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YK05-06 Cruise, Onboard Report
“Expedition for Petit-Spot III”

Outer-rise in NW Pacific & Japan Trench Oceanward Slope
May 12 - May 27, 2005: Yokosuka – Yokosuka

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YK05-06 Onboard Report
Expedition for "Petit-Spot" III

Investigation of Outer-Rise in the NW-Pacific &
the Japan Trench Oceanward Slope
(12 May, 2005, Yokosuka – 27 May, 2005, Yokosuka)

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Shipboard Scientific Party YK05-06

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University of Tokyo &
Nippon Marine Enterprises, Ltd.

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PREFACE

The "Petit-Spot" (Flexure Zone Volcanoes) is a new concept for the Earth Sciences; volcanology, mantle structures, petrology, geochemistry and tectonophysics. It is based on the idea of volcanoes on the flex lithosphere and melting of asthenosphere. We will report firstly young lava fields on the Cretaceous Pacific Plate, eastern tip of the Hokkaido Rise at the NW Pacific. The discovery of this young lava fields on the NW Pacific and the Kaiko Knolls lava field in the Japan Trench would be breakthrough on the Earth Science.

ACKNOWLEDGEMENTS

All onboard scientists express great thanks to the "R/V *YOKOSUKA*" crew and to the "*SHINKAI 6500*" staff of their excellent operations. Also shore-base staff of the JAMSTEC had excellent support for our cruise, particularly for Mr. Tsuyoshi Yoshiume. Mrs. Tohru Kodera, Ichiro Nara, Hitoshi Tanaka, Tomoaki Kudo and Mamoru Sano of Nippon Marine Enterprises, Ltd. supported our daily jobs during the cruise. We sincerely appreciate his generous support. Not at least we are grateful to Prof. Eiichi Takahashi of Tokyo Institute of Technology, Dr. Masataka Kinoshita of JAMSTEC and Prof. Masao Nakanishi of Chiba University for their helps and supports, respectively.

1. Scientific Objectives

1-1. Proposal

Until recently, no present-day volcanic activity had been documented on the cool, thick, and old Cretaceous lithosphere; however, Hirano et al. (2001) reported the presence of anomalously young alkali-basalt lavas (5.95±0.31 Ma Ar-Ar age) on the subducting, ~130 Ma Pacific Plate. Volcanic eruption of the newly discovered lava field occurred on approximately 600 km ESE off the northern Japan Trench based on the present absolute motion of the Pacific Plate (Gripp and Gordon, 1990). This point coincides with the flexural part of the outer rise at present, so that we need to explain how and why such young lavas erupted on the aseismic ocean floor. During KR04-08 cruise "expedition for Petit-Spot II" on last year, our scientific party newly discovered another young volcano, the Yukawa Knoll, on the predicted eruption-site of ~6 Ma lavas on the Japan Trench (Figure 1-1-1).

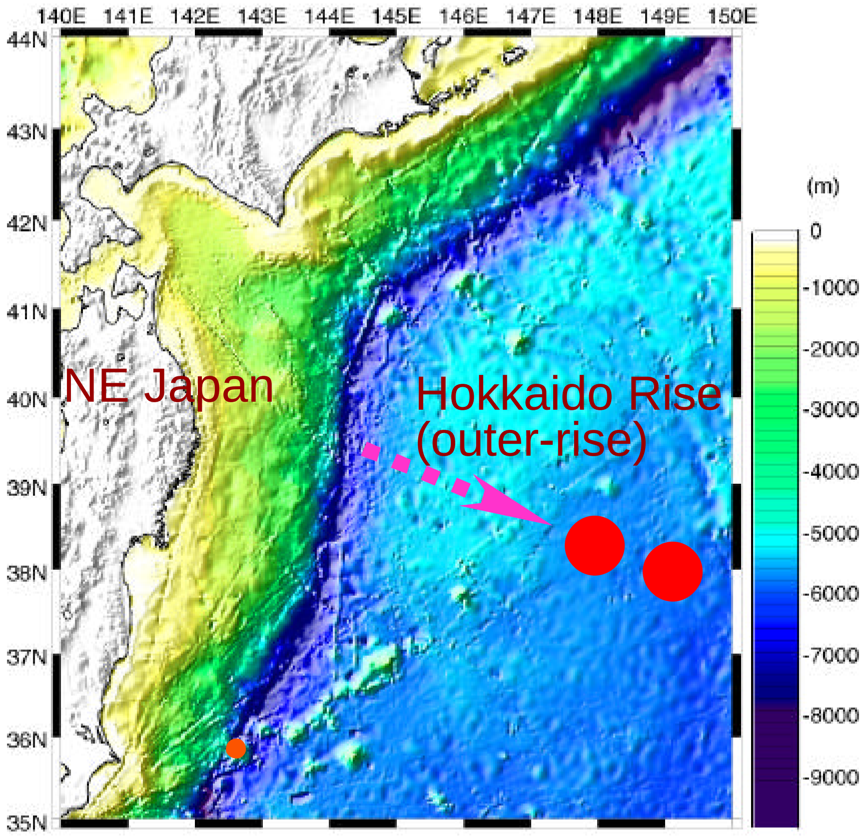

Figure 1-1-1. Predicted and discovered Lava fields of the Petit-Spot, Kaiko Knolls and eastern edge of the Hokkaido Rise (Hirano et al., 2001; KR04-08 onboard report).

The plate tectonics theory suggested by Morgan (1968) was breakthrough of the Earth Science to be able to explain many phenomena on the Earth (e.g. earthquake, volcanoes, oceanic plate evolution, continental moving). Plate motions are Earth's most important tectonic processes, because a tectonic plate moves on the nearly spherical surface of Earth and because a plate works as excellent approximation to be rigid, and plate motions can be represented simply as rigid body rotations. In the limiting case of geologically recent motion, the time derivative of rigid-body rotation can be described by angular velocity, which is an axial vector. The assumption of plate rigidity allows geometrically precise and rigorously testable predictions to be made. The observed near rigidity of the plates also permits the treatment of plate kinematics separately from dynamics. Abundant data describe the geologically recent motion across narrow boundaries linking nearly all the major plates, permitting many tests of plate tectonic predictions.

The dynamics of the Earth's interior is reflected in process at the Earth's surface: due to mantle convection, lithospheric plates experience stress and move in response, based on the overlaying rigid plate (lithosphere) on the ductile asthenosphere, which is the engine of the plate tectonics. The asthenosphere is approximately 200 km thick and, owing to its depth below the Earth's surface. Here the mantle deforms by plastic flow in response to applied pressures above 100 MPa (lithosphere). This zone is considered coincidental with the low-velocity zone of the upper mantle. The asthenosphere is solid even though it is at very hot temperatures of about 1600 ^{o}C due to the high pressures from above. However, at this temperature, minerals are almost ready to melt and they become ductile and can be pushed and deformed like silly putty in response to the warmth of the Earth. These rocks actually flow, moving in response to the stresses placed upon them by the churning motions of the deep interior of the Earth. The flowing asthenosphere carries the lithosphere of the Earth, including the continents, on its back. Although scientists had originally believed that asthenosphere will be melting when the plate tectonics theory suggested, Karato (1986) mentioned the model that the hydrogens in water in determining the structure of the lithosphere- asthenosphere boundary behave as the role of phase transformation in controlling the density and plastic flow properties of Earth's materials and that the asthenosphere is not necessarily melting. However, we do not know "What is asthenosphere?" "Which is that melting or not?" yet.

The large curvatures of the flexed lithosphere cause brittle fractures of the upper lithosphere and ductile flow of the lower lithosphere (Kirby, 1983; McAdoo et al., 1985). If the asthenosphere slightly melts, such melt may be induced to the surface along the lithospheric fracture. The scope of this cruise is for researching the origin of this magmatism and the distributions of such volcanoes on the flexural Pacific Plate by some geophysical observations (OBEM and SCS). Strongly vesicular and undifferentiated lavas for Petit-Spot may have occurred the peculiar eruption on the abyssal plain. We will observe the eruption style and the stratigraphy of volcanoes using the submersible *SHINKAI 6500*.

1-2. Geological Background

On the surface of the Earth is covered with various kinds of rocks and sediments. Above all, alkaline igneous rocks are specific, teaching us what occurs in the deep crust and mantle. In a wide ocean, such as the Pacific, there are many kinds of seamounts and knolls, most of which are the products of hotspot magmatism, but some might not be related to hotspots. The latter includes particular type of alkaline basalts. In the NW Pacific, many seamounts and knolls are along the traces of hotspots which are distributed somewhere in the Pacific, mostly in the equatorial areas. Many traces of seamounts and knolls, some are guyots, some are seamounts, and some are oceanic islands, have been well studied. They are mostly known as of Cretaceous magmatism, and those particularly in the NW Pacific are almost such (Ozima et al., 1977; Takigami et al., 1989; Masalu et al., 1997; Hirano et al., 2002) (Figire 1-2-1). However, Hirano et al. (2001) found a very young alkaline basaltic volcanism which is quite unique and different from the previously known hotspot products from the samples at the Japan trench oceanward slope toe taken by R/V *KAIKO* in 1997 (10K#56) at 39^{o}23.2' N, 145^{o}15.5' E. The age of the rock was determined by Ar-Ar method as to be 5.95±0.31 Ma, late Miocene (Hirano et al., 2001). This study gave very strong shocks to the petrological scientists, particularly why and how such magmatism occurred, and what the implications for the plate tectonics and magmatism are.

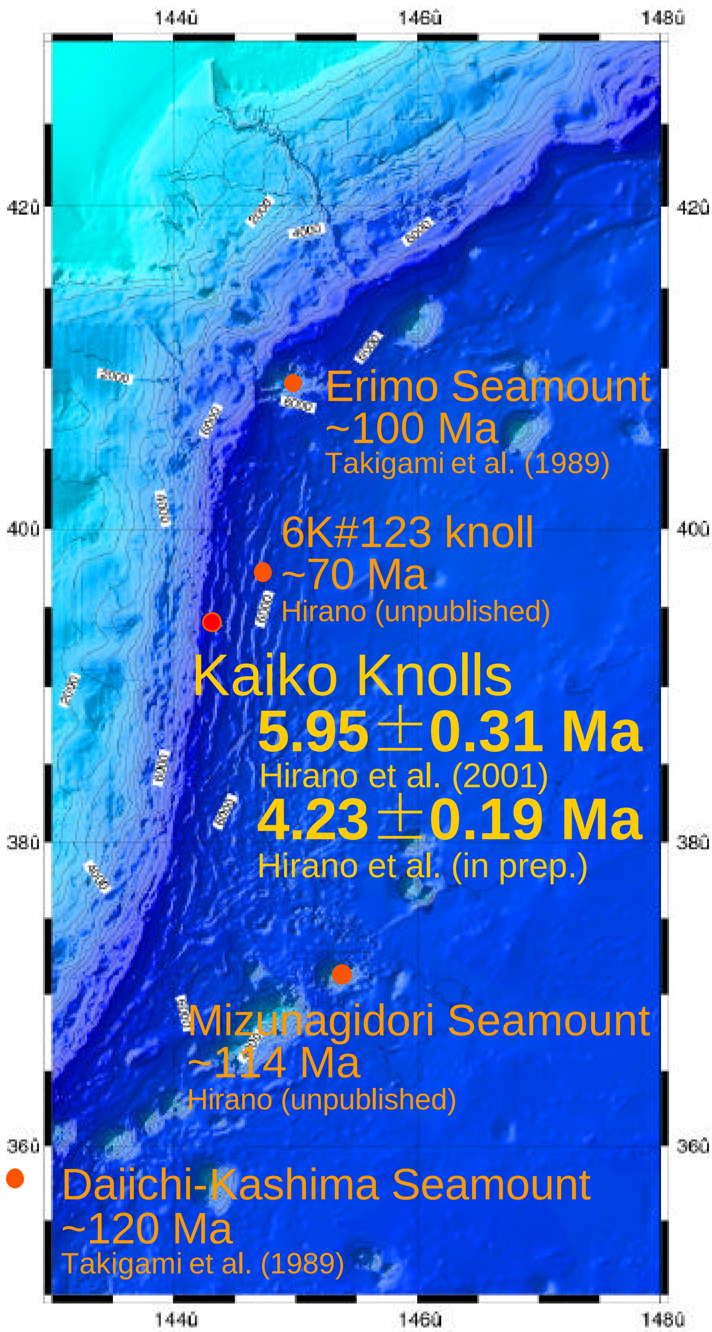

Figure 1-2-1. Some Cretaceous seamounts and guyots on the Early Cretaceous Pacific Plate, offshore NE Japan. Kaiko Knolls were quite young lava fields on such old plate.

The Hokkaido Rise is tectonically interpreted as one of such upward convex swell, called the outer-rise, outer-swell, outer buldge or forebuldge, which has been interpreted as an upward convex swell resulting from subduction of Early Cretaceous Pacific Plate into the Japan and Kuril Trenches. According to the plate subsidence models by Parsons and Sclater (1977) and Levitt and Sandwell (1995), the 130 to 133 Ma part of the Pacific Plate, currently subducting beneath northern Japan (magnetic anomalies M10 to M11; Nakanishi et al., 1992; Nakanishi and Winterner, 1998), should be at a depth of approximately 6000 mbsl. Nevertheless, the shallowest part of the Hokkaido Rise is only 5200 mbsl. In contrast, the easternmost portion of the Hokkaido Rise is 6000 mbsl, suggesting a discrepancy of 800 m not explained by normal subsidence models (Figure 1-2-2). The amplitudes from the Japan Trench to the Hokkaido Rise, particularly northern part of no existing some Cretaceous seamounts (Joban Seamount Chain), estimated on topography and gravity anomalies (Levitt and Sandwell, 1995) is remarkably high and comparable to rises off the southern Kamchatka and Kuril Trenches in the world, although it seems to be the general outer-rise in front of the plate subduction boundary.

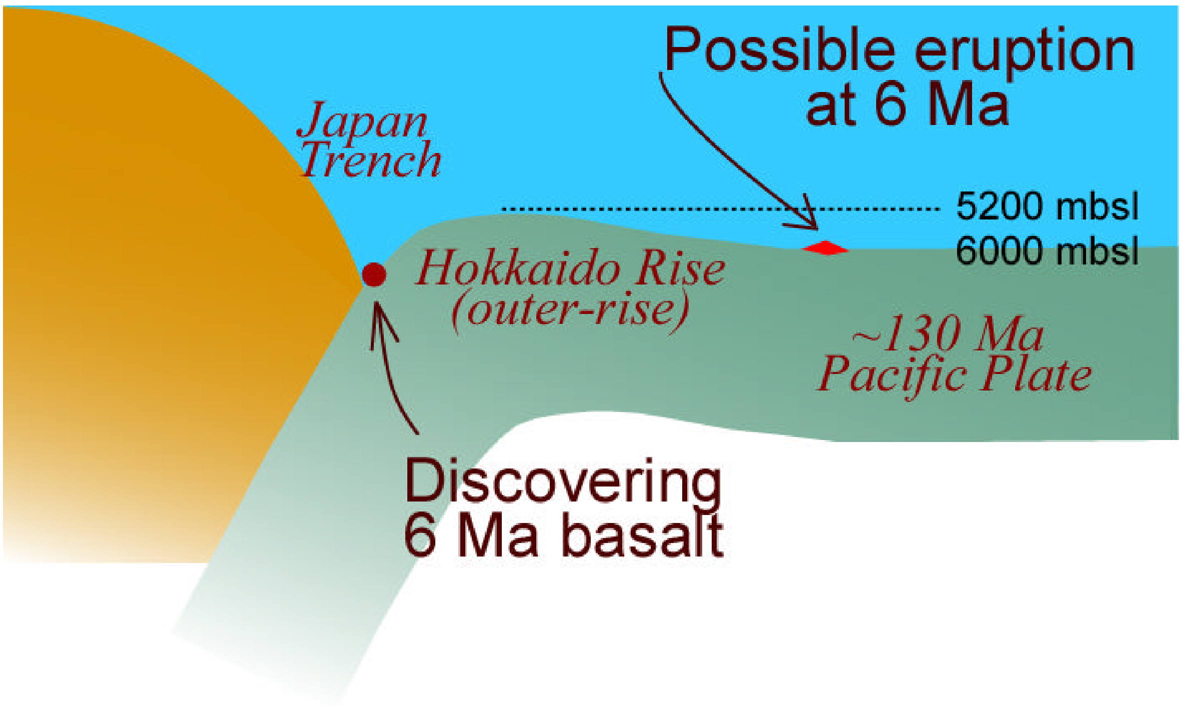

Figure 1-2-2. Predicted eruption-site in the trench and outer-rise systems.

1-3. Scientific Objectives

1-3-1. Naoto Hirano

The Petit-Spot expedition -Detail distribution of young lava field on the outer-rise-

Using on-board data we will firstly report detail distribution of the lava field based on the back-scan image and bathymetry by the Seabeam 2112 and obtaining samples by dredges. High reflection areas in the backscatter image expecting the lava field appear are shown along some irregularly topographic highs and normal faults on the subducting Pacific Plate. KR03-07 cruise results on the last year show that the lava field is composed of two type lavas; one is vesicular lavas forming some topographic highs (possibly pillow lavas) and another is underlying sheet flow (dense and flood-like lavas). The latter would be concealed by topographic highs and pelagic mud. "Which are Kaiko lava field in the Japan Trench accidental or common on the outer-rise?" The some dredges and seabeam data on this cruise should solve this problem.

Eruptive styles on the Petit-Spot (Kaiko Knolls & eastern edge of Hokkaido Rise lava fields)

Investigation of the newly discovered lava fields on KR03-07 and KR04-08 cruises. Sampling will take place simultaneously as dive ascends and descends along each slope of high. An empty SAHF thermometer will be taken to test its ability to withstand pressures at nearly 6000 m depth.

Lavas are highly vesicular (Figure 1-3-1-1), despite 6 kbar hydrostatic pressure at eruption depth; this and the low viscosity of the lavas may form their peculiar morphology. We may observe collapsed structures of inflated pahoehoe lavas with botryoidal lavas located interstitially on the terrace below the flood lavas (Figure 1-3-1-2). The lava may form lobate structures and pyroclastic ejecta despite deep-submarine eruption conditions.

Figure 1-3-1-1. Strongly vesicular lavas from the Kaiko Knolls lava field (KR03-07 onboard report). It is quite peculiar because lavas erupted on the high hydrothermal pressure, approximately 6 kbar.

Figure 1-3-1-2. Basaltic rocks from the newly discovered volcano, the Yukawa Knoll (KR04-08 onboard report). Rocks have some the lope-like structure on the surface.

Source and origin of magma in the mantle

This theme will be the main study of the young lavas on the Japan Trench and outer-rise. We should obtain answers of two questions about the source of magmas in the mantle and the cause of eruption. Firstly we will solve the source mantle of this magma based on the geochemical studies of major and trace element compositions and radiometric isotopes. Each element trend along the differentiation line of magma can indicate the mineralogy of source mantle, which are a tool to consider the depth in the mantle. We think that the variation of obtained rocks such as ol-bearing basalt, cpx-bearing basalt, aphyric basalt and dolerite are useful to recognize the source mineralogy and depth. Sr, Nd, Pb and He isotopes would indicate source material in the mantle (primitive or depleted mantles).

The cause of eruption may be resolved by tectonophysics such as some bendings or fractures of oceanic plate. We will simulate some bendings of the flexural plate with decreasing pressure or fractures into lithosphere. The arrangements of lava field using backscatter on this cruise may also indicate the cause of eruption. Using methods are

- XRF (by N. Hirano, S. Machida and T. Ishii)
- Microprobe analysis for glasses and minerals (by N. Hirano, N. Abe)
- Laser ablation ICPMS (by N. Hirano, T. Hirata and N. Takehara)
- TIMS for noble gases (by J. Yamamoto and N. Hirano)
- TIMS for solid elements (by S. Machida, N. Hirano and J. Kimura)
- Ar-Ar dating (by N. Hirano and K. Nagao)

1-3-2. Natsue Abe

Aims of my research project on this cruise are to understand;

- why does a young volcano erupt and form mono volcanos on an old oceanic plate.
- what the asthenosphere is, and as well as what the oceanc lithosphere is.
- how these alkaline mono volcanos works the whole earth, at least silicate earth, evolution.

Main interest is mineral chemistry of the ultramafic and mafic xenoliths and/or xenocryst in the alkaline basalt. Especially chromian spinel with/without olivine phenocryst and also olivine xenocryst may tell us the origin of these minerals and host magma (e.g., Arai, 1994). The Yukawa alkaline basalt, sampled during KR04-08, includes olivine and orthopyroxene xenocrysts frequently, and also include several peridotite and opyroxenite xenolith and gabbroic xenoliths. These deep sheeted rock may compose the old oceanic plate as the crust and upperupper mantle.

In other words, mineral chemistry and detail description (petrography) of thin sections can tell us the condition of magma formation and capture of xenocrysts; e.g., PT conditions, H_2O content and so on. In addition to this, *in situ* trace-element analysis us ing by LA-ICPMS or SIMS will be taken on clinopyroxene in basaltic samples, and mineral and/or melt inclusions in phenocryst/xenocryst in basalts, and also detrital minerals in sediments. Then compositions of the equilibrium melt with such kind of minerals/melt inclusions will be estimated.

1-3-3. Teruaki Ishii

Lavas are highly vesicular, despite 6 kbar hydrostatic pressure at eruption depth; this and the low viscosity of the lavas may form their peculiar morphology. We may observe collapsed structures of inflated pahoehoe lavas with botryoidal lavas located interstitially on the terrace below the flood lavas. The lava may form lobate structures and pyroclastic ejecta despite deep-submarine eruption conditions.

1-3-4. Stephanie Ingle

Lava morphology, stratigraphy, geology and petrology.

Investigation of a pit-crater and topographic high in the newly discovered lava fields on KR03-07 cruise. Sampling will take place simultaneously as dive ascends and descends along each slope of high. An empty SAHF thermometer will be taken to test its ability to withstand pressures at nearly 6000 m depth.

SHINKAI will first be on the bottom at the base of the crater, and will then climb the gentle slope of the wall of the crater along the high back-scattered area. *SHINKAI* will then climb the small topographic high above the crater. *SHINKAI* will descend a different slope of the volcano and repeat its climb to the summit.

Lavas are highly vesicular, despite 6 kbar hydrostatic pressure at eruption depth; this and the low viscosity of the lavas may form their peculiar morphology. We may observe collapsed structures of inflated pahoehoe lavas with botryoidal lavas located interstitially on the terrace below the flood lavas. The lava may form lobate structures and pyroclastic ejecta despite deep-submarine eruption conditions.

1-3-5. Shiki Machida

Sr and Nd isotopes of basalts from Petit-Spot volcanoes

My interest is bulk rock Sr and Nd isotope compositions of basalts derived from "petit-spot" volcanoes which from the new type intra-plate volcanism in west pacific. Sr and Nd isotopes are not only basic geochemical data set for rock geochemistry, but also important tool for defining the origin of source mantle.

Isotope analysis using Thermal Ion Mass Spectrometer (TIMS) will be taken on basaltic rock colected from each dive site. During KR04-08 and KR03-07 cruises, basaltic rocks were collected from petit-spot volcanoes in outer wall of the Japan trench and in eastern edge of the Hokkaido rise (Yukawa knoll). In my previous work, Sr and Nd isotopic compositions of samples dredged from these knolls were determined. These basalts have enriched Sr and Nd isotope compositions, which are similar to that of Bulk Silicate Earth (BSE) (e.g. Zindler and Hart, 1986). This isotopic feature should be several hypothesizes, but now we have two established hypothesizes. The first hypothesis is that the source mantle of petit-spot volcanism were produced by mixing process of geochemical mantle reservoirs such as DM, EM I, and EM II. The second hypothesis is that the source mantle is originally from primary mantle having Bulk Silicate Earth (BSE) composition. The mantle may be unmodified or unfractionated from the primary mantle. We will try to approach another petit-spot volcanoes that we never collect some samples, during this cruise (Dive #3: #878). The new isotope data determined from these samples must provide additional restrictions to examine the problem for origin of source mantle. Then, I confident that we will get important aspects about the Earth's mantle geochemistry.

Petrology of basaltic xenolith from oceanic crust of the Cretaceous pacific plate

During the KR04-08 cruise, we collected basalt including massive basalt xenolith from the Yukawa knoll. This zenolith is slightly altered and showing depleted trace element composition. Then, we consider that these zenolith was originated from the Cretaceous Pacific plate MORB. To examine detail petrological features, we need more xenolith samples from the Yukawa knoll. We expect that rock samples collected by two dives (Dive #1 and #2: #876 & #877) at the Yukawa knoll include many basalt xenolith. Then, these data contribute to understanding about the genesis of MORB, as well as source mantle, during Cretaceous age.

1-3-6. Masahiro Ichiki & Kiyoshi Baba (Seafloor magnetotelluric survey)

Magnetotelluric (MT) soundings provide us an image of electrical feature of Earth's interior. Because electrical condcutivity of the mantle materials is strongly dependent of temperature, partial melt, and volatiles such as water, electrical conductivity strucutre models estimated through seafloor MT surveys are definitely useful to discuss where the source of the “Petit Spot” volcanic activity is and its realtion to the mantle dynamics. For these objectives, we planed a seafloor MT experiment using six ocean bottom electromagnetometers (OBEMs). The experiment contains two targets: 1) Semi-regional structure of the lithosphere and asthenosphere beneath the “Petit Spot” area based on 10-weeks observation. 2) Regional upper mantle structure in the northwestern Pacific Ocean based on one-year observation.

The first target is focused on the source area of the “Petit Spot” magma. Five OBEMs are deployed on cross-shape array centering on Yukawa knoll with ~100 km intervals (Figure 1-3-6-1).

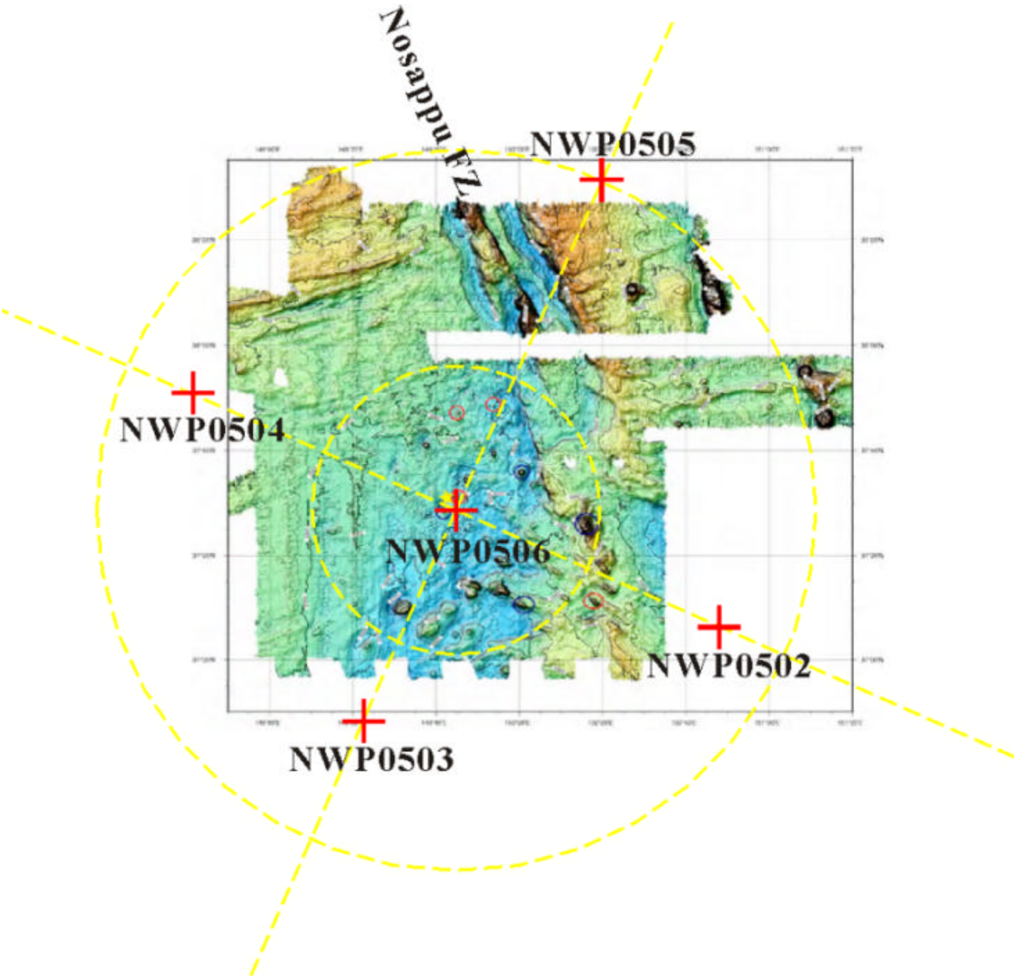

Figure 1-3-6-1. Bathymetry map and the MT site locations around the “Petit Spot” area. Red crosses are the locations where OBEMs were deployed in this cruise. Dashed lines are the directions parallel to and perpendicular to the Pacific plated motion and the circles centering on Yukawa knoll with diameters of 100 km and 250 km, respectively.

We investigate the electrical conductivity of the lithosphere and asthenosphere down to 200 km depth where the peterological studies suggest that the melt generated. One of the most basic questions, wheather the asthenosphere is partially molten everywhere and hence “Petit Spot” is just an indication of pathway to the surface or the asthenosphere beneath the “Petit Spot” area is anomalous with high temperature or high contents of volatiles resulting in partial melt, can be answered through the electrical conductivity structure.

The cross-shape observation array is also designed for dealing easily with the anisotropic electrical conductivity, setting the OBEM sites on the lines parallel to and perpendicular to the current motion of the Pacific plate. Recent seafloor MT study has revealed that the electrical conductivity of the asthenosphere in the East Pacific Rise is mainly controlled by water (hydrogen dissolved in minerals) and anisotropic suggesting the lattice preferred orientation of mantle minerals (Baba et al., 2005). However, it is still unknown wheather the electrical conductivity of old oceanic asthenosphere is anisotropic or not. This study is also the first attempt in the world about this point. Further, structural change associated with Nossapu fracture zone is also taken into account. The lines connecting the sites NWP0504 and NWP0505, and NWP0503 and NWP0502 are orthogonallized to the fracture zone. Observation during ~10 weeks would be enough for the exploration of the asthenospheric depth. Thus, OBEMs deployed at the four sites (NWP0503 – NWP0506) will be recovered by R/V Kairei KR05-11 cruise that is planed in August, 2005. The other site is common to the long-term site (NWP0502), which locates on the southerneast point of the array.

The second target is motivated from a study of global seismic tomography. The P-wave velocity structure model shows a remarkable low velocity region at depths of 300 – 600 km beneath the outer rise (Fig. 1-3-6-2).

