Japan Geoscience Union Meeting 2011
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シャツキー海台で掘削された玄武岩コアを用いた熱消磁と交流消磁の比較
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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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.

キーワード: Age progression, Large Igneous Province, 40Ar/39Ar Geochronology, Jurassic, Pacific Plate, TAMU Massif
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

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
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