Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

BBG21-P01 Room:Convention Hall Time:May 22 18:15-19:30

High resolution sidescan sonar survey at Yokoniwa Rise, CIR, the possible peridotite-related hydrothermal site

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The Kairei Hydrothermal Field (KHF) is located at the southern end of the Central Indian Ridge (CIR), near the Rodriguez ridge triple junction. The KHF was discovered by ROV Kaiko (JAMSTEC) in 2000, based on the preceding report about hydrothermal plume anomaly detected in Hakuho-maru KH-93-3 cruise in 1993. The recent submersible survey in 2009 discovered a group of dead chimneys on the hill north of the KHF, where peridotite is widely exposed. To survey an extent of the dead chimneys, and to know acoustic expression of peridotite outcrops, we conducted high-resolution acoustic survey using AUV-r2D4 (Institute of Industrial Science, The Univ. of Tokyo) in Hakuho-maru KH-10-6 cruise in 2010.

The area of chimneys, tentatively called Yokoniwa Rise, is settled at ˜10 km eastern off-axis from the CIR segment-1. The acoustic survey of AUV-r2D4 is conducted at 100 kHz frequency, 30˜150 m altitude, with 3 knots of vehicle speed. The survey imaged ˜6 km (NS) x ˜2.3 km (WE) area along 4 survey lines. We obtained following results.

(1) Anomarous acoustic signals in water colmn

We found anomalous backscattering signals from water column, at 2 different sites; one is west of survey area located above piles of lava, and another is near the southwestern corner of survey area and no outstanding signals on sidescan sonar imagery. The both anomalous backscattering signals may image turbid water distribution caused by volcanic or hydrothermal activities, both in and out of our survey area. We did not observe anomalous backscattering signals above the reported area of dead chimneys.

(2) Distribution of flat and high-backscattering features

There are a large number of high-backscattering features which seems like a floating cloud: they have obscure boundaries. Because most of the high-backscatering features are not accompanies with acoustic shadow, they are bathymetrically flat features on seafloor. The floating clouds distribute discontinuously and concentrate in ˜N15W trending area. It almost coincides with trend of surrounding abyssal hills. The chimney-like features are found over the high-backscattering features, including the area of dead chimneys and peridotite outcrops observed in 2009.

(3) Tectonic deformation may be not effective in this area.

Linear features on the sidescan sonar imagery are widely varied in trend and relatively short in length: total number of linear features are 216, average trend is N1oW, standard deviation is 20, and average length is 136 m. Most of linear features seems to be controlled by local bathymetry (based on 20 kHz Seabeam2120 data), so that we may observe flow channel or gravitational collapse of seafloor as the linear features.

(4) We will check detail ground reference data of peridotite outcrops, using the sidescan sonar imagery obtained in our survey and submersible's video image obtained in 2009.

Keywords: r2D4, interferometry sonar, floating cloud-like features, chimney-like structure, backscattering signals in water column, Hydrothermal field

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Application of oxygen isotope geothermometry to hydrothermal alteration in the Iheya North field, Okinawa Trough

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Oxygen isotope values of clay minerals enable estimation of their formation temperature, based on the temperature dependence of oxygen isotope equilibrium between clay minerals and water. We measured oxygen isotope values of hydrothermal clay minerals in sediment from the Iheya North Knoll hydrothermal field in the Okinawa Trough. The sediment was obtained by seafloor drilling during the Integrated Ocean Drilling Program (IODP) Expedition 311. Five sites were drilled during the expedition: on a hydrothermal mound at the center of the activity (Site C0016); at 600 m northwest of the mound (Site C0015); at 100 m east of the mound (Site C0013); at 450 m east of the mound (Site C0014) and; at 1550 m east of the mound (Site C0017). We investigated temperature conditions of hydrothermal alteration below the seafloor of the Iheya North field by applying oxygen isotope geothermometry,

Silt (2-63 micrometer) and clay (<2 micrometer) fractions were separated according to Stokes' law by settling powdered core sediment in a standing cylinder. Mineralogy of the bulk sediment and of the clay fraction was determined by X-ray diffractometry. Chemical composition of some clay minerals in the clay fraction was determined by transmission electron microscopy (TEM-EDS). Oxygen isotope values of representative clay fraction samples were determined at GNS Science in New Zealand. For measurement of oxygen isotope values, oxygen was extracted from the clay fraction samples using a CO_2-laser and BrF_5 following the method of Sharp (1990). Prior to isotope measurement, free Fe-oxides were removed following Mehra and Jackson (1960). Where two dominant clay minerals were identified in a clay fraction sample, their abundance ratio was estimated on the chemical composition of the clay fraction determined by EPMA analysis.