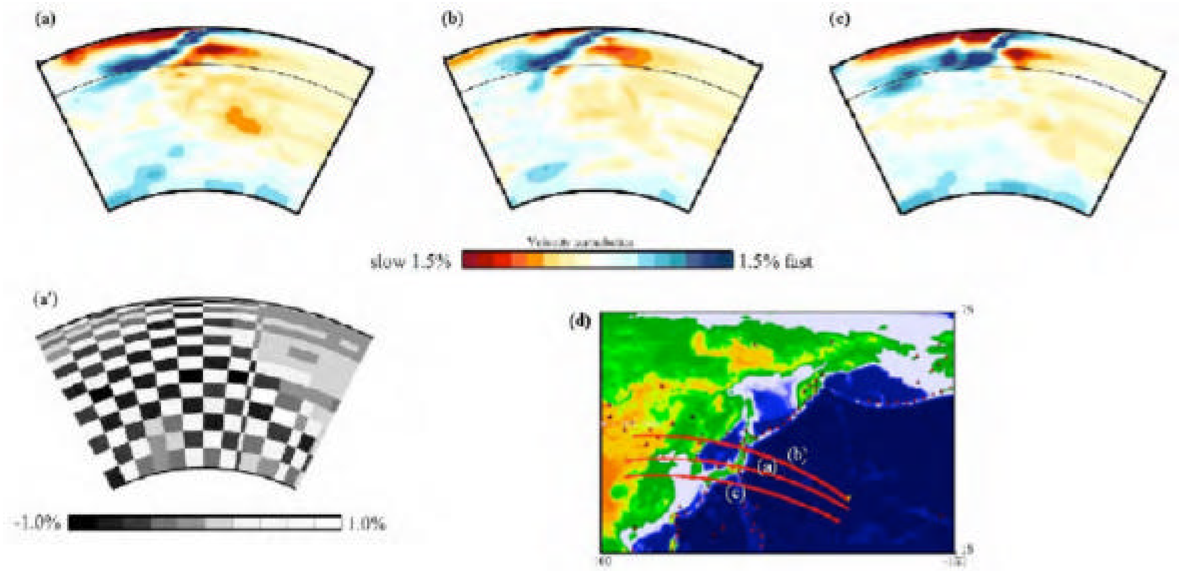

Figure 1-3-6-2. Seismic P-wave tomography model by Obayashi and Fukao (2001). Three sections (a, b, and c) are taken from the global model. The result of resolution test for the section (a) is shown in (a'). The locations of the sections are indicated in the map (d).

The low velocity region seems to extend to the "Petit Spot" area, although its eastern margin is not well resolved by the land-based tomography. Low velocity anomalies are frequently interpreted as high temperature anomalies and hence the low velocity region beneath the outer rise may suggest an upwelling of high temperature materials. However, the upwelling adjucent to the downwelling of the Pacific plate is implausible under realistic mantle viscosity (Yanagisawa, personal communication). For elucidating the physical state of the mantle more acculately, analyzing both the seismic velocity and electrical conductivity is critical. Ichiki et al. (2005) developed a method to distinguish the thermal and compositional (hydrogen) effects on electrical conductivity by refering seismic P-wave velocity. Applying Ichiki et al's method to the northwestern Pacific region enables us to discuss the physical states and dynamics, which may be related to "Petit Spot".

We have carried out a long-term seafloor MT survey in the northwestern Pacific Ocean since 2003 to reveal the regional structure of the upper mantle down to ~400 km depth. We have already collected one-year-long MT data at sites NWP0301 and NWP0302. Two sites newly deployed in this cruise, NWP0501 and NWP0502, respectively locate ~350 km south of the sites NWP0301 and NWP0302 (Fig. 1-3-6-3). These sites are designed for one-year observation. Further, we plan additional long-term surveys in the coming years, which fill the region in the circle centering on the "Petit Spot" area with a diameter of ~1000 km. We ultimately aim to obtain a three-dimensional (3-D) electrical conductivity strucuture model of the upper mantle in the region by analysing these data jointly.

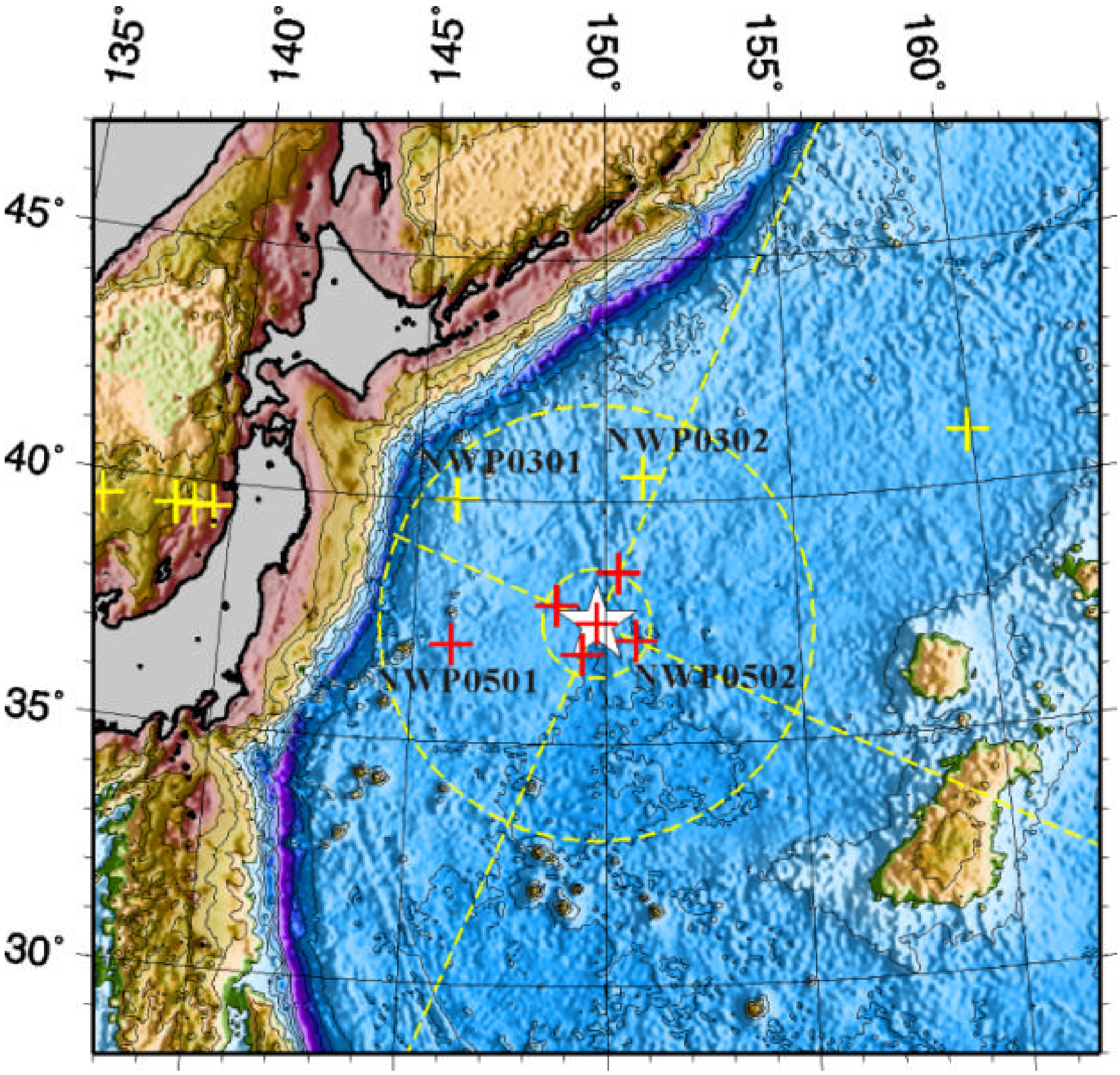

Figure 1-3-6-3. Regional bathymetry map and MT site locations in northwestern Pacific Ocean. The contour interval is 1000 m. Red crosses are the OBEM sites deployed in this cruise. Yellow corsses are the sites where MT data were collected in previous experiments. Star indicates the location of Yukawa knoll, where the fresh alkali basalts were discovered. Dashed lines indicate the directions parallel to and perpendicular to the current motion of the Pacific plate and circles centering on Yukawa knoll with diameters of 1000 km and 250 km, respectively.

1-3-7. Toshiya Fujiwara

Magnetization of Oceanic Crust off the Japan Trench

We propose to investigate magnetic characteristics of oceanic crust off the Japan Trench in the northwestern Pacific. The northwestern margin of the Pacific Plate is being subducted beneath the northern Japanese Islands at the Japan Trench. In the northern part of this trench, the Pacific Plate has a series of parallel magnetic anomalies (Japanese Lineation Set), identified as chron M11-M7 (140-120 Ma). These anomalies are well lineated and have high-amplitudes of ~500-1000 nT, peak-to-trough, in the seaward slope of the trench.

As a previous study, Toshiya Fujiwara has worked on the magnetic anomaly around the Japan Trench in collaboration with Yumiko Noda and Yukari Kido. We have discussed phenomena of gradually decay in amplitude of the magnetic anomaly to the landward from the trench axis, associated with the plate subduction [Noda, Fujiwara, and Kido, IUGG meeting, 2003]. In this study, however, characterization of the oceanic plate “before the subduction” remained less known because of limited areas of existent data in the seaward of the Japan Trench where should be studied for comprehensive understanding of the magnetic source layer in the oceanic lithosphere.

KR03-07 and KR04-08 cruises were unprecedented opportunities to collect data in such areas. Ayumi Obi and Toshiya Fujiwara analysed the magnetic data, and yielded the following results: 1. Along-lineation magnetization off the trench varies with a period of ~50-200 km. 2. Low magnetization appears on the seaward trench slope where horst-graben structure is developed. 3. ~135 Ma crust has higher magnetization and gradually decreases towards ~130 Ma [Fujiwara, Obi et al., JEPS meeting, 2005]. In addition, we measured "Petit Spot" rock's magnetization sampled in the KR03-07 and KR04-08 cruises. We found that these rocks have very high magnetization (~60 A/m).

Still extensive area remain unmapped. More geophysical data are needed to understand the high-resolution spatial variation of crustal magnetization. Thus, my objective of the YK05-06 cruise is to collect magnetic data, and also bathymetry, gravity, and seismic data.

1-3-8. Ayu Takahashi

Pacific plate, which underthrusting Japan Trench forms outer-rise. The volcanoes considered to be related to petit-spot were active at beginning of eastward slope of the outer-rise (Hirano et al., 2001). To certain depth of mantle, there is flow dragged by overlying lithosphere as it moves. The surface figure therefore governs the change of flow within the upper-most part of mantle. At beginning of plate flexure, slight upward mantle flow may cause melting on a small scale. Petrological properties of rock samples will show what kind of mantle material is melting that is indispensable for numerical simulation of magma generation. Thermal structure within mantle, as well as the depth of lithosphere behaves as elastic (or viscoelastic) presumed from OBEM and other geophysical data is also essential to numerical modeling.

1-3-9. Naoki Takehara

Volatiles compositions of the magma

In my graduate thesis, I propose that the highly vesicular basalts forming Yukawa Knoll are produced by the presence of CO2, because high vesicularity is not expected in abyssal basalts. To test this hypothesis, I will analyze the volatile contents in basaltic samples using EPMA and FTIR. Using this information, I will determine the vesicle-producing (degassing) process.

Dixon et al.,(1997) carried out degassing calculations on basalts recovered from the North Arch Volcanic Field, Hawaii. These basalts occurred in an abyssal setting, like Yukawa Knoll, and Dixon et al.,(1997) estimated volatile contents of the mantle source that produced North Arch basalts. I will follow the technique of these authors to determine the degassing process that led to vesicle formation and to estimate volatile contents of the mantle source that formed Yukawa Knoll.

2. Cruise Log

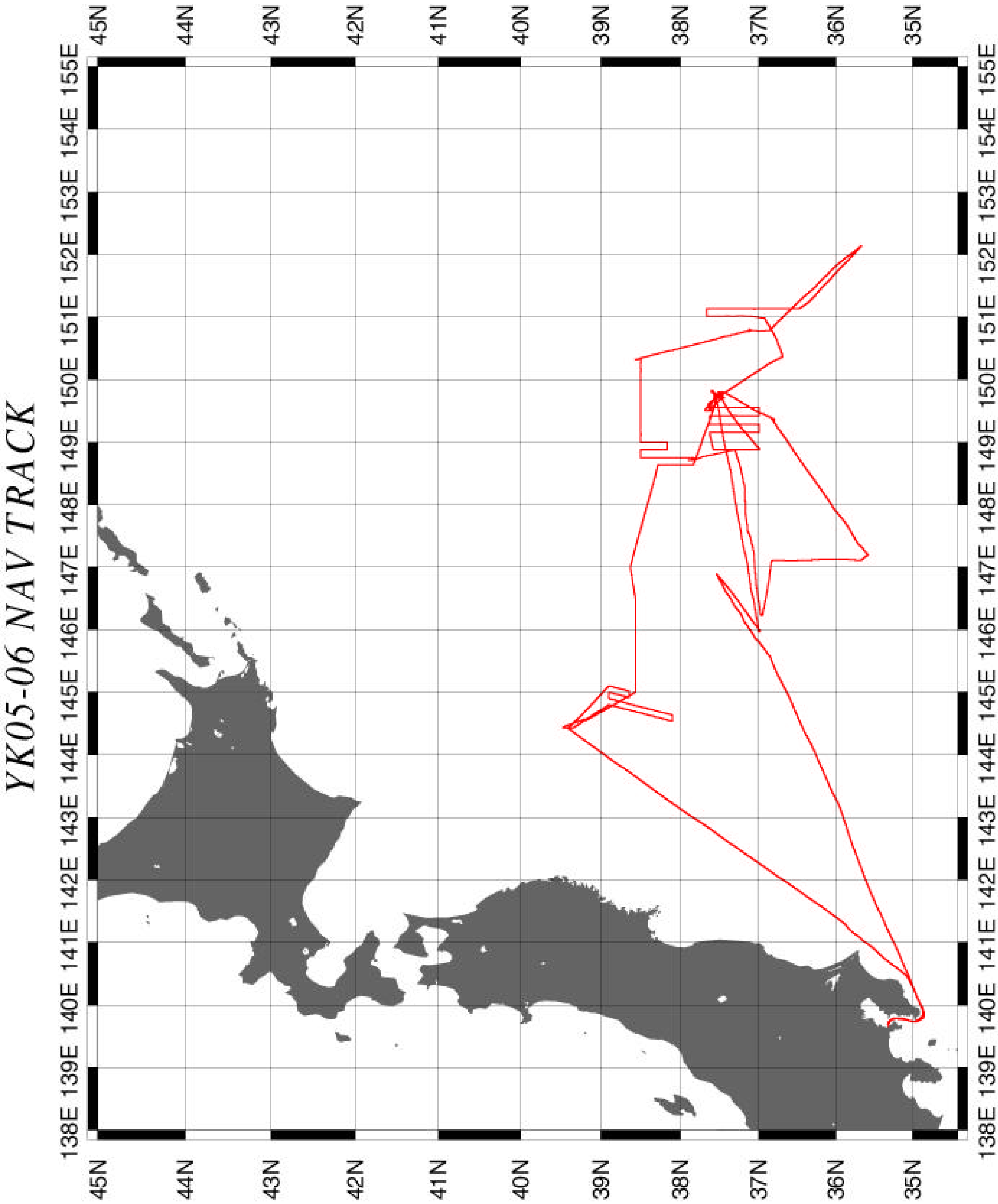

Figure 2-1. Ship track for YK05-06 cruise in the Japan Trench to northwestern Pacific area. We departed JAMSTEC, Yokosuka, at 12 May, and searched on the northwestern Pacific area. After surveying and dives at the Japan Trench oceanward slope on last 3 days, we came back to JAMSTEC, Yokosuka, at 27 May.

2-1. Survey Areas

Our mission for the Petit-Spot Expedition was set up 4 areas for some operations (A to D-area) and 1 broad area (E-area) for survey. On this cruise, we will survey on main A, B and B' areas.

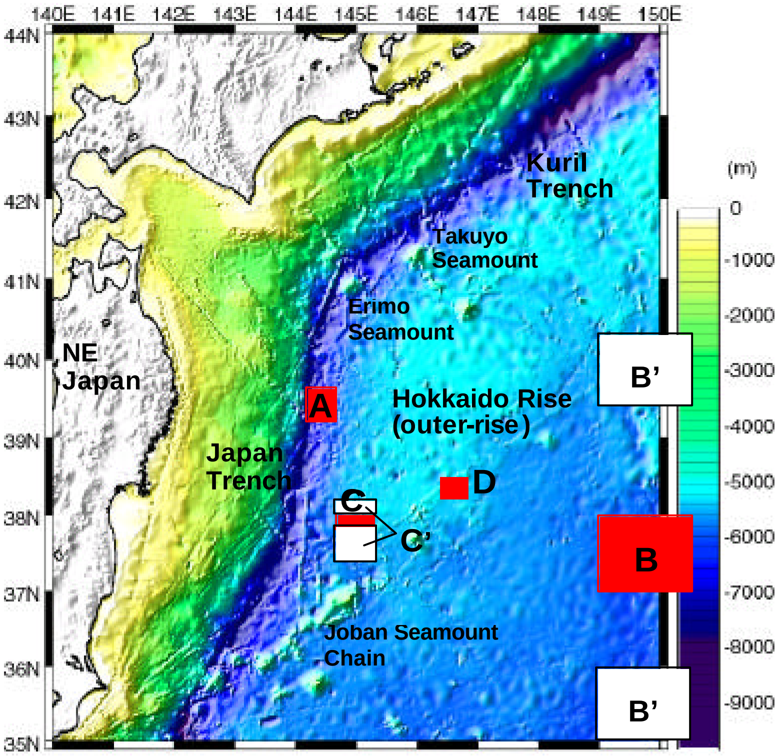

Figure 2-1-1. Map showing survey areas of A to D. A: Japan Trench axis. It is mainly oceanward slope (offshore of the Miyako City, Iwate). B: Around 150^{O}E area. It is near the Nossappu Fracture Zone. C and D areas were surveyed on KR03-07 and KR04-08 cruises. B' area is for the seabeam survey on the Kuril Trench and outer-rise, which will be for searching of another young volcano.

Area E was set up broadly for seabeam and some geophysical survey, which is the range of 35^{o} to 43^{o} N and 142^{o} to 153^{o} E excluding the near shore area to approximately 80 mile form NE Japan and excluding the Russian EEZ areas (see Figure 2-1-3-1).

2-1-1. A-area (Kaiko Knolls in the Japan Trench)

A-area is in the range of 39° 10' to 39° 40' and 144° 05' to 144° 40' and is set up for 1 dive of a knoll in the Kaiko Knolls lava field in the Japan Trench oceanward slope. Although this area is almost 7000 mbsl, one knoll is over 6500 mbsl. We will dive this knoll. The trench oceanward slopes in the world have not yet been fully studied. Some researches have even identified the general topographic characteristics in the Mariana trench, Aleutian trench, and Kuril to Japan trenches. Among them, Kobayashi et al. (1998) verified the trench-trending normal faults and their effect to the landward slope topography. Seamounts on the oceanic plate side may give significant effect to the landward slope topography, deformation and seismicity. Some important knowledges are such seamounts give rise the trigger of a great earthquake along the subducting plate boundary as operating the asperity for seismogenic slip (Tanioka and Satake, 1997). Thus the study of seamounts and knolls in the oceanic plate is very important for the current topics, but the details are not yet so far known.

In the Japan trench and its oceanward side, many seamounts and knolls have been known. The Daiichi-Kashima seamount is the first to know the rupturing seamount to be normal faulted just on the trench axis in the downgoing slab of the Pacific plate (Mogi et al., 1980; Tani, 1998). After this study, many seamounts have been studied, the Erimo seamount in the junction of the Kuril and Japan trenches (KAIKO Project, 1987, 1989), Joban Seamount Chain off Kanto and Tohoku areas in the Japan trench area (Masalu et al., 1997), and Quesada seamount in the Mariana trench (Hirano et al., 2002). Most of them are of Cretaceous age, erupted either in the Macdonald hotspot or other hotspots, and traveled generally to NW-ward, including sporadic different directions as known in the Middle Pacific Mountains direction (Hirano et al., 2002).

However, the especially young, late Miocene, approximately 6 Ma, alkaline basaltic rocks have been recovered from the trench oceanward slope toe off Miyako (Hirano et al., 2001) by ROV KAIKO of JAMSTEC. This finding gave a strong shock to the plate tectonic and igneous rock science community, as approving more research to the same area by Naoto Hirano's proposal. Thus, we try to collect many more rock samples by *Shinkai 6500*'s dive, as well as obtaining bathymetric and other geophysical data including geomagnetics and gravity. The magmatic and plate tectonic significance of studying those rocks may be given elsewhere in this report, or will be fully discussed in Hirano et al. (in preparation).

Here we have an idea to do swath mapping, other than dredging in the Japan trench oceanward slope areas, in the area A, surrounded by the two diagonal points of rectangles of 37 42 N, 149 14.4 E and 37 00 N, 150 30 E. We anticipate some seamounts or knolls, which may be the potential magmatic eruption place for the alkali basalt, if this kind of magmatism is assumed to be the product of some tectonically significant point for bending or buckling of the Pacific plate subduction to produce the Hokkaido Rise, because such bending or buckling may bring the lower plate boundary to be of a horizontally extensional zone. At the same time, the area A-3 is correspondent to the extension of the Hokkaido Fracture Zone from NNW, cutting long in the NW Pacific.

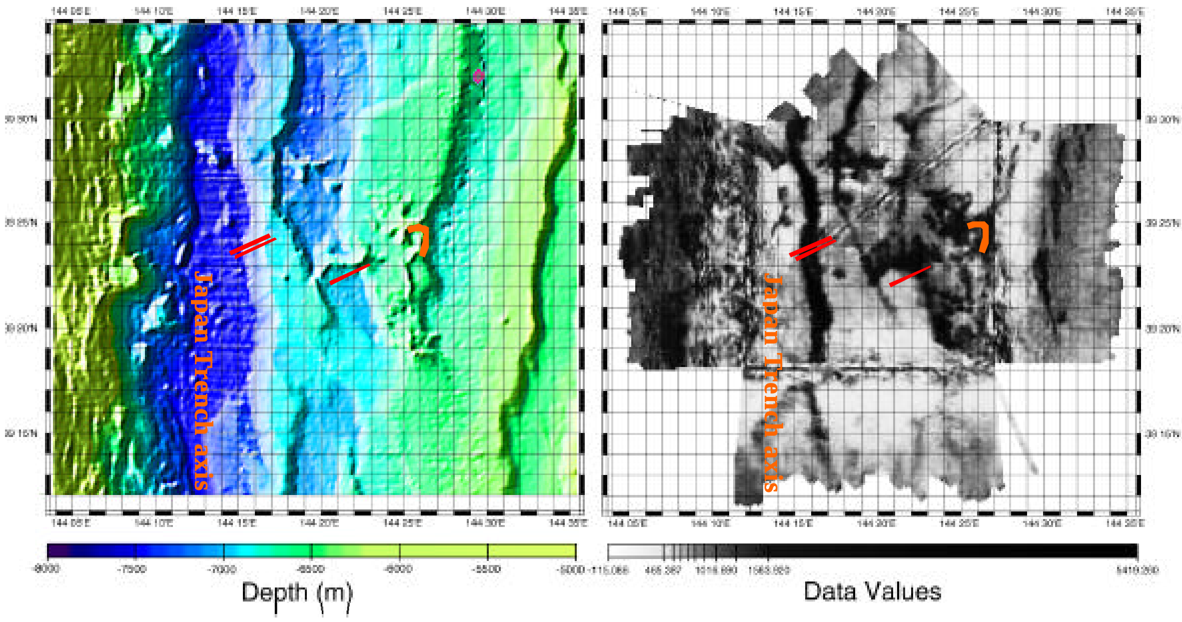

Figure 2-1-1-1. Maps showing the survey area A (Kaiko Knolls lava field). The left and right figures show the bathymetry and side scan image of this area, respectively. Red lines show Kaiko dive site at 1997 and two dredge sites in the KR03-07. Red line of curve shows the dive site of this cruise over 6500 mbsl.

2-1-2. B-area (NW Pacific Basin around 150^o E, around the Nossappu Fracture Zone)

B-area is in the range of 37^o 10' to 37^o 50' and 149^o 20' to 150^o 10' and is set up for 3 dives, SCS and OBEM. KR03-07 and KR04-08 cruises swath-mapped this B-area in the NW Pacific to the east of the Hokkaido Rise. This area was originally chosen as to be the potential place for the magmatism for the Kaiko Knolls. At the same time this area corresponds to the SES extension of the Nosappu Fracture Zone. Therefore, the deepest, complicated topography was anticipated. Side-scan image of the KR03-07 data may show the presence of the Petit-Spot as the young volcanoes (Figure 2-1-2-1).

The mapped area has the diagonal line between 37^o 42'N, 150^o 30'E, and 30^o 00'N, 149^o 00'E. The data show that the remarkable straight line from NWN to SES runs in the eastern part of the area. Sharp ridges with seamounts or knolls are also around the line, arranging en echelon. Soon after we passed some N-S lines with 6.5 mi spacing, we recognized this pattern is composed of en echelon ridges of L or "KU" in hiragana. Some reveres "Sadogashima" shape ridges (Sadogashima in the Japan Sea is of S-shape; reverse of which is of Z-shape) were also found. Also the knolls have often moats or wholes around them. The NWS-SES trending lines are sharp enough to think to be faults, cutting or demarcating the ridges. However, some NE-SW trending faults also cut the former trend. Thus we recognized at least three trends of ridges or faults; N20W, N60W, and N45E. The plausible idea to explain such arrangement is these are products of magma intrusion into three trends, and because the NWN trend is on the fracture zone, the N60W trend might be of extension fracture or Riedel shear (R1) under a left-lateral strike-slip (sinistral) shear regime. According to Nakanishi's NW Pacific magnetic lineament map (Nakanishi and Winterer, 1990), it is known that the Hokkaido Fracture Zone has approximately 400 to 600 km apparent displacement-bearing right-lateral strike-slip (dextral) dislocation. As known the NW Pacific Japanese lineament is of Jurassic-Cretaceous- Paleogene plate, younger toward NW. Therefore, the plausible spreading ridge which produced this lineament was already subducted along the NW Pacific convergent margin. This indicate that when the spreading ridge was there, the ridge-ridge transform fault had inversely left-lateral (Figure. 2-1-2-1).

We can easily reconstruct the relevant shear regime with extension fracture, Riedel shears etc. Possibly the N60 W trending ridges are products of magmatism along such extension fractures, whereas the N20W (NWN) trend ridges paralleling the fracture zone would be products along the leaky transform fault. This kind of leaky fault might be of two or more sets (Figure 2-1-2-1). The N45E trend may be of the ridge trend itself, forming normal faults or others. The ridge and faults area is concentrated in the western part of the area B, so that this part should be the most adequate target for the future study.

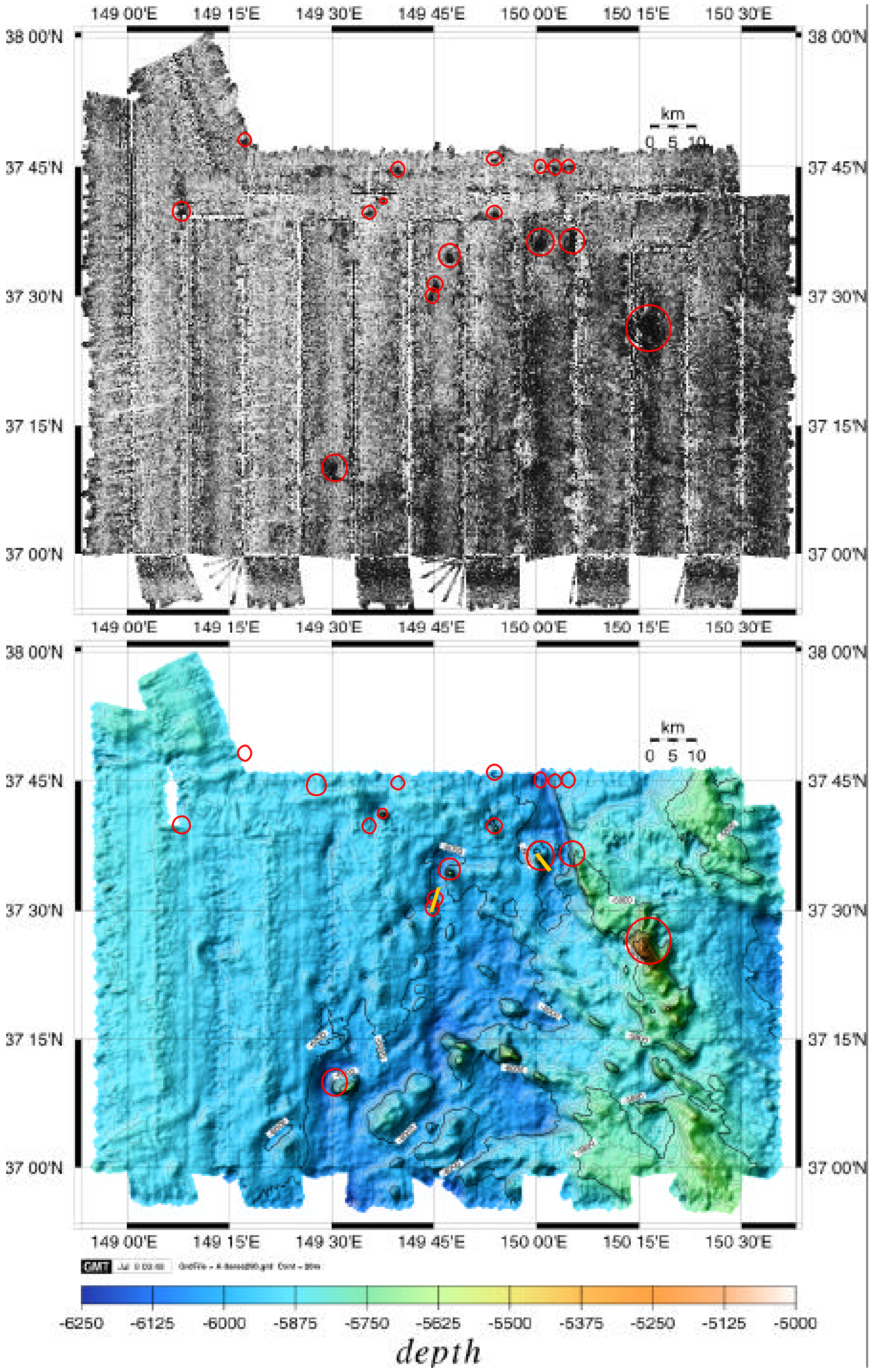

Figure 2-1-2-1. The map showing B-area. The bottom and upper figures show the bathymetry and side scan image of this area, respectively.

2-1-3. B' and E-area (Setting for survey)

Area E was set up broadly for seabeam and some geophysical survey, which is the range of 34° to 41 °N and 142 ° to 153 ° E excluding the near shore area to 15 mile form NE Japan excluding the Russian EEZ areas.

