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Natsushima “Cruise Report”

NT12-08

Wakamiko crater, Kagoshima Bay

April 2, 2012 – April 9, 2012

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

●Contents

1. Cruise Information

● Cruise ID: NT12-08

● Name of vessel: Natsushima

● Title of proposal

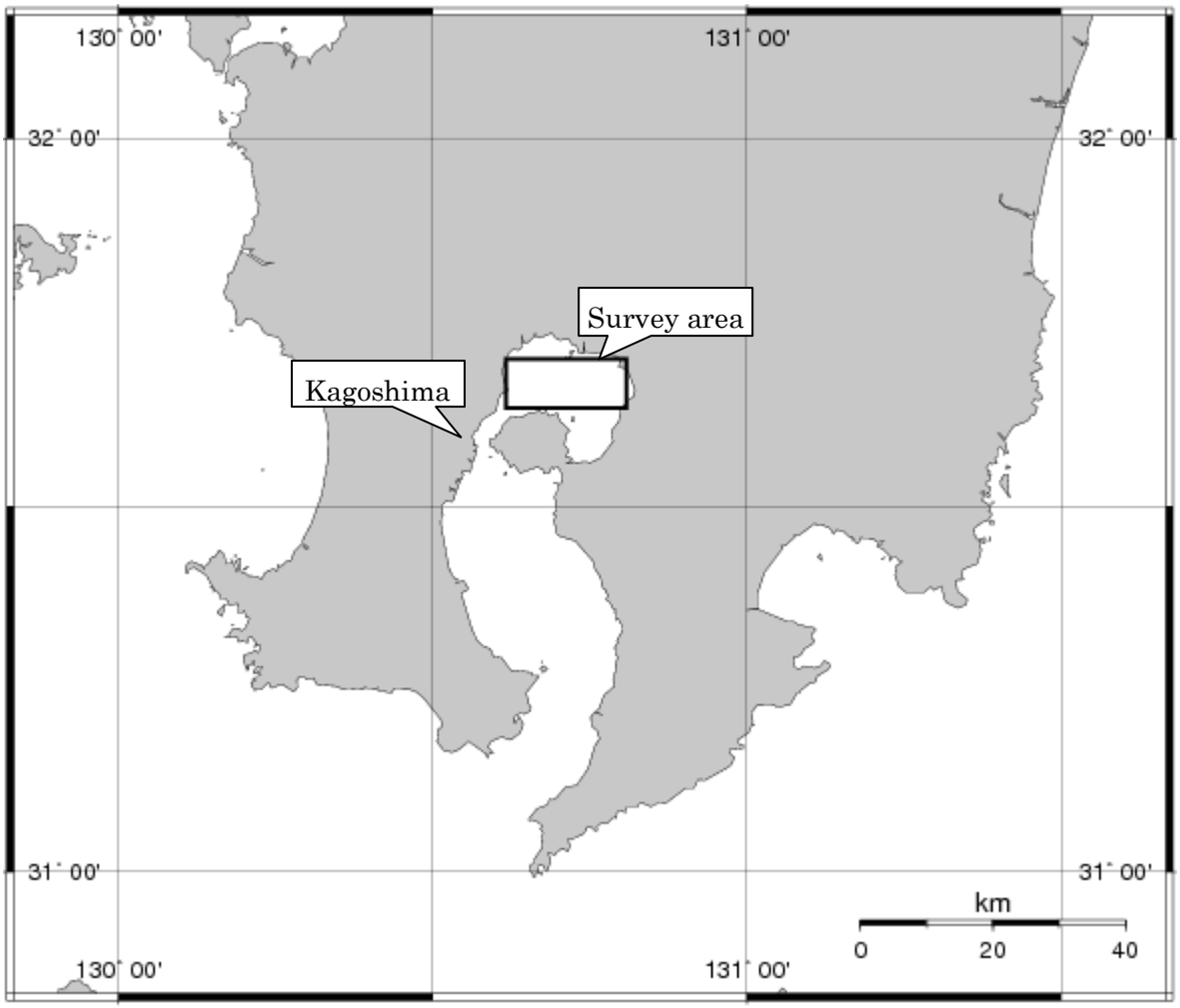
1. Study of Geochemical constraints on the stibnite ore formation with gold deposit
2. Imaging of Tagiri hydrothermal vent field by an autonomous platform system

● Cruise period: April 2nd, 2012 to April 9th, 2012

● Ports of call: Kagoshima – Kagoshima

● Research area: Wakamiko crater, Kagoshima Bay

● Research Map



2. Researchers

● Chief scientist [Affiliation]: Toshiro Yamanaka [Okayama University]

● Representative of the science party [Affiliation]:

Toshiro Yamanaka [Okayama University]

Toshihiro Maki [University of Tokyo]

● Science party:

