

Japan Geoscience Union Meeting 2011

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SCG059-P01

Room:Convention Hall

Time:May 27 10:30-13:00

Seafloor geodetic observation on S/V "Takuyo"

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Japan Hydrographic and Oceanographic Department (JHOD) and Institute of Industrial Science, the University of Tokyo have been developing a system for precise seafloor geodetic observation with the GPS/Acoustic combination technique and deploying seafloor reference points on the landward slope of the major trenches around Japan, such as the Japan Trench and the Nankai Trough.

The past observations show intra/interplate crustal movements at seafloor reference points installed along the Japan Trench and the Nankai Trough, with the precision of less than 1cm/year. In addition, the co-seismic seafloor movement associated with the 2005 off Miyagi Prefecture Earthquake (M7.2) and series of crustal movements indicating the beginning of the reaccumulation after the release of crustal strain in the sea area were detected.

In 2008, JHOD installed the acoustic transducer on the bottom of the Survey Vessel "Meiyo" (550 tons) permanently and started the measurements for the sailing method for observing more efficiently and precisely.

JHOD also installed the new seafloor geodetic observation system on the S/V "Takuyo" (2,400 tons) in 2010. It is expected that the observations by "Takuyo" will be more precise in strong tidal area and the observations by JHOD will increase.

In this poster, we will report the system of sailing seafloor geodetic observation mounted on S/V "Takuyo" and the latest results observed by S/V "Takuyo".

Keywords: seafloor geodetic, GPS/A, seafloor reference point, acoustic ranging

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For Advance of Acoustic Ranging for Observing Ocean Crustal Deformation

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Magnitude 8 class interplate earthquakes have occurred in the Suruga-Nankai Trough with the recurrence intervals of about 100-150 years. To reveal process and estimate occurrence of offshore interplate earthquakes, repeated observation of ocean floor crustal deformation is performed there using the observation system using Kinematic GPS positioning and precise acoustic ranging.

There are next two problems for acoustic ranging caused by the delayed signal that is considered the measure signal reflected at the sea surface : 1) cross-correlation coefficient on the true arrival time relatively drops, and the number of observation data decreases, and 2) the delayed signal causes cross-correlation coefficient on the true arrival time to be smaller than that on the lag time, and true arrival time is estimated wrongly. We must develop a method to perform cross-correlation computation automatically in order to determine true arrival time and to use data containing delayed signal. In this study, we performed numerical experiment of composing multiple waves to verify variation of cross-correlation coefficient depended on amplitude rate and delay time of direct and delayed signal.

We made the theoretical reference wave of the fifth-order M-sequence wave with six cycle carrier waves per unit digit same as measure signal. Considering composed two waves assuming reflection once at the sea surface, we combined the reference wave with delayed wave with delay time, DT. Performing cross-correlation procedure with the combined wave and reference wave, we got cross-correlation coefficient CC1 at the arrival time of direct wave and CC2 at the arrival time of reflected wave. Varying the amplitude ratio of reflected wave relative to the direct wave from 0 to 1, we verified the variation of two cross-correlation coefficients. In the same way, considering composed four waves assuming reflection twice at the sea surface, we the verified variation of three cross-correlation coefficients. Delay time of third reference wave supposed as reflected twice signal is 2DT, and cross-correlation coefficient at the arrival time of twice reflected wave is CC3. DT was varied from 1 to 3 because delay lag of observed wave is this variation.

Combining two waves assuming once reflected wave suggested that delayed wave drop cross-correlation coefficient at the true arrival time relatively to decrease useful data. Numerical experiment proved that CC1 changed from 0.7 to 0.75 when we combined direct wave with reflected wave with the ratio of 1 to 1. We can expect increase of data with cross-correlation coefficients less than the threshold 0.7 because CC1 easily drops less than 0.7 due to some noise. Therefore cross-correlation coefficient of returned signal containing delayed signal decreases caused by measure wave oneself reflected at the sea surface.

For the case of four waves assuming twice reflected wave, CC1 could be less than CC2, and arrival time was read wrongly. CC1 equals CC2 in the only case of combining direct wave with reflected wave with the ratio of 1 to1. Actually, CC1 is larger than CC2 because the theoretical reflectance the sea surface is less than 1.0. CC1 was less than CC2 and CC2 was larger than CC3 in every DT on experiment of combining four waves when the ratio of direct wave, once reflected wave and twice reflected wave was 1 to 2 to 1, respectively. CC1 was sometimes less than CC3. Therefore DT on which it is showed $CC1 < CC3 < CC2$ existed, and we demonstrated numerically that CC1 could be minimum. For the actual data of observed returned signal, second peak of cross-correlation coefficient was found in time $DT=2.5ms$. This fact is consistent in the result of numerical experiment. In consequence, it is caused by measure signal oneself reflected twice at the sea surface that cross-correlation coefficient at the true arrival time was not maximum so that arrival time was read wrongly.

Keywords: Ocean Crustal Deformation, Acoustic Ranging, Advance of Precision, Reflected Signal at the Sea Surface, Cross-correlation Procedure, Numerical Experiment

SCG059-P03

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Layout of buoys and seafloor transponders for next-generation measurement system for ocean floor crustal deformation

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We are developing a geodetic method of monitoring crustal deformation under the ocean using kinematic GPS and acoustic ranging. We deployed benchmarks on ocean floor and determine the positions of them by acoustic ranging from vessel whose position is determined by kinematic GPS technique. Ultrasonic signals are generated from the surface vessel drifting over the benchmarks that replies the signals. Both sound speed structure and the benchmark unit positions are determined simultaneously using a tomographic technique from the two way traveltime of the ultrasonic signals.

We repeatedly carried out measurements at several sites around Nankai trough, South eastern part of Japan. Now the horizontal repeatability is about 3 cm. Although a few measurements in one year enable this repeatability to detect stable deformation rate of the crust due to subduction within few years, unstable temporal variations or faint changes cannot be detected. To monitor the focal area of coming plate boundary earthquakes, real-time monitoring is desirable.

Therefore, we are designing a moored buoy-based next generation measurement system, with which we can continuously monitor the ocean floor crustal deformation.

In the new system, buoys have all the functions which the ship has in the present way. But we need to consider that the positions of the buoys are controlled not by us but by current. We can control only the area of drifting by designing the length of the mooring cables and the buoyancy of the buoys. If we want to make the buoy stable around one point, we can make the cable short but we must make the buoyancy large to avoid sinking by the current, which requires more cost. An appropriate designing of length of the cable and buoyancy is very important.

We theoretically investigated the relationship between buoy-transponder geometry and the accuracy of transponder positioning. We assumed a system consisting of combination of three transponders and three buoys. We calculated the joint probability density function (j-pdf) of the weight center location of the benchmarks, which were called from three buoys in half space homogeneous sound structure, from the synthesized travel time. We defined the FWHM for the peak of j-pdf as an accuracy of the positioning, and then calculated this accuracy with various depths of the benchmarks and geometries of the measurement system.

As a result, we understand relationship between the accuracy of benchmark positioning and the configuration as follows:

1. The appropriate expanse of the benchmarks is about square root of 2 times of the depth.
2. The two triangles by benchmarks and the buoys are preferable being staggered.
3. The accuracy of the benchmark positioning can be kept in the range of 10% worse than the best.
4. If the buoy configuration distorts, 30% shortening of the length of the side makes the accuracy of the positioning 40% worse.

The results suggest that the benchmark positioning accuracy is less robust with distortion of the buoy configuration than with simple shift keeping their configuration. We should design the length of the cables and buoyancy of the buoys to keep the horizontal motion of the buoys not to distort the triangle more than 30% to keep the accuracy in the range from 0 to 40% worse than the best one.