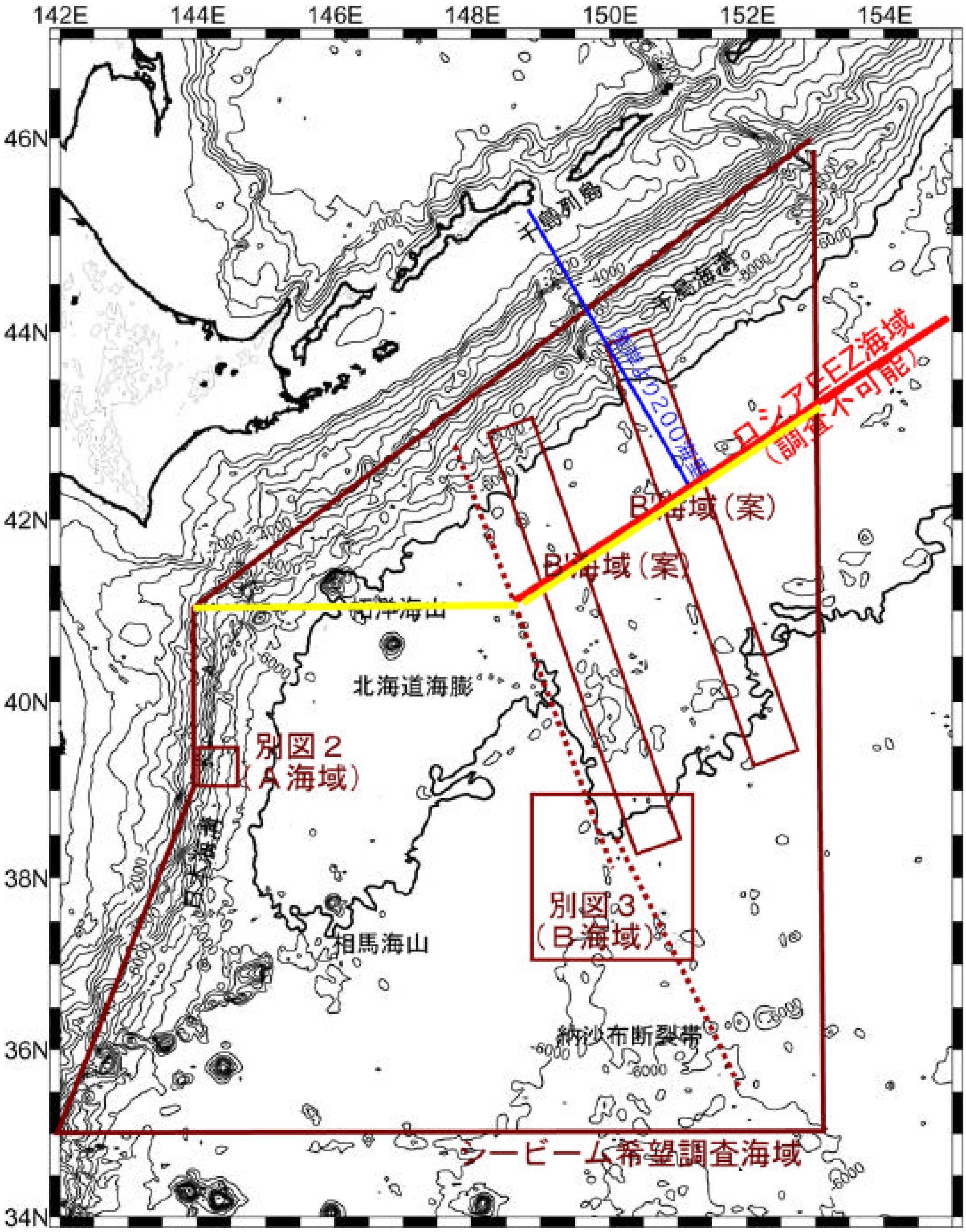

Figure 2-1-3-1. Map showing E-area (in Japanese) for the expedition of Prtit-Spot. North of the red line is the area of Russian EEZ. Dotted line is along the Nosappu Fracture Zone.

2-2. Ship Log

by NME

Date / Time	Note	Weather/ Sea State/ Winds Dir. & Force
12-May-05	Noon Position; 34-51'N, 139-48'E Time Zone; UTC+9h	bc / 2 / SE-3
09:40	Depart JAMSTEC for the research area Transit to NWP0501 point	
11:00-11:30	Guidance of ship's life for new participants in meeting room by chief officer and chief radio officer	
14:00-14:30	Meeting with Shinkai6500 operation team in meeting room	
15:20-16:00	Science Meeting in No.1 Laboratory	
16:40-17:00	"Konpira-san" on Bridge	
13-May-05	Noon Position; 36-55'N, 145-42'E Time Zone; UTC+9h	o / 7 / NE-10
10:20	Suspended Shinkai6500 research dive due to rough sea	
00:00	Put ships clock ahead 60min for S.M.T in long 150-00'E	
14-May-05	Noon Position; 37-00'N, 146-00'E Time Zone; UTC+10h	bc / 3 / N-5
05:00	Transit to NWP0501 point	
07:50	Arrived at OBEM Release NWP0501 point (Area B)	
08:00	Released XBT	
08:33-09:00	Site survey for NWP0501	
09:29	Deployed NWP0501 (36-59.9018'N 145-59.8786'E)	
13:09	Deployed Proton magnetometer	
13:25-1334	Run figure eight for calibration of three-component magnetometer	
13:34	Survey Proton magnetometer Transit to Area B	
18:00-19:00	Science Meeting in No.1 Laboratory	

Date / Time	Note	Weather/ Sea State/ Winds Dir. & Force
15-May-05	Noon Position; 37-29'N, 149-45'E Time Zone; UTC+10h	c / 4 / E-4
05:45	Arrived at Area B	
06:00	Recovered Proton magnetometer	
06:00	Releacsed XBT	
06:36-07:26	Site survey for NWP0503	
08:07	Deployed NWP0503 (37-29.8220'N 149-45.2686'E)	
09:20	Swimmers standing by (Able seaman, Oiler)	
09:59	Shinkai6500 opened vent, start test Dive#876	
11:41	Swimmers standing by (Able seaman, 3E)	
12:00	Shinkai6500 on surface	
12:45	Transit to NWP0506 point	
15:50	Arrived at NWP0506 point	
16:53	Deployed NWP0506 (36-50.3875'N 149-23.3306'E, D=6006m)	
18:00-18:15	Science Meeting in No.1 Laboratory	
16-May-05	Noon Position; 36-53'N, 147-07'E Time Zone; UTC+10h	r / 5 / NW-7
09:00	Suspended Shinkai6500 research dive due to rough sea	
12:00	Coarce to variety in 36-53'N 147-09'E	
17-May-05	Noon Position; 36-53'N, 147-07'E Time Zone; UTC+10h	bc / 6 / E-7
09:30	Suspended Shinkai6500 research dive due to rough sea	
12:30	Transit to NWP0504 point	
15:00	Arrived at NWP0504 point	
15:52	Deployed NWP0504 (37-51.3500'N 149-42.9345'E,D=5848m)	
16:17	Proton magnetometer deployed	

Date / Time	Note	Weather/ Sea State/ Winds Dir. & Force
18-May-05	Noon Position; 37-38'N, 150-37'E Time Zone; UTC+10h	bc / 3 / E-4
06:30	Arrived at NWP0502 point	
06:51	Recovered Proton magnetometer	
08:00	Deployed NWP0502 (38-31.7576'N 150-19.7110'E,D=5848m)	
08:10	Transit to NWP0505 point	
14:30	Arrived at NWP0505 point	
14:37	Deployed NWP0505 (37-07.7904'N 150-46.774'E,D=5848m)	
14:53	Proton magnetometer deployed	
16:43	Recovered Proton magnetometer	
18:04-18:20	Science Meeting in No.1 Laboratory	

19-May-05	Noon Position; 36-55'N, 151-08'E Time Zone; UTC+10h	c / 5 / S-6
08:16	Proton magnetometer deployed	
09:00-09:30	Onboard seminar for crew in officer's mess room (Speakers: Hirano , Baba)	
09:49	MNBES swath mapping survey started	
10:00-11:30	Science Seminar in No.1 Laboratory (Speakers:Ichiki , Fujiwara)	
10:30	Suspended Shinkai6500 research dive due to rough sea	
14:00-15:30	Science Seminar in No.1 Laboratory (Speakers:Baba , Takehara)	
18:19	Recovered Proton magnetometer	
19:21	MNBES swath mapping survey started	
18:00-19:00	Science Meeting in No.1 Laboratory	

Date / Time	Note	Weather/ Sea State/ Winds Dir. & Force
20-May-05	Noon Position; 37-09'N, 149-33'E Time Zone; UTC+10h	bc / 5 / NNW-4
08:08	Proton magnetometer deployed	
09:33	MNBES swath mapping survey started	
10:20	Suspended Shinkai6500 research dive due to rough sea	
18:00-19:30	Science Meeting in No.1 Laboratory	

Date / Time	Note	Weather/ Sea State/ Winds Dir. & Force
21-May-05	Noon Position; 37-29'N, 149-45'E Time Zone; UTC+10h	c / 4 / E-4
03:08	Finished Proton magnetometer	
06:30	Arrived at dive point #878	
06:46	Recovered Proton magnetometer	
08:23	Swimmers standing by (Able seaman, 3E)	
11:27	Shinkai6500 opened vent, start test Dive#877(Observer; Teruaki Ishii)	
14:51	Shinkai6500 on bottom (37-29.7214'N, 149-44.4955'S, D=5,934m)	
16:31	Shinkai6500 leave bottom (37-29.9211'N, 149-44.5280'S, D=5,859m)	
16:31	Swimmers standing by (Able seaman, Oiler)	
16:55	Shinkai6500 on surface	
18:45-19:35	Site survey for #878	
19:00-20:30	Science Meeting in No.1 Laboratory	
19:03	Released G.I gun	
19:15	Released Streamer Cable	
21:51	Started Line BA' (37-32.4626'N, 149-43.1594'E)	
22:38	Pass the cross point (SP#76-77)	
22:59	Ended Line BA' (37-27.9554'N, 149-45.5289'E)	
23:49	Started Line DC' (37-30.8568'N, 149-47.3519'E)	

Date / Time	Note	Weather/ Sea State/ Winds Dir. & Force
22-May-05	Noon Position; 37-38'N, 149-31'E Time Zone; UTC+10h	c / 3 / ESE-4
00:23	Pass the cross point (SP#76-77)	
00:54	Ended Line DC' (37-29.1874'N, 149-42.9633'E)	
01:57	Started Line B'A (37-31.8746'N, 149-43.6187'E)	
02:26	Pass the cross point (SP#76-77)	
02:57	Ended Line B'A (37-27.9673'N, 149-45.5132'E)	
03:52	Started Line D'C (37-30.7371'N, 149-08.5230'E)	
04:23	Pass the cross point (SP#76-77)	
04:53	Ended Line D'C(37-29.1931'N, 149-41.9393'E)	
06:22	Recovered G.I gun	
06:30	Recovered streamer cable	
08:16	Swimmers standing by (Able seaman, 3E)	
08:53	Shinkai6500 opened vent, start Dive#878 (Observer; Stephanie Ingle)	
11:22	Shinkai6500 on bottom (37-37.6682'N, 149-30.3797'E, D=5,979m)	
14:56	Shinkai6500 leave bottom (37-37.3496'N, 149-30.4241'E, D=5,864m)	
16:38	Swimmers standing by (Able seaman, Oiler)	
17:05	Shinkai6500 on surface	
18:10	Towing G.I gun	
18:24	Towing streamer cable	
19:42	Started Line EF' (37-34.4655'N, 149-42.7916'E)	
20:24	Pass the cross point (SP#93-94)	
21:03	Ended Line EF' (37-29.0156'N, 149-47.3428'E)	
22:32	Started Line GH' (37-28.8368'N, 149-43.5945'E)	
23:09	Pass the cross point (SP#81-82)	
23:47	Ended Line GH'(37-33.3974'N, 149-46.5940'E)	

Date / Time	Note	Weather/ Sea State/ Winds Dir. & Force
23-May-05	Noon Position; 37-31'N, 149-45'E Time Zone; UTC+10h	c / 3 / 0
00:53	Started Line E'F (37-33.0638'N, 149-43.2356'E)	
01:28	Pass the cross point (SP#76-77)	
02:08	Ended Line E'F (37-29.0168'N, 149-47.3114'E)	
03:04	Started Line G'H (37-28.9740'N, 149-43.4355'E)	
03:37	Pass the cross point (SP#80-81)	
04:59	Ended LineG'H (37-36.33250'N, 149-48.7812'E)	
06:21	Recovered G.I gun	
06:26	Recovered Streamer Cable	
08:18	Swimmers standing by (Able seaman, 3E)	
08:56	Shinkai6500 opened vent, start Dive#879 (Observer; Shiki Machida)	
11:26	Shinkai6500 on bottom (37-31.3280'N, 149-45.4561'E, D=6,039m)	
15:00	Shinkai6500 leave bottom (37-31.1362'N, 149-45.2742'E, D=5,901m)	
16:43	Swimmers standing by (Able seaman, Oiler)	
17:03	Shinkai6500 on surface	
17:45	Transit to Area A	
17:58	Proton magnetometer deployed	
20:00-20:45	Science Meeting in No.1 Laboratory	

Date / Time	Note	Weather/ Sea State/ Winds Dir. & Force
24-May-05	Noon Position; 34-51'N, 139-48'E Time Zone; UTC+9h	o / 5 / NNE-3
00:00	Put ships clock back 60min for J.S.T	
11:00-11:10	Run figure eight for calibration of three-component magnetometer	
11:16	Released XBT	
12:35	Arrived at Dive point of Area A (#880)	
12:36-13:27	Site survey for #880	
15:46	MNBES swath mapping survey started	
18:00-18:15	Science Meeting in No.1 Laboratory	

25-May-05	Noon Position; 34-51'N, 139-48'E Time Zone; UTC+9h	o / 5 / NNE-3
08:20	Swimmers standing by (Able seaman, 3E)	
08:58	Shinkai6500 opened vent, start Dive#880 (Observer; Naoto Hirano)	
11:40	Shinkai6500 on bottom (39-23.777'N, 144-26.315'E, D=6,478m)	
15:03	Shinkai6500 leave bottom (39-24.642'N, 144-25.239'E, D=6,279m)	
16:47	Swimmers standing by (Able seaman, Oiler)	
17:17	Shinkai6500 on surface	
18:00	Party for crew and scientist in officer's mess room	

26-May-05	Noon Position; 35-22'E, 140-45'E Time Zone; UTC+9h	c / 1 / NE-3
13:00	Group photo on deck	
13:30-14:00	Science Meeting in No.1 Laboratory	
18:00-18:10	Meeting in No.1 Laboratory	

Date / Time	Note	Weather/ Sea State/ Winds Dir. & Force
27-May-05	Noon Position; JAMSTEC Time Zone; UTC+9h	
7:00	Arrived at JAMSTEC	
10:00	Scientist get off R/V "YOKOSUKA"	

* Weather ;b (Blue sky), bc (Fine but Cloudy), c (Cloudy), o (Overcast), r (Rain)

** Sea State ;1 (Rippled Calm), 2 (Smooth), 3 (Slight), 4 (Moderate), 5 (Rough)

*** Wind Force ;0 (Calm), 1 (Light air), 2 (Light breeze), 3 (Gentle breeze; 3.4-5.4m/sec), 4 (Moderate breeze; 5.5-7.9m/sec), 5 (Fresh breeze; 8.0-10.7m/sec), 6 (Strong breeze; 10.8-13.8 m/sec), 7 (Near gale; 13.9-17.1 m/sec)

2-3. Dive Log

2-3-1. 6K#876: Test Dive **by Takahashi**

Dive 876 Test dive Recorded by A.Takahashi

Time (JST+1)	sub head angle	depth (m)	X	Y	description	number of samples collected	consecutive numbering system
10:00		0			launching		
10:31		1500					
10:37					light on		
10:42		2000					
11:02		2094					
11:06		2095					
11:15		2076			start to rise		
11:27		1500					
11:38		1000					
11:49		500					
11:58		100					
11:59		50					
12:00		0			surface		

2-3-2. 6K#877: Yukawa Knoll

by Takahashi, Takehara, Ingle, Abe

Dive					Recorded by S.Ingle, A.Takahashi,		
877	dive observer: T. Ishii				N. Takehara, N.Abe		
Time (JST+1)	sub head angle	depth (m)	X	Y	description	number of samples collected	consecutive numbering system
09:02		0			launching		
09:20		1006					
09:41		2001					
10:03		3005	-460	540			
10:24		4007	-300	260			
10:48		5003					
11:00		5501					
11:17		5916	-532	-11	trim balanced, descending to bottom		
11:27	120	5934	-490	0	on bottom, muddy floor		
11:33	123	5934	-493	-2	mesuring HF		
11:44	123	5934	-525	11	finished HF mesurement		
11:50	126	5934	-517	3	taking push core (red)	PC1(red)	PC1(red)
11:56	21	5930	-470	18			
12:03		5909	-387	60			
12:06	320	5905	-365	63	lobate flow lava		
12:07	7	5904	-344	42	large outcrop lobate lava flows		
12:08	12	5904	-353	40	shinkai stopped		
12:12	13	5899	-321	14.5	large outcrop lobate lava flows; Shinkai looking around, stopped		
12:17	1	5886	-287	29.8	observation finished; Shinkai moving again		
12:18	1	5869	-273	40.8	rubbly floor with mostly mud, some outcrop same as above		
12:20	2	5867	-204	26.2	outcrop visible against muddy floor		
12:31	158	5848	-120	80			
12:44	348	5848	-137	68	gave up sampling rocks		
12:50	337	5848	-38	49	moving to x:100, y:-400		
13:04	0	5948	94	-419	descending to bottom		
13:13	131	5980	0	-400			

13:17	101	5981	-50	-401			
13:23	101	5971	-67.5	-280			
13:30	140	5955	-85	-202	squid		
13:35	138	5938	-120	-152			
13:40	155	5938	-133	-155	blocky outcrop		
13:44	109	5936	-148	-152	start sampling Stop 2		
13:55	114	5932	-153	-137			
13:59	111	5931	-172	-120	sample recovered	1	2-1
14:03	122	5928	-134	-143	sample recovered	1	2-2
14:11	47	5928	-162	-134			
14:15	107	5930	-140	-128	sample recovered	1	2-3
14:23	66	5921	-127	-111	Shinkai ascending		
14:27	123	5905	-139	-87.3			
14:32	91	5879	-167	-21.2			
14:35	97	5860	-156	153	basaltic outcrop visible, pillows?		
14:37	167	5860	-169	31.8	sampling attempted		
14:41	167	5862	-157	31.3			
14:45	166	5860	-167	55.3	sample recovered	1	3-1
14:48	159	5858	-156	41.9	placing dive marker		
14:51	160	5858	-158	36.2	Shinkai finished, begin ascending		
14:58		5500					
15:08		5000					
15:26		4000					
15:48		3000					
16:10		2000					
16:30		1000					
16:55		0			surface		

2-3-3. 6K#878: Pit-Crater **by Takahashi, Takehara, Machida, Abe**

Dive 878	dive observer: S. Ingle				Recorded by S.Machida, A.Takahashi, N.Takehara, N.Abe		
Time (JST+1)	sub head angle	depth (m)	X	Y	description	number of samples collected	consecutive numbering system
08:53		0			launching		
09:14	69	1019					
09:36	359	2002					
09:59	186	3001	1260	650			
10:21	107	4007					
10:45	298	5001					
11:13	91	5923			trim balanced, descending to bottom		
11:22	147	5979	1230	560	on bottom; muddy floor		
11:28	149	5979	1220	578	collecting push core (red)	1	PC1(red)
11:32	165	5979	1222	559	collecting push core (blue)	1	PC2(blue)
11:39	172	5978	1165	568	moving; set head angle to 170		
11:44		5971			yellow fish		
11:46	172	5956	1010	550	rounded manganese nodule outcrop		
11:48	172	5953	996	571	sampling attempted		
12:12	160	5948	988	530	continued		
12:14	152	5948	1000	550	sample recovered	2	1-A, 1-B
12:17	168	5943	1002	557	moving; set head angle to 170		
12:26	172	5910	930	561	outcrop; volcanic breccia		
12:29	116	5906	911	566	sampling attempted		
12:38	125	5904	922	567	steep cliff; strange shape rock, Mn coated?		
12:45	152	5902	920	570	sample recovered	2	2-A, 2-B
12:49	125	5899	924	586	slope covered with hyaloclastite?		
13:11	143	5834	712	687			
13:21	134	5838	696	698	muddy floor		
13:24	282	5847	664	718	sampling attempted		

13:37	324	5847	660	700	sample recovered	3	3-A, 3-B, 3-C
13:39	353	5847	649	700	descending slope; set head angle to 270		
13:49	272	5853	674	482			
13:56	306	5916	694	270	arrived		
14:01	92	5961	689	317	moving; set head angle to 90		
14:08	96	5946	698	450	scooped volcanic breccia	1	SC1
14:12	99	5946	697	442	white fish?		
14:21	93	5942	700	429	sample recovered?	1	4-A??
14:33	103	5884	686	558			
14:41	97	5865	640	612	sampling attempted	1	SC2
14:56	47	5867	640	638	small sample recovered?, off bottom	1	5-A??
15:13		5000					
15:33		4000					
15:55		3000					
16:16		2000					
16:40		1000					
		0			surface		

2-3-4. 6K#879: Northern Yukawa Knoll **by Takahashi, Takehara, Hirano, Abe**

Dive 879	dive observer: S. Machida				Recorded by A.Takahashi, N.Takehara, N.Abe		
Time (JST+1)	sub head angle	depth (m)	X	Y	description	number of samples collected	consecutive numbering system
08:55		0			launching		
09:16	217	1007					
09:37	177	2001					
10:00	306	3003					
10:22	130	4012	1200	600			
10:46	7	5006					
11:18	152	5952	630	657	trim balanced, descending to bottom		
11:26	200	6039	600	673	on bottom; muddy floor		
11:28	200	6039	608	667	collecting push core (red, blue)	2	PC1(red) PC2(blue)
11:34	200	6038	613	661	moving; set head angle to 230		
11:48	216	5986	436	427	some blocks against muddy floor		
11:58	178	5949	376	363	sampling attempted		
12:07	215	5949	390	370	taking 2 samples	2	1-A, 1-B
12:15	221	5925	350	320	moving; set head angle to 220		
12:17	202	5919	296	301	sampling attempted with scoop		
12:36	181	5907	330	290	sample recovered	3	SC1
12:48	176	5907	335	270	sample recovered	2	2-A, 2-B
12:52	203	5898	330	258	moving; set head angle to 200		
12:56	177	5890	291	257	sampling attempted		
13:08	173	5889	300	280	sample recovered	2	3-A, 3-B
13:15	154	5889	292	260	sampling attempted		
13:18					1 sample is picked up		
13:21					1 sample is picked up		
13:23	158	5887	287	253	sample recovered	2	4-A, 4-B
13:26	192	5880	287	265	moving; set head angle to 190		
13:30	190	5876	252	271	sample recovered	2	5-A,5-B
13:46	125	5860	263	290	flying to east		
14:01	320	5926	143	508	arrived, ascending slope		
14:11	227	5902	197	433	sampling attempted		

							6-A, 6-B,
14:27	249	5901	203	440	sample recovered	3	6-C
					round-shape rocks (Mn nodules?)		
14:34	315	5903	240	427	against muddy floor		
14:59	147	5906	252	381	scooped small blocks	1	SC2
15:00	152	5901	229	422	off bottom		
15:16		5000					
15:36		4000					
15:57		3000					
16:17		2000					
16:39		1000					
17:03		0			surface		

2-3-5. 6K#880: 6500m Knoll, Japan Trench by Takahashi, Takehara, Machida, Abe

Dive 880	dive observer: N. Hirano				Recorded by A.Takahshi, N.Takehara, N.Abe		
Time (JST)	sub head angle	depth (m)	X	Y	description	number of samples collected	consecutive numbering system
08:58		0			launching		
09:20		1000					
09:39	300	2013					
10:02	172	3000					
10:24	255	4001					
10:48	201	5000					
11:11	74	6002					
11:27	103	6387	-1318	1162	trim balanced, descending to bottom		
11:38	263	6478	-1341	1183	on bottom; blocky floor		
11:41	263	6478	-1336	1153	outcrop; lava flow bedding is observed, sampling attempted		
11:58	277	6474	-1329	1184	sample recovered	5	1-A,B,C,D,E
12:05	265	6479	-1326	1117	debris flow(?) deposit; sampling attempted		
12:08	263	6474	-1340	1130	sample recovered	5	2-A,B,C,D,E
12:12	309	6473	-1252	1132	flying to north along contour; muddy floor		
12:20			-1200	1160			
12:28	2	6461	-1070	1130			
12:36	264	6451	-980	1100			
12:51	265	6458	-745	1128	observing, muddy floor		
13:03	300	6457	-792	1091	picking up a sample		
13:05	300	6453	-764	1086	sample recovered	4	3-A,B,C,D
13:11	302	6427	-727	1033	moving to X=0,Y=0		
13:16	302	6365	-640	910	still flying to northwest		
13:23	302	6309	-422	635	still flying to northwest		
13:32	286	6392	-118	246	still flying to northwest		
13:39	286	6463	-51	132	on bottom, still moving set head angle to 280		

13:44	287	6465	-5	18	stopped, collecting push core (red)	1	PC1(red)
13:52	139	6465	-10	0	set head angle to 280		
14:00	287	6449	20	-110	muddy floor		
14:04	259	6431	48	-226	lobate lava flow Mn coated, against muddy floor		
14:13	9	6397	69	-280	set head angle to 20		
14:23	32	6379	150	-290	muddy floor		
14:28	273	6371	211	-267	sampling attempted		
14:38	301	6377	166	-323	sample recovered	1	4-A
14:42	325	6349	198	-347	pillow lava?		
14:45	311	6337	180	-355	sampling attempted		
14:48	288	6338	187	-324	sample recovered	1	5-A
14:59	268	6292	288	-383	sampling attempted		
15:02	250	6279	263	-382	sample recovered, start ascending	1	6-A
15:09		6000					
15:28		5000					
15:49		4000					
16:10		3000					
16:29		2000					
16:51		1000					
17:17		0			surface		

2-4. OBEM Logs

by Ichiki, Baba

Date & Time (LTC=UTC+10h)	Note	Ship position/Weather
12-May-05		(39-37N, 141-59E)
19:35	Start running the OBEM (JM6) for NWP0501	/Cloudy
14-May-05		
05:00	Arrive at the deployment point of NWP0501	(37-00N, 146-00E)/
07:30-08:00	Prepare the deployment of the OBEM at NWP0501	Sunny (cloud=2 to 5)
08:30	The OBEM enter the water	
08:32-08:40	Measure the slant ranges	
08:40	Transit to the B area	
18:46	Start running the OBEM (TT8) for NWP0506	
19:33	Start running the OBEM (JM2) for NWP0503	
15-May-05		
07:20-08:08	Prepare the deployment of the OBEM at NWP0506	(37-30N, 149-45E)/
08:00	Arrive at the deployment point of NWP0506	Sunny (cloud=2 to 5)
08:08	The OBEM enter the water	
08:14-08:20	Measure the slant ranges	
08:20	Transit to the #876 Dive point	
15:00-16:00	Prepare the deployment of the OBEM at NWP0503	
15:14	Start running the OBEM (JM4) for NWP0504	
15:50	Arrive at the deployment point of NWP0503	(36-50N, 149-23E)/
16:33	The OBEM enter the water	Sunny (cloud=2 to 5)
16:38-16:48	Measure the slant ranges	
16:50	Transit to southern side.	
17-May-05		
14:30-15:20	Prepare the deployment of the OBEM at NWP0504	
15:00	Arrive at the deployment point of NWP0504	(36-51N, 148-43E)/
15:52	The OBEM enter the water	Sunny (cloud=2 to 5)
15:59-16:05	Measure the slant ranges	
16:05	Transit to the southern side	
17:35	Start running the OBEM (JM1) for NWP0505	

20:36	Start running the OBEM (JM5) for NWP0502	
18-May-05		
06:30	Arrive at the deployment point of NWP0505	(38-32N, 150-20E)/
07:20-07:50	Prepare the deployment of the OBEM at NWP0505	Sunny (cloud=2 to 5)
08:00	The OBEM enter the water	
08:06-08:13	Measure the slant ranges	
08:13	Transit to NWP0502	
14:00-14:30	Prepare the deployment of the OBEM at NWP0502	
14:30	Arrive at the deployment point of NWP0502	(37-08N, 150-47E)/
14:37	The OBEM enter the water	Sunny (cloud=2 to 5)
14:42-14:48	Measure the slant ranges	
14:50	Transit to southern side.	

