Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG66-01 Room:101B Time:May 22 09:00-09:15

The characteristics of crustal structure in Shikoku Basin obtained by seismic exploration

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The Shikoku Basin which locates the north part of Philippine Sea Plate between the Kyushu-Palau ridge and Izu-Bonin (Ogasawara) ridge is an important area to understand the evolution of the backarc basin. The Shikoku Basin was in backarc rifting and spreading stage during 30-15Ma (Okino et al., 1994). Many seismic reflection surveys have been conducted in the Shikoku Basin. There were rarely reflectors of Moho discontinuity and internal crust. However, we recognized clear Moho reflector which obtained by newest seismic reflection survey in 2011. We discuss about the spatial characteristics of Moho and crustal reflectors using the mapping results of attribute analysis for through legacy data in Shikoku Basin.

Keywords: MCS survey, paleo-arc, rifting

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SCG66-02 Room:101B Time:May 22 09:15-09:30

Seismic crustal structure of the Kyushu-Palau Ridge, paleo-island arc in the Philippine Sea plate

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We compiled 27 seismic profiles across the Kyushu-Palau Ridge (KPR), a remnant intra-oceanic island arc extending north-south at the center of the Philippine Sea plate. The seismic profiles consist of multi-channel reflection and refraction exploration and were carried out in 2004-2008 under the Japanese Continental Shelf Survey Project.

The maximum crustal thicknesses of the KPR vary from 8 to 23 km among the seismic lines and are roughly thicker in the north of the ridge than in the south. The thick crust is mainly attributed to the lower crust with P-wave velocity of 6.8-7.2 km/s. Pn velocities just beneath the KPR are less than 8 km/s, often accompanying with rather high Vp of 7.2 km/s at the base of the crust. Reflection signals observed in far offsets along several lines suggest some reflectors exist at the depths 23-40 km beneath the KPR.

The crustal structure of the eastern transition from the KPR to backarc basins of the Shikoku Basin and Parece Vela Basin is characterized by a thinner curst and slightly higher Pn velocity, which may relate to the rifting, breakup and early separation of the proto-island arc. The subducting thin crust of the transition was imaged beneath the Hyuganada, east of Kyushu, where corresponds to the western end of the expected large earthquake model in the Nankai Trough.

On the other hand, the crustal models of the western side of the KPR show large variety in the seismic lines. This is because that the tectonic setting of the western side is different from north to south, such as the Daito Ridges as paleo-island arcs and intra-arc basins in the north, the West Philippine Basin as a backarc basin and the CBF Rise as the spreading center of the West Philippine Basin in the south.

Keywords: Kyushu-Palau Ridge, island arc crust

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SCG66-03 Room:101B Time:May 22 09:30-09:45

Crustal structure and growth of the Forearc region of Izu-Ogasawara arc

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JAMSTEC has carried out seismic surveys in the Izu-Ogasawara-Mariana region to clarify process for arc crustal growth to continent. We have already reported as follows. Much basaltic magmas are needed to make develop arc crust to current one and mafic arc materials are transformed into the mantle (Takahashi et al., 2007; 2008, Tasumi et al., 2008). There is crustal rifting and spreading between current volcanic front and the rear arc (Kodaira et al., 2009). Beneath the forearc region, there is thick arc crust with thickness of about 25 km and relative thin crust with that of about 10-15 km (Takahashi et al., 2011). Although arctic crusts were identified from magnetic anomalies map (Yamazaki and Yuasa, 1998), the real crustal structure with magnetic anomalies is not still shown yet. We carried out a seismic survey using R/V 'Kairei' of JAMSTEC to understand process of arc crusts beneath the forearc region.

The seismic line runs from the Shinkurose to the Ogasawara Trough through the Sumisu spur, the Daini Higashi Torishima knoll, and the Omachi seamount. Obtained profiling of the crustal structure along the forearc shows a variation of crustal thickness. The thick curst distributes around 32.5 degree N, the Sumisu spur, the Daini Higashi Torishima knoll, and the Omachi seamount. There is thin crust beneath the Shinkurose. The Omachi seamount has very thick lower crust the inside. The distribution pattern of the thick crusts is consistent with that of magnetic anomalies (Yamazaki and Yuasa, 1998). In the thick arc crusts with Vp of 6 km/s except the Omachi seamount, the velocity contours of 6 km./s and 7 km/s indicate convex and concave shape, respectively. It is known that the arc crusts on the volcanic front has thick layer with Vp of less than 6 km/s (Kodaira et al., 2007). This suggests that the arc crusts beneath the forearc region have much mafic materials rather than that along the volcanic front, and the result is consistent with past drilling studies (e.g., Taylor, 1992). Around the Shinkurose, thin and shallow crust is identified by this study and has high magnetic anomalies. This suggests that the crust beneath the Shinkurose is not in isostasy and that the entire of the thin crust is uplifted. It is possible that the signature of the Shinkurose is brought by the collision of the Izu-Ogasawara arc to the Honshu arc.

Keywords: Refraction survey, paleo-arc, crustal growth

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SCG66-04 Room:101B Time:May 22 09:45-10:00

Unraveling the Mesozoic continental basement of the proto-Philippine Sea Plate

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The Izu-Bonin arc has been regarded as a typical intra-oceanic arc, where the oceanic Pacific plate is subducting beneath the Philippine Sea plate. The current Philippine Sea plate is a complex of active and inactive arcs and back-arc basins. It is dominated by oceanic crust domains forming three large back-arc basins; Shikoku, Parece Vela, and West Philippine Basins, making the present Philippine Sea plate look like an 'oceanic' plate. However, all of these back-arc basins were formed after the inception of subduction at Izu-Bonin arc, which began at ˜52 Ma. Little is known about the proto-Philippine Sea plate, which existed as a counterpart to the Pacific plate during subduction initiation and before the formation of back-arc basins.

To understand the detailed geology of the proto-Philippine Sea plate, we have conducted manned-submersible SHINKAI6500 and Deep-Tow camera surveys during the R/V Yokosuka cruise (YK10-04) at the Amami Plateau, Daito Ridge, and Okidaito Ridge (ADO) region in April, 2010. The ADO region comprises the current northwestern Philippine Sea plate and considered to represent the remnants of the proto-Philippine Sea plate. The submersible observations and rock sampling conducted during the YK10-04 cruise revealed that ADO region, especially the Amami Plateau and the Daito Ridge, dominantly expose deep crustal section of gabbroic, granitic, and metamorphic rocks, indicating that a part of the proto-Philippine Sea plate is composed of older, non-oceanic, possibly continental, crust. Jurassic to Cretaceous zircon U/Pb ages have been obtained from the ADO plutonic rocks. This suggests that subduction of the Izu-Bonin arc initiated at the Mesozoic continental margin, and later acquired "intra-oceanic"-like setting through formation of the backarc basins.

Furthermore, the detrital zircon studies conducted at the northern Izu-Bonin forearc, counterpart of the ADO region, show that part of the zircons yield Mesozoic to Paleozoic ages, indicating that such continental basement may even exist beneath the present Izu-Bonin arc.

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SCG66-05 Room:101B Time:May 22 10:00-10:15

Comparison of stratigraphy of ferruginous sediments with meteorological events for 11 years in Satsuma Iwo-Jima Island.

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1. Introduction

Satsuma Iwo-Jima Island, which has rhyolite volcano Iwo-Dake, is located 38 km south of Kyushu Island, Japan. Nagahama Bay is small port located in the southwestern part of the island. In the bay, shallow-water hydrothermal activities were identified. Breakwaters constructed around the bay produce semi-enclosed environment to the bay. This provides in the bay to retain reddish brown seawater that contains high density of iron-oxyhydroxides (Ninomiya and Kiyokawa, 2009, Kiyokawa et al., in press, Ueshiba and Kiyokawa, in press). Breakwaters divide Fishermans port in the bay into two sites (designated as E-site and W-site) where iron-oxyhydroxide sediments have accumulated. In W-site, it is identified that iron-oxyhydroxide sediment of 1.5 m has been accumulated since dredging in 1998.

We obtained 13 core samples from the bay. The samples have information on iron-oxyhydroxide sedimentation history in the bay. In this study, we report results of analyses of the samples by FE-SEM, XRD and XRF, and comparison between stratigraphy of the samples and meteorological data from 2000 to 2011.

2. Stratigraphy

We collected 12 cores from W-site and 1 core from E-site of Nagahama Bay with 1-m-long core. The obtained cores showed Fe-rich mud, tuff and sandy mud beds. We identified three thick tuff beds (T1, T2 and T3) and thick sandy mud (SM) bed in ascending order. The tuff beds, 1˜9 cm in thickness, were white and pink color and the SM bed was gray color. From smear slide observation, sandy mud bed was essentially a mixture of rock fragments, volcanic glass, and fine reddish brown grains. The tuff beds were mainly composed of volcanic glass. Fe-rich mud consisted minor volcanic glass and mainly fine reddish brown grains. Based on the FE-SEM observation, this reddish brown grain was 100 nm spherical shape material that included Fe elements.

3. XRF and XRD

XRF showed that these sediments contained high density SiO2 of over 50wt%. Especially, tuff beds contained SiO2 of ˜90wt%. Fe-rich mud bed contained FeO of 9 to 25wt%; other beds have FeO of ˜7wt%. Sandy mud and Fe-rich mud beds above SM bed contained Al2O3 of over 5wt%.

