Cruise summary for the Natsushima Cruise NT12-25

Title of the research cruise: Ferromanganese Crust Deposits in the Daito Ridge and Amami Plateau, the south of the Japanese Islands: Growth Processes and On-site Resource Exploration

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Cruise Term: September 25-October 10, 2012
Port calls: Guam to Naha
Research area: Amami Plateau and Daito Ridge area

Brief report of the research cruise:
We dove with ROV HyperDolphin 3K two times (#1442 and #1444) at the Toubu seamount of the Daito ridge, and one time at the Koniya Seamount, the Daito ridge.
At each survey track between 2000 to 1000m water depths, we mapped successfully with the seafloor microtopograhy and thickness of ferromanganese crusts. This is the first dives of ROV for exploration of ferromanganese crusts deposits at the Amami plateau and Daito ridge, where only a few dredge hauls have been done there.

During dives #1442 and #1444, the southern slope of the seamount, the Daito ridge was studied climbing up to the crest between depths 1950m and 1400m. The average gradient is about 21 degree or less, but whole of the survey line was scarcely covered with sediments. We found 1 to 9cm thick ferromanganese crust covering mostly highly-altered volcanic rocks, probably original breccia or lava. Semi-consolidated limestones partly consist of substrates. The surface morphology of the slopes is generally bumpy or angular where the crusts grow over the outcrops. The knobby surface structure is again characteristic for the crusts in the area, often very thinly covered with foraminifera sands and clayey sediments.

During the dive #1443 at the southern slope of the Koniya Seamount, Amami plateau, the most steep slope of the seamount was explored between depths 1700 and 1450 m with an average gradient of 20 degree or less. The slope were mostly covered with a wide range of size and shape of slumped rocks very thinly ferromanganese-oxide encrusted. The large rock outcrops of angular surface are probably the weathered surface of granitic rock body. The area is scarcely covered with ferromanganese oxide. Other less steep slopes are generally covered with sediments, but no outcrops are

observed.

The continuous mapping the ferromanganese crust cover and its thickness was conducted as case study in the areas and the acoustic and lazer measurement of microtopography and the deposits was successfully conducted during all the three dives with more improved technique, such as gradient-tracking devices.

The members of the Underwater Technology Research Center of The University of Tokyo taking part in this cruise used a system for continuous mapping the crust cover and its thickness. A probe whose orientation was kept perpendicular to the slope using a two axis gimbal system measured the thickness of the crust acoustically and a visual mapping system, "SeaXerocks", composed of a camera, a sheet laser and lights was used to record images of the seafloor that were used to build a coloured 3D reconstruction of the scanned area in post processing. This system has already been deployed on several cruises in the past and has gradually been improved. On this cruise the acoustic probe was mounted on a two axis gimbal system, that automatically adjusts the orientation of the probe so that the sound beam impacts the crust perpendicularly even on sloped terrain. This is necessary when operating in terrain where the inclination of the seafloor varies, as the acoustic reflection is strongest when the sound enters the crust orthogonally. The probe was previously mounted on a single gimbal during a previous cruise (NT12-05) where the angle to the seafloor was controlled manually. On this cruise, the in addition to the use of a double gimbal to control the angle of the probe in both pitch and roll, an automated algorithm using camera images of a laser line and altitude measurements of a DVL was used to compute the slope angle and direction in real time and automatically adjusted the gimbal angles.

Seven dives on Ryusei seamount were planned to deploy the system and survey the Seamount's crust cover, but because of bad weather it was not possible to deploy Hyper-Dolphin at that dive site at all. Instead of that, one dive was possible at Okidaito Seamount where the system successfully mapped the scanned area in colour and 3D and measured the thickness of the crust, where it was present. Samples to verify the measurements were also taken. Sampling was assisted by a rotary rock cutter and a hydraulically powered chisel, which reduced the time necessary for obtaining samples and made it possible to take samples where it otherwise would not have been possible, using Hyper-Dolphin's bare manipulators.

In our future work, we hope to deploy the system to Ryusei seamount, as was originally planned, and focus our studies on Takuyo Daigo seamount and Ryusei seamount as case studies for seamounts with different properties of crusts and substrate.