In this study, we investigated the accuracy on assumption that the velocity structure is half-space homogeneous. In addition, we should check up the appropriate number and geometries of the buoys in the case which sound structure changes in space as well as in time.

Acknowledgement: This research was promoted by a project of the Japanese Ministry of Education, Culture, Sports, Science, and Technology. Trajectory data of moored buoy was provided by Dr. M. Kido, Tohoku University. We appreciate it very much.

Keywords: Buoy, Ocean floor crustal deformation, Acoustic ranging, GPS, Transducer

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SCG059-P04

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Microseismicity around the Chile Triple Junction revealed by Long-Term OBSs

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The Chile Triple Junction (CJT) is positioned on the Chile trench. At the CJT, spreading ridges of the Chile ridge system between the Nazca plate in the north and Antarctic plate in the south subduct beneath the South American plate. Because the southern edge of the source region of the 1960 Chile earthquake is close to the CJT, to obtain coupling between the plates is useful to consider expanse of the 1960 earthquake source region. We carried out an earthquake observation in the CJT region using Long Term Ocean Bottom Seismometers (LT-OBSs). Objectives of the observation are to obtain precise seismic activity and seismic structure around the CJT. Furthermore, to reveal deep structure is one of aims of the observation by using tomography and receiver function analysis. Long term seismic monitoring using the LT-OBSs increases reliability of results because many events can be observed.

The LTOBS was developed at the Earthquake Research Institute (ERI) of the University of Tokyo. A three-component 1-Hz seismometer is installed and seismic signals are sampled at 100 Hz using a 20-bit A/D and record the digitized data continuously on the hard disks for one year. All the components are contained in a 50-cm diameter sphere that is made of titanium alloy. The acoustic transponder for LTOBS has the functions of communication, interrogation and anchor release. An observation area is off Taitao peninsula, Chile where the ridge is subducting. The deployment of the LT-OBSs was performed on 1 March 2009 during the RV Mirai MR08-06 cruise. Due to complex seafloor topography, the topography survey using multi-narrow beam acoustic sounder was carried out to determine deploy positions. Since there was no sea floor observation in the study area, spatial intervals of five LT-OBSs were set to be approximately 30km. After the deployment of the LT-OBSs, small airgun was shot along profiles which connect deployed positions of the LT-OBSs. Simultaneously, a hydrophone streamer was towed to collect reflection data. In March 2010, all the LT-OBSs were recovered by the rescue-salvage ship of the Chilean Navy. After the recovery of the LT-OBSs, reproduction of the data were performed on processing system. Many microearthquakes were recorded and arrival times and P- and S-waves were picked up. From preliminary hypocenter location, 167 events are located within the observation network. Typical seismicity in spreading center is seen in seaward side of the trench. This indicates that the oceanic plates are subducting with spreading of two oceanic plates.

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SCG059-P05

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Imaging of initial structure in Izu-Ogasawara arc obtained by seismic reflection experiment

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It is important to investigate crustal reconstruction for understanding arc evolution. To obtain the knowledge of arc evolution, we should investigate the condition of initial arc crust. In Izu-Ogasawara forearc region, it is known to locate the outcrop of initial arc crust by submarine study. Therefore, Japan Agency for Marine-Earth Science and Technology carried out seismic reflection and refraction surveys in Izu-Ogasawara forearc region in KR10-13 and KR11-01 cruise. Onboard preliminary results show the concave basement along Ogasawara Trough and thin sediments. In this meeting, we will report the preliminary MCS results in these cruises.

Keywords: MCS survey, IBM forearc, initial arc structure

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SCG059-P06

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The configuration of paleo-arc in Izu-Ogasawara forearc region

Mikiya Yamashita^{1*}, Naoto Noguchi¹, Shuichi Kodaira¹, Narumi Takahashi¹, Seiichi Miura¹, Yoshiyuki Tatsumi¹

¹JAMSTEC

In Izu-Ogasawara forearc region, it is known to exist two paleo-arcs formed in Oligocene and Eocene age (e.g. Taylor, 1992). It is important to investigate the configuration of these paleo-arcs for understanding of the crustal evolution by backarc rifting. Japan Agency for Marine-Earth Science and Technology has been carried out seismic refraction and reflection survey using 90 OBSs on Izu-Ogasawara forearc region in 2010 (KR10-13 cruise) for understanding the configuration of paleo-arc along from Shinkurose to Ogasawara Trough. Obtained preliminary results show the clear reflection from seamount and sediments in forearc basin.

Keywords: MCS survey, Paleo-arc, rifting

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Multichannel seismic reflection experiment across the southern end of the Nansei-Shoto trench-arc-backarc system

Noriaki Izumi^{1*}, Daishi Horiuchi¹, Kentaro Kaneda¹, Azusa Nishizawa¹

¹JCG

The Nansei-Shoto trench-arc-backarc system to the south of Kyushu, Japan, is characterized by the Okinawa Trough, as a backarc basin, where continental rifting is incipient.

We have carried out a multi-channel reflection experiment to obtain detailed seismic images across the Nansei-Shoto trench-arc-backarc system since 2008.

International cooperative seismic exploration of Taiwan, the United States and France was conducted to elucidate the seismic structure to the west of Yonaguni-jima Island in the southern end of the Nansei-Shoto trench-arc-backarc system (Liu et al., 1995). They pointed out that the crustal structure in the forearc region is influenced by subduction of the Gagua Ridge which is a N-S trending topographic high to the south of the Nansei-Shoto Trench. However, there is almost no investigation aiming at grasp of the deep structure to the east of Yonaguni-jima Island and subducting Gagua Ridge.

We obtained the multi-channel seismic data across the Nansei-Shoto Island arc and backarc by using a 240 channel hydrophone streamer cable of 3000 m in length, shooting a 3-gun cluster airgun, 5.7 liter (350 inch³)x3 in a total volume, at an interval of 50 m. The survey line of north-south direction was designed to cross the southern part of the Yonaguni Submarine Graben in the south of the Okinawa backarc basin and the Okihateruma forearc basin (East Nan'ao Basin).

The obtained seismic reflection profile showed that a thick sedimentary layer with a thickness of about 2 sec two-way travel time in the forearc basin to the east of Yonaguni-jima Island. The sedimentary layers with almost horizontal reflectors in the upper part on-lap the forearc basement. Horst-and-graben structures in the northern part of the island arc and many intrusions in the trough sedimentary layer are identified, which shows same features obtained to the west of Yonaguni-jima Island by (Liu et al., 1995).

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Features of Multi-Channel Seismic profile in the middle Okinawa Trough

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¹JHOD, JCG

The Okinawa Trough (OT) is a backarc basin accompanying with the Nansei-Shoto arc-trench system. Both of the Nansei-Shoto Island Arc and the OT are divided into northern, middle and southern parts by Tokara Gap, Kerama Gap and their extensions to the northwest. The northern OT has shallow water depth and shaving the trough slope, and the direction of trough axis is NNE-SSW. In contrast, the southern OT has deep water depth and steep trough slope, and the direction of the trough axis is ENE-WSW. The origin of these differences of geomorphic characteristics is presumed that the rifting stage is more advanced in the southern OT than in the northern OT.

Japan Coast Guard has been carried out seismic refraction and multi-channel seismic (MCS) reflection surveys on several survey lines along and across the trench-arc-backarc system to obtain rifting structures, which give further information for estimating the formation process of Nansei-Shoto Island Arc and OT. Japan Coast Guard conducted seismic refraction and MCS reflection surveys on the NW-SE survey line across the trough axis in the middle OT from April to May, 2010. The survey line lies between shallow sea terrace of East China Sea in the northwest and offshore of Tokunoshima Island in the southeast.