XRD analysis indicated that Fe-rich mud and tuff beds contained Si-bearing minerals such as quartz, cristobalite and tridymite. On the other hand, sandy mud and Fe-rich mud beds above SM bed had both Si-bearing minerals and Al-bearing mineral such as albite.

4. Meteorological event

Using 11-years-long meteorological data (rainfall, wind speed and barometric pressure) recorded in Satsuma Iwo-Jima Island, we identified three heavy rainfall (over 100 mm/day) and strong typhoon events (maximum wind speed over 40m/s): Three heavy rainfall events occurred in June 2000 (189 mm/day), June 2001 (124.5 mm/day), and June 2002 (122 mm/day) and three strong wind events by typhoon at 2004 (40.3 m/s, 54.3 m/s and 44.6 m/s), 2005 (43.3 m/s), and 2007 (50.2 m/s).

5. Discussion

Three thick tuff beds were correlated to heavy rainfall events in 2000, 2001 and 2002. The volcano Iwo-Dake has activated since 1990 (Shinohara et al., 2002). Ash accumulations of a few millimeters were observed on Nagahama Bay. It is insufficient to explain the observed thickness of the tuff beds. Therefore, the thick tuff beds were driven by rainfall from unformed tuff-rich sediment around rhyolite Iwo-Dake.

SM bed could correspond to typhoon events in 2004 to 2005. The strong typhoons drove sediment with Al-bearing mineral to Nagahama Bay and form as sandy mud bed. Since breakwater construction in 2006 at entrance of Nagahama Bay, influence of typhoon to the inside of the bay decreased, resulting no accumulation of sandy mud bed by 2007 typhoon event.

6. Conclusion

1) Rainfall over 100mm/day supply ash material to the seafloor of Nagahama Bay from Iwo-Dake. 2) Strong typhoon mixed sediments near the seafloor of Nagahama Bay and various minerals such as Al and Si-bearing material (quartz, cristobalite, tridymite and albite) resediment together on this Bay.

Keywords: Iwo-Jima Island, hydrothermal water, ferric sediment, weather, Kikai caldera

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SCG66-06 Room:101B Time:May 22 10:45-11:00

Dynamics of slab rollback and consequent back-arc basin formation

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The formation of back-arc basins is one of the distinctive characteristics of subduction zones. We performed a numerical study to understand the dynamical mechanisms of slab rollback and the resulting back-arc basin formation by using two-dimensional dynamic numerical models of an integrated plate-mantle convection system. Retrograde slab migration is generated when the slab stagnates in the transition zone or when the deep section of the slab is vertical. In both cases, slab rollback is generated because the deep slab section obstructs the descending motion of the shallow slab section with an inclination. Buoyancy of the 660-km phase boundary acts as the obstructing force in the case of stagnant slab formation, and an anchoring force against the horizontal motion works similarly in the case of vertical slabs. To balance the horizontal component of the obstructing force, a suction force at the plate boundary pulls the overriding plate toward the ocean. Back-arc spreading is produced by means of slab rollback when the overriding plate with a weak back-arc area is fixed to the model boundary. The back-arc deformation becomes compressional when the overriding plate is freely movable despite trench retreat, because the wedge mantle flow viscously drags the overriding plate toward the trench. This implies that forces tending to actuate the overriding plate away from the trench are necessary to generate back-arc extension even when trench retreat is generated by slab rollback.

Keywords: slab rollback, back-arc basin, subduction zone, mantle convection, numerical modeling

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SCG66-07 Room:101B Time:May 22 11:00-11:15

Estimation of electrical resistivity structures beneath the Lau back-arc Basin

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In the back-arc basin, some factors such as the proximity to the convergence boundary, dehydration from the slab and the corner flow within the mantle wedge, which do not appear at the mid ocean ridges, have been considered to affect the seafloor spreading process.

The Lau back-arc Basin is an active back-arc basin, which has been formed in association with the subduction of the Pacific plate at the Tonga Trench. There are 3 distinct spreading systems in the Lau back-arc Basin; Central Lau Spreading Center (CLSC), Eastern Lau Spreading Center (ELSC), Valu Fa Ridge (VFR). Clear transitions in spreading rate and topography have been observed along the spreading center in the 3 spreading systems. In the standard theory on the correlation observerd at the mid ocean ridge, the fast spreading ridge shows topography dominated by the axial high, not by the rift valley (Forsyth, 1992). In the case of the Lau back-arc Basin, however, the southern segment with slower spreading rate shows topography dominated by the axial high, not by the rift valley (Martinez et al., 2006). Thus the Lau back-arc Basin shows an opposite correlation in the relationship between spreading rate and topography to the mid ocean ridge. The distance from the spreading center to the trench and the island arc is suggested to be a cause for the opposite correlation (Martinez et al., 2006; Jacobs et al., 2007) because it varies along the spreading center. The aim of our research is to reveal differences in 2 resistivity structures along separated 2 survey lines and to investigate how the distance from the spreading center to the trench and the island arc has influence on the back-arc spreading process.

Resistivity in the upper mantle reflects mantle temperature, the presence of and the content of melt and volatile elements such as water. We used the Magnetotelluric (MT) method to obtain resistivity structures beneath the basin, by using time-variations of magnetic and electric fields measured on the seafloor.

For the estimation of resistivity structures beneath the Lau back-arc Basin with the MT method, we conducted an electromagnetic observation using 6 OBEMs (Ocean Bottom Electro-Magnetometer) and 11 OBMs (Ocean Bottom Magnetometer) in total on the 2 survey lines across ELSC. The southern survey line is located at 21.3 S, and the northern survey line is located at 19.7 S, and the length of both survey lines are about 150 km. The OBEM measures horizontal 2 and vertical 1 components of magnetic field and the horizontal 2 components of electric field, and the OBM measures the 3 components of magnetic field. We obtained about 12 months length data from 2 OBEMs and 7-9 months length data from 11 OBMs.

The estimated electrical resistivity structures show the following features: (1) Resistive regions of more than 300ohm-m distribute in the uppermost mantle beneath the both survey lines. (2) At the depth of 100-200km, mantle has the resistivity of less than 50ohm-m. (3) At the depth of 150km the resistivity directly above the subducting slab chages beneath the both survey lines, and conductive regions of less than 50ohm-m distribute at deeper region than that depth. Above the slab at the depth of 150km, northern line has a conductive region of less than 30ohm-m at shallower depth than 70km, southern line has the spreading center. Our conclusions from the investigation of the estimated resistivity structures are: (1) The depleted mantle which has undergone the partial melting during upwelling results in forming the resistive regions in the uppermost mantle. (2) The resistivity at the depth of 100-200km cannot be explained by the dry olivine, and requires the exsistence of water or partial melt. (3) It is suggested that dehydration from the slab at the depth of 150km produces the conductive region at shallower depth along the northern line and affects the degree of melting and water content beneath the spreading center along the southern line.

Keywords: Lau, back arc basin, Magnetotelluric method, Tonga Trench

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Tectonic history of the Conrad Rise and initial breakup process of the Gondwana

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The Conrad Rise are situated in the middle of the Southern Indian Ocean between Africa and Antarctic, and regarded as one of the LIPs (large igneous provinces) related to upwelling plume activities. However, hot spot tracks associated with the Conrad Rise are not clearly established and the origin of the Conrad Rise are not well demonstrated. Moreover, the Gondwana breakup process and the relation between plume activity and breakup in the Southern Indian Ocean still remains poor-defined because of the sparse observations in this area. Total intensity and vector geomagnetic field measurements as well as swath bathymetry mapping were conducted during the R/V Hakuho-maru cruise KH-10-7 to understand the tectonic history of the Conrad Rise related to the Gondwana breakup in the Southern Indian Ocean. The dredge rock sampling were also performed at the Ob and Lena Seamounts in the Conrad Rise during the cruise. Magnetic anomaly data as well as swath bathymetry data obtained during the R/V Hakuho-maru cruise KH-07-4 Leg3 and KH-09-5 are also used in this study.

Magnetic anomaly profiles with amplitude of about 300-500 nT are observed almost parallel to the west of WNW-ESE trending structures just to the south of Conrad Rise inferred from satellite gravity anomalies. These magnetic anomalies most likely indicate Mesozoic magnetic anomaly sequence. Mesozoic sequence magnetic anomalies with amplitude of about 300 nT are also obtained along the NNE-SSW trending lineaments between the south of the Conrad Rise and Gunnerus Ridge. Oceanic crusts formed during Cretaceous normal polarity superchron are found in those profiles, although magnetic anomaly C34 has been identified just to the north of the Conrad Rise. However symmetric Mesozoic sequence magnetic anomaly patterns are not observed along the WNW-ESE trending lineaments just to the south of Conrad Rise. These suggest counter part of Mesozoic sequence magnetic anomalies in the south of Conrad Rise would be found in the East Enderby Basin, off East Antarctica. Moreover, approximately one-third of the dredged rock samples at the Ob Seamount are of metamorphic origin, whereas half of recovered samples are volcanic rocks. Gravity anomaly patters in vicinity of the Ob seamount show broad positive anomalies, and are different from that around the Lena Seamount which show negative gravity anomalies around the seamount. These imply that the Ob Seamount are continental origin and have left behind in the middle of the Southern Indian Ocean by initial breakup process of the Gondwana. These results provide new constraints for the tectonic history of the Conrad Rise and the initial breakup process of the Gondwana in the Southern Indian Ocean.