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Masato Nagahara	Faculty of Science, Kyushu University
Kotaro Yonezu	Graduate school of Technology, Kyushu University
Junya Kanemitsu	Graduate school of Technology Kyushu University
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Toshihiro Maki	Institute of Industrial Science, The University of Tokyo
Takashi Sakamaki	Institute of Industrial Science, The University of Tokyo
Takumi Matsuda	Institute of Industrial Science, The University of Tokyo
Luan Ming	Institute of Industrial Science, The University of Tokyo
Yusuke Yano	Hakuyodo Co,Ltd

3. Observation

3.1 Proposal #1: Study of Geochemical constraints on the stibnite ore formation with gold deposit

Summary

The main purpose of Proposal #1 is determination of precipitin condition for hydrothermal minerals from hydrothermal fluids, which emitted from adjacent three vents in the Wakamiko crater hydrothermal field. From the previous study, we found those three vents discharging hydrothermal fluids, which have similar major chemical composition but characterized by various temperature and minor chemical compositions. Such characteristics are expected to understand of geochemical constraints on precipitation condition of hydrothermal minerals below the seafloor. So, during this cruise we planed to collect sufficient amount of hydrothermal fluids for geochemical analyses of minor elements and dissolved gas species from those three vents.

As a result we sampled successfully enough amount of hydrothermal fluids (≥ 2 L) and hydrothermal precipitation from two vents and one shimmering site during four dives.

Preliminary result

Hydrothermal fluid samples were measured concentrations of silica, ammonia, and hydrogen sulfide, and pH on board. Those results are shown as Figures 1, 2, and 3. Those results suggest that end-member fluid composition expected from the sampled fluids is possibly different each

other.

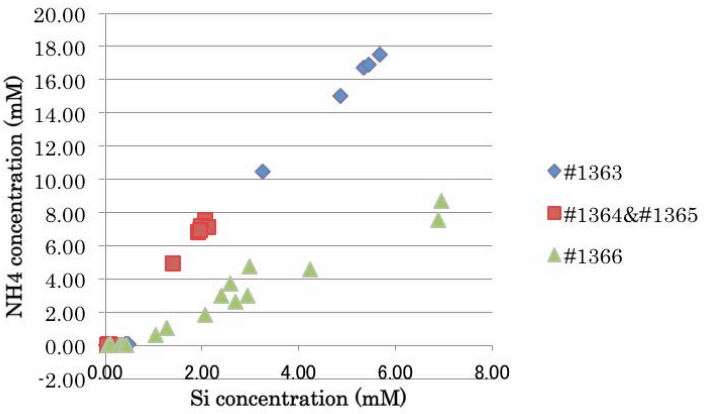

Fig. 1 Si *vs*. Ammonia concentrations of the fluid samples

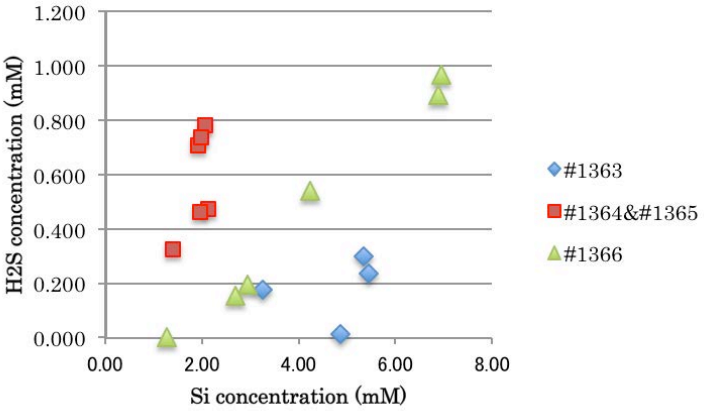

Fig. 2 Si *vs*. H_2S concentrations of the fluid samples

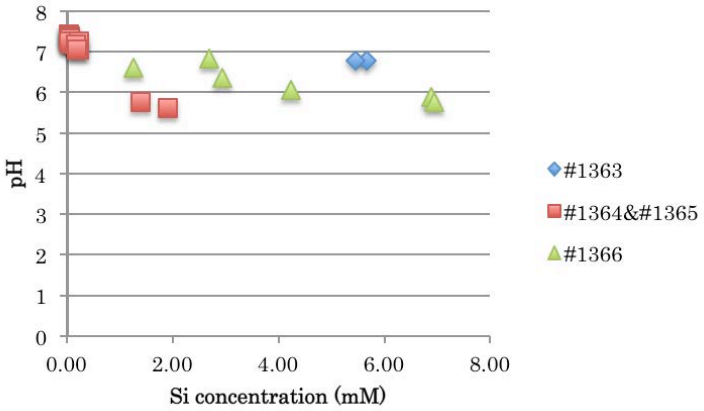

Fig. 3 Si concentrations *vs*. pH of the fluid samples

Future studies

Yamanaka, Kondo, Kashimura, and Chiba [Okayama University]

Fluid chemistry

For comparison of fluid chemistry among each site and time series changes, we plan to measure major elemental compositions together with hydrogen sulfide in the sample fluids. Then we will estimate the end-member fluid composition. Isotope compositions of water and hydrogen sulfide-sulfur will be measured.