Occurrence of hydrothermal clay minerals at the Iheya North field was classified into three hydrothermal alteration zones with increasing depth, based on the clay mineral assemblages; kaolinite and montmorillonite alteration zone (Zone 1); Mg-rich chlorite and Mg-rich chlorite-smectite mixed layer mineral alteration zone (Zone 2); and sericite and Mg-rich chlorite alteration zone (Zone 3) at Site C0013. Hydrothermal clay mineral assemblages at Sites C0014 and C0016 are similar to those at Site C0013.

The oxygen isotope value of smectite in Zone 1 at Site C0013 had a value of +11.4 per mil (VSMOW). Its formation temperature was estimated to range between 130 - 160 ^oC, assuming a value from 0 to +1.5 per mil for the oxygen isotope value of water in equilibrium with the mineral. The oxygen isotope values of the Mg-rich chlorite in Zone 2 and the sericite in Zone 3 at Site C0013 range from +1.6 to +3.3 per mil and their formation temperatures were estimated to be $>$ 220 ^oC. Formation temperatures of the clay minerals at Sites C0014 and C0016 were comparable to those found in the same alteration zones at Site C0013.

This study revealed a layered structure of the hydrothermal alteration zones below the seafloor at a distance of up to 450 m from the hydrothermal mound at the Iheya North field. In addition to different clay mineral assemblage found in each hydrothermal alteration zone, the estimated formation temperatures showed a large gap between Zone 1 and Zones 2 and 3.

Keywords: clay mineral, IODP Expedition 331, seafloor hydrothermal field, Iheya North Knoll, Okinawa Trough, Oxygen isotope values

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Trophic structure of planktonic community in hydrothermal vent field based on stable isotopes

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Primary production in marine ecosystems is through photosynthesis in the euphotic zone and chemosynthesis in the deeper zones. While the productivity due to chemosynthesis in the global ocean is less than that of photosynthesis, local productivity from chemical energy from sub-seafloor fluid flux may provide a significant amount of organic matter into deep-sea ecosystems. Hydrothermal systems in deep-sea areas can be powerful primary production sites, usually dominated by chemolithoautotrophic prokaryotes. The plume from a hydrothermal vent contains many potential sources of metabolic energy, e.g. hydrogen, methane, sulfur compounds, and iron. The primary production in the plume occurs mainly in the early stage of plume evolution, and then gradually spreads into the surrounding ecosystem. The planktonic community of hydrothermal vent fields, presumably is able to use at least some of the organic matter in the plume, and could therefore play a role in connecting the chemosynthesis-based and photosynthesis-based food chains in marine ecosystems.

To estimate the trophic dependence of plankton on the chemosynthetic products provided by hydrothermal vent plumes, research cruises to hydrothermal vent fields on the Indian Ocean Ridge (KH10-06), Izena Hole (KT10-24), Myojin-sho Caldera (KT11-29), and the Iheya North Knoll (KT12-07, NT12-27) were carried out and samples were collected. The samples were collected by plankton nets (MTD, VMPS, ORI) and/or an in-situ large volume pump-filtration system (WTS-LV 30, McLane Ltd.), and were preserved in a freezer (-30oC) until analysis. Nine samples of from the pump-filtration system and 167 samples of net-caught zooplankton, containing carnivores, filter-feeders, fish and jellies, were preserved for this study. After pre-analysis processing by freeze-drying, lyophilization and decarbonating, the stable isotope ratios of carbon and nitrogen in the samples were determined by the laboratory of the Japan Chemical Analysis Center using a Delta V advantage isotope ratio mass spectrometer coupled with an elemental analyzer via ConFlo IV interface.

The stable isotope ratios of nitrogen and carbon were analyzed with respect to the depth, site, and organism type to characterize the trophic structure of the planktonic communities at hydrothermal vent fields. In this presentation we will discuss trends seen in the trophic structure of communities at the research sites and consider the influence played by the surrounding environmental, geochemical and microbial conditions.