Keywords: Indian Ocean, Conrad Rise, Gondwana, magnetic anomaly, gravity anomaly, continental crust

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Petrology of igneous rocks from the Conrad rise, southern Indian ocean

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The Conrad rise is considered to be one of the Cretaceous Large Igneous Provinces and/or of hotspots at the southern Indian ocean. However, several plate reconstruction models denied the hotpot origin because hot spot tracks associated with the Conrad rise are not clearly established. Furthermore, only one petrological investigation had been performed by Borisova et al. (1996), which reported chemical compositions including major and minor compositions similar to those from the Keruguelen plateau. They concluded that the Conrad rise is hotspot of origin. However, no lines of direct evidence are revealed to explain the hotspot or mantle plume of origin.We had a research cruise KH-10-7 (R/V Hakuho-maru), and we dredged igneous, granitic and metamorphic rocks from the Ob and Lena seamounts, the Conrad rise.

Metamorphic and granitic rocks up to 30 kg are dredged from eastern slope of the Ob seamount. Some metamorphic rocks contains the Crd-Spl symplectite indicating isothermal decompression (Gnt + Sil to Crd + Spl) under the equilibrium temperature of 700 to 750^{o}C during the clockwise P-T evolution (Ishizuka et al., 2011). Furthermore, Ishizuka et al (2011) reported monazite CHIME and zircon U-Pb age about 1000 Ma.

Igneous rocks are mostly alkalic classified into basalt and trachy-basalt with minor amount of more alkali-rich igneous rocks. Borisova et al. (1996) reported igneous rocks from trachy-basalt to trachyte. Therefore, igneous rocks from the Conrad rise have wide compositional variations from alkalic basalt (SiO_2=44 wt%) to tracheae (SiO_2>60%). Such compositional variations of the Conrad rise could not be explained by fractional crystallization of basaltic magma unlike those of the Kerguelen plateau (ODP Leg 120 and 183) or Ethiopia continental rift (e.g. Natali et al., 2011). Furthermore, igneous rocks from the Conrda rise contain pyroxenitic and gabbroic xenolith originated from lower crust or upper mantle. These lines of evidences might constrain the tectonic origin of the Conrad rise.

Keywords: Indian Ocean, Conrad rise, Igneous rocks, Petrology

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SCG66-10 Room:101B Time:May 22 13:45-14:00

Results of sea-floor crustal deformation Monitoring at Kumano Basin

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Our research group performs monitoring of sea-floor crustal deformation with the system composed of the kinematic GPS positioning and the acoustic ranging at the three stations (KMN, KMS, and KME sites) at the Kumano Basin from 2004. We have already measured 16, 20, and 7 times at KMN, KMS, and KME sites, respectively. Firstly, we carried out the following procedure for improving the data quality before deriving site velocities:

(1) Correction of travel-times of acoustic ranging wave
(2) Removing the incorrect results of KGPS positioning
(3) Removing the incorrect results of ship's attitude measurement

Next, we determine the sea-floor benchmark position for each epoch using the corrected dataset with fixing the configuration of sea-floor benchmark. We obtain the site velocities from the coordinate of each epoch through the robust estimation method (Tukey's Biweight estimation). The observation shows the steady horizontal displacements with relative to the Amurian Plate of 39 mm/yr in N75W direction, 43 mm/yr in N69W direction, and 42 mm/yr in N75W direction at KMN, KMS, and KME, respectively. The estimation errors of horizontal displacement are 5-10 mm/yr at all the sites. The estimated displacement vectors are almost consistent to the crustal displacement caused by the plate conversion between the Philippine Sea and Amurian Plates at the Nankai Trough.

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SCG66-11 Room:101B Time:May 22 14:00-14:15

Slip deficit at the Nankai subduction zone inferred from seafloor geodetic observations (second thought)

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The Philippine Sea plate (PH) subducts beneath the southwest Japan along the Nankai Trough with a rate of about 4-6 cm/yr, where megathrust earthquakes have repeatedly occurred every 100-150 years. The probability of earthquake occurrence within 30 years from January 1st, 2011 are estimated to be 87 %, 70 %, and 60 % for the next Tokai, Tonankai, and Nankai earthquakes, respectively. We are concerned about the expansion of earthquake damage because these earthquakes have possibilities of interlocking with adjacent segments according to the historical record. Thus, it is important to know the spatio-temporal variation of crustal deformation accompanied with plate interaction. For this issue, we have conducted seafloor geodetic observation at the Nankai Trough using a GPS/Acoustic technique since 2004. In this system, we estimate the position of a surveying vessel by Kinematic GPS analysis and measure the distance between the vessel and the benchmark on the seafloor by Acoustic measurements. Next we determine the location of the benchmark. For the repeatability of this observation, the location of benchmark is determined within a precision of 2-3 cm at horizontal components. Recently, a number of research institutes have conducted seafloor geodetic observation using this technique before and after earthquakes occurred in offshore area, and then they have provided significant achievement to understand inter-, co-, and post-seismic crustal deformation. Several seafloor benchmarks are located at the Nankai subduction zone, which are individually operated by Japan Coast Guard, Tohoku University, and Nagoya University. In the Kumano Basin, we have three seafloor benchmarks located about 60-80 km away from the deformation front of the Nankai Trough. The observations from 2005 to 2010 have illustrated that those benchmarks are moving at rates of about 3-4 cm/yr toward west-northwest with velocity uncertainties of about 2 cm/yr relative to the Amurian plate (AM). In this study, we investigate interplate coupling at the Nankai Trough using onshore GPS velocities derived from Geophysical Survey Institute of Japan and offshore GPS site velocities derived from seafloor geodetic observation. We assume that observed GPS velocities are represented by the superposition of elastic deformation associated with subduction of the PH, rigid block motion of the overriding plate, and error. The plate interface along the Nankai Trough is represented by multiple rectangular faults. Moreover relative plate motion of the PH-AM (Sella et al., 2002) is assigned to the plate interface as a priori constraint.

Keywords: Seafloor geodetic observation, Nankai Trough, Slip deficit rate, GPS, Interlocking

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Monitoring of seafloor crustal deformation using GPS/acoustic techniques at the Suruga trough

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Observation of GPS/acoustic techniques started from the study by Spiess et al. (1998). In Japan, this type of observation has been carried out at the Japan trench, Suruga trough, Nankai trough, and so on. At the present, the accuracy of seafloor positioning is 1 to several cm for each epoch. Velocity vectors at seafloor point are estimated through repeating observations. After the 2011 Tohoku-Oki earthquake, Sato et al. (2011) observed the clear crustal deformation at the seafloor. In addition, Ito et al. (2011) inverted coseismic slip distributions using GPS/acoustic data and onshore GPS data. To observe seafloor crustal deformation is crucial because great earthquakes often have hypocenter under the seafloor, such as Tokai and Tonankai earthquakes.

We observed two observation points across the Suruga trough from 2005 to 2011. Each observation period was about 6?12 hours. East point of the Suruga trough (SNE) was observed 13 times, and West point of the Suruga trough (SNW) was observed 14 times. This study reanalyzed all previous observation data, improving the data quality by following three processes.

1) Muting reflected wave from the sea surface or from the bottom of the vessel in the acoustic data.
2) Removing the acoustic data during the vessel's attitude data exceed a criteria.
3) Removing the acoustic data when the reception condition of GPS signals was unstable.

We estimated the displacement velocity vector with relative to the Amurian plate on the basis of the result of redetermining position of the seafloor point at each epoch. Residual RMS in one epoch improves by about 0.27 ms. The estimated displacement velocity vector is 4.7 plus-minus 1.2 cm/yr to N99W direction at SNE. Comparing our result with the GPS displacement velocity vectors estimated by GSI(Geospatial Information Authority of Japan), both results do not have a significant difference, showing the consistency with the result of onshore GPS measurement. Comparing our result with onshore GPS displacement velocity at the west Suruga trough, there is a significant difference of several mm/yr. This result imply that two plates bounded by the Suruga trough have been undergoing convergence.

Keywords: seafloor crustal deformation, GPS/acoustic techniques, Suruga trough, monitering, reflected waves

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG66-13 Room:101B Time:May 22 14:30-14:45

Recent efforts for GPS/acoustic seafloor geodetic observation by Japan Coast Guard

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We have been developing a system for precise seafloor geodetic positioning with the GPS/Acoustic combination technique and deploying seafloor reference points on the land-ward slope of the major trenches around Japan, such as the Japan Trench and the Nankai Trough.

In March, 2008, we permanently installed an acoustic transducer on the hull of the middle-sized survey vessel ”Meiyo” and started sailing observations. This improvement enabled us to obtain more stable observation results. In addition, we have started the replacement of seafloor stations since 2009 to ensure the long-term observation.

From the past observations, we have successfully detected seafloor crustal deformation caused by the subduction of the oceanic plate and co-seismic displacements associated with large earthquakes. In particular, for the 2011 Tohoku-oki earthquake, huge co-seismic displacement of about 24 m toward ESE and about 3 m upward has detected at the seafloor reference point just above the hypocenter.

In this presentation, we introduce our recent efforts on seafloor geodetic observation.

1. Observational aspect

(1) Additional deployment of seafloor reference points to the Nankai Trough

To monitor seafloor movement spatially in the focal regions of Tokai, Tonankai and Nankai earthquake, we have deployed nine new seafloor reference points on the landward slope of the Nankai Trough in addition to the existing six points from off-Omaezaki to off-Muroto.

(2) Installment of observation equipment to the S/V ”Kaiyo”

Subsequent to the S/V ”Meiyo” in March 2008 and the S/V ”Takuyo” in December 2010, we installed observation equipment to the middle-sized S/V ”Kaiyo” in February 2012.

