaminant of the high B concentration of the altered rocks.

We also compared the B content of Shatsky Rise rocks to those of normal sea floor, Site 1179 located near the Shatsky Rise. The B contents of Shatsky rocks (up to 130 ppm) are significantly higher than the Site 1179 basement rocks (less than 40 ppm). This observation indicates that Shatsky Rise is important budget of B on the Pacific sea floor.

Keywords: Shatsky Rise, Boron, Chlorine

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SVC007-P01 Room:Convention Hall Time:May 27 10:30-13:00

Comparison between thermal demagnetization and alternating field demagnetization of basement basalts on Shatsky Rise

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During ocean drilling studies, many basaltic cores have been recovered and their paleomagnetism has been used to estimate age and make plate reconstructions. However, exact estimation has often been hampered by drilling induced overprint on the basaltic cores, which leads to equivocal interpretations. In order to understand how to remove drilling induced overprint, we have investigated the difference between thermal demagnetization and alternating field demagnization for samples recovered by ocean drilling. The samples are igneous rocks from Site U1349 recovered on Shatsky Rise during IODP Expedition 324. The Site U1349 basalts are highly altered massive lavas. Some samples appear to be altered under subaerial conditions. For the analysis, cubic samples (8 cc) were cut into multiple 1 cc cubic specimens, and only the specimens from inner part of the cubic samples were demagnetized to minimize the effect from the drilling overprint. We allocated at least two specimens from the same cubic sample: one for alternating field and the other for thermal demagnetizations for comparison. Analytical results show that some samples indicate 2 remanent components; one is the characteristic remanence which is directed towards the origin on the Zijderveld diagram, and the other is a vertical component which seems to be a drilling induced remanence. Alternating field demagnetization data showed a clear difference between characteristic remanence and drilling induced remanence. Vertically magnetized soft components induced by drilling were removed by alternating field at 10 mT. On the other hand, thermal demagnetization data showed overlapped unblocking spectrum of 2 components, and one sample showed that drilling induced remanence could not be removed completely up to 475 degree C. Traditionally, thermal demagnetization results have been preferred to use for directional analysis on paleomagnetism of oceanic basalts due to the self-reversal behavior. However, our results show that drilling induced remanence was well removed by alternating field demagnetization at 10 mT. These results indicate that alternating field demagnetization at low field before thermal demagnetization is a useful method to extract characteristic remanent magnetization in these rocks.

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SVC007-P02 Room:Convention Hall Time:May 27 10:30-13:00

Preliminary 40Ar/39Ar Ages of the Shatsky Rise, IODP Expedition 324

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The most crucial objective of IODP Expedition 324 to the Shatsky Rise is determining its age and evolution by applying high-precision 40Ar/39Ar geochronology. The achieved 160 to 180 m of penetration depths in the volcanic basement of the two main volcanic edifices on Shatsky Rise, the TAMU and ORI Massifs, have provided relatively fresh material (compared to dredge sampling) in Holes U1347A and U1350A. This presentation focuses solely on the outcome of a preliminary test run of 12 groundmass samples and 4 plagioclase mineral separates from a selection of stratigraphic units within these two holes, as carried out on our MAP 215-50 mass spectrometer in the 40Ar/39Ar geochronology laboratory at Oregon State University (USA). This preliminary test is required to establish in detail what the outgassing behaviors are of these very low ($<$0.1-0.2 wt%) K2O samples from Shatsky Rise, to estimate how much radiogenic 40Ar* has in fact been generated in these ~140-146 Ma samples, to determine how much the samples have been affected by alteration, and to allow us to high-grade the intricate sample preparation protocols accordingly. Following this preliminary test, the same samples (plus a large suite of additional samples) will be run again on a newly-funded multicollector ARGUS VI noble gas mass spectrometer. Because the sensitivity of the ARGUS VI system is at least 3 times higher when run in an all-Faraday multicollector mode or 20-30 times higher when run in the ion-counting discrete multiplier-mode, it is expected that these very low-K2O samples can be run using a smaller sample size while achieving higher precisions. The overall goal is to achieve age dates that are better than 0.5 Ma in 2 sigma precision and hopefully approaching the 0.3 Ma mark. This final project will be carried out in close collaboration with Drs. M. Widdowson and K. Heydolph. Together, we will provide key intercalibration results from two international 40Ar/39Ar geochronology laboratory using laserprobe incremental heating techniques.

Keywords: Age progression, Large Igneous Province, 40Ar/39Ar Geochronology, Jurassic, Pacific Plate, TAMU Massif

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Tectonic history of the Pacific-Izanagi-Farallon Triple junction before the formation of the Shatsky Rise

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Shatsky Rise is an oceanic plateau located about 1600 km east of Japan. The rise contains three large volcanic massifs that rise to depths of 3200-2000 m. All three have domes of Cretaceous pelagic sediments up to 1 km thick at their summits (Sager et al., 1999). The southern part of the rise has seismic velocity structures typical of oceanic plateaus: the layers are similar to oceanic crust but several times thicker (Den et al., 1969; Gettrust et al., 1980). The magnetic anomaly lineations from Late Jurassic to Early Cretaceous were identified around the rise (Nakanishi et al., 1999). The magnetic lineations are traceable through low parts of the rise between volcanic massifs, indicating nearly normal lithosphere, and between large volcanic edifices. Many lineations form bights near the rise axis and show former locations of the Pacific-Izanagi-Farallon triple junction. They indicate that the junction was in a ridge-ridge-ridge (RRR) configuration and closely followed the rise axis from chron M20 to chron M4.