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Keywords: hydrothermal vent, trophic structure, stable isotope ecology, plankton

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Geochemical study of diversity and distribution of ecosystem sustained by hydrothermal and cold seep discharge fluids

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In contrast to abyssal zone where is believed vast, desert-like habitats i.e., quite low diversity and biomass, deepsea hydrothermal vents and cold seeps sustain huge population of characteristic and endemic benthic organisms. Those benthic community, called chemosynthesis-based community, has been supported primarily by chemosynthetic and methanotrophic microbial production, which use some reduced chemical species and methane emitting from the vents and seeps as energy source. Especially at hydrothermal system we usually focus on venting hot fluid as sole energy source for such benthic community, however, benthic animal community is sometimes spreading widely far from the vents. In addition some common benthic organisms observed usual deep seafloor can be found slight densely around the vents and seeps. Those common organisms may be also supported by the chemosynthetic and/or methanotrophic microbial production. It means that such fluid discharge zone, i.e., hydrothermal vents and cold seeps, possibly support larger biomass once expected. In order to clarify how and what support the common benthos and chemosynthesis-based community observed around deepsea vents and seeps, we conducted geochemical analysis using stable isotopes of C, N, and S composed soft tissues of organism samples. As a result, many common benthic organisms observed around the vent fields rely on chemosynthesis-based products and some vent and/or seep endemic species have secondary energy and food sources other than primary energy source, venting or seeping fluids.

Keywords: TAIGA, Chemosynthesis-based animal, Stable isotope

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Distribution of granule containing cells in deep-sea hydrothermal plume

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Deep-sea hydrothermal plume harbors chemolithoautotrophic microbes depending on high concentration of sulfur, methane and hydrogen supplied from hydrothermal fluid. These microbes plays two important roles in deep-sea geochemical cycle; 1. They produce organic carbon as primary producer in deep-sea ecosystem. 2. They remove phosphate, arsenate, iron, manganese, and REEs from water column by oxidation reaction or absorption to their organic yields. SUP05 microbes are most abundant and important group in hydrothermal plume microbial community. The SUP05s utilize various reduced sulfur compounds and hydrogen as electron donor and they accumulate sulfur glance in the cell. The accumulation of sulfur is effective and important strategy for SUP05s growth because the sulfur concentration in the plume becomes decreasing during the plume evolution. In this study, I investigated the spatial distribution of granule containing cells in hydrothermal plume using backsccater signal of flowcytometer at a single cell level and compared with total cell densities, SUP05 cell densities, and physicochemical parameters.

Keywords: Deep-sea hydrothermal plume, microbial ecology, cell growth zone, sulfur cycle, primary production, flow cytometry

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U-Th radioactive disequilibrium dating of hydrothermal vent of Okinawa and South Mariana Trough

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Biological and ore-deposits research are progressing on hydrothermal vent of Okinawa Trough and South Mariana Trough. In this study, we measured the age of sulfide minerals from seafloor hydrothermal systems using U-Th radioactive disequilibrium dating. Thorium is not soluble in hydrothermal fluids and is not precipitated in hydrothermal minerals while uranium is precipitated in these minerals. Therefore, we can apply to U-Th radioactive disequilibrium dating because 234U in mineral decays to 230Th with time.

We analyzed uranium and thorium isotope ratio in these minerals by an ICP-MS with Multi collector type (IsoProbe). The rock sample was powdered to 100 - 250 meshes, and 250 - 500 meshes, and performed electromagnetism separation using the isodynamic separator. Then sample was leached by 5% HNO3 with ultrasonically for 30 minutes and Milli-Q water 30 minutes, and dried at 80 C.

Before analysis by multi-collector type ICP-MS, we need to separate U and Th in sample solution after acid decomposition of sample. Especially, presences of Ba (barium) and Pb (lead) would make analyses difficult. In order to separate U-Th efficiently, we apply two steps of column chromatography (AG1X-8 and U/TEVA) were performed (Takamasa et al., Quaternary Geochronology, 2012).

Some sample from Archean site of South Mariana Trough, is also analyzed by ESR age for cross-check. These ESR ages were consistent with our U-Th radioactive disequilibrium age (Takamasa et al., Quaternary Geochronology, 2012). Moreover, our method can determine ages of minerals as young as 50 year, when a sample contains enough U but little Th.

The samples from Pika site, Urashima site, Archean site, and Snail site in South Mariana Trough yielded ages of 560-9000 year, 250-1160 year, <50-4000 year and < 100 years, respectively. These results suggest that the oldest ages from each site are correlated with the distance from the spreading axis.

Keywords: U-Th radioactive disequilibrium dating, South Mariana Trough, Okinawa Trough, hydrothermal ven