2. Analysis aspect

We have been considering the application of a new analysis method using the advantages of sailing observation for further precise seafloor positioning. This method is to determine the 3D position of the array of four seafloor stations under fixing the configuration and has the potential to detect not only horizontal movement but also vertical movement on the seafloor.

We have reanalyzed observation data obtained before the 2011 event by this method and determined crustal deformation at all seafloor reference points. We plan to report observation results by this method for the future.

Keywords: seafloor geodetic observation, off Miyagi Prefecture, Nankai Trough

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SCG66-14 Room:101B Time:May 22 14:45-15:00

Study for the efficient seafloor geodetic observation planning

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[1]JHOD, JCG

Japan Hydrographic and Oceanographic Department 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 along the Japan Trench and the Nankai Trough. The main purpose of seafloor geodetic observation is to estimate the crustal deformation velocity by observing the position of the seafloor reference points in the time series. We have succeeded in detecting seafloor motion associated with the subduction of the oceanic plate beneath to the continental plate and with the coseismic crustal deformation.

Recently, we have deployed nine new seafloor reference points along the Nankai Trough, in addition to the existing six points. It is necessary not only to monitor the existing points constantly but also to estimate the motion velocity of the new points as early as possible. Because the ship time is limited, we must design the observation plan which optimizes the observation time, precision and observation frequency. Thus, it is important to evaluate the estimated velocity data.

As positioning data increases, the estimated velocity converges to a constant value. Estimating convergent rates for the existing plan (actual data) and the various plans (numerically calculated data) enables us to evaluate the result. In this presentation, based on the result of the calculated convergent rate of velocity, we suggest the more efficient observation plans.

Keywords: seafloor geodetic observation

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SCG66-P01 Room:Convention Hall Time:May 22 15:30-17:00

The structure of the Kikai submarine caldera in the southern off Kyushu, Japan

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1. Introduction

Kikai Caldera (Matsumoto, 1943) is a mostly submerged caldera complex located in the southern Japan 40 km off Kyushu Island. Two islands, i.e. Satsuma Iwo-jima and Takeshima, are the only parts above the sea level while numerous submarine peaks are scattered on and below the sea level.

Kikai Caldera is believed to be the source of Akahoya tephra (Machida and Arai, 1978). The date of the eruption was determined as 7300 cal. BP (Fukusawa, 1995), and that is the most recent VEI-7 class eruption in the eastern margin of Asia. Intense earthquakes (Naruo and Kobayashi, 2002) and tsunami (Geshi, 2009) are presumed to have taken place at the climax of the eruption. There are two other series of giant eruption deposits that are considered to have originated from the Kikai Caldera complex and this indicates that it has been serving as an eruptive center for the past 150,000 years at least.

2. Methods

We conducted a number of seismic reflection observations in two survey cruises (KT-10-18 and KT-11-11) in 2010 and 2011 using a research ship Tansei-maru of JAMSTEC. The sound source was a 150 cubic inches G-I gun with 10 seconds of shot interval, and a 48-channled streamer cable was used for acquisition. Totally 25 profiles were obtained.

3. Interpretations of the results

First, the entire caldera has an asymmetrical structure with its floor aslant. While a clear, steep normal fault is observed in the west of the southern caldera perimeter, the entire northern part and some parts of the eastern perimeters are collapsed into blocks like slumps.

Second, the central mountainous area seems to mostly consist of pre-caldera body not likely to have been formed by post-Akahoya volcano. It is collapsed northeastward and its deposits are buried by several thick facies of possibly including Akahoya Eruption.

Third, another caldera that has not been hitherto recognized has been discovered. There is a 10 km wide sharp plunge of acoustic basements below the thick deposits in the southeastern end of the Kikai Caldera. Its location matches the circular negative Bouger anomalies (Onodera et al., 2010). The caldera should be formed before Akahoya Eruption because its rim where overlaps present Kikai Caldera perimeter is missing.

Keywords: Marine Caldera, Seismic Observations, Hydrothermal, Marine Geology, Submarine Volcano

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SCG66-P02 Room:Convention Hall Time:May 22 15:30-17:00

The geochemical characteristics of basaltic and acidic volcanics around the Myojin depression in the Izu arc

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Around the Myojin Depression, westside of the Myojin-sho caldera in the Izu arc, seamounts are distributed and hydrothermal activity and deposition are found from the Baiyonneise Caldera, one of seamounts at the northern side. Some knoll chains distribute in the eastside of the Myojin Depression, and connect between these knolls. This circulator distribution of seamounts and connected knoll chains considered to the dykes are similar to the geographical features of the Kuroko Depositions in the Hokuroku Region, Northwest Japan (Tanahashi et al., 2008). Hydrothermal activities are also found from the other rifts (Urabe and Kusakabe 1990). Based on these observations, the cruise KT09-12 by R/V *Tansei-Maru*, Ocean Research Institute (ORI), University of Tokyo, investigated in the Myojin Rift. During the cruise, basaltic to dacitic volcanic rocks and some acidic plutonic rocks were recovered by dredge system. Herein, we present petrographical and chemical analyses of these rock samples with sample dredged by the cruise MW9507 by R/V *MOANA WAVE*, and consider the association with hydrothermal activities and depositions.

Dredges during the cruise KT09-12 were obtained at the Daini-Beiyonneise Knoll at the northern side, Daisan-Beiyonneise Knoll at the southern side, and the *Dragonborn Hill*, small knoll chains, at the southeastern side of the depression. Many volcanic rocks are basalt, and recovered mainly from the *Dragonborn Hill*. Andesite and dacite was recovered from the Daini- and the Daini-Bayonneise Knoll. Tonalites were recovered from the Daisan-Bayonneise Knoll.

Volcanic rocks from the rift zone including the Myojin Rift show across-arc geochemical zonation, depleted in the volcanic front (VF) side and enriched in the reararc (RA) side. The Dragonborn Hill is distributed near the VF, and depleted geochemical characteristics similar to the volcanics from the volcanic front. On the other hand, the Dragonborn Hill basalts show more than 6 wt% and 0.88 wt% of MgO and TiO_2 and less than 50 wt% of SiO_2. The range of volcanics from each dredge sites show narrow variation, less than 1 wt% of SiO_2. Other basalts from the Myojin Rift also show the same geochemical characteristics. These characteristics are different from the volcanics from the VF, e.g. that of Sumisu caldera shows more then 50 wt% of SiO_2 and fractional geochemical trends. Tamura et al. (2009) divided the Quaternary rhyolites of the Izu arc into three types based on geochemical and associated crustal characteristics. The R1 rhyolite and shows depleted in high fluid strength elements (HFSE) and rare earth elements (REE). The R2 and R3 rhyolites show enriched in HFSE and REE. They considered that the geochemical differences between the three types of rhyolites are closely related to volcano type and crustal structure, and described that these rhyolites were produced from the melting of intermediate arc crusts heating by dikes from the basaltic volcanoes. However, the composition of the basalts from the Dragonborn Hill shows different geochemical characteristics from the VF basalts. Therefore, the magma genesis of these basalts is independent, not directly from the VF volcano by intrusion.

The acidic rocks also show across-arc geochemical variation similar to basalts. Rhyolites recovered near the Myojin Depression show similar geochemical characteristics to R2 by Tamura et al. (2009), and those from the RA side show similar characteristics to R3. We conclude this across-arc variation of rhyolite composition is associated with that of intermediate middle crust and ultimately mantle ones. The mantle under recent Izu arc is considered to show depleted at VF side and enriched at RA side (Haraguchi et al. 2011; Ishizuka et al. 2011).

Keywords: Intra-arc rift zone, Magma genesis, Acidic Volcanism, Hydrothermal activity

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SCG66-P03 Room:Convention Hall Time:May 22 15:30-17:00

Igneous rocks about North Myojin back-arc rift zone -mainly acid plutonic rocks-

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On the volcanic front of the Izu-Bonin Arc, Kuroko type hydrothermal deposit such as Myojin knoll caldera, Myojin-sho caldera, Suiyo seamount, Mokuyo seamount are distributed. In back-arc area, it is only the Hakurei hydrothermal deposit of the Bayonnaise knoll. It is known that the large-scale Kuroko deposit exists a lot in back-arc area in the Northeastern Japan Arc. So, it would be submarine geological survey has carried out in the Northern Myojin back-arc rift zone and, Bayonnaise area from 2009 to 2011 by research ship ”Boseimaru ”.

In the Bayonnaise knoll (31 degrees 58 minutes N; 139 degrees 45minutes E), hydrothermal deposit, dacite, felsic pumice and carbonate rocks, are sampled.

In the north side of the third-Bayonnaise knoll which located to Bayonnaise knoll for southwestward about 20km, basalt, felsic pumice and acid plutonic rocks(longer axis about 40cm) were sampled from the elliptical basin (East-West about 1.7km, north-south about 1km). This is the first report the acid plutonic rocks were picked in back-arc area.

1) Rhyolitic and basaltic volcanic activities with bimodal volcanic activity in this area, were recognized.

2) Acid plutonic rocks are the low K series tonalite which was compared with the middle crust of the Northern Izu-Bonin Arc. Acid plutonic rocks would be distributed middle crust in the back-arc area.