2-5. SCS Logs **by NME**

NO.	LINE NAME	DATE (UTC)	TIME (UTC)	F.S.P L.S.P	S.P POSITION Lat.	Lon.	NUMBER OF SHOT	LENGTH (m)	DIRECTION	GI-Gun Delay	Streamer Depth	Ship Speed	Mode
1	Line B'A	2005/5/21 2005/5/21	11:59:45 12:59:34	13 144	37_31.87856'N 149_43.57633'E	37_27.95547'N 149_45.52892'E	132	7920	153.19°	55.5msec	7-10m	4.0knt	Time (29.2sec) Distance (60m)
2	Line DC'	2005/5/21 2005/5/21	13:49:54 14:54:30	1 144	37_30.85685'N 149_47.35199'E	37_29.18745'N 149_41.96338'E	144	8640	243.89°	55.5msec	5-7m	4.0knt	Time (29.2sec) Distance (60m)
3	Line B'A	2005/5/21 2005/5/21	15:57:28 16:56:59	1 131	37_31.87460'N 149_43.61875'E	37_27.96738'N 149_45.51324'E	131	7860	153.195°	55.5msec	5-7m	4.0knt	Time (29.2sec) Distance (60m)
4	Line D'C	2005/5/21 2005/5/21	17:52:15 18:53:04	1 137	37_30.73712'N 149_47.08523'E	37_29.19313'N 149_41.93935'E	137	8220	243.8873°	55.5msec	5- 7m	4.0knt	Time (29.2sec) Distance (60m)
5	Line EF'	2005/5/22 2005/5/22	09:42:18 11:03:31	1 178	37_33.46550'N 149_42.79161'E	37_29.015693'N 149_47.34283'E	178	10680	139.4224°	55.5msec	5-7m	4.0knt	Time (29.2sec) Distance (60m)
6	Line GH'	2005/5/22 2005/5/22	12:32:16 13:47:17	1 164	37_28.83685'N 149_43.59458'E	37_33.39746'N 149_46.95460'E	164	9840	30.33513°	55.5msec	5-7m	4.0knt	Time (29.2sec) Distance (60m)
7	Line E'F	2005/5/22 2005/5/22	14:53:22 16:07:36	1 161	37_33.06384'N 149_43.23562'E	37_29.01681'N 149_47.31144'E	161	9660	139.4226°	55.5msec	5-7m	4.0knt	Time (29.2sec) Distance (60m)
8	Line G'H	2005/5/22 2005/5/22	17:04:16 18:59:54	1 263	37_28.97408'N 149_43.43551'E	37_36.33250'N 149_48.78122'E	263	15780	30.33533°	55.5msec	5-7m	4.0knt	Time (29.2sec) Distance (60m)
						TOTAL	1310	78600					

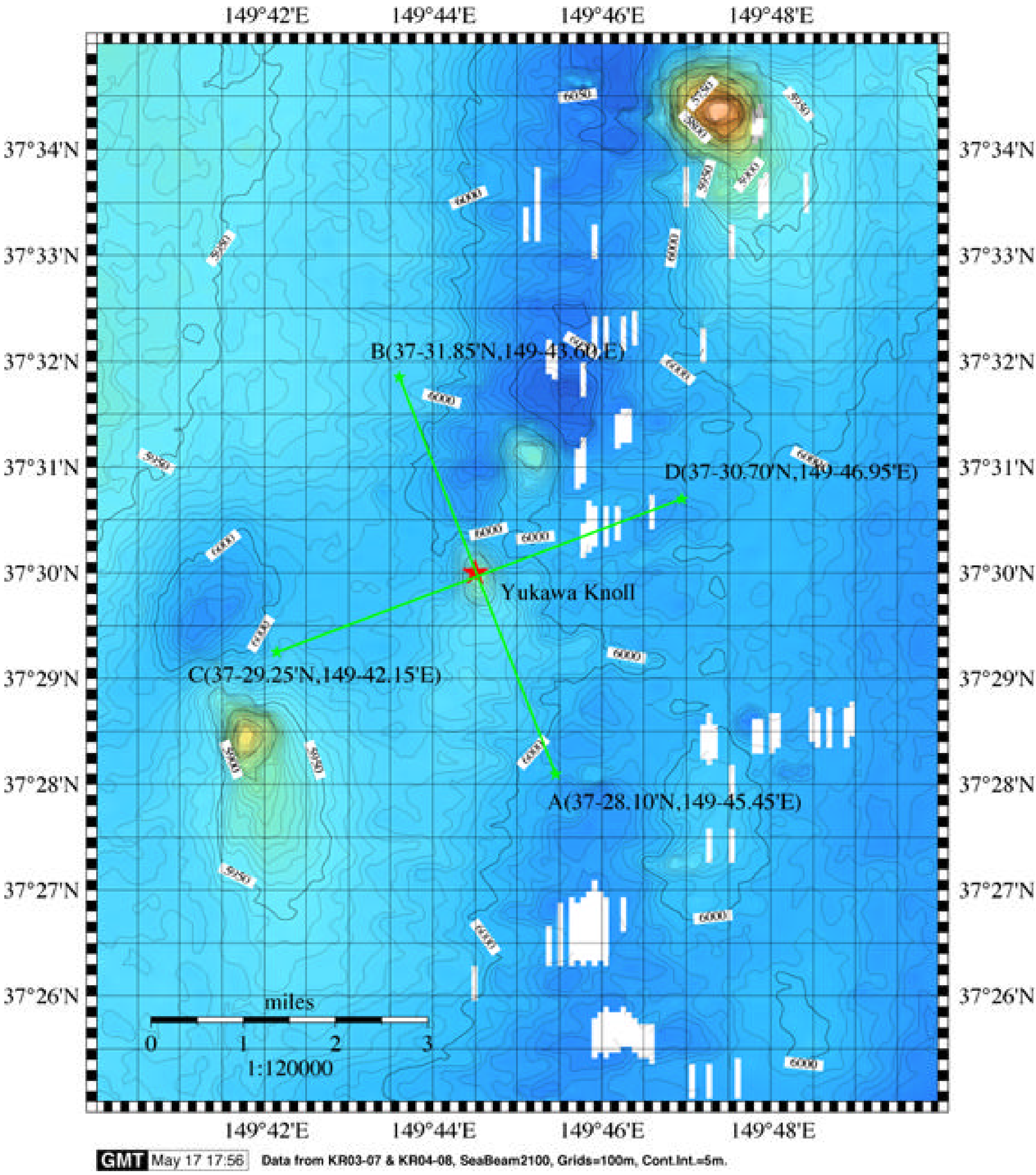

Figure 2-5-1. SCS survey lines #1 at 21st May.

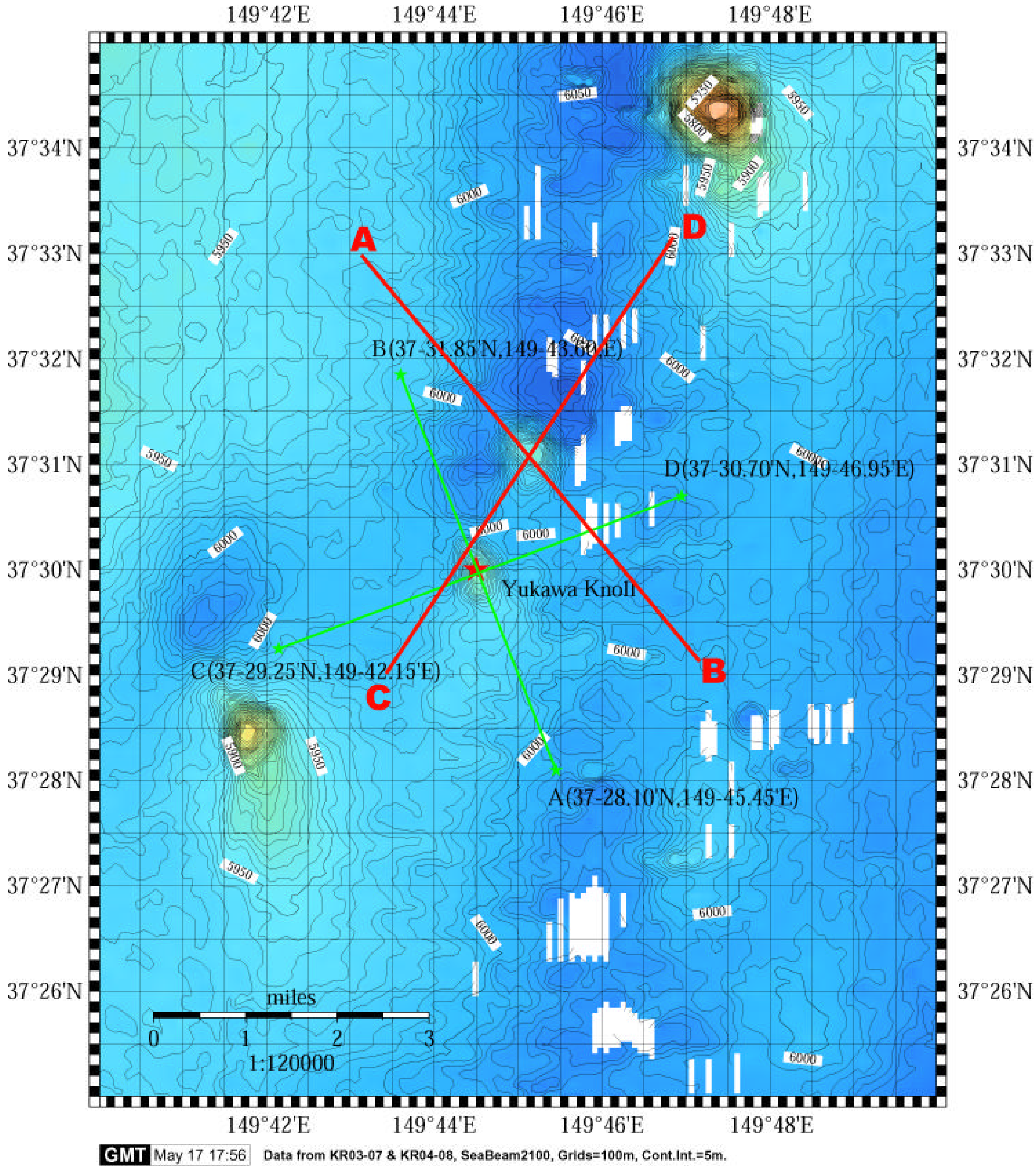

Figure 2-5-2. SCS survey lines #2 (showing red lines) at 22nd May.

3. Participants

3-1. Onboard Scientists

Name	Address Position	Telephone	E-mail Address
Naoto Hirano *Chief Scientist*	Department of Earth and Planetary Science, Tokyo Institute of Technology Post Doctral Fellow		
Natsue Abe *Vice-chief Scientist*	Institue for Research on Earth Evolution, Japan-Agency for Marine Earth Science and Technology Research Scientist		
Teruaki Ishii *Scientist*	Department of Ocean Floor Geoscience, Ocean Research Institute, University of Tokyo Associate Professor		
Toshiya Fujiwara *Scientist*	Institue for Research on Earth Evolution, Japan-Agency for Marine Earth Science and Technology Research Scientist		
Masahiro Ichiki *Scientist*	Institue for Research on Earth Evolution, Japan-Agency for Marine Earth Science and Technology Research Scientist		
Stephanie Ingle *Scientist*	Department of Earth and Planetary Science, Tokyo Institute of Technology Post Doctral Fellow		
Kiyoshi Baba *Scientist*	Institue for Research on Earth Evolution, Japan-Agency for Marine Earth Science and Technology Research Scientist		
Shiki Machida *Scientist*	Department of Ocean Floor Geoscience, Ocean Research Institute, University of Tokyo Post Doctral Fellow		
Ayu Takahashi *Scientist*	Graduate School of Science, University of Tokyo Master's Cource Student		
Naoki Takehara *Scientist*	Department of Earth and Planetary Science, Tokyo Institute of Technology Post Graduate Recearcher		
Tohru Kodera *Technician*	Nippon Marine Enterprises, Ltd. Marine Technician		
Ichiro Nara *Technician*	Nippon Marine Enterprises, Ltd. Marine Technician		
Hitoshi Tanaka *Technician*	Nippon Marine Enterprises, Ltd. Marine Technician		
Tomoaki Kudoh *Technician*	Nippon Marine Enterprises, Ltd. Marine Technician		
Mamoru Sano *Technician*	Nippon Marine Enterprises, Ltd. Marine Technician		

3-2. Crew & 6K Staff

S. Ishida	Captain
T. Aoki	Chief Officer
T. Inoue	2nd Officer
T. Egashira	3rd Officer
K. Tabuchi	Chief Engineer
K. Matsukawa	1st Engineer
T. Ohta	2nd Engineer
D. Gibu	3rd Engineer
S. Watase	Chief Radio Operator
K. Kitamura	2nd Radio Operator
M. Nakamura	Boat Swain
M. Ishimori	Able seaman
K. Ogasawara	Able seaman
K. Shikama	Able seaman
Y. Yoshino	Able seaman
S. Fujii	Able seaman
T. Okuyama	Sailor
M. Kobayashi	No. 1 Oiler
T. Fukubara	Oiler
T. Hashimoto	Oiler
K. Miura	Oiler
R. Suzuki	Assistant Oiler
K. Hirayama	Chief Steward
S. Kobayashi	Steward
S. Tanaka	Steward
T. Shiraishi	Steward
K. Hirayama	Steward
Y. Yamaoka	
Y. Mori	
R. Sugimoto	

Y. Imai	Operation Manager
T. Sakurai	Assistanat Operation Manager
Y. Sasaki	1st Submersible Staff
K. Iijima	1st Submersible Staff
K. Kawama	1st Submersible Staff
F. Suda	1st Submersible Staff
Y. O-no	1st Submersible Staff
M. Yanagitani	2nd Submersible Staff
H. Ueki	3rd Submersible Staff
Y. Chida	3rd Submersible Staff
F. Saito	3rd Submersible Staff
K. Totsuka	3rd Submersible Staff

3-3. Photos

Group photo with Shinkai 6500 on the R/V Yokosuka deck at 26th May.

4. Observation

4-1. Ocean bottom electromagnetometer (OBEM)

by Ichiki & Baba

Magnetotelluric method is one of the most powerful tools to investigate electrical conductivity structure, in which magnetic field and electric field are observed simultaneously. The ocean bottom electromagnetometer (OBEM) measures magnetic and electric fields on ocean floor. Our equipments used here are the 3rd and 4th genes of the two-glass-sphere type's OBEM made in Japan, which are called OBEM2001 and OBEM2005, respectively. Figure 4-1-1 and Plate 4-1-1 show the exterior of our two-glass-sphere type's OBEM. Li Batteries and acoustic transducer circuits are packed in a glass sphere. The fluxgate-type magnetometer, voltmeter, and tilt meter are packed in the other glass sphere. Silver–silver chloride electrodes (Plate 4-1-2) are attached to the end of each pipe. We can record three components of the magnetic field and two horizontal components of the electric field on the memory card. Table 4-1-1 shows that the specification of the digital recording system in OBEM.

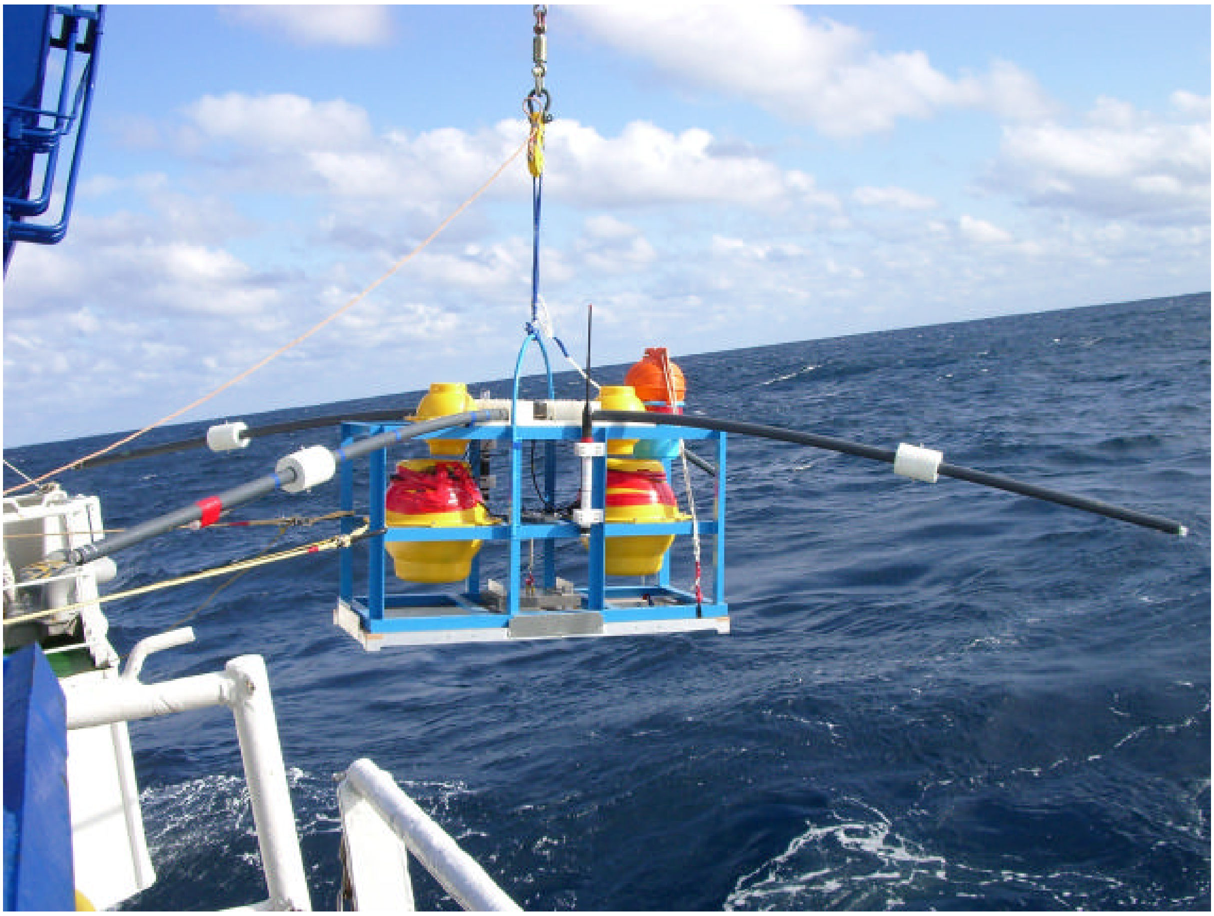

Plate 4-1-1. Photograph of the exterior of the OBEM

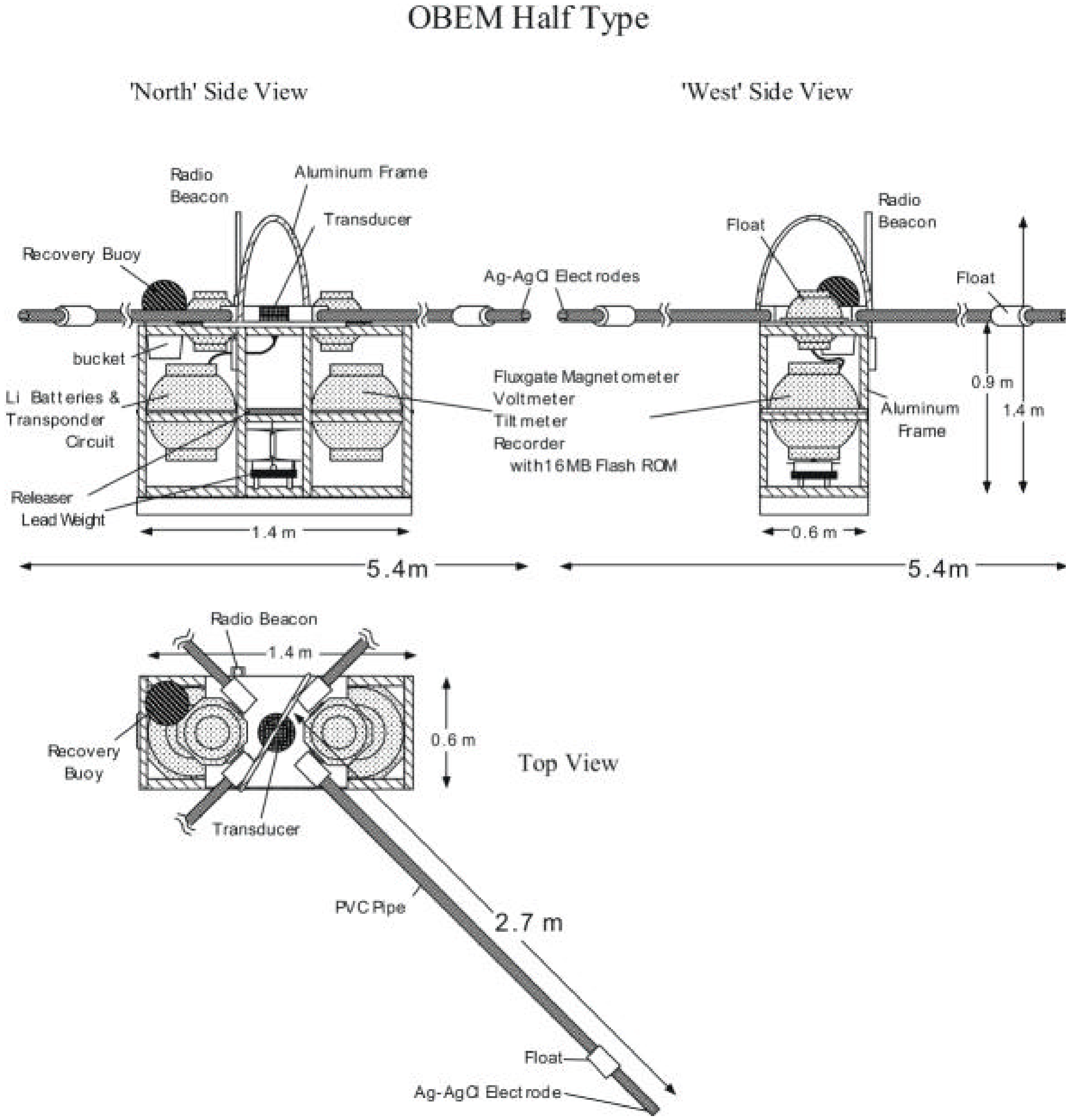

Figure 4-1-1. Side and top views of the two-glass-spere type's OBEM. The 1st gene of this type was manufactured in 1996. Its total weight in air is 130kg (without the lead weight). Main lead weight the mass of which is 40 kg is attatched in deployments.

Plate 4-1-2. Photograph of the Silver-Silver chloride electrode.

Table 4-1-1. Specification of the digital recording system in OBEM

OBEM TYPE	FIELDS	RANGE (A-D)	DYNAMIC RANGE	LSB	NOTE
OBEM2001	Magnetic field	2 bytes (16 bits)	±327.67 nT	10 pT	N, E positive
	Electric field		±10 mV	0.305176 μV	S, W positive
	Tilt		±8 deg.	0.00001deg	N down, W down positive
	Temperature	18000	-55 to 125degC	0.01degC	
OBEM2005	Magnetic field	2 bytes (16 bits)	±327.67 nT	10 pT	N, E positive
	Electric field		±10 mV	0.305176 μV	S, W positive
	Tilt		±8 deg.	0.00026deg	N down, W down positive
	Temperature	18000	-55 to 125 degC	0.01degC	

The OBEMs are equipped with lead weight, radio beacon and flushing light. In recovery time, the OBEM releases the weight according to acoustic command from ship, and then pops up by self-buoyancy. The radio beacon and flushing light have pressure switch which is turned off under water pressure. When the OBEM pop up to sea surface, they start working and help us to find the OBEM. The flushing light has a light sensor which works when it is dark. It is very useful to find the OBEM in nighttime. Recent OBEMs also mount a recovery buoy-rope system (Figure 4-1-2). The buoy becomes free from a bucket when a weight is released, and it drags a rope stored in a bucket. It is for easier recovery of OBEMs at the time of their retrieval. We can easily catch the OBEM from shipboard by catching the buoy and hauling on the rope.

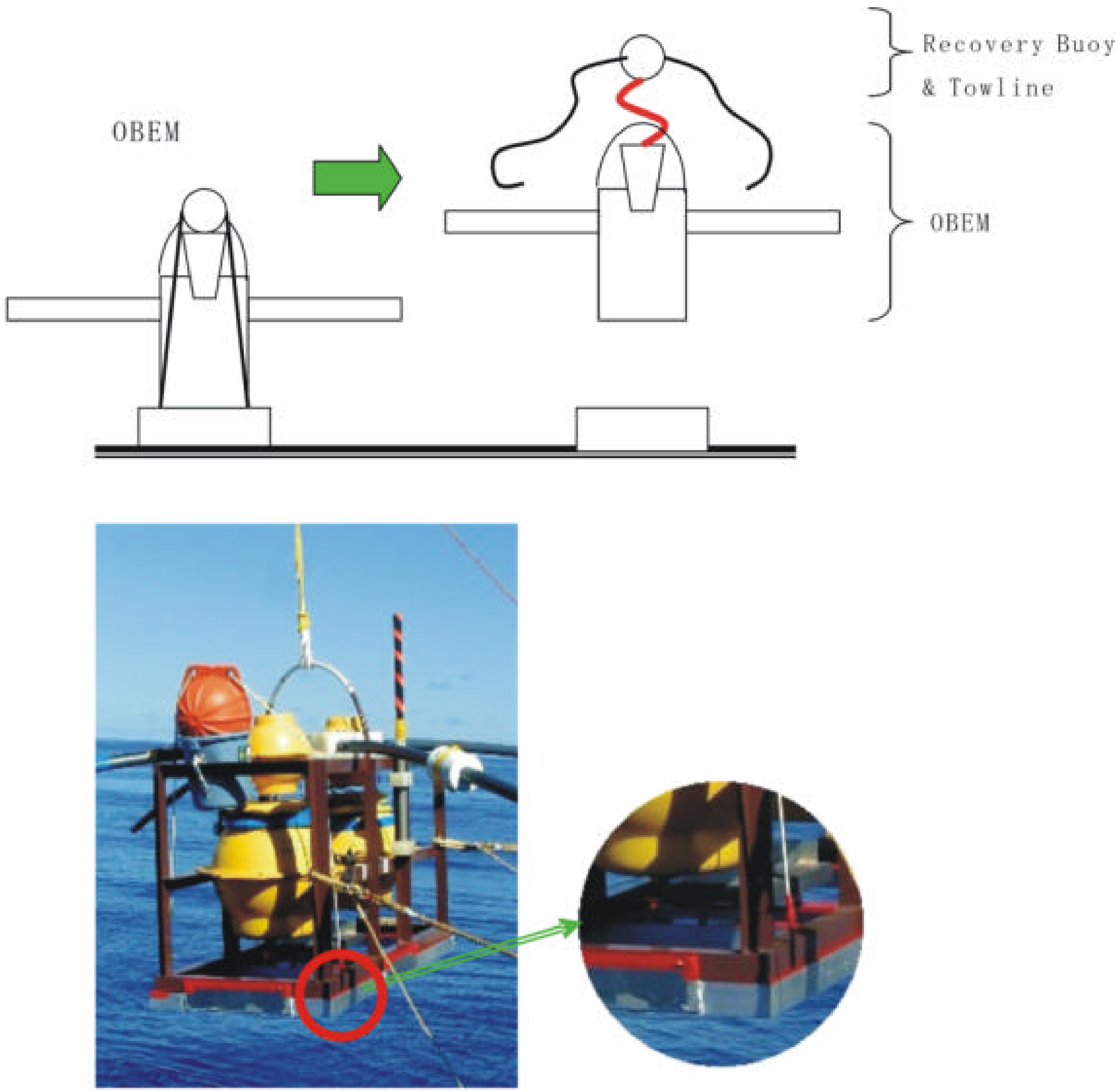

Figure 4-1-2. Recovery buoy-rope system. The stopper is fixed between lead weight and OBEM aluminous frame. Once the lead weight is released, the stopper becomes free and the buoy rises forward.

4-2. Single-channel reflection surveys (SCS) by NME

Single-channel reflection surveys (SCS) were carried out in this cruise. We investigated Yukawa Knoll using SCS. In those investigations, the total number of shots was 1,310 shots, and the total length of track line was 78,600m.

4-2-1. Single Channel Seismic (SCS) profiler

This survey using SCS system that is important of investigation of geological sturvey. During the SCS system, we used GI Gun, Steamer cable, both equipments controller and data processing PC. A streamer/source lay out is described in fig 4-1, 4-2.

The seismic source GI (Seismic Systems, Inc. TX, U.S.A.) gun is used to "true GI. mode" whose volume is 350 cu in. (Generator: 245 cu in., Injector: 105 cu in.). GI gun has two structures (Generator and Injector) to make an ideal firing pulse. The first, Generator produces the primary pulse, while the second, Injector is used to control the oscillation of the bubble produced by the Generator. In this cruise, the GI gun was towed at ca. 30m from the stern center of R/V YOKOSUKA and towing depth was about 3.5 meters. Shooting rate was distance-mode which is 60 meters with a ship speed of ca.4 knots, controlling by "NavLog"(MarimexJP, Inc., JAPAN). "Firing Controller" (Clover Tech, Inc., JAPAN) controls trigger timing to GI gun and firing time delay control between Generator and Injector structures of GI gun.

Seismic data is received by an analog streamer that is filled in castor oil. The streamer (made by Services et Instruments de Geophysique, FRANCE) has a 65 meters active section with 48 hydrophones (S.I.G.) and 200 meters leading cable. In this cruise, the streamer was towed on the port side and the towing depth was 5-10 meters. The streamer depth control handling was using air that means air is put in or put out of streamer.

On-line received seismic data was monitor, process, and record in Delph Seismic+ (TRITON ELICS International, Inc., U.S.A.) on PC with SEG-Y format. It can also plot out to gray scale printer GSP-1086 (EPC LABORATORIES, Inc., Danvers MA U.S.A.). After seismic data is received, it is transferred to off-line processing system to print out and process. We used software SPW (PARALLEL GEOSCIENCES, Inc. U.S.A.) to process seismic data. We tried to explain about the structure of under the seafloor.

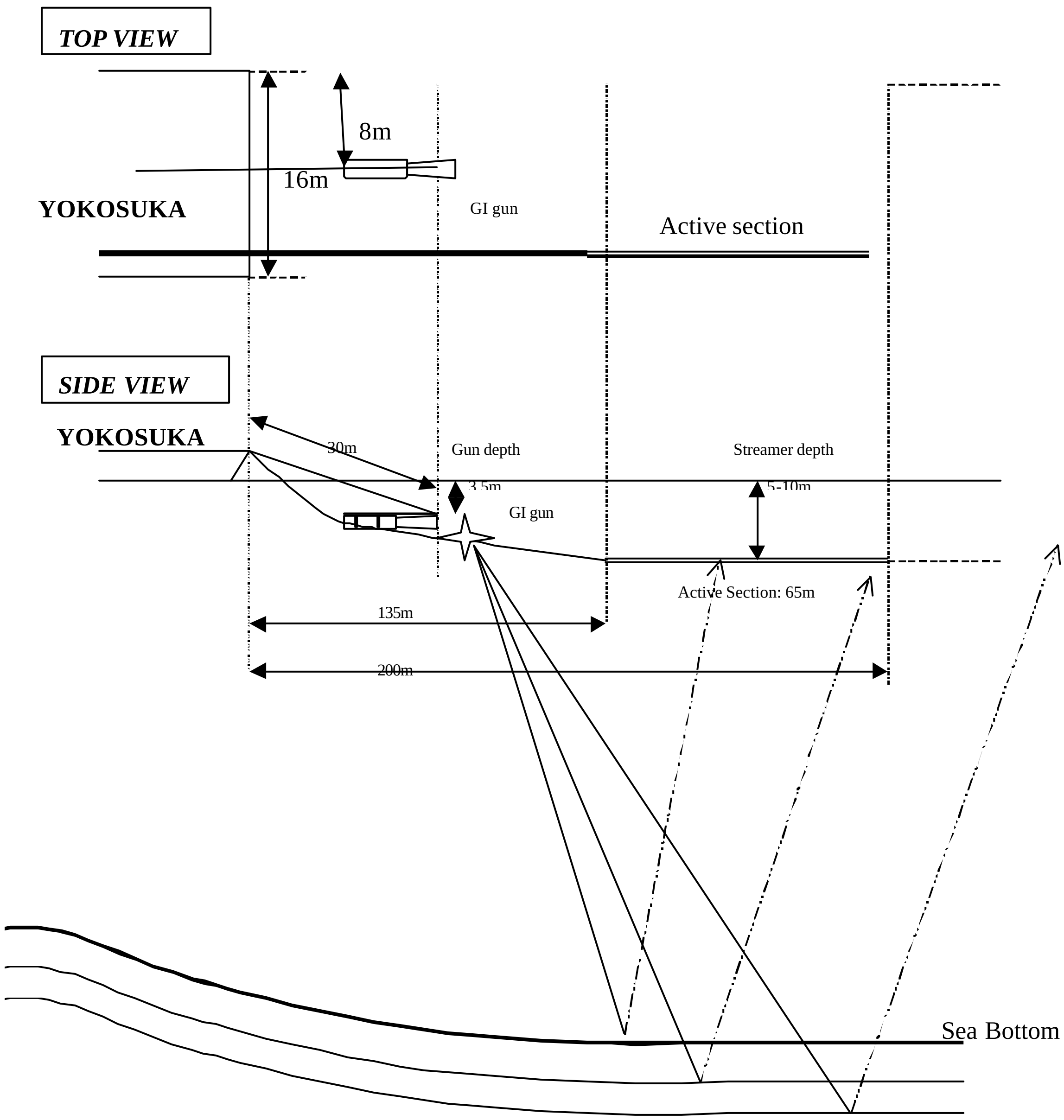
TOP VIEW
8m
16m
YOKOSUKA
GI gun
Active section
SIDE VIEW
YOKOSUKA
30m
Gun depth
Streamer depth
3.5m
5-10m
GI gun
Active Section: 65m
135m
200m
Sea Bottom

Figure 4-2-1.