According to the MCS profile, the trough slope in the northwest part of the survey line has thick sediment layers with a thickness of more than 5 sec two-way travel time and any normal faults with their throws to the southeast fall cut the thick sediment layer. The trough bottom has thick sediment layers with a thickness of more than 2 sec two-way travel time and many normal faults of southeast fall in northwest region and northwest fall in southeast region cut the thick sediment layer.

The transition area of faults with their throws to the southeast to the northwest locates more closely the trough slope in the northwest of OT than the trough axis estimated from topographic data.

Keywords: Multi-Channel Seismic profile, backarc basin, Okinawa trough

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Refined crustal structure of Ogasawara Plateau - keys to estimate its formation process

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¹Japan Coast Guard

The Ogasawara Plateau is a conspicuous topographic feature on the northwestern Pacific Basin, with an area of larger than 40,000 square kilometers. Its top is approximately with a depth of 1000 m, relatively >4000 m higher than surrounding flat deep oceanic floor. Previous studies revealed that the plateau was covered with thick Cretaceous carbonates and located on the late Jurassic oceanic seafloor, indicating that igneous formation of the Ogasawara Plateau occurred within Late Jurassic to Cretaceous periods.

However its accurate formation model has not been constructed yet. Did concentration of intraplate igneous activities, similar to volcanism forming many seamounts around the Ogasawara Plateau, in the limited area contribute to form its large body? Or did a large-scaled igneous activity occur during a short period?

Japan Coast Guard conducted large-scaled seismic reflection experiments with multi-channel streamer cable and refraction experiments with ocean bottom seismographs on the Ogasawara Plateau with four long survey lines which total length exceeds 2,000 km. Our former seismic data analysis made clear important results that crustal thickness of the Ogasawara Plateau is >20 km, similar to that of the Izu-Ogasawara arc, and that the Ogasawara Plateau seems to collide with the arc on the Philippine Sea plate at a trench. However crustal structure of the plateau has not been analyzed well in detail. To estimate a formation process of the Ogasawara Plateau, a more accurate analysis in a velocity structure of the plateau crust was applied. Its result shows layered structure of the Ogasawara Plateau crust and will give important keys not only to construct its formation model but also to reveal what it is.

Keywords: crustal structure, Ogasawara Plateau

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Volcanic history and surrounding oceanfloor of the Marcus Island, Western Pacific

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Most of seamounts on the western Pacific Plate formed before 70 Ma in the so-called West Pacific Seamount Province (WPSP) which is characterized by relatively short seamount chains maybe indicating a significant short-lived hotspot system (Koppers *et al.*, 2003). The geochronological studies of each Cretaceous seamount, on the other hand, show the long-lived main shield stage of volcanism, because a seamount remained above a hotspot for a long time (approximately 10 m.y.: Hirano *et al.*, 2002). This may be attributed to either of the following two possibilities: 1) An abundant heat supply as in the superplume episode in the Early Cretaceous (Cox, 1991; Larson, 1991; Larson and Kincaid, 1996). 2) Slow absolute motion of the Early Cretaceous Pacific Plate (3-6 cm/yr.) (Duncan and Clague, 1985; Henderson *et al.*, 1984).

The research cruise using R/V *Yokosuka* equipped with the submersible *SHINKAI 6500*, was conducted around the Marcus Island (Minamitori-shima) on May 2010 in order to know the detail history during the formation of the Marcus Island. The shipboard multibeam acoustic surveys showing the detail bathymetry discovered the volcanic cones on seamount slope and the clusters of small conical volcanoes on surrounding abyssal plain (Oikawa and Morishita, 2009; This study). Most of cones are several hundred meters in height and 1-10 km in diameter. We observed the stratigraphy of Cretaceous volcanoes near the Marcus Island using the submersible *SHINKAI 6500*. Highly vesicular lavas were sampled at the volcanic cone on the seamount slope. The olivine-bearing dense lavas, on the other hand, were obtained at the steep slope beneath the lava platform in bathymetry, implying main-shield stage lavas in contrast to volcanic cones probably erupted at the rejuvenated stage during the Marcus Island formation.

Keywords: Pacific plate, Marcus Island, seamount, hotspot, Cretaceous, alkali basalt

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New geophysical data obtained from the southern part of the West Philippine Basin and the Palau Basin

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The West Philippine Basin (WPB) occupies western part of the Philippine Sea Plate (PSP). The spreading history of WPB has not yet been well understood despite accumulation of studies since 1970s. The origin of WPB was first proposed by Uyeda and Ben Avraham [1972], which proposed that WPB was formed by entrapment of a segment of the Kula-Pacific Ridge in the middle Eocene. Hilde and Lee [1984] and Jolivet et al. [1989] supported the entrapment model. On the other hand, a backarc origin model of WPB was proposed by Lewis et al. [1982], Seno and Maruyama [1984], and Deschamps and Lallemand [2002]. Deschamps and Lallemand [2002] compiled bathymetry, paleomagnetic data, and seafloor age, and suggested that WPB is a back arc basin that had developed between two opposed subduction zones from about 54 to 30 Ma, and that rollback of these trenches provided the driving force for the spreading. They also suggested that WPB underwent a clockwise rotation through the opening, and that the direction of the spreading rotated counter-clockwise. However, the deficiency of the data south of spreading center (Central Basin Fault, CBF) hampered testing this mode.

In this study, we compile bathymetry and magnetic anomaly data of the southern part of WPB and the Palau Basin, which occurs to the south of WPB bordered by the Mindanao Fracture Zone. The dataset includes data from previous cruises of R/V Mirai, and newly obtained data during R/V Yokosuka YK10-14 cruise. The strike of abyssal hills near CBF in WPB is close to E-W, whereas that of the southern part near the Mindanao Fracture Zone is nearly NW-SE. This suggests that the spreading direction of WPB changed counter-clockwisely with time as suggested by Deschamps and Lallemand [2002]. Three component magnetic anomaly data in the Palau Basin suggest occurrence of magnetic lineations close to N-S in strike. Together with N-S trending abyssal hill morphology, it is considered that the Palau Basin was formed by seafloor spreading of an E-W direction.

Keywords: magnetic anomaly, seafloor spreading, Philippine Sea Plate, West Philippine Basin, abyssal hill

SCG059-P12

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Magnetic anomaly mapping and rock-magnetism of seafloor rocks at the hydrothermal sites in the southern Mariana Trough

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Magnetic anomalies observed in the ocean are basically originated from the variation of magnetization of oceanic crust. Hydrothermal vent activity is a possible cause of reduction of magnetization intensity in the small scale due to alteration of oceanic crust by the fluid circulation. In order to detect magnetic signals resulted from the variations of crustal magnetization under the hydrothermal vent sites area in the southern Mariana Trough, the magnetic field at the hydrothermal sites were measured by using the AUV URASHIMA during the cruise YK09-08.

Three components of the magnetic field were measured by using four fluxgate magnetometers attached to the AUV along the survey lines of 100-300m height from the seafloor. Crustal magnetizations were calculated from downward component of magnetic anomalies assuming a constant thickness source layer (250m). Some of the hydrothermal sites show lower magnetization than those of the surrounding areas. These low magnetization areas suggest that the basaltic rocks have been altered by hydrothermal activities.

In the cruise of Taiga10M, 1-4 m length cores were collected from the seafloor rocks using the BMS (Boring Machine System) of the Hakurei-Maru No. 2. Also, in the nine dives of SHINKAI-6500 during the cruise YK10-11, rock samples were collected from the seafloor. We have been studying remanent magnetization and basic magnetic property of these samples. Preliminary data show that remanent magnetization intensities of fresh basalts are 20-80 A/m and those of altered basalts are of the order of 1 A/m. These measured rock-magnetic data can be used in calculation of crustal magnetization and thus provide a better understanding of the geological structures of the hydrothermal sites.