Keywords: Bayonnaise knoll, back-arc, acid plutonic rocks, North Myojin back-arc rift zone, tonalite, middle crust

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SCG66-P04 Room:Convention Hall Time:May 22 15:30-17:00

Geological and petrological studies in the southern Mariana margin, –R/V Thomas G.Thompson TN273 Cruise quick report–

ISHII, Teruaki[1*], Fernando MARTINEZ[2], Katherine A. KELLEY[3], Robert J. STERN[4], Yasuhiko OHARA[5], TN273 Cruise on board 19 scientists[6]

[1]Fukada Geological Institute, [2]University of Hawaii, [3]University of Rhode Island, [4]University of Texas at Dallas, [5]Hydrographic and Oceanographic Department of Japan, [6]University of Washington, Seattle, etc

TN273 aboard R/V Thomas G. Thompson (about 3000 ton, 80 m long; operated by the University of Washington, Seattle) was a 32-day cruise from 22 (Thu.) Dec. 2011 ? 22 (Sun.) Jan. 2012, departing and returning to Guam (Apra Harbor). Fernando Martinez and Katherine A. Kelley served as co-chief scientists aboard Thompson. The project was titled: The Southeast Mariana Forearc Rifts and Southernmost Mariana Trough Spreading Center: New Insights into the Tectonics and Magmatism of Intraoceanic Arcs. In this area of the southern Mariana margin, magmatically robust back-arc spreading transitions to rifting of the margin with broadly distributed volcanic and tectonic activity. This allows an investigation of supra-subduction zone magmatism and tectonic deformation with varying distance from the trench and subducting slab.

Research areas: (A) the southern end of the Mariana spreading center, the Malano-Gadao ridge, (B) the southeastern Mariana forearc rifts (SEMFR) zone including the Fina Nagu Volcanic Chain to the southeast of the backarc ridge, and (C) the Shinkai Seep Field (SSF) discovered in 2010 by the Shinkai 6500 at the dive site #6K1234 (observer T. Ishii) in the southern Mariana trench inner wall, about 5625 m deep, located about 80 km northeast of the Challenger Deep (see Ohara et al, 2012).

Survey methods: (a) deep-towed sidescan sonar mapping with the 30 kHz IMI-30 sonar, (b) wax core for collecting fresh glasses from Malanao-Gadao neovolcanic zone, (c) chain bag dredge for collecting igneous rocks, (d) underway bathymetry mapping by the multibeam Simrad EM302, underway gravity measurements, towed magnetometer measurements, (e) Miniature Autonomous Plume Recorders (MAPRs) for measuring pressure, temperature, optical backscatter in the water column and oxidation-reduction potential (Eh), to search for hydrothermal signatures.

Research results: (a) All areas were successfully mapped with the deep-towed sidescan sonar (b) wax coring was operated at 6 sites, which were selected using sidescan sonar maps, with recovery of fresh glasses from the Malano-Gadao neovolcanic zone, (c) chain bag dredge was operated at 45 sites, which were selected using sidescan sonar maps, also with recovery of igneous samples from the SEMFR, Malano Gadao ridge, and Fina Nagu Volcanic Chain (d) underway bathymetry mapping by the multibeam Simrad EM302, underway gravity measurements and towed magnetometer measurements were achieved successfully, (e) Miniature Autonomous Plume Recorders (MAPRs) recorded some new hydrothermal plume signatures.

The R/V Thomas G. Thompson is a very capable and attractive research vessel ably supported by 20 crew members. The cruise successfully mapped and sampled the target areas which, together with scientific and technical legacy data (including low-tech dredging and wax coring) that we have inherited from our previous investigators and onshore processing of images and geophysical data and laboratory studies of collected samples, will lead to a better understanding of the tectonic and magmatic activity in this unique subduction area.

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Keywords: R/V Thomas G. Thompson, the southern Marian forearc, the Shinkai Seep Field (SSF), deep-towed sidescan sonar IMI-30, TN273 Cruise

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SCG66-P05 Room:Convention Hall Time:May 22 15:30-17:00

New precise topographic map of the southwestern Ryukyu area off the eastern coast of Taiwan (new version)

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The southwestern Ryukyu area is the key to understanding the role of the arcuate-shaped trench-arc-backarc system towards the orogeny of Taiwan; with the viewpoint of the northwestern termination of subduction of the Philippine Sea Plate against the Eurasian Plate and the consequent collision against Taiwan from the eastern side. In 2010 we compiled the available multibeam bathymetric survey data in this area, including the northern part of the West Philippine Basin, Ryukyu (Nanseishoto) Trench, fore-arc basin, island-arc zone and Okinawa Trough and reported the precise topographic map at the JPGU2010 Assembly. Recently US NOAA/NGDC site provides the multibeam bathymetric database from which the debugged multibeam data in original format (with format ID in MB-SYSTEM) are downloadable. Then the new data from total 16 cruises (2 from R/V Marcus G. Langseth, 2 from R/V Melville, 7 from R/V Roger Revelle, 2 from R/V Kilo Moana, 3 from R/V Maurice Ewing) were added to the previous version in order to create a new version of the topographic map in this area. An en-echelon feature of Gagua Ridge, a meandering deep sea channel in the central area of the Huatung Basin, underwater landslides along the western rim of the basin (off the east coast of Taiwan) are depicted in the new map.

Keywords: Taiwan, Ryukyu Arc, Okinawa Trough, West Philippine Basin, Huatung Basin

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SCG66-P06 Room:Convention Hall Time:May 22 15:30-17:00

Development of acoustic observation method for seafloor hydrothermal flow

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In October 2009, we conducted seafloor reconnaissance using a manned deep-sea submersible Shinkai6500 in Central Indian Ridge 18-20deg.S, where hydrothermal plume signatures were previously perceived. An acoustic video camera DIDSON was equipped on the top of Shinkai6500 in order to get acoustic movie images of hydrothermal plumes. The acoustic movie images of the hydrothermal plumes had been captured in three of seven dives.

We could identify shadings inside the acoustic movie images of the hydrothermal plumes. Silhouettes of the hydrothermal plumes varied from second to second, and the shadings inside them also varied. These variations were thought to be corresponded to internal structures and flows of the plumes. These are only a few acoustic video images of the hydrothermal plumes. Results from this observation show that DIDSON has a potential of equipment for hydrothermal flow observation.

We performed a tank experiment so that we will have acoustic images of water flow under the control of flow rate. The purpose of the experiment was to understand relation between flow rate and acoustic image quantitatively and to develop a quantitative observation method for seafloor hydrothermal flow.

Water was heated in the hot tub and pumped to the water tank through the silicon tube. We observed water flows discharging from the tip of the tube with DIDSON. Flow rate had been controlled and temperatures of the discharging water and background water had been measured. The proposed method to observe and measure hydrothermal flow is the one to utilize a sheet-like acoustic beam. Scanning with concentrated acoustic beam gives distances to the edges of the hydrothermal flows. And then, the shapes of the flows can be identified even in low and zero visibility conditions.

We will report the overview of the tank experiment and proposed observation method in this presentation.

Keywords: seafloor hydrothermal flow, acoustic video camera, DIDSON

Japan Geoscience Union Meeting 2012
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SCG66-P07 Room:Convention Hall Time:May 22 15:30-17:00

Magnetization structure of Hakurei Deposit using vector magnetic anomalies measured using AUV

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The geomagnetic anomaly measured by a scalar magnetometer,such as a proton
precession magnetometer cannot be defined its direction, then it does not satisfy the Laplace's equation. Therefore physical formula describing the relation between magnetic field and magnetization cannot be established.

Because the difference between results obtained from scalar data and from vector data is very significant, we must use vector magnetic field data for magnetization analyses to get the more reliable and exact solutions.

The development program of fundamental tools for exploration of deep seabed resources started with the financial support of the Ministry of Education, Culture, Sports, Science & Technology (MEXT) in 2008 and will end in 2012. In this project, we are developing magnetic exploration tools for seabed resources using AUV (Autonomous Underwater Vehicle) and other deep-towed vehicles to measure not the scalar magnetic field but the vector magnetic field in order to estimate magnetization structure below the sea-floor exactly and precisely.

We conducted AUV magnetic survey in 2011 at the thermal area called Hakurei deposit in the Bayonnaise submarine caldera at the southern end of Izu island arc, about 400km south of Tokyo.

We analyzed the observed vector magnetic fields to get the vector magnetic anomaly fields using the method of Isezaki(1984). We inverted these vector magnetic anomaly fields to magnetization structure.

CONCLUSIONS

1.The scalar magnetic field TIA (Total Intensity Anomaly) has no physical formula describing the relation between M (Magnetization) and TIA because TIA does not satisfy the Laplace's equation. Then it is impossible to estimate M from TIA.

2.Anlyses of M using TIA have been done so far under assumption TIA=PTA (Projected Total Anomay on MF (Main Geomagnetic Field)), however, which caused the analysis error due to eT= TIA - PTA .

3.We succeeded to measure the vector magnetic anomaly fields using AUV despite the severe magnetic noises around the magnetometer sensors. The method of Isezaki(1984) works good to eliminate these noises.

4.We got the very precise magnetization structure in the Bayonnaise submarine caldera area at the southern end of Izu island arc.

We used the prism model which forms the shape of magnetized source body whose top is the sea-floor. The total number od prisms is 1500 making the 3 layers (0-80m,80-160m, 160- 240m below the sea-floor, 25x20=500 prisms in 1 layer). The 4500 unknowns(3 unknowns, Mx,My,Mz in each prosm) are obtained from 12000 observed vector magnetic anomaly fields by inversion method.

5. The tentative result shows that the 1st and 2nd layers have smaller intensity of magnetization compared to the 3rd layer. The 2nd layer has the smallest of three layers. However the Hakurei deposit area in the 2nd layer has the a little bit greater magnetization than surrounding area which suggests that the Hakurei deposit includes some magnetic minerals.

