Cruise Summary

1. Cruise Information

Cruise number: NT09-02 Leg.2

Ship Name: Natsushima

Title of the cruise: Northwest Pacific
(Manganese Crust Cruise to #5 Takuyo Seamount)

Chief Scientist: Tetsuro Urabe (Graduate School of Science, The University of Tokyo)

Representative Scientist: Tetsuro Urabe (Graduate School of Science, The University of Tokyo)

Title of proposal: Formation and metal-enrichment of ferromanganese crust as an interplay among fluid convection, seafloor environment and microbial activity of seamount in western Pacific basin

Cruise period: Feb. 8, 2009 (Saipan) – Feb. 24, 2009 (Yokosuka) (17 days)

Port call: Embark: Saipan, Mariana Island, Disembark: Yokosuka, Japan

Number of Dives: 7 (HPD-#953 - #959)

Research area: #5 Takuyo Seamount (23°00'N, 153°20'E)

Research maps: See attached.

2. Overview observation:

We explored the occurrence of cobalt-rich ferromanganese crust (hereafter: Mn-crust) at the depth interval from 2,990m to 950m at #5 Takuyo Seamount (23°00'N, 153°20'E), northwest Pacific using *ROV Hyper Dolphin/RV Natsushima* between February 8, 2009 and February 24, 2009. The Mn-crust is chemical sedimentary rock that covers extensively the surface of seamounts or ocean plateaus with a thickness between 1 and 20 cm. Due to the high adsorption capacity of constituent manganese oxides, appreciable concentration of cobalt, copper, nickel, rare-earth elements (REEs), platinum-group elements (PGEs), and others are known to occur. This makes the Mn-crust as low-grade, giant deposit on the present-day seafloor which can be the resource of these metals in near future. Besides, the slow but steady accumulation rate (2-7 mm per million years) of

Mn-crust for up to 50-60Ma makes it an excellent recorder of the oceanic environmental change throughout the Cenozoic era (von Stackelberg, 1979, Usui et al., 2007).

We conducted 7 dives and collected 712kg of rock/crust samples (n=113), 13 sediments, and 13 bottom seawater samples. Rock/crust samples are split for chemical (major, minor, & trace elements), isotopic (Os, Be, Sr), mineralogical, microbiological (DNA, FISH, culture experiment, etc.), and engineering (sound velocity measurement etc.) analyses. The sediments and water samples are served mainly for microbiological and mineralogical purposes as reference samples.

We tested two new payload instruments during the cruise; that is, micro-topography profiling system and underwater diamond saw. The former is to measure the topographic roughness of the seafloor to identify the area with Mn-crust cover. The system will be integrated in future AUV-borne exploration system which can measure the thickness and distribution of the Mn-crust. The latter is a sampling tool to cut off rocks to from outcrops. This worked excellent not only for collecting many samples from desired place but also for inspection of substrates of particular outcrops.

We found that the Mn-crust is ubiquitous at depth between 3,000m and 1,000m of the seamount. The summit of the seamount (D=950m, 22°57'N, 153°23'E) is characterized by limestone outcrop and its platy floats which are covered by thin Mn-crust. On the other hand, steep slopes or escarpments that surrounds the seamount at depth between 1,400m and 2,500m are characterized by thick Mn-crust on the surface of lava, pyroclastic rocks, and gravels/talus deposits. The abundance decreases with depth around 3,000m partly because of increasing coverage of terrace sediments on calmer slope. In other words, the occurrence of Mn-crust is controlled by rock facies and the stability of the substrate. It is also plausible that the seawater characteristics may contribute the thickness and the chemical composition; oxygen minimum of the area exists at depth around 900m near the summit (0.9 mg/l) and increase to 2.4 mg/l at 3,000m depth.

It is also clarified that the Mn-crust occurs beneath sediment cover at flat-top portion of the seamount. We poked the sediment with a bar to check

the existence of the crust at several locations. It is extremely hard to distinguish sediment-covered crust and sediment without this check even though the full-high vision image of the *Hyper Dolphin*.

It should be emphasized that the present cruise is the first and monumental one even in the world because of the following aspects; (1) large amount of Mn-crust specimens are collected systematically from known depth, (2) observation and inspection of substrate were made with clear and oblique image within a few meters above seafloor between 1,000m and 3,000m, (3) multi-disciplinary research among geology, mineralogy, chemistry, microbiology, and engineering was performed for the first time in the history of Mn-crust. The results of this cruise will be beneficial both for acientific and exploration points of view.

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