Keywords: Mariana, hydrothermal activity, magnetic anomaly, rock magnetism

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Study of submarine volcanic activity at the 17N Mariana Trough back-arc spreading axis

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This paper presents the results of detail mapping of volcanic products and tectonic features of the axial valley floor in the 17N segment, Mariana back-arc spreading axis based on the observations of Shinkai6500 submersible.

Submersible observations dive 1088 and 1089 are consistent with the interpretation of side scan sonar (SSS) image analyses. However, high-backscatter regions in the dive track of 1090 are underlain by pillow lava, indicating the intensity of backscatter does not always give consistent results with the lithofacies.

General trends of faults, fractures and cracks are 165E and 170E, which are subparallel to and oblique to the spreading axis, respectively. In addition to these, faults, fractures and cracks running at high (Type 1) and acute (Type 2) angles to the spreading axis are present.

Cross cutting relationships between these tectonic features indicate the order of formation from Type 2, Type 1 to Type 3. Type 3 is observed on the latest volcanic products.

Sheet flows do not exist on slopes steeper than 9 degree, where pillow flows dominate, indicating that lava morphology depends on the slope of the basement.

SCG059-P14

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REE composition of submarine volcanic rocks in the southern Mariana Trough

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Rare earth element composition was analyzed for submarine volcanic rocks taken from the southern Mariana Trough to evaluate the characteristics of source magmas related to the rifting and spreading of southern end of the trough.

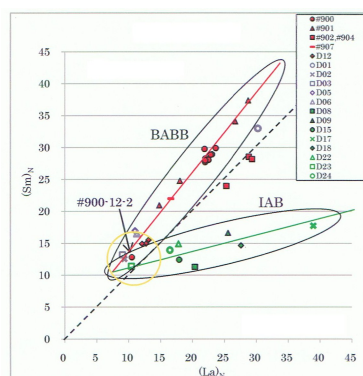
Mariana Trough is a back-arc basin formed in association with the subduction of Pacific Plate beneath Mariana ridge. The southern Mariana Trough is topographically high and flat compared with the middle and north region of the trough. In the studied area, at least three sets of back-arc spreading ridge, and presently active ridge is on the edge of the trough adjacent to the active arc volcanic chain. The active back-arc ridge is separated into three segments, and magma chamber was recognized beneath the boundary between northern two segments. Four rift zones are found on the southern end of the trough, and the most eastern one is presumed to be most active.

Rare-earth elements were analyzed using ICP-MS applied to combination of In-internal standard and standard addition methods. Analytical error was checked using JB-1a, and that of each element concentration was smaller than 5% except Tm and Lu, which were less than 7%.

Volcanic rocks obtained from the active back-arc ridge are basalt and andesite, of which SiO₂ concentration is 50-60%. CI-normalized REE composition patterns of those rocks are similar to that of N-MORB while La and Eu are slightly depleted. Fresh quenched glass layer without Mn coating was recovered from the southern end of active ridge, and the REE pattern of this rock is also similar to N-MORB. Chemical compositions of rocks from the ridge crest just above the magma chamber and the southern end are similar to each other, and the lowest SiO₂ and REEs concentrations among studied back-arc volcanic rocks indicate the most primitive composition of source magma of this area. All rocks except one from remnant ridges at the center of the trough give the REE patterns similar to that of N-MORB.

Volcanic rocks from submarine volcanoes on the four rift zones at the southern end of the trough are basalts, of which SiO₂ concentration is 48-51%. They give LREE-enriched REE patterns except one sample, which was taken from the easternmost zone. Among those rocks concentration of REEs decreases toward the east. The rocks taken from the three different seamounts on the easternmost rift zone, and the rocks from two seamounts give LREE-enriched arc like REE pattern, while, the other gives N-MORB like REE pattern. Normalized La/Sm ratio of the rocks from the rift zones can be plotted on the line having trend of about 4, and one of the endmember ratio is concordant with that of primitive back-arc volcanic rock. The La/Sm ratio becomes higher with increasing SiO₂ concentration, while negative Eu is not observed. Thus, the island-arc volcanic rocks of the studied area have the same source magma as the back-arc volcanic rocks, and the degree of addition of crustal material would be different to verify the chemical composition.

One volcanic rock taken from the easternmost rift zone has N-MORB like REE pattern and similar major chemical composition to the back-arc volcanic rock taken from the southern end of the active back-arc spreading ridge, indicating that spreading has already started at the easternmost rift zone, and probably, the southeastern end of the Mariana Trough is active back-arc volcanic zone.



SCG059-P15

Room:Convention Hall

Time:May 27 10:30-13:00

Estimation of dose-rates for Mariana hydrothermal sites and comparisons with laboratory measurements

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The Mariana Trough is a present-day spreading backarc basin behind the Mariana Trench, where the Pacific Plate subducts under the Philippine Sea plate. The Mariana Trough is also characterized by active hydrothermal circulation with heat and chemical fluxes from the seafloor. Determination of the timescales of hydrothermal activity in the Southern Mariana trough has become important after the discovery of large hydrothermal plumes, with sudden changes in hydrothermal and volcanic activity in the sea floor. The long-term change of hydrothermal activities is also interesting in respect of ore formations. A systematic geochronological study of hydrothermal activities has not been possible due to the lack of methods which cover the age ranges of interest. In light of this, Electron Spin Resonance (ESR) dating of barites (BaSO₄) has been attempted in chimneys deposited from hydrothermal vents at the Archean site in the South Mariana spreading center and in the Okinawa Trough.

Estimation of ESR ages requires evaluation of onsite annual dose-rate estimation or laboratory measurements of radioactivity. Gamma spectroscopy of samples can be performed using scintillation or semiconductor detectors. Semiconductor detectors such as HPGe have high resolutions (~0.5% at 662 keV), but require cooling at liquid Nitrogen temperatures, and have lower efficiencies in comparison to scintillation detectors. We used a NaI(Tl) scintillation detector for measurements of gamma spectra at the Archean, Urashima, Pika and Snail deep sea hydrothermal sites. The relative dose-rate values are nearly two orders of magnitude higher than background at the Archean sites, and at least an order of magnitude higher at the Urashima site. Furthermore, a correlation was observed between rock type and relative dose-rate at all hydrothermally active sites. At the Archean sites, dose-rates values for dead chimneys were two orders of magnitude higher than background values. However, dose-rates for basalts from Archean and Snail sites were around a factor of 10 higher than background values. At the Pika site, the basalt dose-rates were only a factor of two higher than background. Our presentation will also provide estimates of dose-rate for three samples based on laboratory measurements of U, Th and K using high resolution gamma spectrometry, and investigate the correlation between relative dose-rates estimates with laboratory estimates.

Keywords: radiation, Southern Mariana, ESR, dating, radon

SCG059-P16

Room:Convention Hall

Time:May 27 10:30-13:00

Optical dating of quartz from hydrothermal sites in Middle and southern Okinawa Trough

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The Okinawa Trough is a 1200 km long, northeast-trending basin behind the Ryukyu Arc (Ishibashi et al. 1988). Since it is a back-arc basin in early spreading, modern submarine hydrothermal activity and mineralization have many characteristics which have aroused wide attention. The long-term change of hydrothermal activities is of interest in respect not only of ore formations but also of evolution of biological communities supported by the hydrothermal activities. Submarine hydrothermal fluids from the Okinawa Trough tend to be strongly influenced by interaction of the hydrothermal fluids with organic matter in the sediment resulting in high alkalinity and NH₄⁺ concentrations of the fluids (Glasby and Notsu, 2003). The fluids also contain high concentrations of CO₂ of magmatic origin. A systematic geochronological study of hydrothermal activities has not been possible due to the lack of methods which cover the age ranges of interest.