6.We strongly recommend to carry out the magnetic survey using a three component magnetometer to get TF and TA which have many advantages for magnetic analyses (magnetization, upward continuation etc.) which cannot be done using scalar TIA.

Keywords: vector geomagnetic anmalies, magnetization, thermal mineral deposit, AUV, block model

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SCG66-P08 Room:Convention Hall Time:May 22 15:30-17:00

Deep-sea tests of a geomagnetic field vector exploration system using AUV and deep-towed vehicle

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As the global demand for natural resources has increased, it has been more important to maintain a stable supply of them. In this situation, undeveloped seabed resources like methane hydrate and sea-floor hydrothermal deposits have also focused attention recently. Exploration techniques are, however, not good enough to estimate accurate abundance of them. From these viewpoints, we have been developing an exploration system of the deep-sea geomagnetic field vector using AUV and deep-towed vehicle.

The magnetic exploration system consists of two 3-axis flux-gate magnetometers, an Overhauser magnetometer, an optical fiber gyro, a main unit (control, communication, recording), and an onboard unit. These devices except for the onboard unit are installed in pressure cases (depth limit: 6000m). Thus this system can measure three components and intensity of the geomagnetic field in the deep-sea.

We have tested the magnetic exploration system during four cruises so far. In 2009, the first test of the system was carried out in the Kumano Basin using AUV Urashima and towing vehicle Yokosuka Deep-Tow during the R/V Yokosuka YK09-09 cruise. In this test, we sank a small magnetic target to the seafloor, and examined how the system worked. As a result, we successfully detected magnetic anomaly of the target to confirm the expected performance of that in the sea.

In 2010, the magnetic exploration system was tested in the Bayonnaise Knoll area both using a titanium towing frame during the R/V Bosei-maru cruise and using AUV Urashima during the R/V Yokosuka YK10-17 cruise. The Bayonnaise Knoll is a submarine caldera with an outer rim of 2.5-3 km and a floor of 840-920 m, which is located in the Izu-Ogasawara arc. A large hydrothermal deposit, Hakurei deposit lies in the southeast part of the caldera. In the R/V Bosei-maru cruise, we observed three components of magnetic anomalies at depths of 400-570 m along SE-NW and WE tracks across the caldera. In the R/V Yokosuka YK10-17 cruise, we observed three components and intensity of magnetic anomalies at altitudes of 60-100 m around the Hakurei deposit and at depth of 500 m over the caldera.

In 2011, the magnetic exploration system was tested in Suruga Bay using a titanium towing frame during the R/V Bosei-maru cruise. In this test, an acoustic system of positioning (SSBL) and data communication was newly added to the system. We observed three components of magnetic anomalies at depths of 420-480 m and distances of 300-400 m behind the ship along an NS track parallel to the axis of Suruga Trough.

From these tests, we have succeeded in measuring the geomagnetic field vector and intensity using the AUV and the deep-towed vehicle, and also have obtained detailed magnetic anomaly in the Hakurei deposit area (the analysis of AUV magnetic data will be presented by Isezaki et al. in the same session). We will here present the outlines of the measurement system and the results of the tests in the sea. Note that this study has been supported by the Ministry of Education, Culture, Sports, Science & Technology (MEXT).

Keywords: geomagnetic vector, geophysical exploration, sea-floor hydrothermal deposits, seabed resources, development of instruments

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SCG66-P09 Room:Convention Hall Time:May 22 15:30-17:00

Improved method of the correction for the magnetic field produced by vehicle body

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The vehicle magnetization correction (Isezaki, 1986) is the most essential but the most puzzling process in the magnetic vector field analysis. It often happens that a part of variation in magnetic field apparently correlates to the vehicle attitude, or that correction coefficients and the resulting magnetic field variation significantly depend on which data set we use to calculate the correction coefficients.

We would fail to obtain good correction coefficients when (a) there exists a time lag between the magnetic field and the vehicle attitude data (even a 0.5 second lag can affect the result), or (b) the data set to calculate the coefficients are not enough to obtain numerically stable solution. As for (a) we can find and correct the time lag by trial calculations with shifted data. We can also stave off the case (b) by taking care to collect data in as variable vehicle attitudes as possible.

But even if it is neither the case, results are often far from satisfactory. It has been attributed to some viscous behavior of the vehicle magnetization which cannot be represented in the linear observation equation. However, we rather consider that we have missed out the most appropriate correction coefficients and that errors are mainly caused by the assumption of the geomagnetic reference field as the ambient field in the calculation of correction coefficient. We present an improved method of the correction and its application to deep-sea magnetic field data obtained with AUVs.

1. Correction method considering magnetic anomalies at the place of calibration

In the current method the geomagnetic reference field is assumed as the ambient field. But if the anomaly field has a component perpendicular to the main field, that considerably affects the coefficients and resulting magnetic profiles.

This problem can be well settled by solving the anomaly field together with the correction coefficients as follows:

(1) the observation equation becomes linear by neglecting a small term considering that the induced magnetization coefficients are expected much smaller than 1 and that the anomaly field is much smaller than the main field.

(2) the number of variables are apparently 15 (12 correction coefficients + 3 components of the anomaly field), but the component of the anomaly field parallel to the main field cannot be determined because it is complementary to the diagonal elements of the induced magnetization coefficient matrix. Therefore, adding the two components of the anomaly field perpendicular to the main field as independent variables the number of variables becomes 14.

The solution is obtained by using the least squares method, but the method using normal equation results in an unrealistic solution, which does not satisfy the conditions for the linearization. Iterative methods such as the Gauss-Siedel method work good: the coefficients calculated by using the current method (i.e., assuming the reference field as the ambient field) and zero anomaly field are appropriate as the initial solution. If some anomalies exist a slightly different coefficients would be obtained accordingly. As long as we applied to our deep-sea data these revised coefficients significantly improve the resulting magnetic profiles, suppressing false variations correlating to vehicle attitude changes.

2. Level shifts in anomalies among parallel survey lines

If we have several EW survey lines for example, it often happens that there is an apparent level shift between the east-going and west-going lines. This kind of false variations can be mostly removed by changing slightly a part of the coefficients (specifically, the horizontal components of the permanent magnetization Hp1 and Hp2 and the two elements in the induced magnetization matrix a31 and a32). We present some simple formulations to give the correction value.

Isezaki, N. (1986), A new shipboard three-component magnetometer, Geophysics, 51, 1992?1998.

Keywords: three-component magnetic field measurement, vehicle magnetization correction

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Near-bottom geomagnetic survey over NTO (Non-transform offset) massif at Central Indian Ridge

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The near-bottom magnetic data reflect the difference, such as rock types and degree of weathering, rather than magnetic polarity reversal pattern. In this presentation, we focus on the magnetic characteristics over the hydrothermal field. If the host rock is extrusive (basaltic) rock, thermal demagnetization is expected, and there are a number of these research results. On the other hand, if the host rock is upper mantle rock, it is expected the positively enhanced magnetization by induced magnetization of magnetite through serpentinization. But this type of magnetic feature is not so much reported.

We conducted near-bottom magnetic survey using an AUV (Autonomous Underwater Vehicles), R2D4 during R/V Hakuho-maru KH10-6 cruise on November 2010. Three-component magnetometer was attached in the head of R2D4. Only one dive was done at NTO (Non-transform offset) massif between Central Indian Ridge segment1 and segment2 near the Rodriguez triple junction. NTO massif is considered to be composed of lower crust and/or mantle rock, and these rocks sometimes are exposed on its surface. The survey was consisted of four NS trending lines of about 6km and the line interval was about 500m. The mean vehicle height was 80 m from seafloor and the height varied between 40 and 200m. The figure 8 turn was operated before entering the survey line to calculate the vehicle magnetization coefficient. Three component magnetic data were calculated by removing ship magnetization estimated from vehicle coefficient. Total magnetic anomaly was calculated from three components magnetic data and by removing the IGRF value. Crustal magnetization was calculated through a magnetic inversion method (Honsho et al., 2012). 100m-thick magnetic layer and ambient magnetic direction were assumed in the calculation.

Northern survey area shows 0 or reversed magnetization and southern survey area shows positive magnetization. This positive magnetization is observed on the shallow area of the NTO massif. The remarkable high magnetization up to 30A/m is observed at the eastern area of the southern survey area. It spreads 500m$*$1500m in EW and NS direction. This area corresponds to shallow, NS trending knoll. Basalt, peridotite and serpentinized peridotite were dredged at the western slope of this knoll during the same cruise. In addition, a collection of dead chimney was found on the knoll by submersible dives of Sinkai 6500 on 2009. Based on the dredged rocks and the discovery of the dead hydrothermal field, it is reasonable to consider that this high normal magnetization is caused by induced magnetization originated from water-mantle rock interaction. Our geomagnetic result is a good example of the magnetization feature of mantle rock hosted hydrothermal field.

