Japan Geoscience Union Meeting 2012
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SCG66-01 Room:101B Time:May 22 09:00-09:15

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

YAMASHITA, Mikiya[1*], KODAIRA, Shuichi[1], TAKAHASHI, Narumi[1], PARK, Jin-Oh[1], NAKANISHI, Ayako[1], MIURA, Seiichi[1], KANEDA, Yoshiyuki[1]

[1]JAMSTEC

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

NISHIZAWA, Azusa[1], KANEDA, Kentaro[1*], OIKAWA, Mitsuhiro[1]

[1]Japan Coast Guard

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

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

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

TAKAHASHI, Narumi[1*], Mikiya Yamashita[1], Yukla Kaiho[1], Takeshi Sato[1], Seiichi Miura[1], Tetsuo No[1], Shuichi Kodaira[1], Yoshiyuki Tatsumi[1]

[1]Japan Agency for Marine-Earth Science and Technology

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

TANI, Kenichiro[1*], ISHIZUKA, Osamu[2], UEDA, Hayato[3], DUNKLEY, Daniel Joseph[4], HORIE, Kenji[4], SHUKUNO, Hiroshi[1], HIRAHARA, Yuka[1], TAKAHASHI, Toshiro[1], NICHOLS, Alexander[1], TATSUMI, Yoshiyuki[1]

[1]IFREE, JAMSTEC, [2]Geological Survey of Japan/AIST, [3]Hirosaki University, [4]National Institute of Polar Research

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.

UESHIBA, Takuya[1*], KIYOKAWA, Shoichi[1], GOTO, Shusaku[2], ITO, Takashi[3], IKEHARA, Minoru[4], YAMAGUCHI, Kosei E.[5], NINOMIYA, Tomomi[1], NAGATA, Tomoaki[1], MINOWA, Yuto[1], IKEGAMI, Fumihiko[1]

[1]Kyushu University, [2]Geo-Resources and Environment, AIST, [3]Ibaraki University, [4]Marine Core Research, Kochi University, [5]Toho University, NASA Astrobiology Institute.

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

NAKAKUKI, Tomoeki[1]*

[1]Earth Planet Syst Sci, Hiroshima Univ

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

SHIBATA, Yuki[1], SEAMA, Nobukazu[1*], MIZUMA, Keiko[1], KIMURA, Maho[1], KOBAYASHI, Seiya[2], MATSUNO, Tetsuo[1], NOGI, Yoshifumi[3]

[1]Kobe University, [2]The Graduate University for Advanced Studies, [3]National Institute of Polar Research

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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SCG66-08 Room:101B Time:May 22 11:15-11:30

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

NOGI, Yoshifumi[1*], SATO, Hiroshi[2], Hideo Ishizuka[3], SATO, Taichi[4]

[1]NIPR, [2]Senshu Univ., [3]Kochi Univ., [4]GSJ/AIST

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

SATO, Hiroshi[1*], NOGI, Yoshifumi[2], ISHIZUKA Hideo[3], SATO, Taichi[4]

[1]Senshu Univ., [2]NIPR, [3]Kochi Univ., [4]GSJ/AIST

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

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

Results of sea-floor crustal deformation Monitoring at Kumano Basin

TADOKORO, Keiichi[1*], IKUTA, Ryoya[2], WATANABE, Tsuyoshi[1], NAGAI, Satoru[1], YASUDA, Kenji[1], SAKATA, Tsuyoshi[1], ETO, Shuhei[1], OKUDA, Takashi[1]

[1]Graduate School of Environmental Studies,Nagoya University, [2]Faculty of Science, Shizuoka University

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)

WATANABE, Tsuyoshi[1*], TADOKORO, Keiichi[1], IKUTA, Ryoya[2], NAGAI, Satoru[1], OKUDA, Takashi[1], YASUDA, Kenji[1], Tsuyoshi Sakata[1], Masahiro Kuno[3]

[1]Nagoya Univ., [2]Shizuoka Univ., [3]Mie Pref. Fisheries Research Inst.

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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SCG66-12 Room:101B Time:May 22 14:15-14:30

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

YASUDA, Kenji[1*], TADOKORO Keiichi[1], IKUTA ryoya[2], WATANABE Tsuyoshi[1], NAGAI Satoru[1], ETO Shuhei[1], SAKATA Tsuyoshi[1], SAYANAGI Keizo[3]

[1]Graduate School of Environmental Studies, Nagoya University, [2]Shizuoka University, [3]Tokai University

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

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

SATO, Mariko[1*], ISHIKAWA, Tadashi[1], UJIHARA, Naoto[1], WATANABE, Shun-ichi[1], Masayuki Fujita[1], MOCHIZUKI, Masashi[2], Akira Asada[2]

[1]Hydrogr. and Oceanogr. Dept. of Japan, [2]IIS, Univ. of Tokyo

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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Study for the efficient seafloor geodetic observation planning

WATANABE, Shun-ichi[1*], SATO, Mariko[1], ISHIKAWA, Tadashi[1], UJIHARA, Naoto[1]

[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