This paper presents initial results of feasibility studies to date quartz grains from two cores collected from Tarama Knoll, and the Izena Cauldron in the Middle and Southern Okinawa Trough. We extracted quartz from both core samples using standard chemical procedures, and subsequently used the SAR (single-aliquot regenerative) method for estimating the OSL (optically stimulated luminescence) equivalent dose. Preliminary results indicate an equivalent dose of ~6 Gy for the 1108-MB sample from the Tarama Knoll. For the core sample from Izena Cauldron, equivalent doses have been observed to have a bimodal distribution, and the average equivalent dose based on 9 aliquots is ~40 Gy. Dose-rates were estimated from K, U and Th measurements using a low background pure germanium gamma ray detector. The presentation will highlight OSL methodologies, and present preliminary ages of hydrothermal activities in the Middle and Southern Okinawa Trough at the above two sites.

References:

- G. P. Glasby and K. Notsu, 2003, *Ore Geology Reviews*, 23, 299.
J. Ishibashi et al., 1988, *Geochemical Journal*, 22, 107.

Keywords: Okinawa Trough, dating, OSL, quartz, hydrothermal activity

SCG059-P17

Room:Convention Hall

Time:May 27 10:30-13:00

Spatial scale of hydrothermal circulation in the Iheya north site, inferred from heat flow and other data

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¹Graduate School, Kocjho Univ., ²JAMSTEC, ³Univ. Hawaii, ⁴Arizona State Univ.

Numerous surface heat flow data were obtained during 2002-2008 in the area of the Iheya-North hydrothermal field in the middle Okinawa Trough, in order to clarify the spatial extent of the hydrothermal circulation system. In 2010, Drilling study was carried out during IODP Expedition 331, and new subbottom temperature data were acquired around the hydrothermal site.

Within a small basin surrounded by knolls, three distinct zones are identified with different heat flow values, which we termed the high-, moderate-, and low-heat-flow zones. In the high-heat-flow zone located near the western edge of the basin, extremely high and widely scattered heat flow values were measured within ~500 m of the active hydrothermal mounds, venting black smoker fluid of maximum 311 degC. With increasing distance east of the high-heat-flow zone, heat flow gradually decreases from 1.0 to ~0.1 W/m² in a region where surface sediment is dominated by clay and a high-resolution bathymetry indicates a smooth seafloor surface. We term this area the moderate-heat-flow zone. Further to the east (~2 km from the high-heat-flow zone), the seafloor consists of coarser sediment with a rugged surface, and heat flow is very low (<0.1 W/m²), as designated the low-heat-flow zone. We suggest that such anomalously low heat flow can be explained by the recharge of seawater into the formation, and that hydrothermal vents or diffuse flow in the high-heat-flow zone can drive this kilometer-scale hydrothermal circulation within the Iheya-North knoll complex, if the sediment below the moderate-heat-flow zone is impermeable enough to prevent vertical fluid migration but is permeable enough to encourage horizontal flow.

2-dimensional numerical simulation was conducted to estimate possible permeability structure, including impermeable surface layer and permeable zone below. We report results from numerical simulation as well as new IODP data.

Keywords: hydrothermal circulation, Okinawa Trough, Iheya north field, heat flow, IODP

SCG059-P18

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Time:May 27 10:30-13:00

Release of elements from basaltic rocks at high temperature and high pressure using a flow-type hydrothermal apparatus

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Hydrothermal fluids with a variety of chemical characteristics are generated in the sub-seafloor by reaction of various rocks with seawater under various physical conditions. Chemical diversity of the hydrothermal fluids leads to phylogenetical and physiological diversity of microbes thriving there (Nakamura and Takai, 2009). Experimental evaluation of water-rock reaction under the seafloor is needed to better understand deep-sea hydrothermal systems (Suzuki et al., 2009). To date, many experiments using batch system have been performed. However, there are few experiments using flow system simulating natural environments. Our goal is to develop a flow-type hydrothermal apparatus, to put it to practical use, and to understand marine hydrothermal system better.

We developed a flow-type hydrothermal apparatus that consists of HPLC pumps (flow rate: 6?600 ml/h), a preheating bath (SUS316, 100 ml), a water-rock reaction bath (hastelloy C276, 390 ml) and a cooling bath (SUS316, 5 l). The preheating and reaction baths are equipped with a heater (maximum temp. 300°C and 500°C, respectively). This apparatus can be operated at a pressure up to 50MPa. In the present experiments, the following settings were used: 6 ml/h of flow rate, 250°C for the preheating bath, 400°C for the reaction bath and 40MPa of pressure. Grains of a basaltic rock (300 g) that was collected in the Izu-Oshima Island were used for the water-rock reaction experiment. The surface area of the grains was 4.52 m²/g, determined by N₂-BET method. We operated the apparatus for 1271 hours with rocks and ultra-pure water, for 1920 hours in that with ultra-pure water only, and for 864 hours with artificial seawater. Aliquots of reacted water were collected over time, and then pH and concentration of elements of these samples were determined by pH meter and ICP-AES.

Measured temperature in the reaction bath and pressure were stable at 340°C and 40.1MPa during operation. Although pH in the experiment with ultra-pure water only was stable between 7.0 and 7.3, pH in the experiment with rocks and ultra-pure water was stable between 8.7 and 9.0. Concentration of elements in the reacted water increased with time. Release rates of each element from the basaltic rocks were calculated: Si, 5.25.E-11; Na, 1.93.E-12; Al, 6.34.E-13; K, 2.17.E-13; Fe, 7.72.E-14; P, 3.05.E-14; Li, 1.70.E-14; As, 1.94.E-15; Hg, 6.16.E-16; Ni, 4.62.E-16; Zn, 1.86.E-16; Rb, 3.35.E-17 (mol/m²/s). In the experiment with the artificial seawater, Fe, Ni and Cr concentration increased.

This is the first report on the release rate of several elements (e.g., P) from basaltic rocks in a flow system under high temperature and high pressure. Our results provide insight into dissolution of basaltic rocks in natural environments under high temperature and high pressure, such as deep subsurface environments. However, some problems rise for the experiment with seawater. Further modification of the hydrothermal apparatus is required to simulate the seawater-rock reaction in laboratory.

Keywords: water-rock reaction, elemental dissolution, deep-sea hydrothermal system, flow-type hydrothermal apparatus, TAIGA project

SCG059-P19

Room:Convention Hall

Time:May 27 10:30-13:00

Long-term gamma-ray observation on deep seafloor off Hatsushima Island in Sagami Bay

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In the multi-disciplinary cabled observatory located on deep seafloor at a depth of 1175 m off Hatsushima Island in Sagami Bay, which was deployed in March 2000, long-term gamma-ray observation with NaI(Tl) detector has been carried out since the deployment of the observatory. The observatory was recovered in March 2002, and re-deployed in November 2002 about 40 m south of the previously deployed location. Since then, gamma-ray observation has been continued at the same position for more than 8 years up to present. Gamma-ray sensor is installed on seafloor whose 3 inch NaI(Tl) scintillation detector is attached downward touching seabed. It has multi-channel (256 ch) pulse height analyzer and energy spectra of gamma-ray can be obtained. It is known that output signal of NaI(Tl) detector is affected by temperature variation. However, since the water temperature at the observation site on deep seafloor is 3 degree C and is almost constant, the influence with temperature is negligible. On the other hand, some kind of signal drift associated with aging could occur.