Dissolved gas chemistry

Dissolved gas and fumarolic gas samples collected using vacuum bottle samplers are planed to measure chemical compositions and isotopic composition of methane and carbon dioxide under supporting by Dr. Toki in Ryukyu University. Those data will support to estimate geochemical and geophysical state of hydrothermal fluid below the seafloor.

Chimney mineralogy and isotope geochemistry

Mineral composition of hydrothermal precipitate composed the chimneys and mounds will be studied. Those mineral assemblages and isotopic signature of silicate minerals will provide many geochemical and geophysical information. Those studies will be conducted with Dr. Murakami in AIST.

Nagahara and Ishibashi [Kyushu University]

Rare metal elements in hydrothermal ore samples

We are planning to detect presence (or absence) of rare metals in the hydrothermal ore samples mainly composed of stibnite, which were obtained during this cruise. We will determine abundance of rare metal elements with NAA (Neutron Activation Analysis) technique, under collaboration with Kyoto University Research Reactor Institute. We will also conduct EPMA (Electron Probe Micro Analyzer) analysis to identify minerals which bear rare metal elements. Based on these analyses, we will discuss mechanism of involvement of rare metal elements into hydrothermal sulfide ore deposits.

Yonezu and Kanemitsu [Kyushu University]

Minor element in the fluid samples

In order to clarify the geochemical condition during stibnite-gold precipitation from hydrothermal water, trace amount of gold and REE concentration in hydrothermal water will be determined by ICP-MS after selective concentration and separation. Especially, REE chondrite-normalized patterns may give us the redox-condition of the hydrothermal water. By determination of gold concentration in hydrothermal water, the relationship between the characteristic of the hydrothermal water and stibnite will be discussed, and it leads to the

understanding of the mechanism of stibnite-gold precipitation.

Speciation of minor elements in the mineral samples

In order to determine the chemical state of gold co-precipitated with stibnite, X-ray photoelectron spectrometry and X-ray absorption spectrometry will be applied. The chemical state of gold in stibnite is still ambiguous. In general, gold is present as gold bisulfide in hydrothermal water. As metallic state of gold has not yet observed in stibnite by EPMA, it is important for the determination the chemical state of gold for the elucidation of the stibnite-gold precipitation condition as well as further refining process of antimony and gold.

Okamura and Noguchi [Kochi University]

We will conduct the chemical analysis (total inorganic carbon, alkalinity, pH, nutrients, and seawater density) on the fluid samples collected during this NT12-08 cruise, and clarify the carbon cycle system at Wakamiko crater.

In case of the geochemical discussion with other results (especially alkalinity affected species such as boron and HS^-), we collaborated with Dr. Yamanaka in Okayama University and other co-workers.

3.2 Proposal #2: Imaging of Tagiri hydrothermal vent field by an autonomous platform system

Summary and future studies

i. Seafloor mapping by an autonomous system

We are developing an autonomous platform system consisting of a seafloor station and a hovering-capable autonomous underwater vehicle (AUV) in order to visualize hydrothermal vent fields. During this cruise, the prototype system consisting of AUV Tri-TON (Fig. 4) and the station was deployed on the seafloor with the depth of 200 m, near the chimneys in Wakamiko Crater. The experiments were carried out on 4, 6, and 8 April. The vehicle succeeded in finding the seafloor station by acoustic communication and then observed seafloor by following waypoints defined with regard to the station. Fig. 5 shows the estimated trajectory of the AUV at the dive on 6 April. The vehicle succeeded in finding the seafloor station by acoustic communication and then observed seafloor by following waypoints defined with regard to the station. Thus, the performance of the system was verified. Fig. 6 is one of the seafloor photos taken by the vehicle during the dive.