Keywords: Seafloor morphology, magnetics

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Tectonics of southern Central Indian Ridge: implication for spatial and temporal variation of melt supply

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The Central Indian Ridge (CIR) is categorized into intermediate spreading systems and its southern end forms a R-R-R triple junction with SWIR and SEIR. The southern CIR shows slow-spreading morphology, where the axial valley develops along the ridge crest and an oceanic core complex has been reported near the triple junction. We conducted detailed geophysical mapping all over the OCC and three submersible dives in 2006. On the top of the corrugations, several deformed rocks (mylonite, cataclasite, and schists) were recovered and striations parallel to the corrugation was widely observed on the seafloor. The observations suggest that the OCC had formed during Matsuyama chron at the southwestern inside-corner of the CIR-2 segment. Another small OCCs were also discovered in the same cruise, about 18km eastern off-axis of the southernmost (CIR-1) segment. Olivine-rich gabbroic rock, troctolite, dominates the recovered samples and a weathered Pl-dunite was also sampled from the 3170m WD. In recent cruises in 2009 and 2010, we further discovered ultramafic exposure at non-transform offset massif between segments CIR-1 and CIR-2, and at past NTO massifs or segment ends. They are associated with relatively smooth surface without corrugation and their extent is several kilometers. These structures suggesting melt-limited environment are distributed along 2nd order segment boundary from the axial valley to 30km off-axis, i.e. ˜1.7 Ma. This unique environment is likely related to the formation of Kairei Hydrothermal Field (KHF) at CIR-1 ridge flank, where the fluids shows the high concentration of hydrogen and low methane content, and a hydrogen-based hyperthermophilic subsurface lithoautotrophic microbial ecosystem was confirmed. The widespread OCC-like structures around the triple junction are key to solve how and when an oceanic detachment nucleates and develops to localize the strain for a few million years and to understand adjacent unique, hydrogen-rich, hydrothermal activities.

To understand the tectonic evolution of the area we here compile the bathymetry, magnetics, and gravity data collected during previous six cruises, then make the detailed bathymetry, equivalent magnetization and residual mantle bougurer anomaly maps, ranging from the triple junction to CIR-4 segment. The mapped area covers the axial valley and off-axis up to chron 2Aold (˜3.6 Ma). The OCC-like structures are concentrated in CIR-1 and southern CIR-2 on and off-axis areas. The northern CIR-3 and 4 segments seems relatively magmatically active, with low RMBA and higher magnetization. Central magnetic anomaly high is recognized along the SEIR and CIR, not along SWIR. The off-axis areas of CIR-1 segment shows high RMBA in general, suggesting the existence of high density material in the shallow part. The 24S OCC is also accompanies by clear RMBA high. The deep-tow magnetic profile across the CIR-segment shows highly asymmetric spreading since 2Ma, supporting the idea that the detachment faulting may play an important roll in the formation of OCC-like structures.

Keywords: mid-ocean ridge, oceanic core complex, hydrothermal activity, detachment, oceanic crust, seafloor spreading

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SCG66-P12 Room:Convention Hall Time:May 22 15:30-17:00

Relation with spreading rate and stability of spreading in Southeast Indian Ridge (SEIR)

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The Southeast Indian Ridge (SEIR) is the boundary between Antarctic Plate and Australian Plate. The spreading rate of SEIR is 59-75 km/Ma (Small et al., 1999). An EPR-type axial high is observed on the ridge crest west of 102 E, whereas the ridge crest east of 102 E is characterised by a MAR-type axial valley (Ma and Cochran, 1997). The previous study on the relationship between the spreading rate and stability of spreading suggests that fast-spreading ridges such as the ridges bounding the Pacific Plate show stable spreading in that the Magnetic Boundary Strike (MBS) is almost parallel to the model isochron estimated by Muller et al. (2008), and that slow-spreading ridges such as the Southwest Indian Ridge show unstable spreading considering the high variability of the MBS on both sides of the ridge crests. The present study is to verify this hypothesis in the case of SEIR which is classified as an intermediate-spreading ridge. The 3-D magnetic data obtained on board the MIRAI MR03-04 Leg6 Cruise and SHIRASE JARE45 Expedition were analysed to get precise seafloor age and spreading rate on both sides of SEIR. The 3-D magnetic data were also used to calculate the Intensity of the Spatial Differential Vectors (ISDV) and the MBS's along the ship tracks. The tracks of the former cruise cross the SEIR at 90 E and 100 E, whereas the track of the latter cruise crosses SEIR at 110 E. The results shows that the standard deviation of the MBS is low in the area west of 100 E and high in the area east of 100 E. The variability of the spreading rate estimated from the seafloor age is lower in the former area whereas that is higher in the latter area. Therefore, it is concluded that the ridge crest west of 100 E has been more stable in spreading process than that east of 100 E.

Keywords: Southeast Indian Ridge, Magnetic anomaly

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Bending-related Topographic Structures of the subducting plate in the Northwestern Pacific Ocean

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Elongated topographic structures associated with bending of the subducting oceanic plate along the western Kuril, Japan and Izu-Ogasawara trenches, were investigated using available multibeam bathymetric data.

The outer rise earthquake occurred just in the same day after the 2011 Tohoku Earthquake. Several studies pointed out high occurrence probability of outer rise earthquake near Japan Trench after the 2011 Tohoku Earthquake. The outer rise earthquake may generate tsunami even if its magnitude were not so large. Faults associated with outer rise earthquakes are observed in the oceanward trench slope. Bending-related faults are ubiquitous structures of oceanic plates incoming to trenches. In general, the faults are thought to be formed parallel or subparallel to the bending axis of the incoming plate, namely the trench axis, in most trenches. Oceanward slopes of several trenches have bending-related structure with a strike different from the trench axes (Masson, 1991; Kobayashi et al., 1998; Ranero et al., 2003). In these areas, abyssal hill fabrics made parallel to spreading centers by activity of normal faults were reactivated instead of the creation of new faulting parallel to the trench axes.

The Mesozoic Pacific Plate is subducting along the Kuril, Japan, Izu-Ogasawara, and Mariana trenches (Nakanishi et al. 1992). Kobayashi et al. (1998) investigated the bending-related structures of the oceanward trench slope of the western Kuril and northern Japan trenches using the bathymetric data obtained by the multibeam echo-sounder, SeaBeam. They concluded that the abyssal hill fabrics are revalidated when abyssal hill fabrics trend within 30 degree of trench axes.

To examine controlling factors for strikes of bending-related structures, it is indispensable to describe oceanic spreading fabrics and to identify magnetic anomaly lineations. The oceanic spreading fabrics consist of inherited abyssal hill fabrics and other preexisting weak zones related to seafloor spreading process, which are fracture zones, non-transform offsets, and so on. Magnetic anomaly lineations on the Pacific Plate incoming to trenches east of Japan were identified by Nakanishi et al. (1989; 1999). The curved lineation was identified at the Japan Trench near 38 N (Nakanishi et al., 1989, 1991), but was not assigned an age. No lineations were identified very near the trench axis of the Izu-Ogasawara Trench (Nakanishi et al., 1989). In these areas, it is difficult to examine controlling factors for strikes of bending-related structures.

The new bathymetric map demonstrated that most of bending-related topographic structures exist in the oceanward trench slopes deeper than 5600 m. The map revealed that bending-related topographic structures are developed parallel to the trench axis or inherited seafloor spreading fabrics. Detailed identification of magnetic anomalies near the Japan Trench revealed curved lineations and discontinuity of lineations associated with propagation ridges. Comparison between the detailed bathymetric and magnetic anomaly lineation maps elucidated that abyssal hill fabrics were reactivated where the angle between abyssal hill fabrics and trench axis is less than about 30 degree. The topographic expression of bending-related structures are classified into two types according to whether new faults develop parallel to the trench axis or inherited seafloor spreading fabrics reactivate.

Reference: Nakanishi, M., Bending-related topographic structures of the subducting plate in the northwestern Pacific Ocean, in Accretionary prisms and convergent margin tectonics in the northwest Pacific Basin, Modern Approaches in Solid Earth Sciences, 8, edited by Y. Ogawa, R. Anma, and Y. Dilek, Springer Science+Business Media B.V., pp. 1-38, doi 10.1007/978-90-481-8885-7_1, 2011.

Keywords: abyssal hill fabric, bending-related topographic structure, deep-sea trench, magnetic anomaly lineation, outerrise, Pacific Plate

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JAMSTEC core sample curation - Improvement of usability

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Marine core samples are important research/educational resources for various scientific fields. Using marine core samples, we can obtain important information to understand the earth-ocean-atmosphere system. Since 2008, JAMSTEC has been providing curation service for marine core samples recovered by the JAMSTEC research cruises. The core samples are available for general research/educational purposes through this service. Currently, we have about 5900 sections of marine core samples, and about 4400 of them are already available for research/education.

To stimulate cross-disciplinary research/education projects through the JAMSTEC core sample curation, we are trying to attract researchers/educators who are interested in marine core samples, as well as those who have been involved in core sample research for a long time. For this purpose, maintaining a large collection of marine core samples and associated data is not sufficient. It is also important to develop a user-friendly system in which users can access relevant information without difficulty.

Information for requesting JAMSTEC core samples and associated data is accessible at following websites; ”JAMSTEC Core Sample Curation” and ”JAMSTEC Core Data Site” [1, 2]. Users can plan their research/educational projects using online information and can submit sample requests by e-mail. The newly implemented map-based sample search system in the ”JAMSTEC Core Sample Curation” website, which used to have only a text-based sample search system, provides a much improved searchability to users. On the other hand, we are accumulating new data, such as high-resolution scanned images, X-ray CT scanogram images and paleontological age information, and these data are added into the ”JAMSTEC Core Data Site”. These fundamental data will help users to have a better understanding of the nature of samples when they plan a research/educational project.

After 4 years of its services, the JAMSTEC core sample curation is now entering into an expansion phase. In addition to the efforts for integrating sample/data collection and developing a user-friendly system, we will cooperate with various national/international activities which provide databases and sample curation services to the scientific community.