The calibration was carried out by using energy peaks of natural radiation, i.e. Bi-214 of U-series, Tl-208 of Th-series and K-40. As the result, channel number that corresponds to each energy peak decreased at almost constant rate. In case of K-40 peak (1461 keV), corresponding channel number decreased as large as 10 channels for the period of 8 years.

As the observational result, significant signal level i.e. net area increase of Bi-214 peak was observed in October 2006. Increase of K-40 was observed when M5.8 earthquake occurred east off Izu Peninsula on April 21st in 2006 which caused mudflow. When M5 class earthquakes occurred on Dec. 17th and 18th in 2009, increase of K-40 seems to be less significant. Tl-208 shows seasonal increase possibly related to the amount of suspended materials in seawater associated with spring bloom at sea surface. This indicates that sedimentation caused by suspended materials could be distinguished from that caused by mudflows through gamma-ray observation. Causes of those observational phenomena will be studied in detail based on further evaluation of long-term gamma-ray data considering those calibration results.

Keywords: gamma-ray observation, NaI(Tl) detector, deep seafloor off Hatsushima Island in Sagami Bay, east off Izu Peninsula earthquake, mudflow, suspended materials

SCG059-P20

Room:Convention Hall

Time:May 27 10:30-13:00

A reconnaissance for sub-bottom diastrophism and origin of methane hydrate in Toyama Trough, eastern margin of Japan Sea

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On 14-15th June 2010, during the JAMSTEC R/V Natsushima cruise NT10-10 Leg2, a reconnaissance investigation was executed in the north-central Toyama Trough in order to search for the microorganism decomposition type of methane hydrate buried under the sedimentary region along the Toyama deep-sea canyon. Research objectives are the verifications of the following hypothesis: The generation origin of methane which seeps out at the sea bottom of the Toyama Trough seems different in a southern part and an north-central part, and such a difference corresponds to the difference in crustal strain concentration and activity of tectonic movement.

We report our results of the sea-truth inspection with the precise swath bathymetry by multi-narrow beam echo sounding (MBES) utilizing SEABAT 8160 system and visual observations by the 1412th submersible dive of ROV Hyper Dolphin (HPD1142).

The surface ship survey was conducted within the rectangular area enclosed by the coordinates 37d56.0mN, 137d35.0mE, 38d15.0mN, 138d10.0mE. In the survey box three subarea, A1, A2, and A3 are filled with 0.5 to 1.0 miles interval of swaths. The system also acquired back-scattering data available to visualize as side scan sonar image. This bathymetric investigation aims mainly to map any tectonic morphology and the following aspects are pointed out. In the survey area A1 more than eighty-two spots of strong backscattering were recognized. Some source materials such as chemosynthesis livings, carbonate crusts, pock marks bared sandy and/or gravel-rich seabed, buried gas-hydrate dome, etc. are estimated during the MBES survey.

Submersible observation HPD1142:

On the basis of MBES survey in the A1 area NW offing Sadogashima Island, HPD1142 was conducted on the eastern margin of sediment flat of the central Toyama Trough. The vehicle arrived 1785m.w.d. bottom on one of the strong reflective spots which fringe the frontal zone of a debris-flow apron.

The first MBARI corer recovered the oxidized fragile clay, white soft clay and bluish grey colored semi-condensed clay. The middle layer seems like kaolin-like clay derived from eroded part of rhyolites. No outcrop of bedrock was observed through the surveyed route but sometime dense fields of sea anemones were found on muddy bottom. They seem to belong to only one species and stood on buried stones within the surface mud less than several centimeters in thickness. This interpretation was clearly justified by MBARI sampling which recovered bottom materials including a sea anemone and its basement stone. Therefore distribution of numerous sea anemones (density is more than 1-2 individuals per 1 square meters) might indicate spatial distribution of float stones in the muddy floor.

Moreover, bared rocks in larger size were also observed to be foundation of sea anemones. Recovered rock samples are all rhyodacites.

Most interesting is a rubble mound found earlier in the dive, at 1776m.w.d. bottom, where is a little bit higher than the landed point (1785m.w.d.). Most rubble is of rectangular shaped rhyolite but planar carbonate crusts were also observed on the entire mound surface. One tip of carbonate crust was recovered interstitial spaces (matrix) of this rubble mound were filled by pale skin-colored, kaolin clay. Consequently, this mound concluded to be an old vent of a small mud volcano, although it includes many lags of rhyolite and rhyodacite.

To conclude the dive HPD1142, it observed the facies boundary between sedimentary flat and piedmont apron of debris flows, although entire region is covered by fragile mud. The A1 area is composed of an intercalation (alternation) of debris flow deposits and hemipelagic and fluvial (back swamp) formations. The thickness of debris formation would be thickened towards the steep slope of the Sadogashima Island. Ground water discharge is probable more or less in the side of sedimentary flat along the facies boundary zone.

Keywords: Toyama Trough, eastern margin of Japan Sea, strain concentration zone, methane hydrate, submersible dive, neotectonics

SCG059-P21

Room: Convention Hall

Time: May 27 10:30-13:00

The geophysical intra-segmentation variation at the ultra-slow spreading Southwest Indian ridge 35-40E

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It has been widely accepted for many years that the gross morphology of the mid-ocean ridge spreading centers varies with the spreading rate. Over the last decade, several exceptions to the spreading rate dependency have been reported. Recently, the ridge morphology is thought to be governed by the balance of the melt supply and the spreading rate. In this time, we attempt to understand how the variation of melt supply affects ridge architecture using geophysical observations (bathymetry, geomagnetism and gravimetric).

The Southwest Indian Ridge (SWIR) is an ultraslow spreading system, where the spreading rate is almost constant over the whole system, 14-16 mm/yr. The ridge shows a wide variability of seafloor structure, indicating that the spatial and temporal variation of melt supply may play a critical role in the structural process of mid-ocean ridge. The survey area is between Prince Edward fracture zone and Eric Simpson fracture zone (35-40E), which is one of the first order segments of the SWIR and the length is about 300 km. This segment is fully covered by prominent geoid high anomaly, and the Marion Island, the nearest the hotspot (37 51E 46 52S) from the ridge, is now located on 28 Ma crust about 250 km south from the SWIR. Low Na_{8.0} (Na₂O contents at MgO=8wt%, indicator of the degree of melting) along the axis within the geoid high area has also been reported.

New swath bathymetry, magnetic data and gravimetric data were acquired in 2008 and 2010 by scientists aboard R/V Hakuho-Maru (KH07-04, Leg2 and KH09-05, Leg4). Basement dredge, seismic survey and electromagnetic survey were also conducted during these cruises. Brief geophysical results were already presented by Sato et al., 2010, so now we focus on the development of oblique spreading subsegment based on the analysis of geophysical and geochemical data. We draw the following conclusions;

1) The continuity of seafloor morphology and magnetic isochrones adjacent orthogonal (35 30E to 36 20E) and oblique spreading subsegment (36 20E to 37 10E) at the western half of the survey area suggest that oblique spreading geometry is not a stable structure at least in the survey area. The current oblique subsegment could be orthogonal spreading segment around 3-4 Ma. Major element variation of the obtained MORBs suggest that the primary melt condition (P, T and major composition) is same at orthogonal and oblique subsegment (Sato et al., 2011). On the other hand, trace elements of the MORBs are slightly higher than the typical MORB (Sato et al., 2011). These results suggest that the slightly difference of the source mantle and the degree of melting may result in the forming of the orthogonal and oblique subsegment.

2) Some volcanic structures and moderate present normal magnetization are observed within the axial valley of the oblique subsegment. These may imply that the oblique spreading segment is not amagmatic segment and the melt supplied to the oblique subsegment is more divided into small scale, resulting in the formation of the third-order segment (Mizuno et al., 2010) through the melt focus process.