4-2-2. Single channel seismic profiler system components

4-2-2-1. Source

GI-gun (Seismic Systems, Inc. Houston U.S.A.)

Total volume: 350 cu in. (Two structures: Generator; 245 cu in. Injector; 105cu in.)

Air pressure: 13.7Mpa (2000psi)

We use one GI-gun. It is towed by 12mm dimension wire (SUS), which is combined electric cables and a high-pressure air hose. Towing length is ca. 30m.

GI-gun firing controller (Clover Tech, Inc., Tokyo JAPAN)

It controls shooting delay time between Generator and Injector from 0.1-99.9msec. The delay time depends on the GI gun depth and air pressure. And it provides firing pulse to G & I.

Oscilloscope

Oscilloscope displays the Time Break from hydrophone attached to the GI gun. Operator can find and control an ideal firing pulse shape from it. The operator had better use digital oscilloscope than analog one. Because digital oscilloscope can get signal before trigger and it has ability to sampling high resolution. Therefore, operator can keep good firing pulse and record the waveforms to PC and so on.

Air compressor (LMF24/150-E60　VC2214W15)

Type: 4 steps compressing and cooling by air

Compressing steps: 4

Compressing liquid: Air

Inlet pressure: Atmospheric pressure

Inlet temp. (max): 45℃

Rpm: 1000rpm

FAD at inlet condition: 24 ? /min

Discharge pressure: 13.7Mpa (2000psi)

Power consumption: 365 kW

Power source: 440V, 60Hz (4 faze interchange)

4-2-2-2. Data Acquisition

Streamer (Services et Instruments de Geophysique, FRANCE)

The active section of the SIG Streamer (200m Lead in section, 65m active section and 30m-tail rope) contains 48 hydrophones (SIG 16a65) spaced at 1m interval. This streamer receives reflected wave from sea bottom and converts to electric signal at these hydrophones. In the middle transferring on board, the signal is amplified at a preamplifier in the streamer. And ahead of the streamer, there is a depth transducer that search depth of streamer.

SIG depth monitor and power supply

Depth monitor: Power supply; 100 VAC

Output; 24V / 30mA to transducer

Consumption; 10VA

Streamer power supply: 1 battery 12V, 600mA

4-2-2-3. Seismic data on-line processing system

DELPH SEISMIC (TRITON ERICS International, Watsonville CA U.S.A.)

DELPH SEISMIC the software is used to record or playback the seismic data (single or multi-channel) or Sub-bottom profiler (SBP) data in a Window-NT or 95 PC environments. Recorded seismic data can be saved any media, as you like; we saved in hard disk and CD-R(650MB).

Plotter (EPC LABORATORIES, Inc., Danvers MA U.S.A.)

We use gray scale plotter GSP-1086 to plot acquired seismic data in real time.

NavLog (Marimex. Inc., JAPAN)

NavLog the software is a navigation system in Windows-XP PC environments, control shooting rate (distance or time), record a shot position.

4-2-2-4. Seismic data off-line processing system

SPW (PARALLEL GEOSCIENCES, Inc. U.S.A.)

SPW (Seismic Processing Workshop) is software of processing seismic data. After recording, we saved raw data (SEG-Y formatted) in CD-R (650MB) and transferred to the off-line processing system. In the off-line processing system, these raw data is reformatted to SPW format.

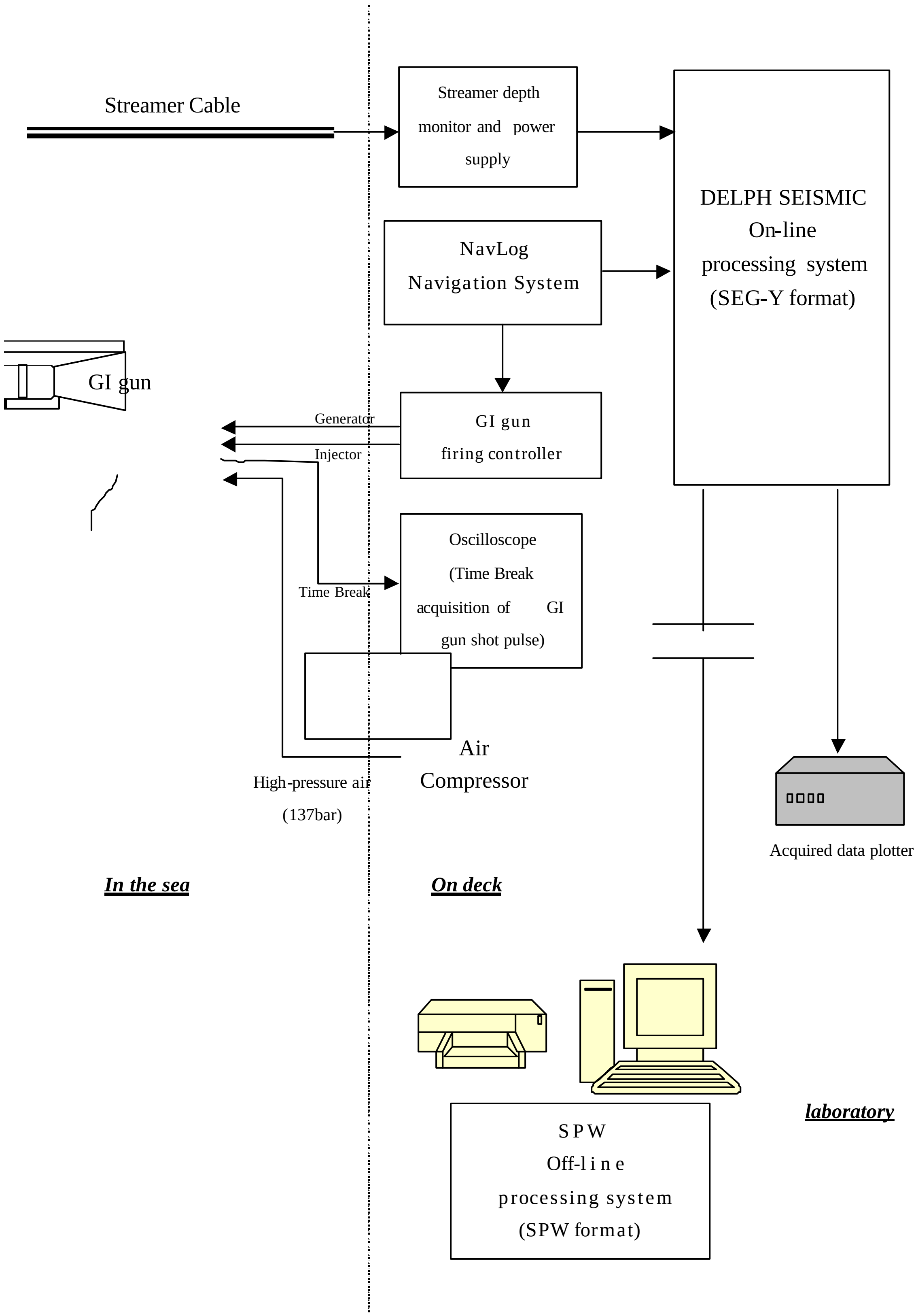
Streamer Cable
Streamer depth monitor and power supply
DELPH SEISMIC On-line processing system (SEG-Y format)
NavLog Navigation System
GI gun
Generator
Injector
GI gun firing controller
Oscilloscope (Time Break acquisition of GI gun shot pulse)
Time Break
Air Compressor
High-pressure air (137bar)
Acquired data plotter
In the sea
On deck
laboratory
SPW Off-line processing system (SPW format)

Figure 4-2-2.

4-3. Multibeam Echosounder with the Sub-bottom Profiler (SeaBeam 2112.004)

Bathymetric data were collected by a multibeam echosounder system, SeaBeam 2112.004 (L-3 Communications SeaBeam Instruments). SeaBeam 2112.004 collects bathymetric and sidescan data to deep sea over a wide swath of up to 140. The system has sub-bottom profiler using 4 kHz echo. There are three UNIX-based workstations and one Windows-based personal computers in the system. SeaBeam 2112.004 has a vertical reference unit, which is installed in the gravimeter room, and a sound velocity-meter unit for seawater of sea surface, which is installed in the boatswain's storeroom.

The projector array is a 14-foot long linear array positioned fore and aft along the ship's keel. It forms a downward projected acoustic beam whose maximum response is in a plane perpendicular to its axis.

The system transmits an acoustic signal from projectors mounted along the keel of the ship. The acoustic signal travels through the seawater to the seafloor and is reflected off the bottom. Hydrophones mounted across the bottom of the ship receive the reflected signals. The system electronics process the signals, and based on the travel time of the received signals as well as signal intensity, calculate the bottom depth and other characteristics such as S/N ratio for echoes received across the swath. The data is logged to the hard disk for post processing which allows for additional analysis.

The beam angle is narrower, 2° in the fore/aft direction, than a traditional echosounder, PDR. The receiver array detects and processes the returning echoes through stabilized multiple narrow athwartship beams in a fan shape. The hydrophone array has a flat shape in the case of R/V "KAIREI", although the standard SEA BEAM 2000 series system has a V-shaped array. The system synthesizes 2°×2° narrow beams at the interval of 1°, and the swath width varies from 120° at depths from 1500 m to 4500 m, 100° from 4500 m to 8000 m and 90° deeper than 8500 m.

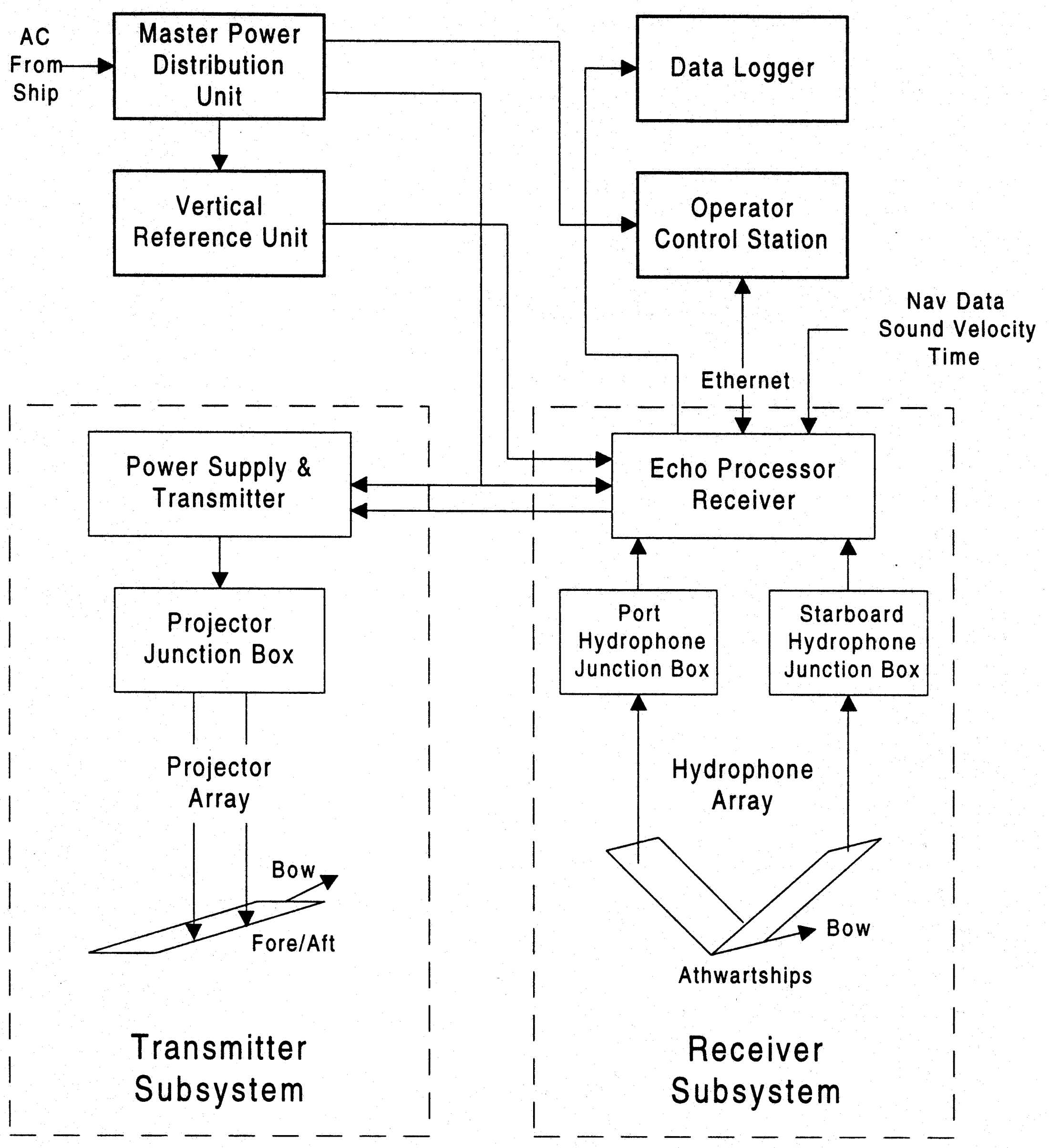

Figure 4-3-1. Basic diagram of the SAE BEAM system

The horizontal resolution of the bathymetry data depends on the depth of seafloor and ship's speed because a pinging interval increases as the depth, for example about 20 sec. at 6500 m. The accuracy of depth measurement is reported at 0.5% of the depth of seafloor.

The obtained raw data includes data records of each ping (bathymetry, side scan image, position), nautical information and correction parameters such as sound velocity profile of seawater. There is a real-time display software to show bathymetric map on the display as well as sidescan and amplitude maps.

4-4. Geophysical instruments

4-4-1. Gravimeter

Onboard gravity measurement was performed using a BODENSEEWERK KSS31 marine gravimeter system, which was installed in the gravimeter room. According to "Sea State" filtering (low-pass filtering to cancel out gravity effect by ship's movement), the gravity data delays 76 seconds. "Sea State 2" was selected in this cruise. The gravity data were logged per minute in this cruise.

The system incorporates ship's position, speed, and heading through the local area network in the ship, and performs the Etovös correction on-line. The measured gravity value (-1432.4 mGal) at the JAMSTEC pier in Yokosuka at the beginning of this cruise is tied to an absolute gravity value (979758.7 mGal), which value was determined by the previous on-land gravity measurements. The final "gravity tie" must be done in consideration of sensor drift of the gravimeter during the cruise by measurements before departure and after arrival at the pier. Therefore, accurate gravity data processing (readjustment of time difference, Etovös, drift, and reference gravity corrections) should be done after the cruise.

4-4-2. Proton Precession Magnetometer

The total magnetic field measurements were collected by a surface-towed proton precession magnetometer, PRTO10 (Kawasaki Geological Engineering Corporation). The PROTO10 consists of two main units, the sensor and the control units. The sensor, which is towed about 300 m behind the ship, detects intensity of the total geomagnetic field as an electronic signals induced by the precession of proton. The control unit is installed in the dry laboratory. The control unit can set parameters, measurement interval, charge time, capacity of condenser, and so on. The interval of measurement during this cruise was 20 seconds. The data file is renewed everyday.

4-4-3. Shipboard three-component magnetometer

A shipboard three-component magnetometer system, SFG1214 (Tierra Tecnica), was used to measure the three components of the geomagnetic field. Three-axes flux-gate sensors with ring-cored coils were fixed on the roof of the bridge (about 2 m from the roof). Outputs of the sensors were digitized by a 20-bit A/D converter (1 nT/LSB), and sampled at eight times per second. Ship's heading data were also sampled at 8Hz, which were transmitted directly from a gyrocompass for navigation in the bridge. Roll and pitch data of 8 Hz were provided from an attitude sensor (TVM-4) installed on the floor of the gravity meter room. Ship's position and speed data were taken from LAN every second. Logging of these data was carried out using a computer. The data file is renewed everyday. "Figure-8 turns" (a ship runs along an 8-shaped track consisting of two circles) for calibration of the ship's magnetic effect was performed three times during this cruise.

4-5. Stand-Alone Heat Flow meter (SAHF) by Fujiwara

Stand-Alone Heat Flow meter (SAHF) is designed to measure heat flow by manned submersibles or ROVs. Five thermistors are situated within the probe at 11 cm intervals. SAHF takes measurements as an off-line system, heat flow is measured while observer is conducting something else at that position or elsewhere. SAHF can also be used for long-term monitoring of sub-bottom temperature. We prepared two SAHFs, designated as SAHF-6 and SAHF-7. These SAHFs are equipped with LED, which flashes during operation. The descriptions of SAHF are shown in Table 4-5-1 and Figure 4-5-1.

Table 4-5-1. Description of SAHF.

Material	Alloy of titanium
Weight	4.0 kg in air, 2.6 kg in seawater
Length of pressure case	294 mm
Diameter of pressure case	85 mm (SAHF-1)
Length of probe	600 mm
Diameter of probe	13.8 mm (filled by silicon oil inside)
Number of thermistors	5
Accuracy	0.01 °C
Resolution	0.001 °C
External Interface	RS232C (9600bps, 8 bit, Non-parity, 2 stop-bit)

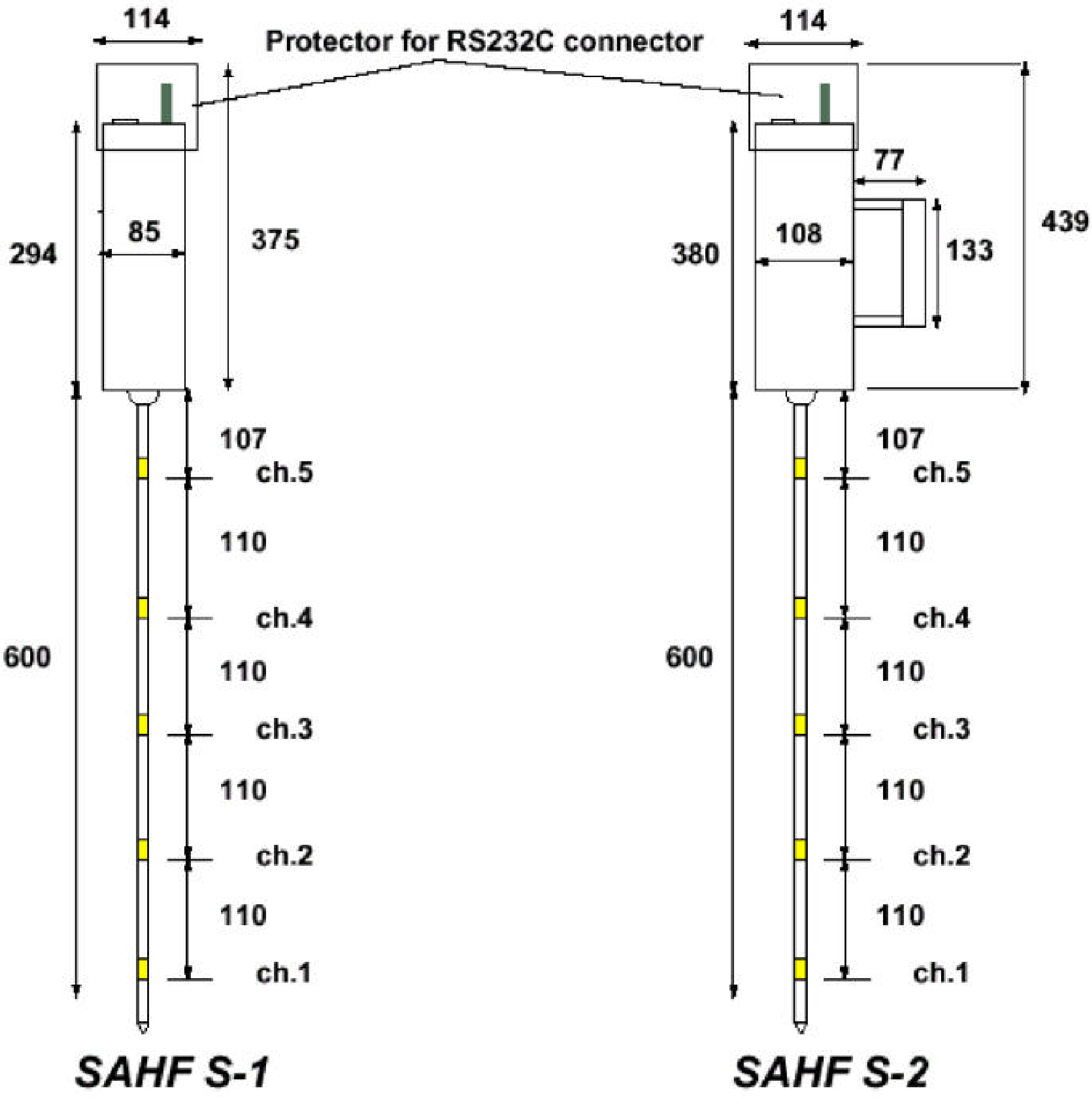

Figure 4-5-1. Graphical description of SAHF.

5. Preliminary Results

5-1. 6K Dive reports

by Ishii, Ingle, Machida & Hirano

We dove to three knolls at the B-area and the one site of knoll and fault wall on the Japan Trench, oceanward slope, which are young volcanoes on the Early Cretaceous Pacific Plate erupted at 0-1 Ma and 4-6 Ma, respectively. The targets of these four dives are sampling rocks, observation of eruptive styles and discussion of the stratigraphy of the monogenic volcanoes. One young knoll for our first dive, named the Yukawa Knoll, at the B-area was discovered by the dredge (D-07, 08) during KR04-08 cruise. Two other knolls at the B-area show the similar features of the data by bathymetry, back-scattering and sub-bottom profiling.

Another one for dive is on the Kaiko Knolls lava field, the Japan Trench oceanward slope. We expected the two type of lavas, which are 6 Ma flood lavas and 4 Ma knolls.

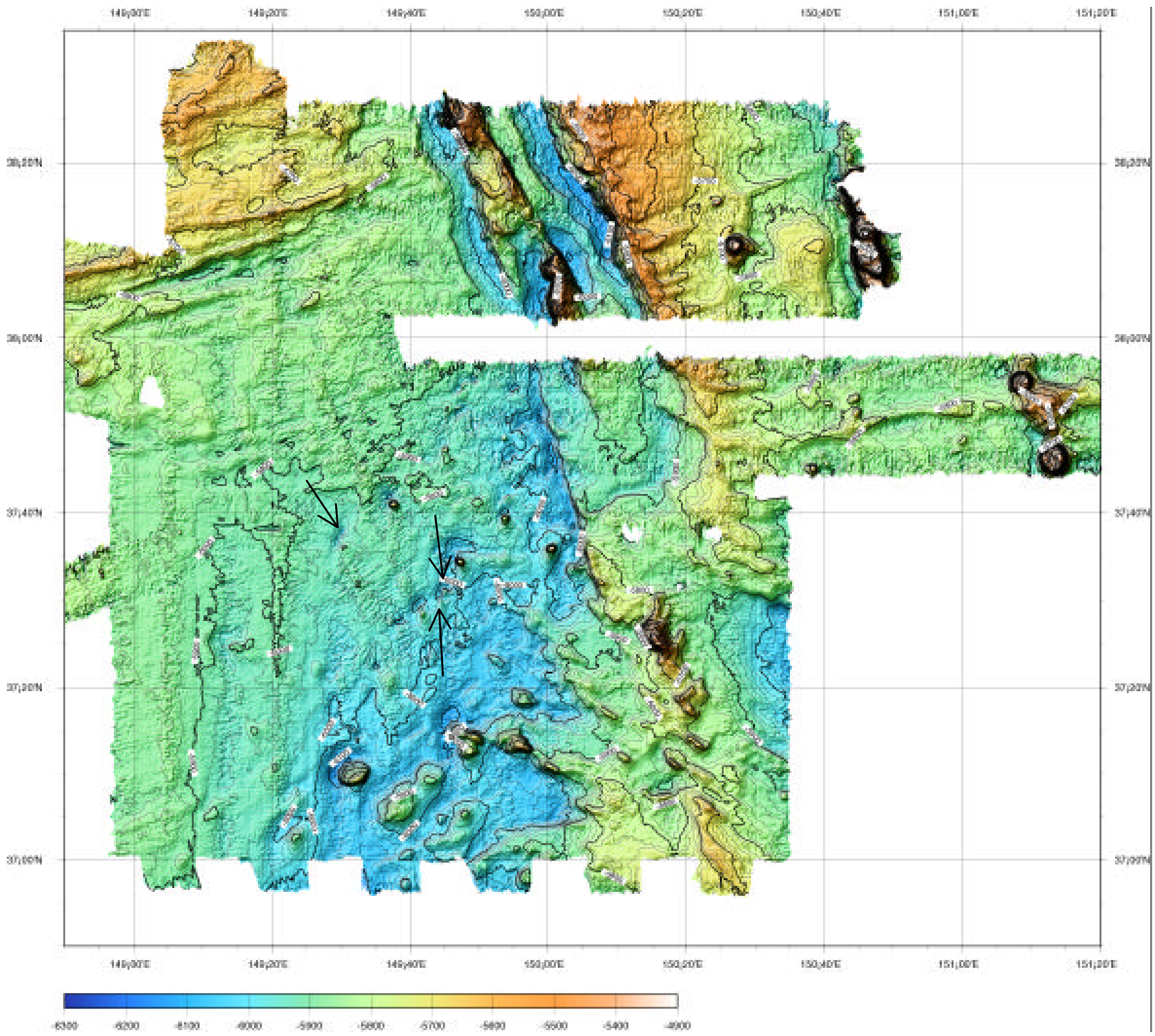

Figure 5-1-1. Bathymetrical map of the B-area by the KR04-08 cruise. Three dive points are shown by arrows.

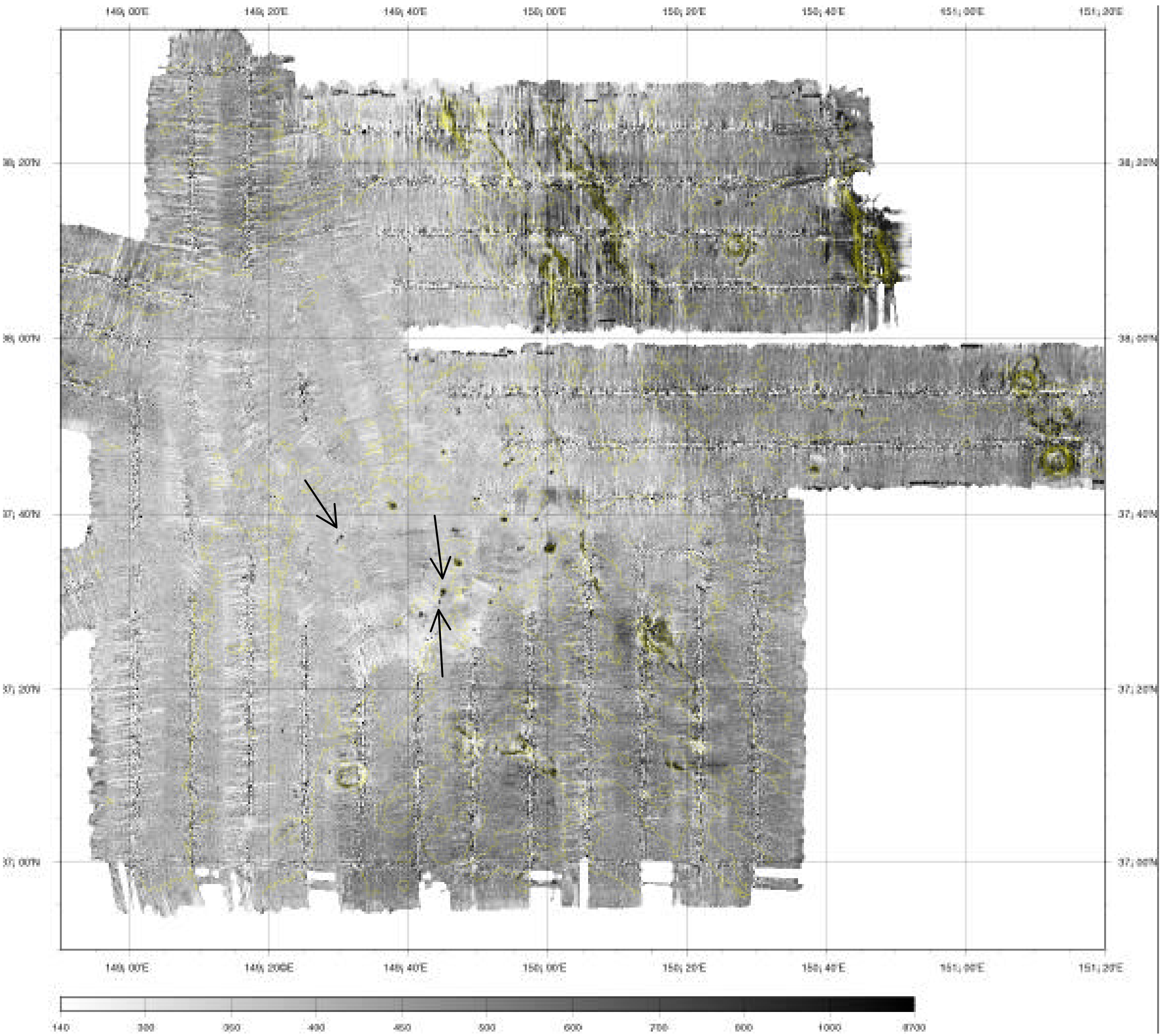

Figure 5-1-2. Back-scatter image of the B-area by the KR04-08 cruise. This is the same scale and area as Figure 5-1-1. Three dive points are shown by arrows.

5-1-1. 6K#877: Yukawa Knoll

Date: 22 May, 2005
Dive point: A small knoll (Yukawa Knoll), off Iwaki-shi, Fukushima-prefecture, Northwestern Pacific basin
On bottom: 37°29.7214'N, 149°44.4955'E, D=5934m
Off bottom: 37°29.9211'N, 149°44.5280'E, D=5859m
Pilot: Itaru KAWAMA
Co-pilot: Yoshinari OONO
Observer: Teruaki ISHII (Ocean Research Institute, University of Tokyo)

Payloads

(1) Two sample baskets with partings and sample boxes,
(2) 2 Push corers,
(3) One marker with No. 11,
(4) Heat flow, SALF (thermometer),
(5) 35mm type TTL handy film camera, 35mm type TTL handy digital camera and handy digital video camera.

Research Title

The geological and petrological investigation on a young small knoll (Yukawa Knoll), found during KR04-08 cruise, off Iwaki, Fukushima-prefecture,Northwestern Pacific basin.

Objectives

The main objectives of this dive are

(1) To make a detailed topographic map and geological cross sectional view on a small and young volcanic knoll (Yukawa Knoll, (about 1Ma)), found during KR04-08 cruise, off Iwaki-shi, Fukushima-prefecture, Northwestern Pacific basin, in comparison with regional topographic swath mapping by R/V Yokosuka HS-10 system. The shape of the knoll is a truncated oval cone elongated NNW direction with about 1200m (long) x 800m (short) diameters and 100m high.