[1] ”JAMSTEC Core Sample Curation” http://www.jamstec.go.jp/kochi/jc_curation/e/
[2] ”JAMSTEC Core Data Site” http://www.godac.jamstec.go.jp/coredata/e/

Keywords: Marine core sample, sample management, curation

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Accuracy due to ray tracing and velocity structure in acoustic ranging to develop seafloor geodetic observations

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On-land geodetic observations are not enough to monitor crustal activities in and around the subduction zone, so seafloor geodetic observations have been required. However, present accuracy of seafloor geodetic observation is an order of 1 cm or larger, which is difficult to detect differences from plate motion in short time interval, which means a plate coupling rate and its spatio-temporal variation. Our group has developed the observation system and methodology for seafloor geodesy, which is combined kinematic GPS and ocean acoustic ranging. One of influence factors is acoustic velocity change in ocean, due to change in temperature, ocean currents in various scale, and so on. A typical perturbation of acoustic velocity makes an order of 1 ms difference in travel time, which corresponds to 1 m difference in ray length. In modeling, due to approximation, there are some differences between modeled ray paths and actual ones, which cause modeling errors in travel times. We have investigated these effects in seafloor geodesy using both observed and synthetic data to reduce and evaluate estimation errors of benchmarker (transponder) positions and to develop our strategy for observation and its analyses. Estimation procedure for benchmarker positions is similar to those used in earthquake location method and seismic tomography. So we have applied methods in seismic study, especially in tomographic inversion.

For observed data, we use the method of a one-dimensional velocity inversion with station corrections, proposed by Kissling et al. [1994], to detect spatio-temporal change in ocean acoustic velocity during observations over the Suruga-Nankai Trough, Japan. From these analyses, some important information has been clarified in travel time data. We found significant changes in ocean acoustic velocity with various spatial scales. Most of travel time changes and/or modeled acoustic velocity changes can explain small velocity changes/anomaly(s) at a depth of 600m or shallower, through forward modeling of travel time data using simplified velocity structure. However, due to simple data acquisition procedure, we cannot detect velocity anomaly(s) precisely in space and time, that is a size of anomaly and its (their) movement.

Through forward modeling of acoustic travel time data, we demonstrate various modeling to verify detected changes in observed data and to evaluate model error due to difference between velocity models and between modeled and real ones. And also, we estimate differences in pseudo-bending ray tracing and actual ray under basic ray theory, which include comparison between precise and approximate solutions.

Through these analyses, we have tried to evaluate recovery of benchmarker positions in tomographic inversion using synthetic data including anomalous travel time data to develop idea to calculate benchmarker positions with high-accuracy. In the tomographic inversion, we introduce some constraints corresponding to realistic conditions. This step gives us new developed system to detect crustal deformation in seafloor geodesy and new findings for understanding these in and around plate boundaries.

Keywords: seafloor crustal deformation measurement, acoustic ranging, ocean acoustic velocity structure, ray tracing method, tomographic inversion

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

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We are developing a geodetic method for 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.Both sound speed structure and the benchmark positions are determined simultaneously from the two way travel time of ultrasonic signals.

We repeatedly carried out measurements at several sites around Nankai trough, South western part of Japan. Now the horizontal repeatability is about 1-5 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 slight changes cannot be detected. To monitor the focal area of anticipated plate boundary earthquakes, lower repeatability error is desirable. The most effective factor of that is a temporal-spatial variation of sound speed structure. In the measurement system we are taking, we can average spatial variations of sound speed structure, though, it also includes temporal variations. We are planning to install a moored buoys-based next generation measurement system using tomographic technique as a method of dividing temporal and spatial variations of sound speed structure completely.

Therefore, we are designing a moored buoy-based next generation measurement system.But we need to consider that the positions of the buoys are controlled 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 composed of three transponders installed at a depth of 1000 m and three buoys and also set buoy-transponder geometries were equilateral triangles. The length of a side of them was 2000m.We assumed the sound speed structure as two layers.We defined 'initial sound speed structure (ISSS)'on which the value of sound speed in first layer (0-100 m in depth) was 1523 m/s and it in second layer (100-1000 m in depth) was 1486 m/s.Then we also set another sound speed structure with 99.98% of the value of sound speed on ISSS to consider horizontal spatial variations of sound speed structure. We calculated travel-time using these two structures depending on positions of buoys.We calculated the joint probability density function (j-pdf) of the weight center location of benchmark from the synthesized travel time.We calculated the positioning accuracy, the FWHM for the peak of j-pdf, with various geometries of the measurement system.We also evaluated this accuracy in X, Y, and Z components.

The results show the following relationship between the accuracy of benchmark positioning and the configuration:

(1) If the weight center location shifts 1000 m from the best position, the accuracies in X and Y components can be kept in the range of 25 % worse than the best solution.

(2) If the buoy configuration distorts, 40% shortening or lengthening of the length of side makes worse the accuracy by 10 %.

(3) In both simple horizontal shifts of buoys and the distortion of the buoy configuration, the ratio of the deterioration of accuracy in Z component is larger than that in another two components.

Taking the accuracy in Z component into account, the results suggest that the benchmark positioning accuracy is less robust with simple shift keeping their configuration than with distortion of the buoy configuration. And (3) also agrees with the fact that our real measurements show the horizontal error is better than the vertical error.

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

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Results of Seafloor geodetic observations along the Nankai Trough

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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.

In this poster, we summarize seafloor geodetic observation results at seafloor reference points along the Nankai Trough until fiscal 2011 by the array constraint analysis method (Matsumoto et al. 2008) and introduce the new seafloor reference points in fiscal 2011.

Keywords: seafloor geodetic observation, Nankai trough

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Development of an underwater gravimeter

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We have developed an underwater gravimeter for hydrothermal deposit surveys. A detectable resolution of 0.1 mgal was set as the development target, considering gravity anomalies due to a typical hydrothermal deposit with a dimension of 500 m x 500 m x 10 m and a density contrast of 1 g/cm^3 and a survey altitude of 50 m from the seafloor. The newly developed gravimeter system is stored in two pressure cases made of titanium alloy and is operable up to 4200 m in water depth. In order to keep its verticality, a gravity sensor (MicroG LaCoste S-174) is mounted on a gimbal control unit with an inertial navigation sensor (PHINS) and is stored in the first pressure case, while the data acquisition system is in the second case. Data are obtained at sampling rates of 88.1 Hz and 100 Hz from the gravity sensor and from the PHINS, respectively. High-frequency noise due to vehicle motions can be reduced by applying a low-pass filter to the collected data. We made gravity measurement experiments on a machine simulating pitch and roll motions with a period of 16 s and an amplitude of 7.5 degree, which is greater than expected in actual vehicle motions. Two-step low-pass filtering with 1-s and 150-s Gaussian filters was applied to the collected data. A vehicle speed of 2 knots and the filtering width of 150 s correspond to a spatial resolution of 75 m after this low-pass filtering, which is small enough to detect the gravity anomalies due to the deposits. The experiments revealed that the gravimeter has a gravity anomaly resolution better than the requirement: as the results of the low-pass filtering, tilt and earth tide corrections and assumption of linear temporal drift, RMS errors of 0.04 mgal and 0.02 mgal were obtained for the experiments of pitch and roll motions, respectively. A cruise is planned in September 2012 to test the hybrid system of this gravimeter and a gravity gradiometer, which is developed simultaneously, on an autonomous underwater vehicle (AUV).

Keywords: gravimeter, underwater, inertial navigation, jimbal, AUV

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Evaluations of a new resonant quartz-based accelerometer for oceanographic installations

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Earthquake and its related phenomenon have a broad range of frequencies and magnitudes. A lot of studies show that it is very useful to catch motions broadly with frequencies as much as possible, and it is essentially important for seismometer so as not to clip the record even when strong oscillation comes. One of the solutions is multi-sensor system. It requires, however, lots of resources such as electric power and special size. Considering the many limitations in marine environments, compact system is preferable. For the purpose of implementation of broad band seismic and geodetic observation easily in marine region, we have been evaluating a new type accelerometer, which is an application of resonant crystal transducers. The sensor has several features such as small size, low power, shock protection, and a suitable temperature range for oceanographic installations. The range of full scale is +/- 2g, so it is also relatively robust for strong motions. In addition to above, we have been evaluating several issues in a vault of Nokogiriyama Geophysical Observatory of Earthquake Research Institute, the University of Tokyo. In this presentation, we show the test environment and the results, and discuss the possibility of oceanographic installations. The records we have obtained look reasonable as compared with other seismometers in the vault. The frequency responses of the new sensor judged from power spectral density is better than that of conventional accelerometers used in marine regions both in high frequency (1 Hz - 10 Hz) and long period (10 s -). Long-period waves can clearly be seen during reasonable time after earthquakes, and the lowest self noise level near 10 s is about -140 dB. The curve between 10 s and 500 s on frequency versus acceleration spectrum density follows an 1/f slope. It means that the new sensor may work as not only a broadband seismometer which can record various events such as local earthquake, teleseismic events and slow slips but also a gravitometer, which can be used for the sensor of mass changes. The earth tide should be recorded in the sensor if we used it as a gravitometer. However, the earth tide could be seen from the record only after processing, and the periods what the tide can be seen are limited. We are considering two points, which are the clock system and the thermal condition, to improve the measurement system for obtaining more accurate long-period data. As of present, some improvements are required for gravitometric use, while we think it works well as a seismometer which could be mounted in various types such as cabled system, AUV and pop-up system.

Keywords: quartz accelerometer, strong motion, broad band, gravity