3) The asymmetric seafloor morphology and crustal thickness at oblique subsegment may be caused the same process at the inside and outside corner of the ridge-transform intersection. The recovery of mantle peridotites at the northern off-ridge part of the oblique spreading segment can support this idea.

Assuming that the on-axis geochemical variation can extend to that of the off-axis, the ~3 Myr temporal crustal thickness variation calculated using shipborne gravity (Sato et al., 2010) may be closely related to the difference of the source mantle. However; it should be remembered that the ridge obliquity may encourage the along axis melt migration from oblique subsegment to the adjacent orthogonal subsegment, resulting in the melt focusing.

Keywords: mid-ocean ridge, seafloor morphology, magnetic anomaly, gravity anomaly

SCG059-P22

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The geochemical intra-segment variation at the ultra-slow spreading Southwest Indian Ridge 35-37E

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Mode of spreading style at the mid-ocean ridge might depend on both spreading rate and amount of melt supply. Furthermore, melt supply depend on physical (temperature and pressure) and chemical (composition) of the source mantle. Therefore, the geochemical variations along the ridge with spreading-rate should reflect the differences physical and chemical variation beneath the ridge.

We attempt to investigate central part of the Southwest Indian Ridge (SWIR) which is one of the ultra-slow spreading systems with spreading rate of 14-16 mm/year. The research area is a part of the first order tectonic segment between the Prince Edward and Eric Simpson fracture zones. This segment is considered to be affected by Marion hotspot located south of the SWIR (le Roex et al., 1989). According to T. Sato (2010) and T. Sato et al. (2011), the segment is subdivided into five subsegments: three orthogonal spreading subsegments and two oblique spreading subsegments. In this study, we report geochemical variations of basalts from three subsegments, i.e. western orthogonal spreading subsegment, western oblique spreading subsegment, and central orthogonal spreading subsegment. At eastern end of the western orthogonal spreading subsegment and off-ridge of the western oblique spreading subsegment, topographic height is developed.

We had two cruises (KH-07-4 Leg 2 and KH-09-5 Leg 4) in 2008 and 2010 aboard R/V Hakuho-Maru. During two cruises, we performed 17 dredge operations, and we obtained MORB, mantle peridotite, metamorphic and sedimentary rocks along the central part of the SWIR (Sato et al., 2008, 2010). At the western part of the segment between the Prince Edward and Eric Simpson fracture zones (35.5-37.5E), we performed 7 dredge operations. Geochemical variations are summarized as follows.

1) Most of measured major elements variations can be explained by the crystal fractionation. Estimated compositions of the primary melt, which is back calculated based on equilibrium mineral compositions, for basalt from orthogonal spreading segment and oblique spreading segment have similar compositions. It indicates that the primary melt in this area was finally equilibrated with the mantle under the same conditions (P, T, major composition) even in the different ridge morphology.

2) Basalts from topographic high and oblique spreading segment have enriched compositions in trace elements including rare-earth elements, particularly in highly incompatible elements. Trace element compositions of source mantle calculated by degree of melting (Na₈: Na₂O content at MgO=8.0 wt%) indicate that basalts from topographic high and oblique spreading segment have enriched compositions in trace elements than those from normal spreading ridge.

3) Helium isotope ratio (³He/⁴He) of the basaltic glass from oblique spreading segment is approximately 8.0R_a which is similar value to typical MORB.

4) Mantle peridotites are recovered at the northern off-ridge part of the oblique spreading segment, suggesting that avolcanic conditions occurred immediately after formation of the topographic high.

These pieces of information allow us to have the following conclusions.

Geochemical variations along SWIR at 35.5-37.5E are mainly derived from source mantle geochemical heterogeneity particularly for highly incompatible elements. Differences of degree of melting have a small contribution to the geochemical variation. Enrichment in highly incompatible elements is not due to the direct effect of activity of the Marion hotspot although the possibility could not be denied that past hotspot activities metasomatized depleted source mantle.

Keywords: mid-ocean ridge basalt, Southwest Indian Ridge

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SCG059-P23

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Different source of Os among basalts and peridotites from the ultra-slow spreading SWIR from 34E to 40E

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The ridge magmatic systems of all oceans are the place directly forming crusts and are good places to observe how different the crust forms among the mid-ocean ridges which have variable spreading rates possibly associated with amount of melt supply. The geochemical studies especially isotopic studies are effective to get information of source of the supplied melts. To investigate one of the unique ridge systems, the central part of the Southwest Indian Ridge (SWIR), known as an ultra-slow spreading system (14-16 mm/yr) is selected. We had two cruises in 2008 (KH07-4 Leg2) and 2010 (KH09-5 Leg4) aboard R/V Hakuho-Maru and dredged aphyric to porphyritic basalts, peridotites, metamorphic and sedimentary rocks from 17 sites during two cruises from 34E to 40E along SWIR (Sato et al., 2008, 2010). The Re-Os isotope system for basalts and peridotites was applied to identify their source. One of the major advantages using Re-Os system is that they are relatively immune to secondary effects, e.g., sea water alteration and mantle metasomatism. The Os isotope ratios of spinels separated from serpentized peridotites which dredged from the Prince Edward fracture zone indicated more depleted signature than the mean value of abyssal peridotites ($^{187}\text{Os}/^{188}\text{Os}=0.125$). The time of Rhenium depletion (TRD) ages around 1Ga of these spinels show that these peridotites experienced melt extraction at least around 1Ga.

Keywords: ultra-slow spreading, Southwest Indian Ridge, Os isotope ratio

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SCG059-P24

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Petrographical characteristics of Peridotites from near the Kairei hydrothermal field, Central Indian Ocean

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In recent submersible investigation and dredge cruising at near the Kairei hydrothermal field, southern Central Indian Ridge, we have recovered a lot of serpentized and/or heavy altered mantle peridotites.

For unraveling the ultramafic rock-seawater reaction, we observed petrographically these peridotite samples especially in term of relic primary minerals such as olivine, pyroxene and spinel. Most sample generally shows that develop a typical mesh-rim texture of lizardite with brucite or magnetite at olivine and form bastite at pyroxene rim. Other secondary minerals such as talc and tremolite are occurred from a few samples.

Based on the result of these petrographical observation, we are going to identify secondary minerals using Raman spectroscopy and measure the mineral chemical composition of these minerals by EPMA and LA-ICP-MS.

Keywords: Kairei hydrothermal field, serpentized peridotite, low-temperature alteration, serpentine, talc

SCG059-P25

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Time:May 27 10:30-13:00

Petrology of gabbroic rocks from the Godzilla Megamullion in the Parece Vela Basin, Philippine Sea

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Godzilla Megamullion is the largest Oceanic core complex (OCC) with a dimension of ~125km x ~55km, occurs in the Parece Vela backarc Basin, within the Philippine Sea (Ohara et al., 2001). OCCs are domal bathymetric highs interpreted as portions of the lower crust and/or upper mantle exposed via low-angle detachment faulting (e.g., Tucholke et al., 1998).

Recent cruises (KR03-01, KH07-02 and YK09-05) recovered gabbroic rocks and plagiogranites from 16 localities along the surface of Godzilla Megamullion. In this contribution, we will report petrographical analysis of the gabbroic rocks.

Gabbroic rocks are classified into leucocratic gabbro, gabbro, olivine gabbro and Troctolite (based on olivine-plagioclase-pyroxene systematics (Streckeisen, 1976)) or leucocratic gabbro, leucocratic hornblende gabbro, pyroxene hornblende gabbro and hornblende pyroxene gabbro (based on pyroxene-plagioclase-hornblende systematics (Streckeisen, 1976)). The volume of olivine gabbro and troctolite are 5% or less.