(2) Sampling of constituting basaltic rocks, that is, pillowed lava, sheet lava, volcanic glass includig peperite, hyaloclastite, paragonite, as well as xenolithes of mantle- and lower crustal-rocks such as peridotite and gabbroic rocks from various depths for reconstruction of a detailed geological cross section of the old Pacific lithosphere (about 130Ma) down to the asthenosphere.

(3) Sampling of sedimentary rocks including Mn-nodules and soft sediments by push cores for study geological evolution induced by very young volcanic activities (about 1Ma) in

this area.

(4) Heat flow measurement using a deep sea thermometer produced by Dr. Masataka KINOSHITA (SALF) at a muddy sea bottom.

(5) Marker (Number 11) will be placed at dive site for future dive reference.

Results

The gentle slope of the Dive 877 is covered by thin layer of unconsolidated hemipelagic silty softsediments. Volcanic glass, volcanic breccia, Mn-nodule with siltstone-core and soft sediment were recovered using manipulators and push core-sampler, respectively in this dive.

(1) SHINKAI 6500 Dive 877 was carried out along two courses, that is, the first one is between 5934m and 5859m deep along the southern slope (about 7°of average-dipping), the second one is between 5931m and 5859m along the western slope (about 14°of average-dipping). Total dive time and observation time in the bottom are 7 hours 52 minutes and 3 hours 24 minutes, respectively.

(2) About 13 efusive rock samples (volcanic rocks ranging from fresh pebble size basalt to relatively altered volcanic breccia coated by thin to 10mm Fe ·Mn-oxide) and 2 Mn-nodules with siltstone core having 10-30mm thick Fe ·Mn-oxide crust as well as one push core (mixture of sea-water and hemipelagic soft sediment) were collected.

(3) Two sets of video tape-records with 3 hour 30 minutes each by No.1 and No.2 digital video camera were obtained. Still camera records of 306 digital shots and 2 roles of photos by 35mm film TTL handy camera as well as 189 shots by TTL handy digital camera were also obtained.

(4) The slope was divided into steep slope showing stairs-shaped outcrop comprising syngenetic (?) volcanic breccia with thin Fe ·Mn-oxide crust and sedimentary rocks with thick Fe ·Mn-oxide crust, and gentle slope comprising hemipelagic soft sediments including volcanic pebbles and occasional gravels coated by very thin Fe ·Mn-oxide.

(5) Many animals and signs of animals including bioturbation, excrements, dens and trail-traces were spread over throughout the slops, particularly among hemipelagic soft sediments. High density of animals suggests the existence of unknown food supply-system in this area, induced probably by recent igneous activities. One big white animal with log shape (100cm long, 20cm diameter) was observed, assumed as a kind of sea-anemone.

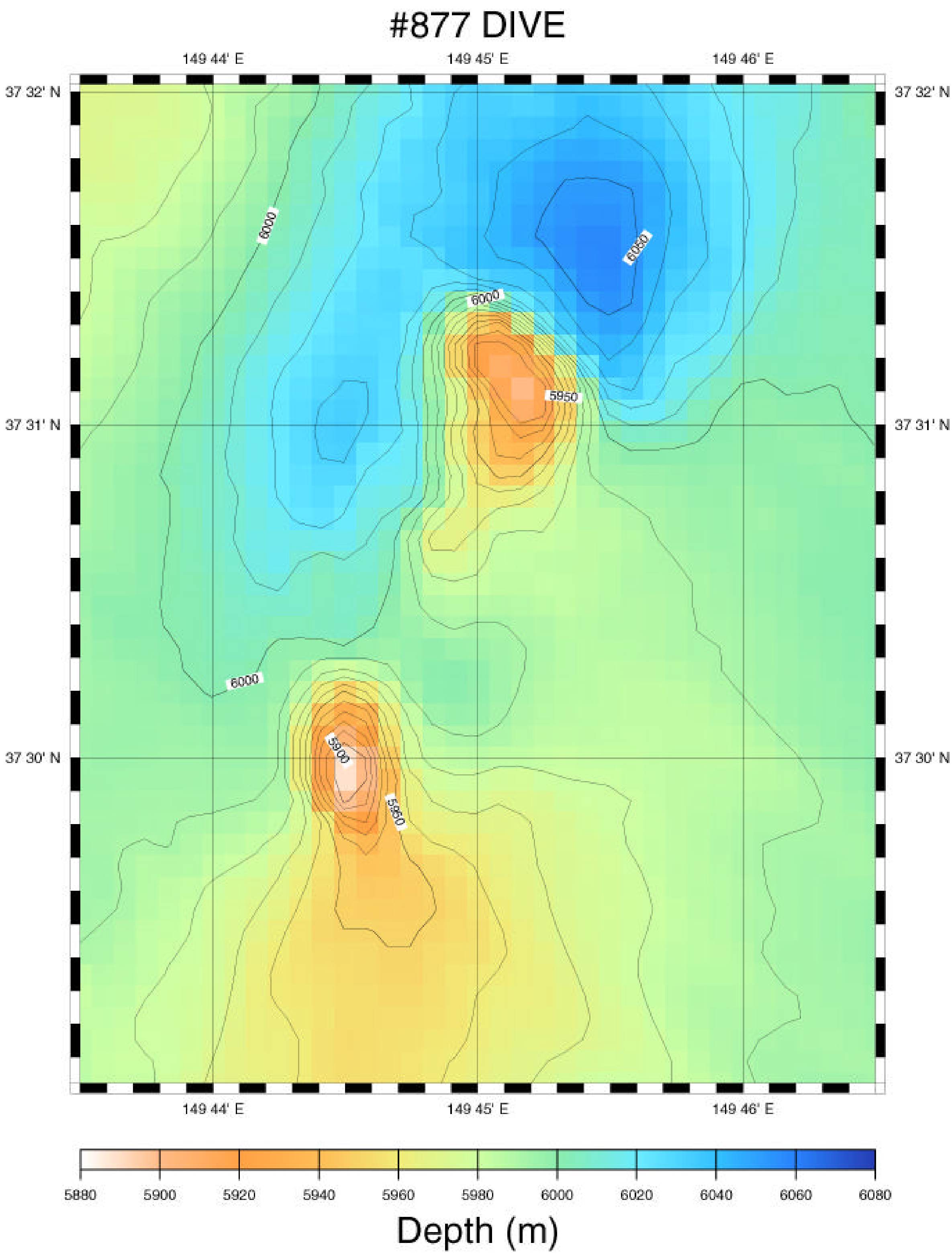

Figure 5-1-1-1. Detail bathymetric map around the dive#877 site. Southern knoll, the Yukawa Knoll, is the target of this dive.

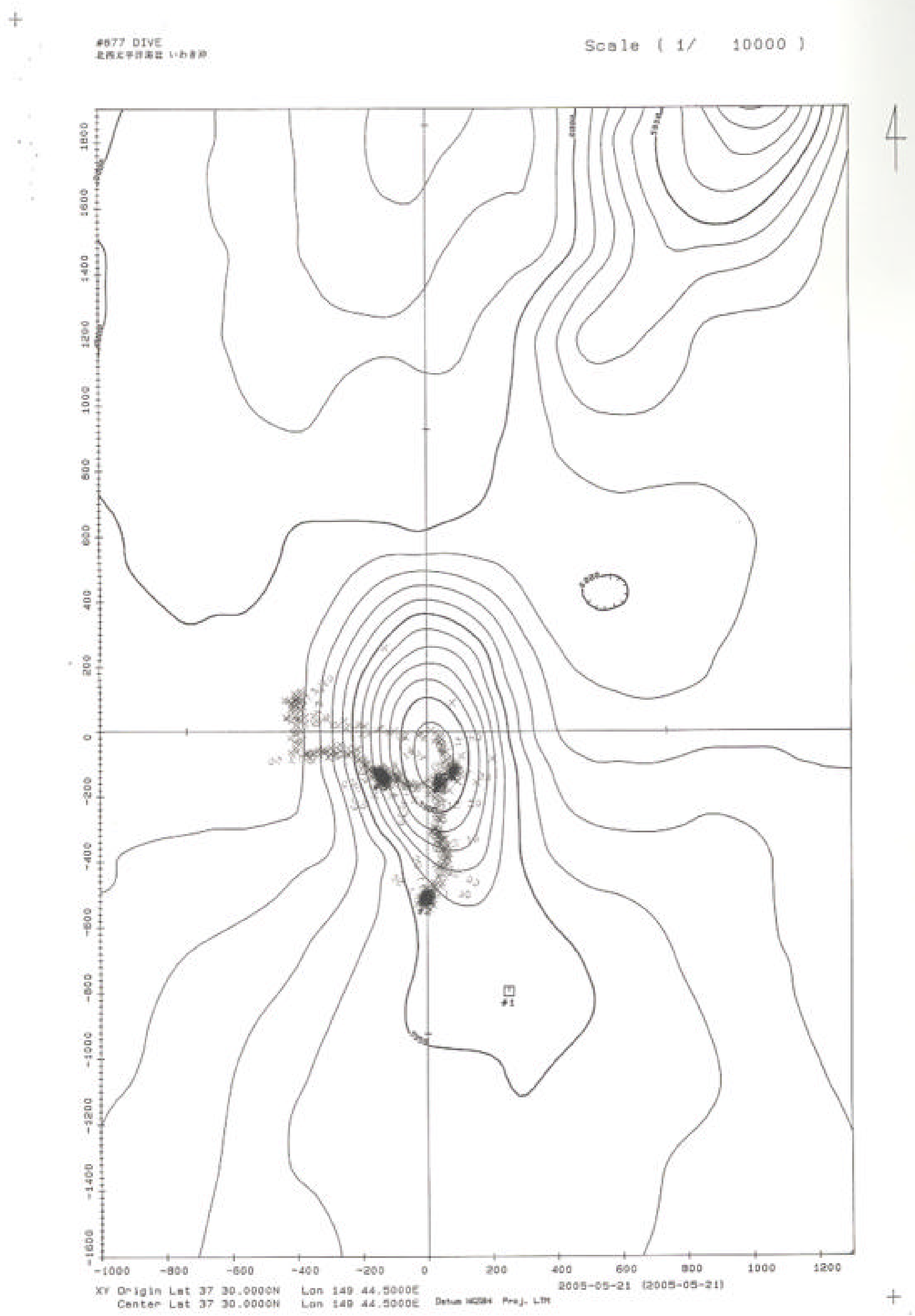

Figure 5-1-1-2. 6K#877 dive track on the 20 m contour map.

5-1-2. 6K#878: Pit-crater

Date: 22 May, 2005
Place: Northwestern Pacific Basin, Pit-crater in lava field
37°37.60' N, 149°30.50' E
Pilot: Toshiaki Sakurai
Co-pilot: Yosuke Ichida
Observer: Stephanie Ingle (Tokyo Institute of Technology)

Dive #878 started in the flat basin, to the northeast of the nearby small topographic high. The purposes of the dive were to investigate the nature of the pit crater (basin) and the adjacent high; the structure of rocks on the topographic high and type of rocks comprising it; and evaluate whether any recent volcanic activity has taken place in this area.

The basin at the beginning of the dive was fully covered in soft pelagic sediment. The base of the northern side of the topographic high contained outcrop of rounded and lobate-shaped rock, but recovered samples were manganese crusts only. The slope of the hill was characterized by oblong shaped rock outcrop; this rock could not be sampled in-situ but it is likely an evolved lava (high viscosity of lavas causes flows to be tube-shaped). Rock fragments sampled in this area appear to be volcanic breccias containing clasts of lava enclosed in sedimentary rock; manganese coating on these breccias is thin, suggesting they were deposited recently. The top of the hill contained tabular-shaped rocks, most likely uplifted lava flows. Rocks sampled at the top of the hill were basaltic with thin manganese crusts. The western flank of the hill was more heavily sedimented and no visible outcrop was present. Samples obtained by scooping at the midpoint of the western flank's slope were lava clasts, one containing a peridotitic xenolith; the scooped samples at the top were peperite.

Abstract

Preliminary interpretations are: 1) low basin with small topographic high (cryptodome? – partly extrusive) to SE; 2) various rock types including vesicular basalt clasts (some with xenoliths), pumice, and lava fragments, primarily as clasts in volcanic breccias; and 3) thin manganese coating of breccias suggests they were recently deposited.

Video Highlights

(1) 11:20 – 11:35 (camera #1 or #2) arrive at the landing site: pelagic mud basin with some bioturbation; take two push cores.

(2) 12:10 – 12:30 (camera #1 or #2) base of the dome: elongate, lobe-shaped lava flows (pumice or other evolved rocks?) with manganese crusts; angular rock fragments (volcanic breccias with lava clasts); tabular lavas.

(3) 12:40 – 13:00 (camera #1 or #2) climbing the steep slope of the dome: elongate, lobe-shaped lava flows (pumice or other evolved rocks?) with manganese crusts; 'botryoidal' pillows with manganese crusts; angular rock fragments (volcanic breccias with lava clasts
(4) 13:25 – 13:45 (camera #1 or #2) top of the dome: large, tabular shaped lavas turned on side (uplifted by later volcanic activity?).
(5) 14:15 – 14:25 (camera #1 or #2) west flank of dome: angular lava fragments in pelagic sediment.
(6) 14:45 – 15:00 (camera #1 or #2) top on west flank of dome: angular lava fragments in pelagic sediment.

Purposes of Dive

1. To determine the nature of the high back-scattered area (believed to be crater) observed in sidescan sonar data between 5920 m and 5980 m.
2. To evaluate the rock morphology and eruptive or emplacement style of the rock forming the pit crater, the topographic high and its flanks.
3. To collect rock samples from this previously unsampled area for further geologic and petrologic investigations.

Payload

2 – sample baskets
1 – sample container with lid
1 – scoop for lava pebbles
2 – push cores
1 – SAHF thermometer (empty, for pressure withstanding evaluation)

Summary of Dive Operations

Dive Plan

Dive #878 was initially targeted because of its topographic low feature that produce a high back-scattered area in sidescan sonar data. A topographic high on the southeastern side of the topographically low feature was also of interest. It was suspected that the basin and the neighboring high were volcanic features.

Topography

Sidescan sonar and relectivity data (SeaBeam) collected on this and previous surveys of this area show a low basin (pit crater?) at 5980 m depth and a small hill (lava dome?) from 5980 m to 5890 m depth to the southeast of the basin. Another basin exists to the south of this basin.

These features had not been previously sampled or examined by submersible or ROV.

Geology

SHINKAI descended to 5980 mbsl to the basin. Two push cores were taken as first was not completely filled. SHINKAI then crossed the basin to the base of the high. First samples recovered near this base (topo line 5950). SHINKAI ascended the hill from the north, stopping again at 5935 to sample – sampling continued up to 5925 topo line. SHINKAI finished its ascent of the high and took additional samples. SHINKAI descended the high on the western flank and turned around to ascend it again. Outcrop was poorer along this slope; stopped at mid-point during ascent to scoop sample (topo 5960) and then continued to the top of high and took another scoop sample.

SHINKAI 6500 reached bottom at 5980 m depth at 11:23. The seafloor was moderately bioturbated, relatively smooth pelagic sediment. We took 2 push cores shortly after reaching bottom. We began a course at 170° from the crater toward the high feature but encountered no obvious igneous rock until 11:50 when steep walls appeared before us with outcrop. The outcrop was made up of mostly lobate lava flows and large pillows, well coated in Mn crusts and sediment. We stopped to take 2 rock samples at 12:14 at this depth of 5950 m (samples 1a and 1b). We then moved up the wall to 5935 m and began attempting to sample at 12:40. The wall was made up of mostly lobate lava flows and the lavas were well coated in Mn crust and sediment. We took two rock samples at this location as we were moving up to 5925 m (samples 2a and 2b). SHINKAI then ascended to the top. Near the top of the high, large tabular lava flows were observed, and one 'ridge'-like outcrop was present. At depth of 5885 m, we took 3 samples among these lava flows at 13:37 (samples 3a, 3b, and 3c).

SHINKAI then descended the high feature along its western flank in order to ascend and sample that side. At the base, mostly pelagic sediments were observed with scattered rock fragments. We ascended to 5940 m and took a scoop sample (scoop 1) of the rock fragments in the pelagic sediments at 14:20. We then ascended to nearly the top of the high feature, at 5850 m and took a final scoop sample (scoop 2) of the rock fragments at 14:40 before SHINKAI began its return ascent to the surface.

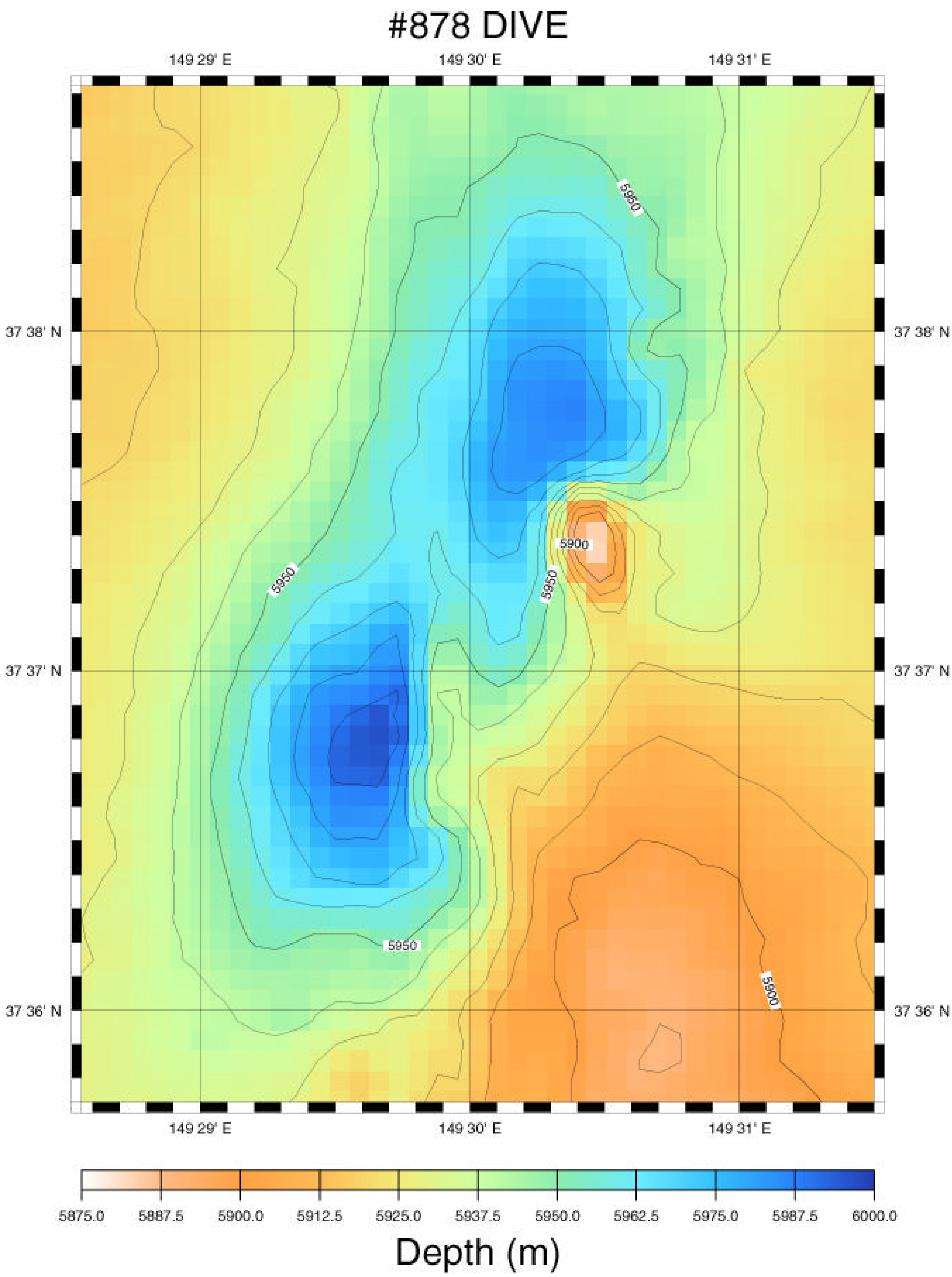

Figure 5-1-2-1. Detail bathymetric map around the dive#878 site. Eastern slope in these two craters show high back-scatters. The small knoll was found by the site-survey of this dive.

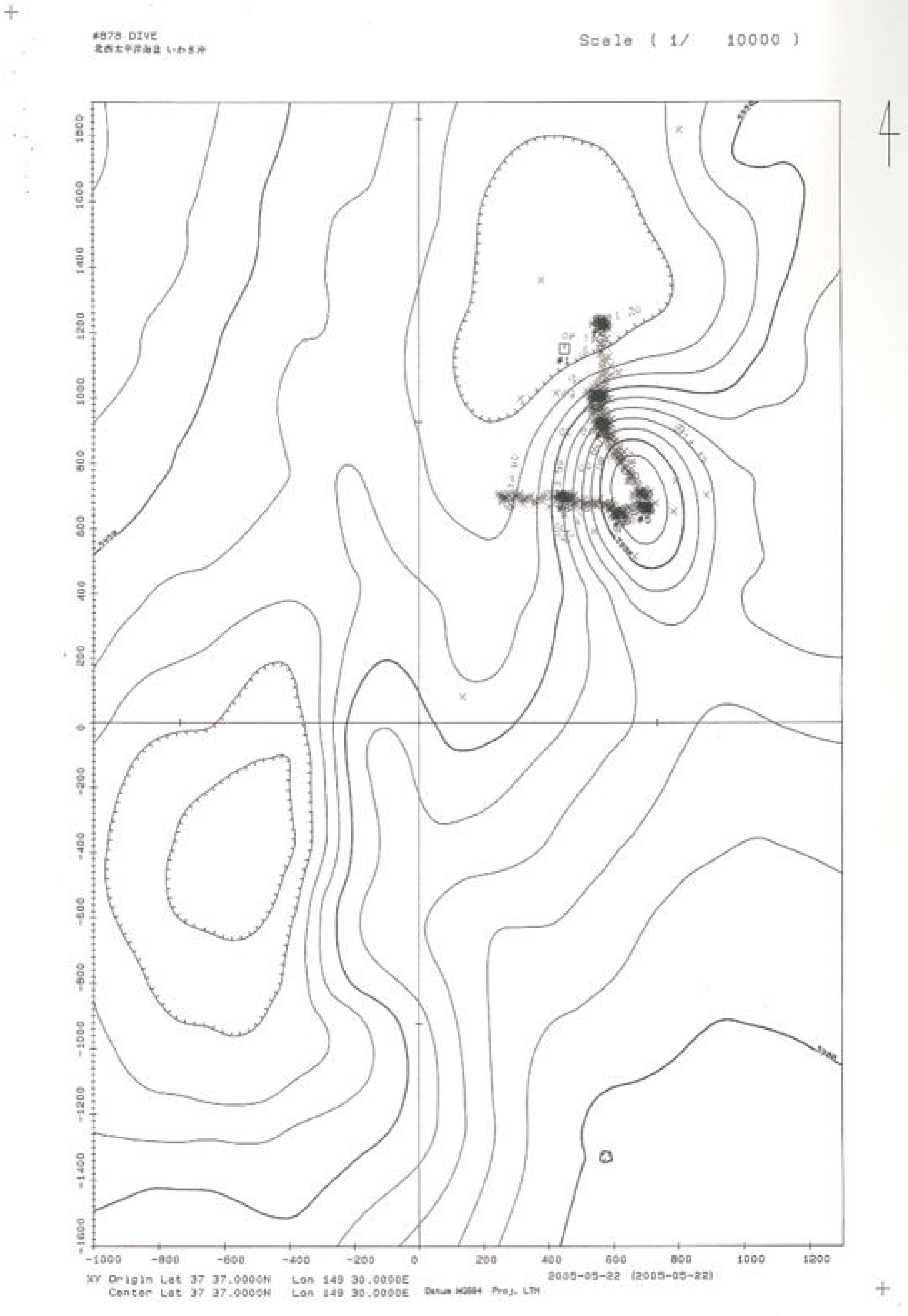

Figure 5-1-2-2. 6K#878 dive track on the 20 m contour map.

5-1-3. 6K#879: Northward knoll of Yukawa Knoll

Date: May 23, 2005
Place: Kita-Yukawa Knoll
37° 31.10’ N, 149° 45.20’ W
Pilot: Masanobu Yanagitani
Co-pilot: Yoshio Ohno
Observer: Shiki Machida (Ocean Research Institute, University of Tokyo)

Abstract

The dive track began at the base of the Kita-Yukawa knoll. In the crater, sheeted lava flows and huge lava lobes distributed as some outcrops into thick soft mud. The flat floor extended on the top of knoll. Some tumuluses and botryoidal shaped lavas or sedimentary rock are built up on the floor. At the bottom of knoll, slightly hard siltstone was covered with very thin soft mud.

The occurrences of outcrops of the Kita-Yukawa knoll exhibited in limited area around the summit of knoll. The pillow lavas and the pillow robes are dominated in almost outcrops. Soft pelagic mud is thinly covered.

Purposes of Dive

Investigation of a knoll of the newly discovered lava fields on KR03-07 cruise. The dive continuously takes place sampling along each slope. Shinkai6500 will be firstly on the bottom at the base of knoll, and climb the gentle slope along the high back-scatter area.

High vesicularity of lavas in spite of 6 kbar hydrostatic pressure and the low viscosity of lavas may form the peculiar morphology of lavas. We may observe the tumulus and interstitially botryoidal lavas on the terrace below the flood lavas. The lava may form the lopy structure and pyroclastic ejecta in spite of deep-submarine circumstances.

Payload

2 – sample baskets
1 – sample container with lid
2 – push corers
1 – scoop

Dive Plan

In order to investigate the stratigraphy of the Kita-Yukawa knoll, dive is planned to start ascending the eastern slope of knoll, and continuously observation and sampling along the slope. The landing point was selected at the base of the knoll as close point as possible. On arrival to the top of knoll, Shinkai6500 flies and goes down to the lava formation at full speed.

The second part of dive is at typical lava formation, which may composed of the lavas of predominated field in the Kita-Yukawa knoll. Some samplings of lava are taken place. We should understand some differences of the occurrence, rock type and lava morphology.

The targets of this dive were:

1. To assess and observe the nature and composition of the Kita-Yukawa knoll,
2. Continuously sampling from lower to upper of central crater in the Kita-Yukawa knoll,
3. To observe the distribution of lava formation and lava morphology.

Summary of Dive Operation

The eastern slope of the Kita-Yukawa Knoll

Firstly Shinkai6500 arrived at the bottom of the Kita-Yukawa knoll. Brown pelagic sediments were obtained around the arrival point. These were collected Push Core 1-red and 2-blue, (6039 m in depth, 11:28 to 11:28). Sediments occurred to about 6,000 m in depth (11:47).

Although thin mud sediments covered the floor, white silt stone constituted some steps (11:47). Continuously, some round-shape rocks and outcrops with thin pelagic sediment cover occurred. The outcrop occurrences increase as climb up the floor. After 11:57, at 5945 m in depth, we attempt sample correction on sheet-shape outcrop. But, We cannot get sample because the outcrop did not have any cracks. Manganese was shown on scratched surface. We collect some samples on the sea floor (1-A at 12:03 and 1-B at 12:05).

Outcrops occurrences were decrees again, many small fragments occurred (12:14). We try to get fragments using scoop. Pumice was corrected (SC1; 12:33, 5,909 in depth). Soon after SC1 sampling, huge round-shape outcrops occurred on sediment floor. This outcrop shows pillow or robe structure, and consider as lava flow. Light brown peperite was observed on contact margin with sediment floor (12:35). Pillow, robe, and tube lavas cover on almost whole sea floor consist of sediment, and flow down the slope. Lava outcrops were partly brecciated with some cracks. Shinkai sampled brecciated lava fragments (2-A at 12:47, 3-A & 3-B at 13:03- 13:08, and 4-A, B, C at 13:17-13:21). Lava flows were observed to about 5,870 m in depth. Shinkai arrived at roof of the Kita-Yukawa knoll. Outcrop of sheet-shape sedimentary rock was obseved. (5,869 m, 12:28, no collection).

Shinkai jump to southern part of lava layer. At 14:00, 5,926 m in depth, we re-arrived at the bottom again, where pelagic sediment floor including fragments of probably basalts. During the moving toward north along slope, we can see continuously the lava tube, pillow lava are observed. At the 14:11, we tried to get lava tube sample, but cannot get sample because the outcrop did not have any cracks. We retried the floor rocks (samples 6-A, B, C). It was difficult to obtain samples, because these were covered by soft sediment or manganese.

After the sampling we changed the plan to scoop sampling (14:38), thinking about the time-out of Shinkai6500 investigation.

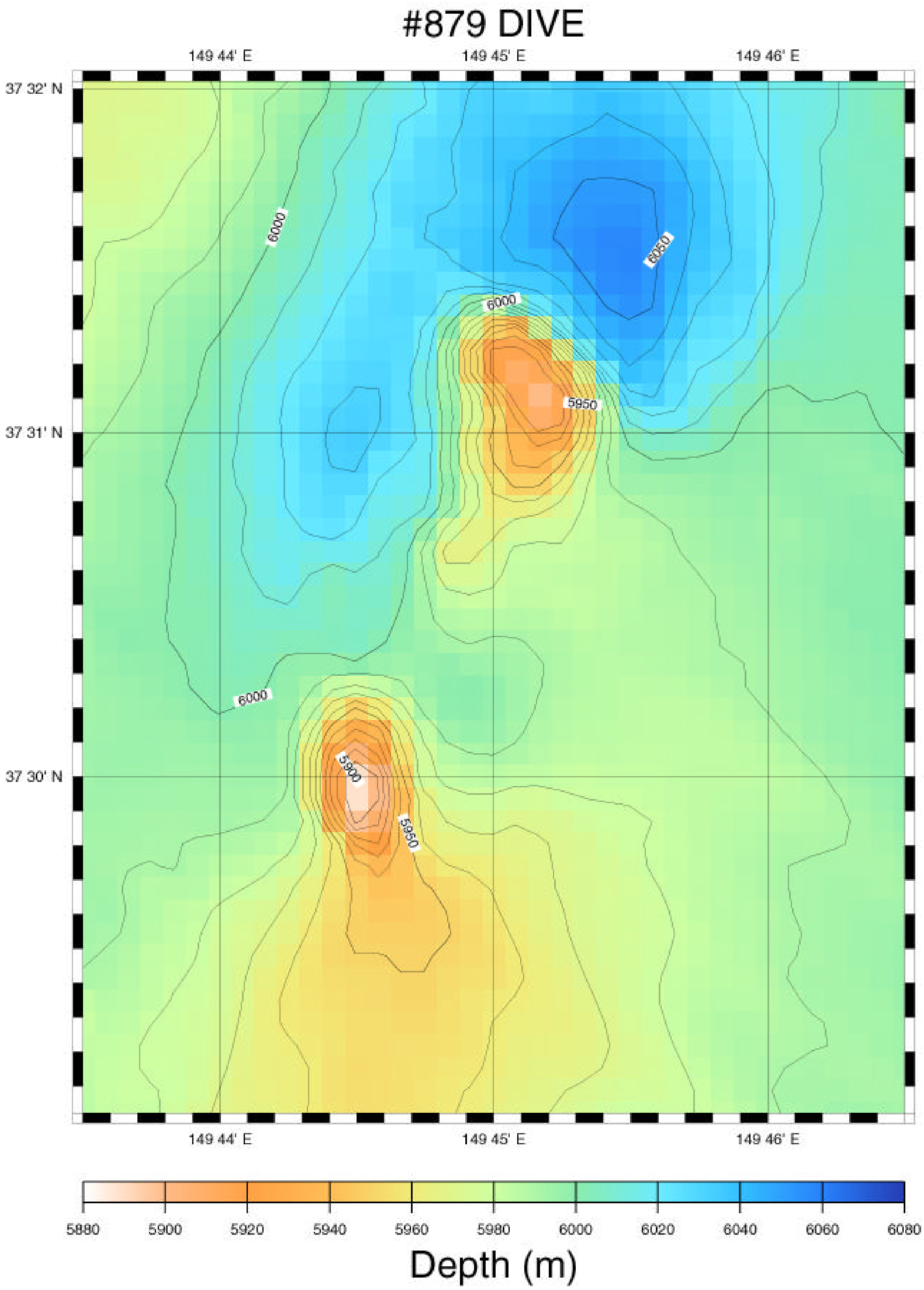

Figure 5-1-3-1. Detail bathymetric map around the dive#879 site. Southern knoll is the Yukawa Knoll for the previous #877 dive. The knoll for this dive is northern one.