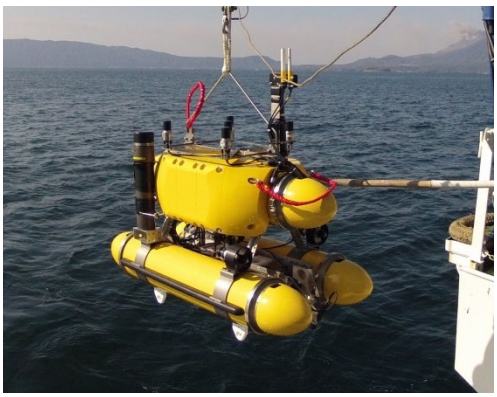

Fig. 4 AUV Tri-TON

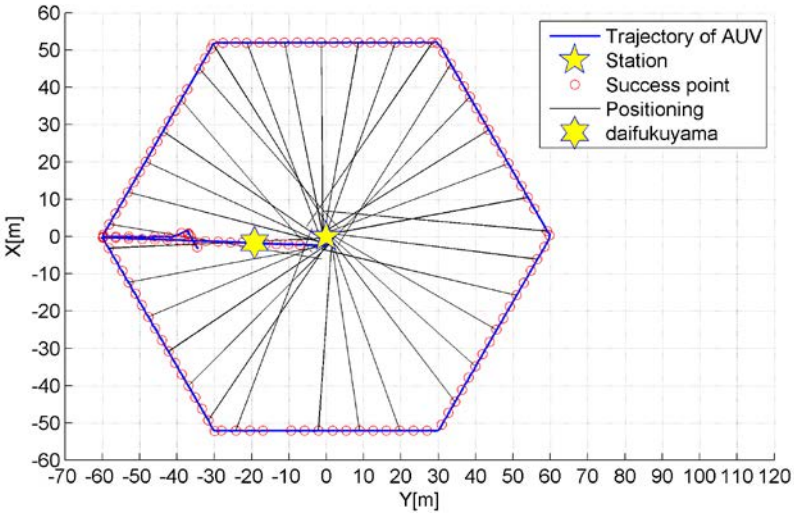

Fig. 5 Trajectory of Tri-TON (Dive 3)

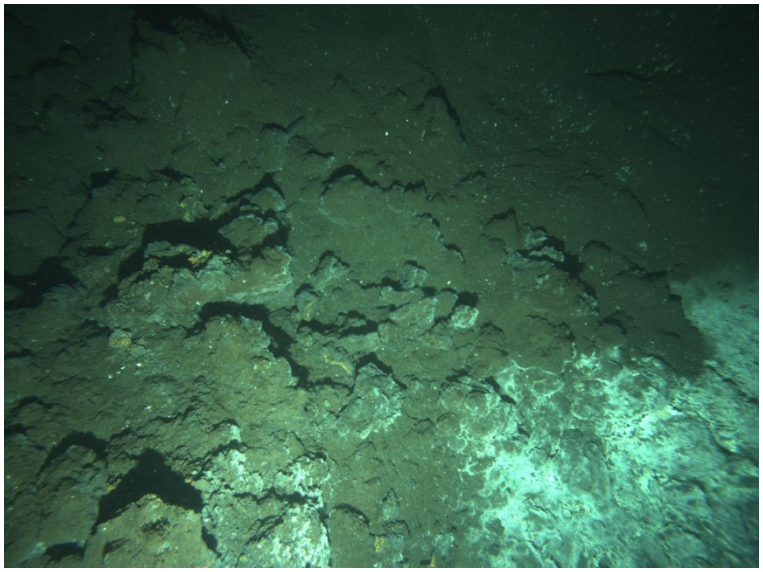

Fig. 6 Seafloor photo taken by the vehicle (Daifuku-yama chimney).

ii. Study on the potential of hydrothermal vents as power sources

Hot fluid coming out from hydrothermal vents has a potential as power sources, as there is a significant temperature difference between the hot fluid and surrounding water. During this cruise, the energy potential of the White Cone chimney in Wakamiko hydrothermal field was evaluated by measuring the flow velocity (Fig. 7) and temperature. A testing model of a power generator made with Peltier devices was also deployed to the vent, for feasibility study (Fig. 8).

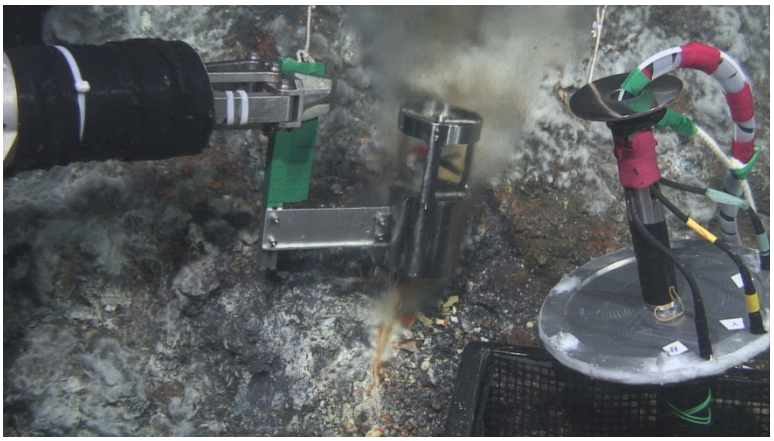

Fig. 7 Flow velocity measurement (HPD #1365 dive).

Fig. 8 Power generation test (HPD #1365 dive).

4. Notice on Using

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