Leucocratic hornblende gabbro, pyroxene hornblende gabbro and hornblende pyroxene gabbro contain hornblende, clinopyroxene, plagioclase and Fe-Ti oxide. These gabbros are further classified into several lithological types on the basis of modal and mineralogical assemblage as shown below:

1. Fe-Ti oxide rich type: this type contains abundant Fe-Ti oxide (17 vol% as maximum), hornblende and plagioclase (maximum An = 50). Range of #Mg in clinopyroxene is 42-73.

2. Fine grain type: this type has relatively primitive composition (FeO/MgO = 0.94-1.88). Range of #Mg in clinopyroxene is 73 - 78.

3. Coarse grain type: this type mainly consists of plagioclase (mean An = 50, maximum An = 75) and clinopyroxene (range of #Mg = 73-87), and poor in hornblende. FeO/MgO ratio of bulk composition is 0.53-1.07.

4. Sheared type: this type includes mylonite and amphibolite, products of shearing and subsequent retrograde metamorphism within the lower crust (Harigane et al., 2008)

Olivine gabbro contains plagioclase (An = 68-77), clinopyroxene (#Mg = 73-88) and olivine (Fo = 84-86). Troctolite contains plagioclase (An = 72-83), and olivine (Fo = 87-88).

Olivine gabbro, troctolite and coarse grain type gabbro, which have relatively primitive composition, were recovered only from the vicinity of the beakeaway of Godzilla Megamullion. On the other hand, Fe-Ti oxide rich type and plagiogranite, which have relatively evolved composition, were recovered from all over the surface of Godzilla Megamullion. It should be noted that these evolved lithologies were particularly abundant near the termination of Godzilla Megamullion.

Keywords: gabbro, Godzilla Megamullion, Oceanic core complex, Parece Vela Basin

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Sediment Wave in the Conrad Rise (Preliminary result of KH10-7 cruise)

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Sediment waves are often formed in association with bottom currents and turbidity currents. Reconstructing the development of these sediments can provide clues to understand paleo-currents and related oceanic environments. The Conrad Rise, located in the Southwestern Indian Ocean, is expected to have sediments that are affected by the environmental change such as glacial-interglacial cycle, because it is located between the subtropical front and the northern limit of the drift ice. A series of sediment waves are discovered at the Conrad Rise in the KH07-4 cruise, but the quantity of data is not enough to reconstruct paleo-currents. Accordingly, additional multi-beam bathymetry and seismic reflection surveys were conducted in the KH10-7 cruise in order to reconstruct the sedimentary environments.

The sediment waves are located at all depth range of the survey area between 2400 and 3400 m. Wave length are 1-2 km, lateral height is 5-40 km, and maximum height of crest is ca.150 m. Their strikes are variable but roughly arranged in parallel or slightly oblique to the contour lines. Morphology of sediment waves is variable in the northern, middle, and the southern part of the survey area. In the northern area, they have WNW-trending linear sediment waves. Heights of waves are higher compared with the other areas. In the middle area, NW- to nearly NS-trending sediment waves are observed. Some arcuate and crosscutting sediment waves are observed. In the southern area, highly continuous, arcuate sediment waves are observed.

The sedimentary strata in the survey area are divided into three units, A, B, and C in descending order based on seismic facies and their external forms.

The Unit A has 0.1-0.5 sec thick in the two-way travel time (TWT), with thickening southward external form. This unit is transparent with continuous reflectors inside. Reflectors are parallel to its upper surface. The migration of sediment waves is observed but less than a wave length. A strong reflector (A-1 reflector) is observed at the middle of the unit. The amplitude of the reflector is weak in the southern area whereas strong in the northern area. The depth of the reflector varies in each waves, especially in the northern area.

The Unit B has 0.1-0.2 sec thick in TWT, with lens-shaped external form. A strong reflector is observed at its upper surface. Though the upper surface shows undulation parallel to the sediment wave, internal reflectors are not parallel to the upper surface. Local erosional truncation is observed. Reflectors in the lower part are low-amplitude and poorly continuous ones.

The Unit C is 0.7 sec thick at maximum in TWT, with similar seismic facies to that of the Unit B. Its upper part has strong reflectors whereas transparent in the lower part. Reflectors are onlapping to the basement with basin-fill external form.

Based on these observations, we interpreted sedimentary environments of the Conrad Rise. In the seismic profiles, migration of sediment waves is little and the unit A shows continuous and transparent facies, thus significant change of the bottom current is not expected during sedimentation of the unit. Unit B is interpreted as a kind of local landslide deposit. Component of the unit is not uniform because it has some strong reflectors inside. Erosional truncation at its upper surface indicate that the unit is eroded during the sedimentation of the unit A. The component of the Unit C can be similar to that of the unit B.

The significant change of sedimentary environment is observed only twice at the boundaries of sedimentary units. Thus, these changes are not corresponding to cyclic change such as glacial-interglacial cycles. In order to reconstruct the bottom currents, we need to observe the relationship between the bottom current and sediment waves.

Keywords: Southern Ocean, Sediment Wave, Conrad Rise, Bottom Current

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Driving force and internal deformation of the Pacific plate deduced from two-dimensional GPS analysis

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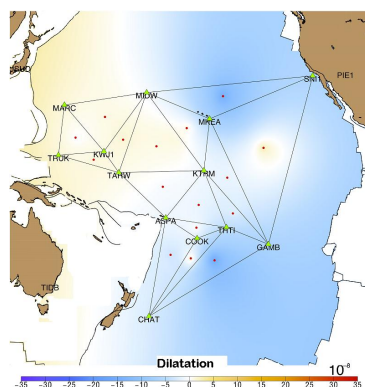
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The motion of the Pacific plate using GPS data has been estimated previously, e.g., Larson et al., 1997 and Beavan et al., 2002. Beavan et al. analyzed up to 11 years of data from 1990 to 2001 for twelve stations on the Pacific plate. Their analysis showed that the GPS sites offshore of southern California are presently moving 4-5 mm/yr relative to the predicted Pacific plate velocity whereas the easternmost sites in South Island, New Zealand, are moving about 3 mm/yr relative to the Pacific plate. However, the two-dimensional distribution and the cause of the deformation of the plate were not clear.

Therefore, this study aimed to determine the Pacific plate motion and intra-plate deformation by adding new GPS data, and to infer the cause of the internal plate deformation from the estimated two-dimensional pattern of the dilatation of the Pacific plate.

GPS data from 1998 to 2006 of fourteen stations on the Pacific plate are used for this analysis, including seven IGS stations, five GSI stations, and two stations of Western Pacific Integrated Network of GPS (WING). We applied a linear approximation to the nine years of data of each set of daily coordinates.

The result shows that the Pacific plate is dilated in the western part and is contracted in the east. This can be explained by expansion near the subduction zones and by contraction near diverging ridges. This mechanism is in harmony with the theory that the plates are driven mainly by slab pull and ridge push forces, introduced first by Forsyth and Uyeda, 1975.



Keywords: Pacific plate, internal deformation, driving force of plate motion, GPS, dilatation

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Slab pull force and direction of plate motion

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Gordon,1978 showed two endpoints of subduction zone of a plate can represent the direction of the plate rotation by the sum of the slab pull forces. But the Pacific Plate, for instance, is not subducting at some subduction zones such as the New Hebrides trench and New Britain trench, but some other plates are subducting below the the Pacific plate. This means that those part of trenches should not be included for the calculation of the direction of the plate motion.

We developed a method for computation of Euler poles of plate rotations with various parameters, e.g., distribution of subducting slabs, slab length/thickness/density, and dip angles. New Euler pole of the Pacific Plate rotation estimated about 20 degree southward from that of Gordon,1978.

Keywords: slab pull force, driving force of plates, Euler pole