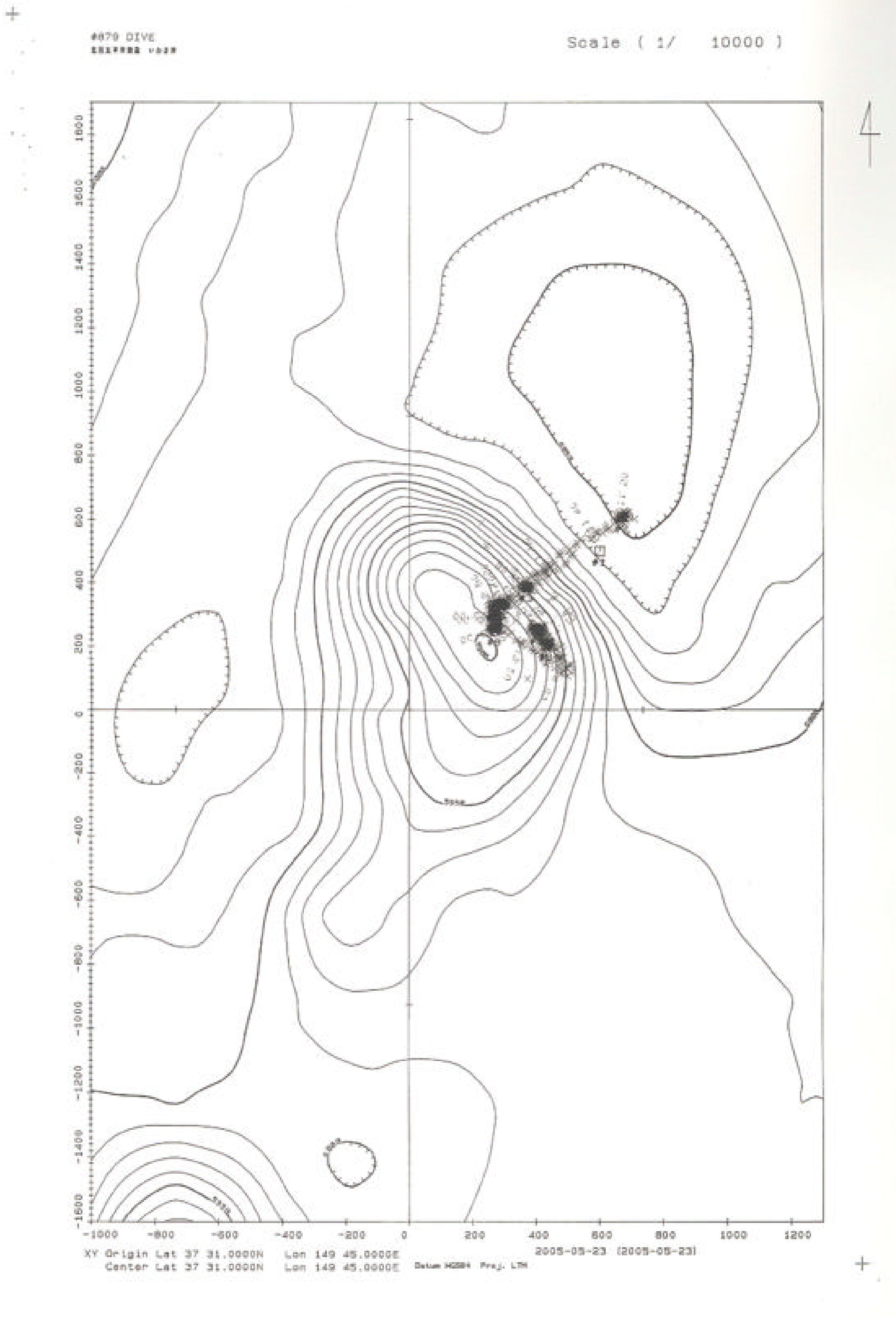

Figure 5-1-3-2. 6K#879 dive track on the 20 m contour map.

5-1-4. 6K#880: Kaiko Knolls lava field, the Japan Trench

Date: May 25, 2005
Place: Kaiko Knolls lava field, Japan Trench oceanward slope;
39° 23.78' N, 144° 26.30' W
Pilot: Kazuki Iijima
Co-pilot: Hirofumi Ueki
Observer: Naoto Hirano (Tokyo Institute of Technology)

Abstract

The dive track began at the cliff of horst and graben in the Japan Trench. The target knoll in the Kaiko Knolls lava field is truncated by the normal fault of this cliff and has approximately 180 m high on the terrace above this cliff. *Shinkai6500* firstly went north along this cliff on 6500 mbsl level. We observed the two type-lavas, vesicular lavas and close-packed lavas, which may be lavas of the knoll and flood lavas of the base of lava field, respectively (e.g. Dredged rocks on the KR03-07 cruise).

After flying to the concave part of northward culdesac by ridges of the knoll from the cliff, *Shinkai6500* climbed the knoll to the top. The hill-side of the knoll forms some lobate lavas coating the manganese in the pelagic sediments. Lavas were also strongly vesicular.

Purposes of Dive

The Kaiko Knolls lava field was discovered during the KR03-07 cruise. In this lava field, the bathymetric map shows WNW-ESE alignments of knolls. The back-scan images show the high reflectivity of the knolls and along the normal faults of horst and graben, which would be young lavas composed of some sheeted lava flows underneath volcanic edifices (knolls). Knolls of amoeba-like shape are the vents of younger volcanism in the Kaiko Knolls lava field. The purposes of this dive are to assess and observe the characteristics of flood lavas and knolls. In addition, it is important to understand petrological and geochemical characteristics of the two lava types in the Kaiko Knolls lava field.

Payload

2 – sample baskets
1 – sample container with lid
2 – push corers
1 – "Fujikuda"-type scoop
1 – marker

Dive Plan

Dive #880 mainly has two target areas in the occurrences of the Kaiko Knolls lava field. First target area is cliffs along the normal fault truncating the knoll, approximately 6500 m in depth. The landing point is as deep point as possible at the cliff. Dive is planned to start going along the 6500 m in level and continuously sampling along the cliff, which may be composed of the flood lavas underneath the knoll, plagic sediment of post young lavas and oceanic basement. In the boundary area between the younger knoll and the older flood lavas, it is important to understand the relationship between those. After the observation of cliff and sampling, the dive subsequently flies and goes to the southern root of the knoll at full speed.

The second part of dive is at the southern bottom of knoll. Lava and push core are sampled. The dive ascends to the top of the knoll. Continuously some samples also are taken place from bottom to top of the knoll. We should understand some differences of the occurrence, rock type, and vesicularity of rock.

The targets of this dive were:

- ✧ To assess and observe the nature and composition of two types of lavas; 1. dense basalts of flood lavas truncated the normal fault, and 2. highly vesicular lavas from the knoll, which have confirmed in the previous dredges.
- ✧ Continuous sampling from lower to upper parts of knoll.
- ✧ To observe the flood lavas typical of the Kaiko Knolls lava field and to confirm the thickness of pelagic mud deposit overlying flood lavas.
- ✧ To observe the nature of a knoll, especially the differences from the flood lavas.

Video Highlights

(1) 11:40 on the bottom (camera #1, #2)

Steep cliffs. This is near the sampling points of R-001A-D, R-002A-E.

(2) 11:42 (camera #2)

Nice sheeted lavas in the brecciated outcrops. We can confirm the horizontal direction of lava flows.

(3) 11:42 (camera #2)

Sampling 5 rocks of R-001A-D and R-002A.

(4) 12:04 34” (camera #1)

A truncated pillow or lobe in the brecciated outcrop.

(5) 12:06 (camera #1 and #2)

Sampling 4 rocks of R-002B-E.

(6) 13:01 (camera #2)

Sampling 4 rocks from the white-colored and hard floor into the soft pelagic

(7) 13:08-38

Flying to the next site.

(8) 13:49 (camera #2)

Sampling Push Core#1 (red).

(9) 15:58 (camera #1 and #2)

White and slightly (?) hard mudstone in the soft mud floor.

(10) 14:02 (camera#1 and #2)

Probably Mn-coated lobate lavas.

(11) 14:06- (camera#1 and #2)

Baked mud of the bottom of lobate lavas with some white and hard mudstone.

(12) 14:32 (camera#2)

Sampling some fragments (4 rocks) of R-004.

(13) 14:44-46 (camera #2)

Sampling 1 rock of R-005.

(14) 14:55 (camera#1)

Sampling 1 rock of R-006.

Summary of Dive Operation

Steep cliffs along the normal fault

The dive track began at the cliff of horst and graben in the Japan Trench. The target knoll in the Kaiko Knolls lava field is truncated by the normal fault of this cliff and has approximately 180 m high on the terrace above this cliff. *Shinkai6500* firstly went north along the perpendicular cliff on 6500 mbsl level. Outcrops were highly brecciated. Some sheeted lavas were partly observed. Although some outcrops were composed of blackish and reddish-brawny parts and were sampled each, we sampled quite similar 9 rocks (R-001A, B, C, D and R-002A, B, C, D, E). Slopes of cliff became mildly to the north and soft mud deposited. Before the flying to the main part of the knoll, we observed another type of lavas and sampled 4 rocks (R-003A, B, C, D), which were dense basats like almost rocks of the KR04-08 D02 (KR04-07 Onboard Report). Therefore, these rocks may be underlying lava flows of the knolls.

Climbing the knoll

After the observation of cliff and sampling, the dive subsequently flies and goes to the southern root of the knoll at full speed. Seabeam map shows some limbs from the center of knoll, which are two northward limbs, one westward limb and two southward limbs. The eastward limbs may also lengthen to the graven below the normal fault. *Shinkai* arrived at southern bottom of the knoll, the northward culdesac by ridges (limbs) of the knoll. One push core are sampled (PC#1 red). After starting to climb the mountain, we observed outcrops of the lobate lavas, which may be coated by manganese because some lobes were big.

Lavas were also strongly vesicular coated by thick manganese.

Sea cucumber

This dive site was observed too many holothurian (sea cucumber, sea slug) in the almost part of the dive track without the cliff site. They seemed to give the back to windward to the bottom current.

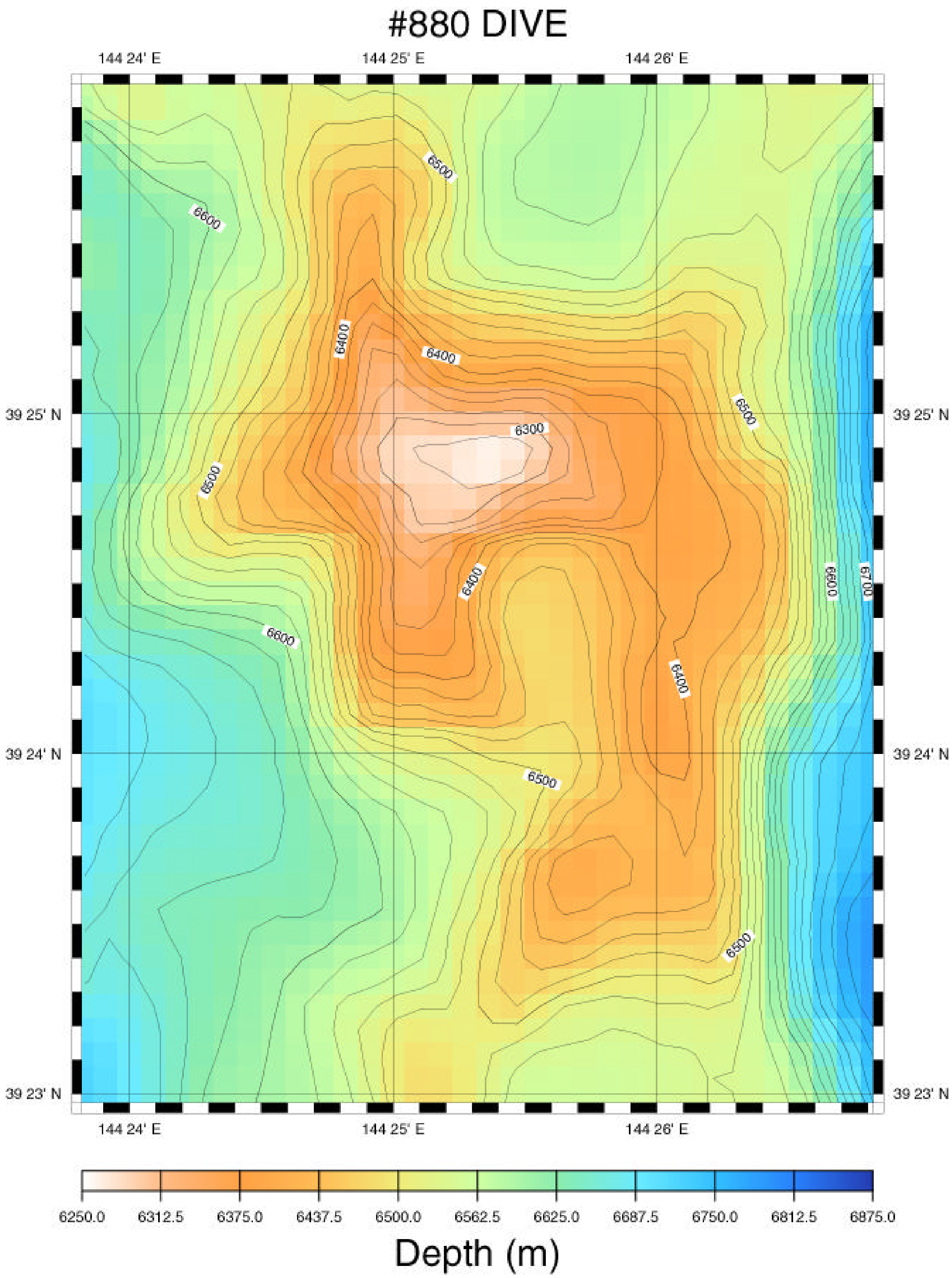

Figure 5-1-4-1. Detail bathymetric map around the dive#880 site. This knoll is most big mountain in the Kaiko Knolls lava field.

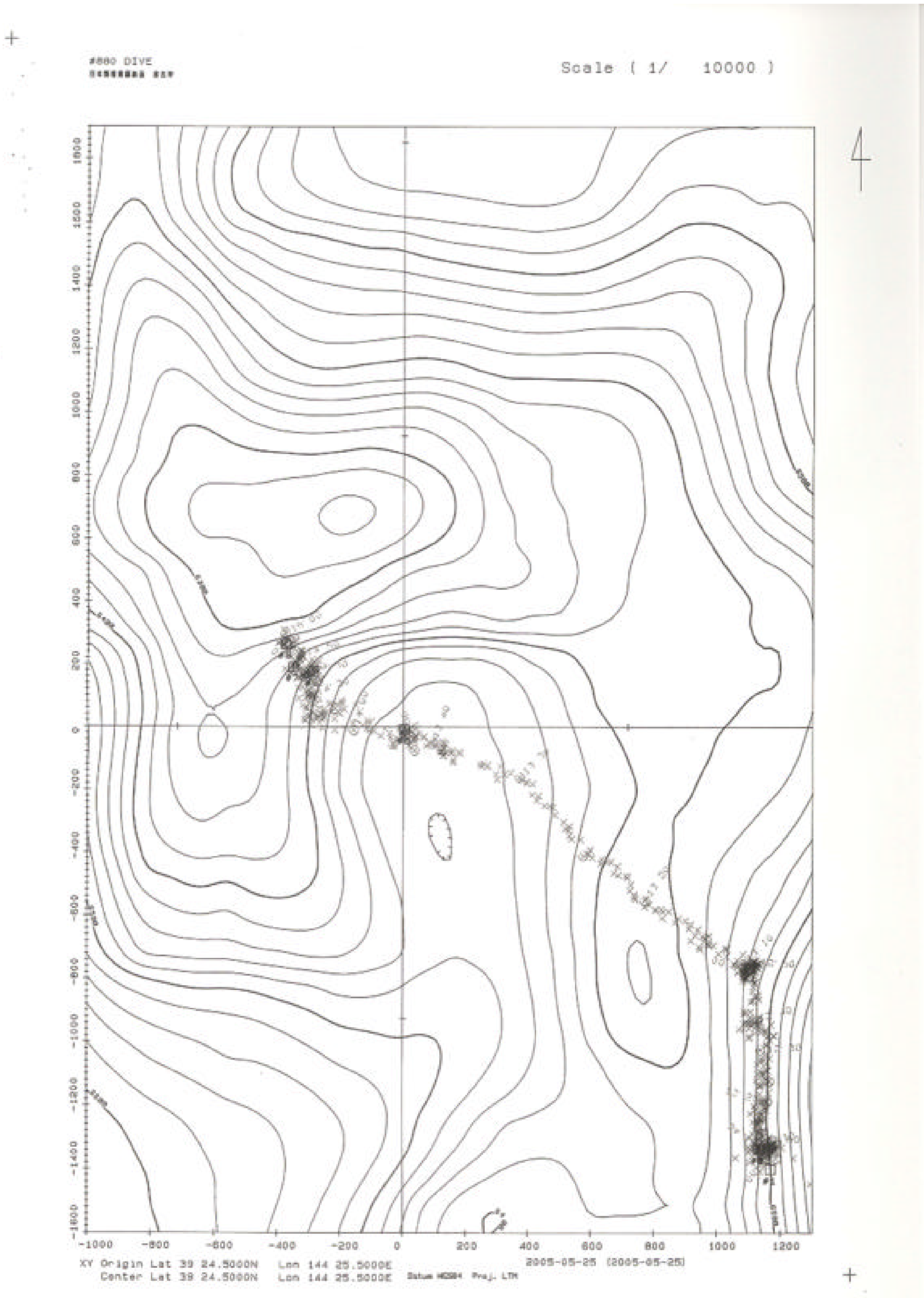

Figure 5-1-4-2. 6K#880 dive track on the 20 m contour map.

5-2. OBEM Deployment **by Ichiki & Baba**

In the YK05-06 cruise, we deployed 6 OBEMs and figure 5-2-1 shows the locations where OBEMs were deployed. Table 5-2-1 represents the information of the location where deployments were carried out. Furthermore, figure 5-2-2 shows the bathymetry contour maps beneath deployed positions, which were revealed by the multi narrow beam in this cruise. The all deployments were successfully finished up to 18th May, 2005 in JST. As is described in the chapter 1-3-6, to elucidate the local to regional electrical conductivity distribution beneath the Yukawa-knoll is the most important target and the 5 OBEMs, which are NWP0502 to NWP0506, will allow us to reveal the conductivity distribution. Four of them will be recovered after about 3 months' observation in the KR05-11 cruise. While the 2nd target, which is the semi-global to global deep mantle conductivity distribution exploration, is revealed by NWP0501 and NWP0502 data. The 2 OBEMs will be recovered after 1 year's observation in another cruise, next year. Just after each deployement, we confirmed each OBEM's sinking by measuring slant ranges with acoustic communications. Those observation logs can be seen in the A.8. The acoustic communications were very fine at each site. However, we did not wait the settlement on the seafloor of each OBEM and did not carry out "three-point calibration" owing to saving the ship time. The three-point calibrations will be performed in the KR05-11 cruise.

All electrodes used here are WHOI-type manufactured by Clover Tech. Inc. Thirty electrodes (5 electrodes x 6 OBEMs) from 38 electrodes were selected after aging test during about 10 days. Figure 5-2-3 shows the result of the aging test, in which one electrode were used as the common. In the aging test, sea water near the JAMSTEC pier was used. Considered the different nature of local sea water, measurements start after several days from deployment in order that the electrodes take time to come to equilibrium to surrounding seawater. Sampling intervals are fixed at 60 seconds. Table 5-2-2 lists the time table of the OBEM observation. For the 4 OBEMs to be used in the short duration observation, the additional lead weights were attached because of the shortage of sinking force by little amount of battery (Plate 5-2-1). We list the information of the radio beacons, flushing lights, and acoustic release system mounted on each OBEM in Table 5-2-3. The vendor of the all radio beacons and the flushing lights are Novatech Inc.

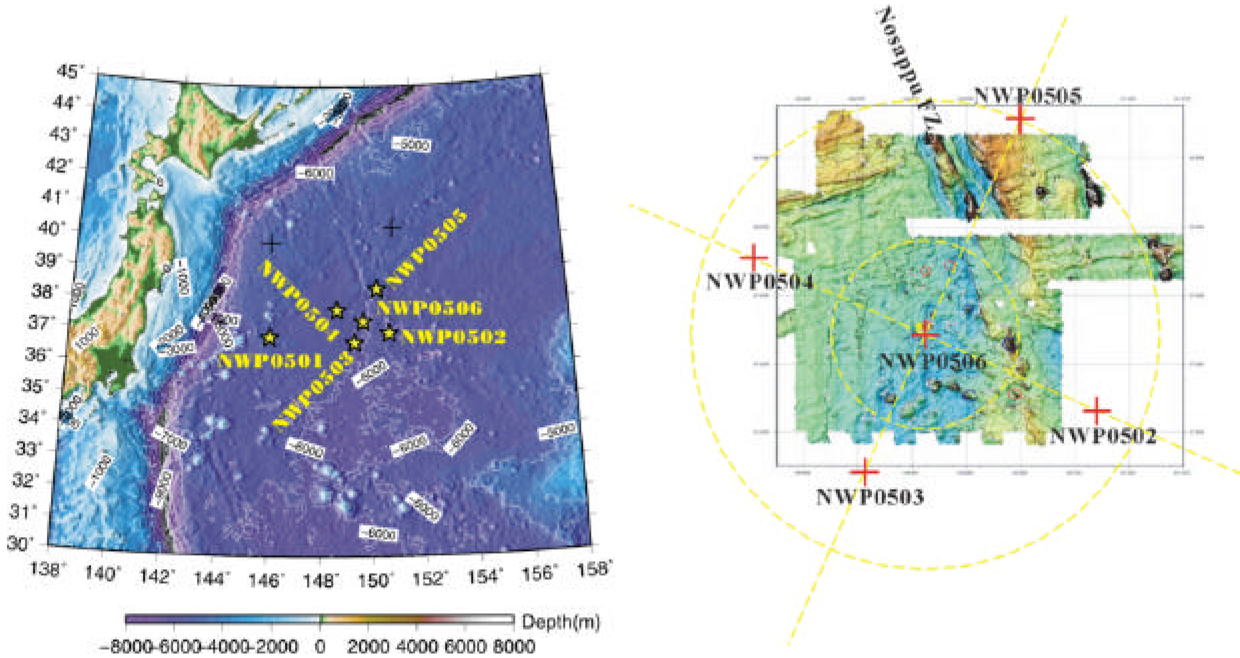

Figure 5-2-1. OBEM deployed position superimposed on the bathymetry map. Nosappu FZ means Nosappu fracture zone.

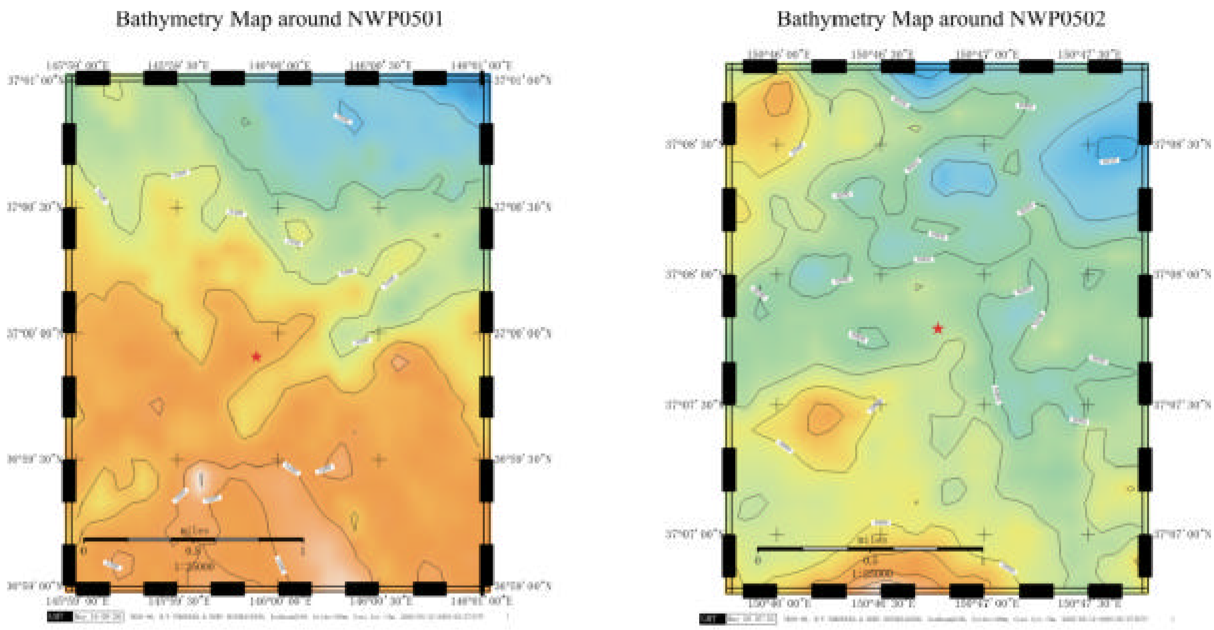

Figure 5-2-2. Six OBEM deployed positions superimposed on the bathymetry map revealed by the multi-narrow beam in this cruise.

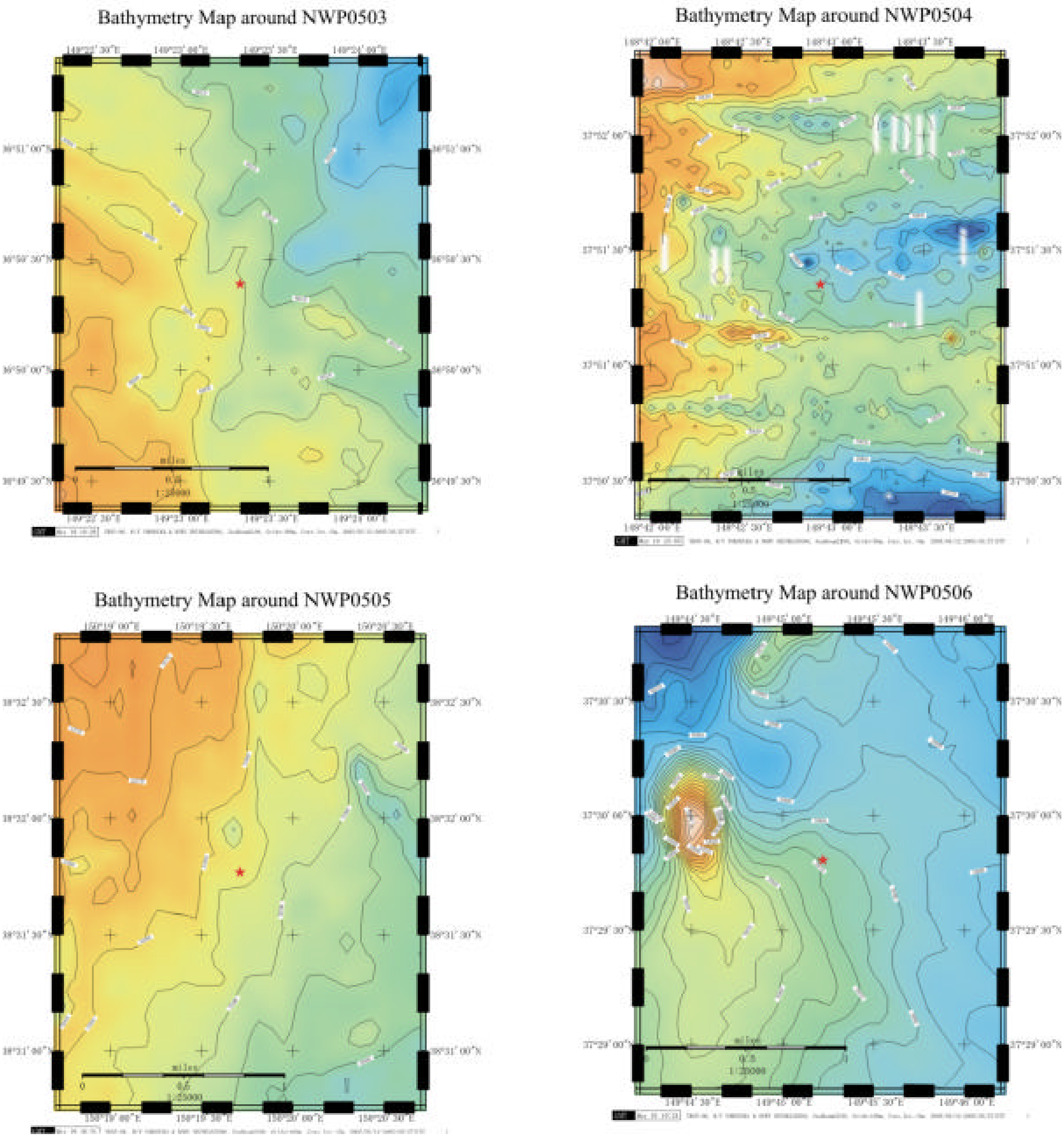

Figure 5-2-2. Continued…

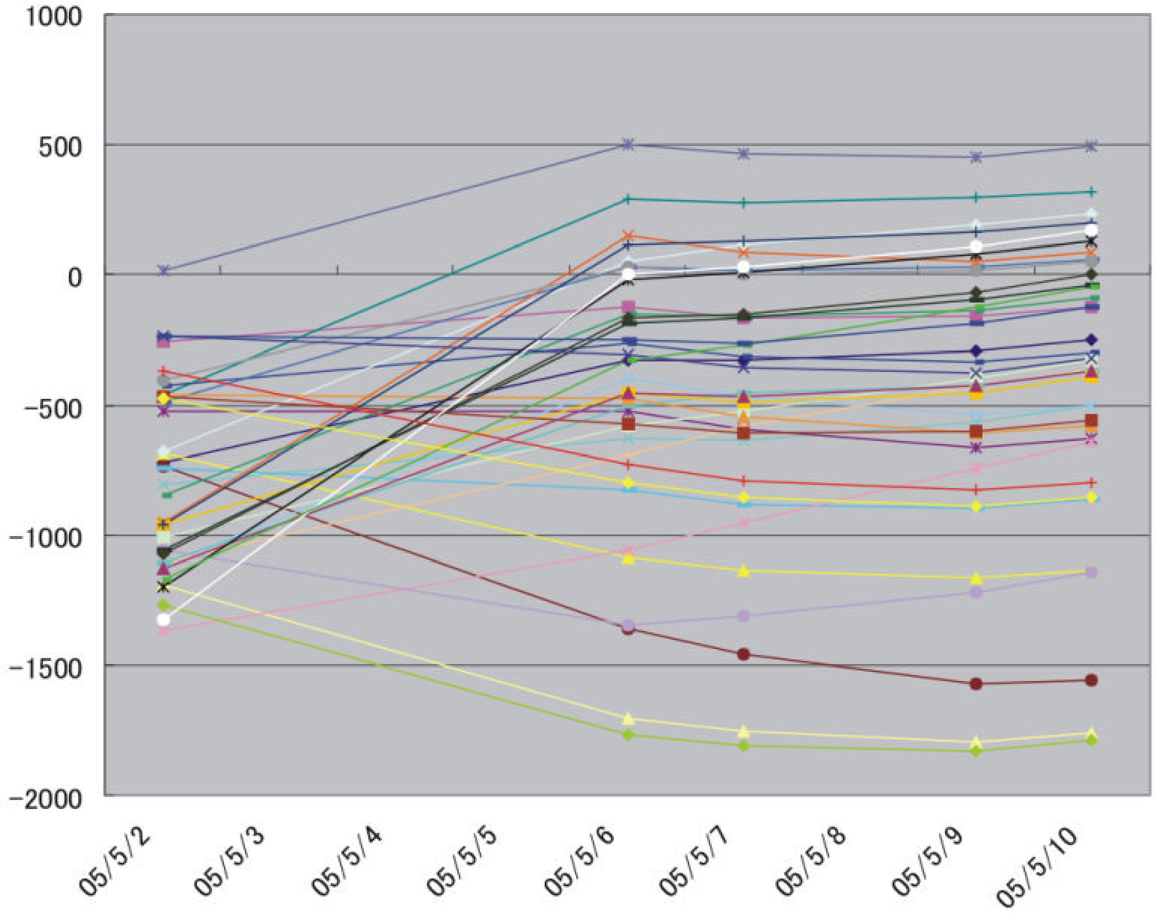

Figure 5-2-3. Aging test of the electrodes. Number of all electrodes are 38. The common electrode's ID was 0503044. The unit of vertical axis is micro-volts. The aging test started on 2nd, May, 2005. Each 5 electrodes were selected on the day before the deployment day.