Two histories of the formation of Shatsky Rise were proposed. One is that Shatsky Rise was formed by a mantle plume that captured a triple junction (Nakanishi et al., 1999). The appearance of a mantle plume caused a regional reorganization of the Pacific-Izanagi-Farallon triple junction. Simultaneously, the triple junction jumped northeast to the location of Shatsky Rise, annexing a piece of the Farallon plate and causing a short-lived microplate nearby. Subsequently, the triple junction remained near the mantle plume as shown by the confluence of magnetic lineations along the rise to chron M4. Shatsky Rise is the trace of the mantle plume on the Pacific Plate. The other is that Shatsky volcanism occurred because the triple junction jumped to a location underlain by a large volume of anomalously fusible shallow mantle (Sager, 2005). Decompression melting near the triple junction resulted from the reorganization of the plate boundaries.

To test plume head versus ridge tectonics models of the Shatsky Rise formation, it is necessary to expose detailed configuration of the plate boundaries among Pacific, Izanagi, and Farallon plates before the formation of Shatsky Rise. The geomagnetic and bathymetric measurements were conducted in three cruises by R/V Mirai in 1999, R/V Hakuho-maru in 2006, and R/V Yokosuka in 2008 to expose the plate boundaries configuration. Most of ship tracks were designed to identify magnetic anomaly lineations and to expose tectonic fabrics around Shatsky Rise. The detail bathymetric survey exposed the abandoned ridges southwest of Shatsky Rise. The new detailed identification of magnetic anomaly lineations revealed that the magnetic bights of lineations between chrons M22 and M21 do not exist. These observations indicate that the reorganization of the Pacific-Izanagi-Farallon triple junction started after chron M22 and did not synchronized with the formation of Shatsky Rise.

Keywords: Shatsky Rise, triple junction, mantle plume, Pacific Plate

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Tectonic fabrics of the Manihiki Plateau

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The Manihiki Plateau, which lies in the western equatorial Pacific Ocean, is considered to be one of the Cretaceous Large Igneous Provinces. The water depth of the plateau is at approximately 2500-4000 m and is several thousands meters shallower than the surrounding oceanic basins. Three major geomorphic plateaus, High, North, and Western plateaus, are discernible within the plateau itself. The depth of the Western Plateau, about 4000 m, is deeper than those of the other plateaus. The Danger Islands Troughs (DIT) and Suvarov Trough are the major linear deep narrow depressions within the plateau (Mammerickx et al., 1974). DIT separates the Western Plateau from the High Plateau to the east. DIT is thought to be a trace of the plate boundaries (Winterer et al., 1974). The age of the plateau is about 117 Ma (Ingle et al., 2007; Hoernle, et al., 2010). Several previous studies (Lonsdale, 1997; Billen and Stock, 2000; Hoernle et al., 2004) proposed the Manihiki Plateau rifted from the Hikurangi Plateau that is situated east of New Zealand at the present. On the other hand Larson et al. (2002) proposed that the Pacific-Farallon-Phoenix triple junction originated at the northwest corner of the Manihiki Plateau around 119 Ma and a volcanic episode around 123.7 Ma created the Manihiki Plateau with at least twice its present volume. Taylor (2006) and Davy et al. (2008) proposed that Manihiki Plateau, Hikurangi, and Ontong Java plateaus were formed from one mega mantle plume around 120 Ma. To expose the formation of the Manihiki Plateau, we collected bathymetric data by R/V Hakuho-maru in 2003, 2005, and 2010. In 2010, we conducted multichannel reflection seismic survey in the northern part of the plateau (Nakamura et al., this session).

The topographic expression of DIT is a trough bordered by ridges with a height of 2500 m above the floor of the trough. The depth of the northern part of DIT, north of 7 30'S, is 5900 m. That of the southern part is 4800 m. There is a seamount, which high is 2500 m, between the northern and southern parts of DIT. The floors of the troughs south of 7 35'S are almost flat. Seismic profiles indicate that the floors are filled with sediments as much as 1.0 s thick.

The 4700 m contours at the base of the eastern and western trough walls are approximately parallel to each other except for the landslide areas. Our detailed bathymetric map shows the 4700 m contour at the base of the eastern trough wall can fit in with those of the western wall. These observations imply NE-SW extension in DIT. There is the NE-SE trending seafloor fabric in the seafloor north of DIT. The tectonic fabric suggests that the seafloor was formed by an NE-SW extension occurred by an extensional shear zone. We do not have enough information to determine when the shear zone was active. If the shear zone was a part of the plate boundaries at the time of the formation of the Manihiki Plateau, DIT is thought to be a trace of an oblique spreading system or a leaky transform fault. This idea is similar to the Model I proposed by Winterer et al. (1974).

Keywords: Manihiki Plateau, abyssal hills, Pacific Plate