Table 5-2-1. Deployed positions and the depth beneath the positions

Site Name	OBEM ID	Deployed position (WGS-84)		
		Latitude	Longitude	Depth
NWP0501	JM6	N36°59.91'	E145°59.89'	5590m
NWP0502	JM5	N37°07.7894'	E150°46.7174'	5993m
NWP0503	JM2	N36°50.3875'	E149°23.3335'	6006m
NWP0504	JM4	N37°51.3508'	E148°42.9327'	5848m
NWP0505	JM1	N38°31.7691'	E150°19.7083'	5575m
NWP0506	TT8	N37°29.8059'	E149°45.2235'	5971m

Table 5-2-2. Observation parameters

Site Name	OBEM ID	Setting Time (UTC)	Start Time (UTC)	Sampling Int. (sec.)	Dipole Length N-S/E-W (m)	Planned Duration
NWP0501	JM6	2005.05.12 09:35:00	2005.05.22 00:00:00	60	5.22/5.22	1 year
NWP0502	JM5	2005.05.17 10:36:11	2005.05.22 00:00:00	60	5.21/5.21	1 year
NWP0503	JM2	2005.05.14 09:33:14	2005.05.22 00:00:00	60	5.31/5.28	2.5 months
NWP0504	JM4	2005.05.15 04:04:03	2005.05.22 00:00:00	60	5.22/5.22	2.5 months
NWP0505	JM1	2005.05.17 07:35:00	2005.05.22 00:00:00	60	5.27/5.27	2.5 months
NWP0506	TT8	2005.05.14 08:46:50	2005.05.22 00:00:00	60	5.25/5.25	2.5 months

Table 5-2-3. Information of the flushing light, radio beacon, and acoustic release system for OBEMs

Site Name	OBEM ID	Flashing Light	Radio Beacon		Acoustic Release System	
			Frequency	Code	Vender	Release Code
NWP0501	JM6	mounted	43.528MHz	JS12-030	Kaiyo	2C-3 (Tx14.5kHz Rx:10.563kHz)
NWP0502	JM5	mounted	43.528MHz	JS12-031	Kaiyo	1B-3 (Tx:14.5kHz, Rx:11.029kHz)
NWP0503	JM2	mounted	43.528MHz	JS12-028	Kaiyo	1C-1 (Tx:13.501kHz, Rx:11.029kHz)
NWP0504	JM4	mounted	43.528MHz	JS12-033	Kaiyo	1A-2 (Tx:13.501kHz, Rx:11.029kHz)
NWP0505	JM1	mounted	43.528MHz	JS12-032	Nichiyu	3-H
NWP0506	TT8	mounted	43.528MHz	JS12-029	Nichiyu	3-F

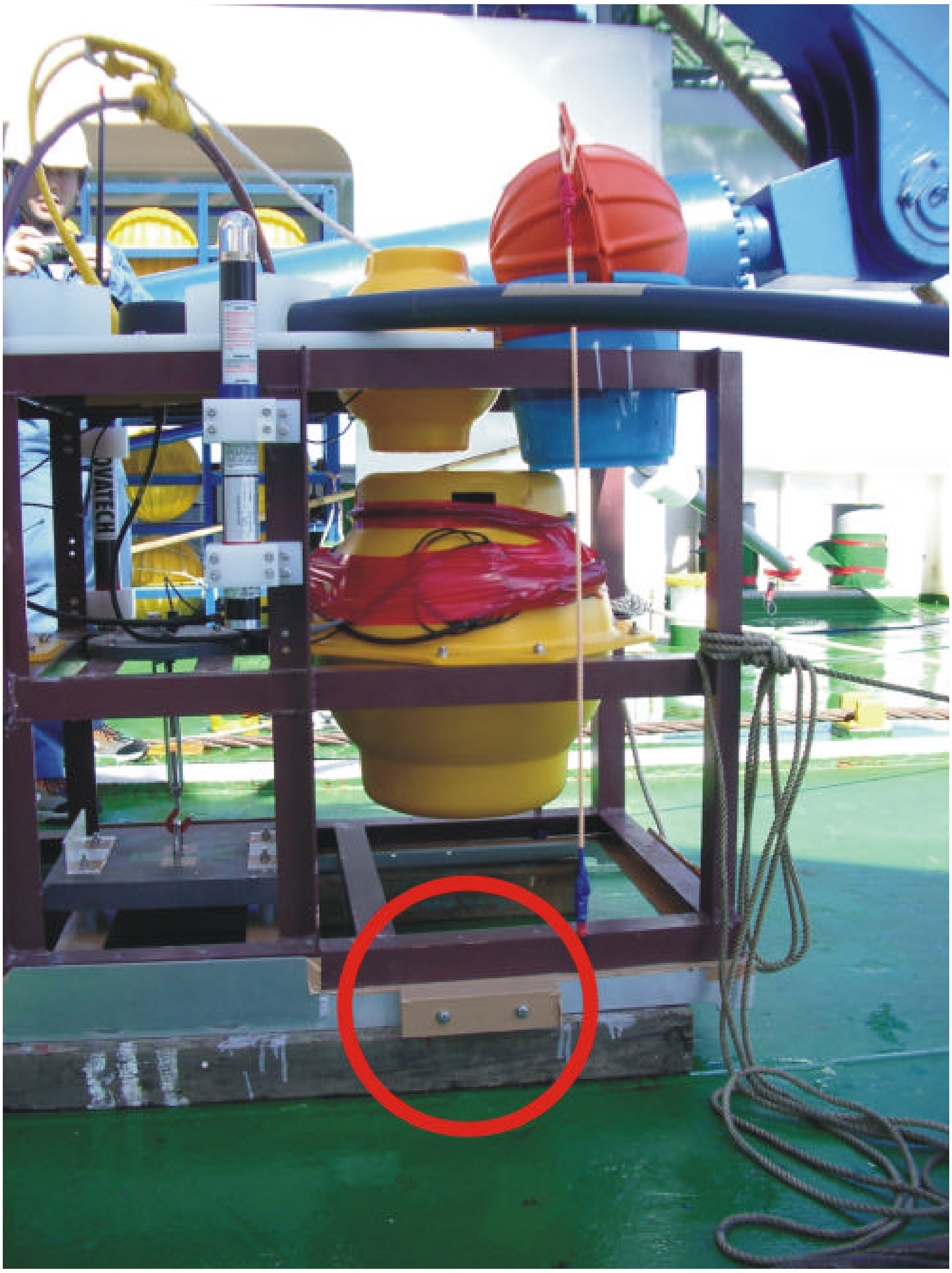

Plate 5-2-1. Additional weight settlement. The weight is attached in the side of the glass sphere for the battery and the recovery buoy.

5-3. Single Channel Seismic Reflection

by Fujiwara, Ichiki, Baba & Kodera with NME

During the YK05-06 cruise, single channel seismic (SCS) reflection surveys were conducted on May 21st and 22nd. The survey was intended to reveal the subsurface structure of small knolls in the B-area. The survey lines are shown in Figure 5-3-1 and Table 5-3-1. Lines of 4-5 nautical miles in length cross at the small knolls. The green cross in Figure 5-3-1 was situated at the Yukawa Knoll, and the yellow cross was at the North Yukawa Knoll (tentative). The cross tracks were designed to run along the long- and short-axis of the knolls to evaluate their volume accurately, if the subsurface structure of the knolls were similar figures and conical. The survey tracks also passed small depressions which appear accompanied with the knolls (Figure 5-3-1).

Table 5-3-1. SCS survey plan.

Line A-B (Yukawa Knoll: NNW to SSE)			
	Start:	37° 31.85' N	149° 43.60' E
	End:	37° 28.10' N	149° 45.45' E
Line C-D (Yukawa Knoll: WSW to ENE)			
	Start:	37° 29.25' N	149° 42.15' E
	End:	37° 30.70' N	149° 46.95' E
Line E-F (North Yukawa Knoll: NW to SE)			
	Start:	37° 33.00' N	149° 43.30' E
	End:	37° 29.15' N	149° 47.20' E
Line G-H (North Yukawa Knoll: SW to NE)			
	Start:	37° 29.00' N	149° 43.50' E
	End:	37° 33.23' N	149° 46.82' E

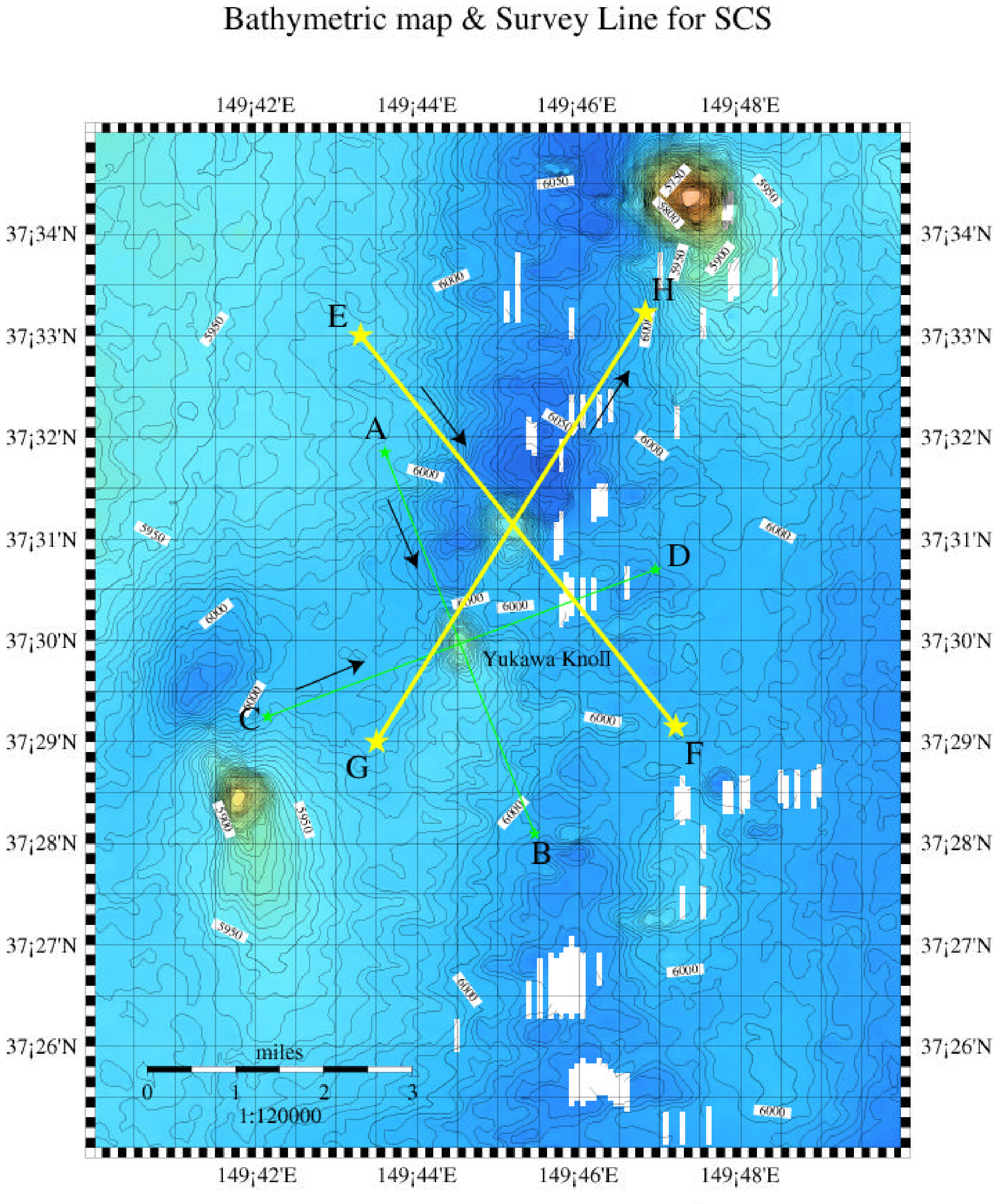

Figure 5-3-1. Ship tracks of the single channel seismic reflection survey. Arrows show the ship's direction of movement.

Survey ship speed was ~4 knots. A GI gun (G: 245 cu in., I: 105 cu in.) with air-pressure of 140 atm was used for a seismic source (See Section 4-2 for detail description of the observation). Shots were fired at a spacing of 60 m due to an air-compressor's capacity. Much shorter shot interval was needed to clarify such a small structure. Thus, the ship passed each line twice in the same direction of movement to compare or put together each other profile. Water depth of a hydrophone streamer towed behind the ship was set to ~7-10 m on May 21st survey, and the towing depth was changed to ~3-5 m on May 22nd because high frequency in wavelength was well preserved.

Figures 5-3-2 and 5-3-3 show seismic profiles of Line A-B (Yukawa Knoll: NNW to SSE) and A'-B' (second round) along long-axis of the knoll (Figure 5-3-1). Reflection patterns of the two profiles correlate well. Since the water depth is ~6000 m, the reflectors around 8.0 sec two-way travel time (TWT) are refections from the seafloor. These reflectors are weak in amplitude. The sediment layer, which is lying beneath the seafloor, is found to be transparent in the study area. Horizontally lying reflectors with weak amplitude are partly identified within the sediment layer. The sediment covers ~0.3 sec TWT, indicating sediment thickness of ~300 m. Around 8.3 sec TWT, reflectors with the strongest amplitude are commonly indentified (I-reflector hereafter). These reflectors are presumed to be reflections from top of oceanic igneous crust of the Pacific Plate. Around 8.2 sec TWT, strong reflectors are identified between the seafloor and I-reflector (II-reflector hereafter). These are probably reflections from volcanic edifices related to the Yukawa Knoll. These reflectors lie horizontally apart from the knoll.

In the portion between bottom of the depression and crest of the knoll (Shot no. ~74-86), both I- and II-reflectors are too unclear to distinguish. The portion is ~720 m in width. There is no strong reflector but relative weak reflector in series. Possible explanation is that this portion is opaque because of inhomogeneous in the sediment layer. Or, there is 3D-like reflective structure with steep scarps (ex. diapir, conduit, pipe, etc), thus the seismic waves scatter. I-reflector dips downward at the boundary between the clear and unclear distinguishable portions (Shot no. ~65-74, ~82-90). The strong reflectors lying horizontally are visible beneath I-reflector to the south of the knoll (right side in Figures 5-3-2 and 5-3-3).

Figures 5-3-4 and 5-3-5 show seismic profiles of Line C-D and C'-D' (Yukawa Knoll: WSW to ENE) along short-axis of the knoll. Throughout the survey, profile's patterns along the same line correlate well. The major reflectors identified in Line A-B are also identified. The extent of II-reflector is narrow compared to that in Line A-B. The reflector becomes shallow from 8.3 sec to 8.2 sec TWT toward the knoll.

The seismic patterns at the North Yukawa Knoll are similar to those found at the Yukawa Knoll (Figures 5-3-6, 5-3-7, 5-3-8, and 5-3-9). In addition, Note that Line E-F also shows that no strong reflector and a series of weak reflection zone is exsisting between the Yukawa Knoll and the North Yukawa Knoll.

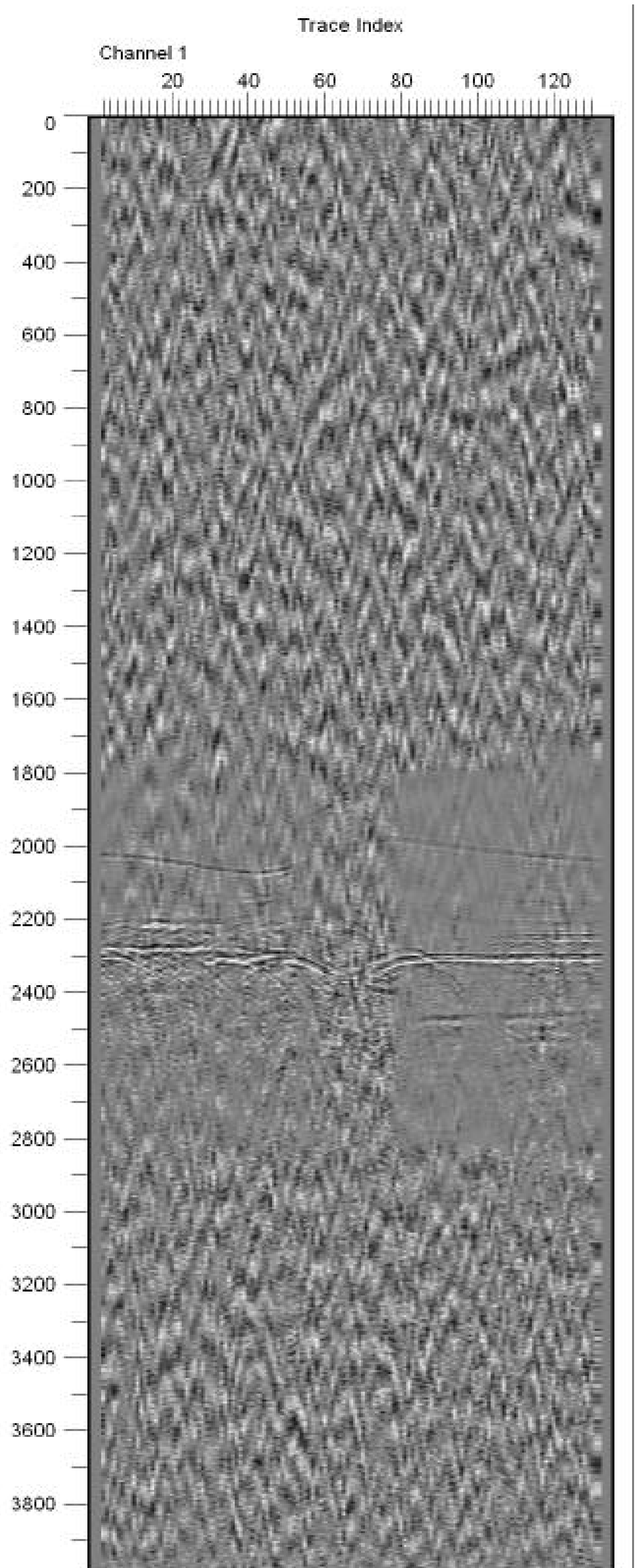

Figure 5-3-2. Seismic profile Line A-B. Vertical axis shows two-way travel time (msec). 6000 msec is subtracted from true TWT.

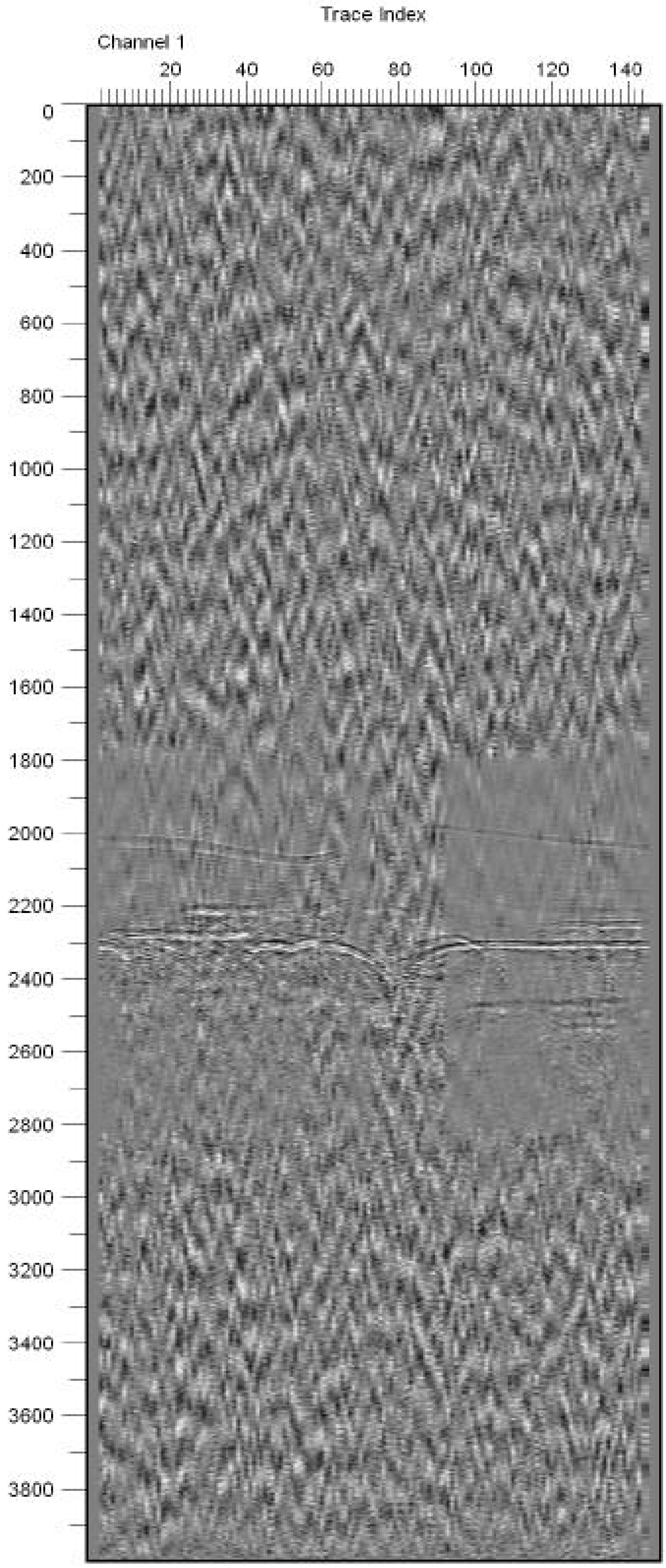

Figure 5-3-3. Seismic profile Line A'-B'.

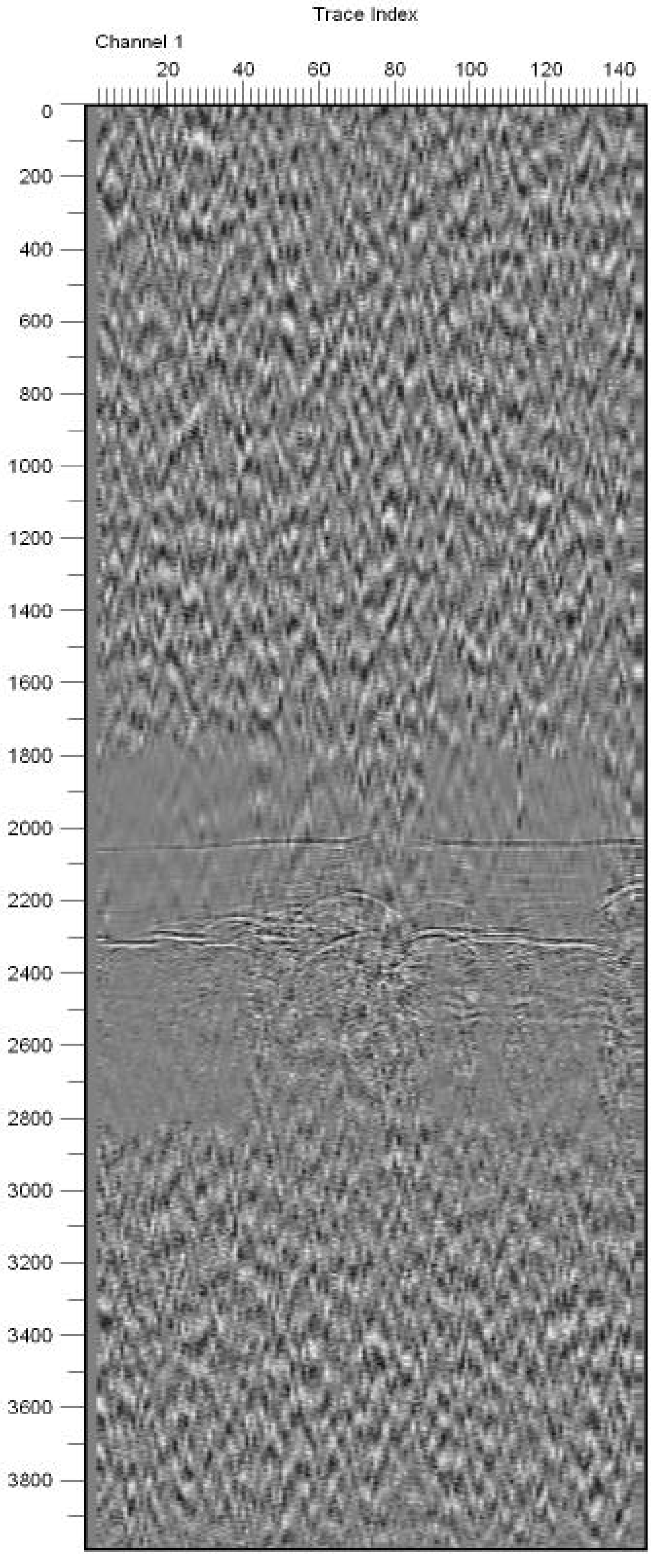

Figure 5-3-4. Seismic profile Line C-D.

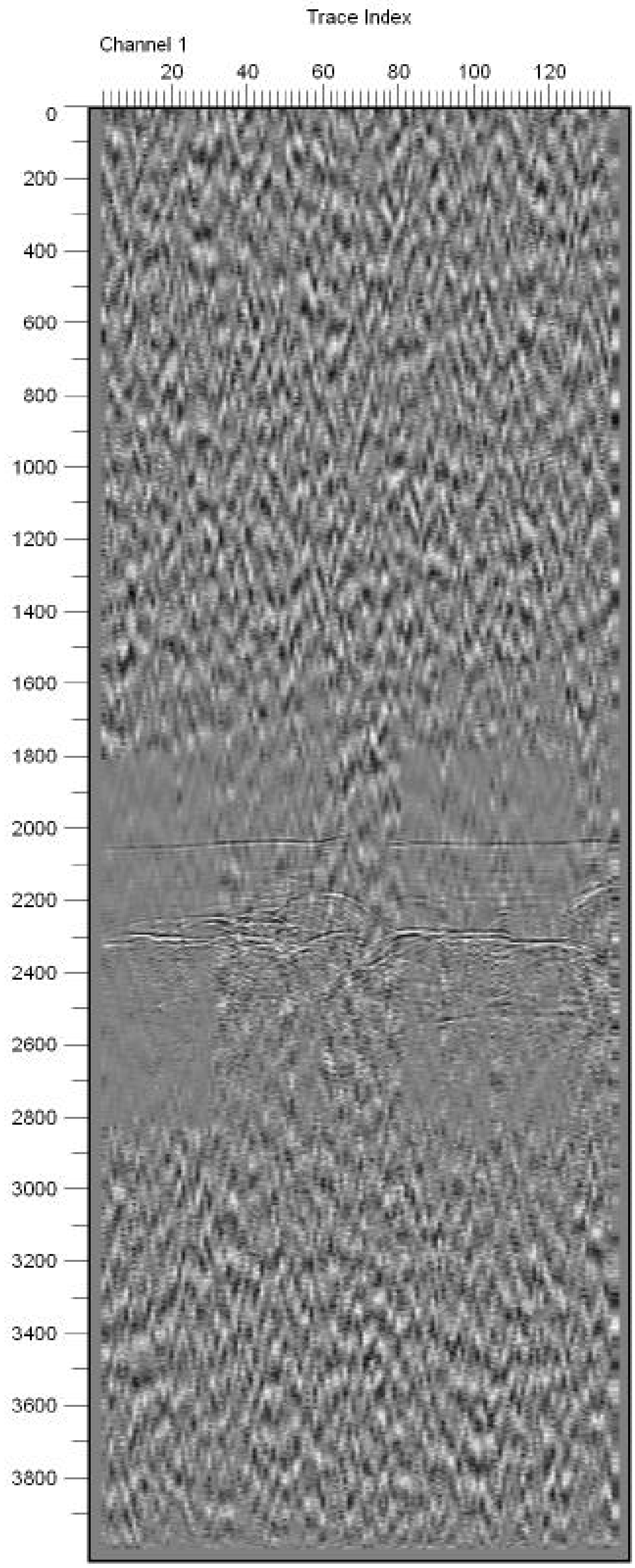

Figure 5-3-5. Seismic profile Line C'-D'.

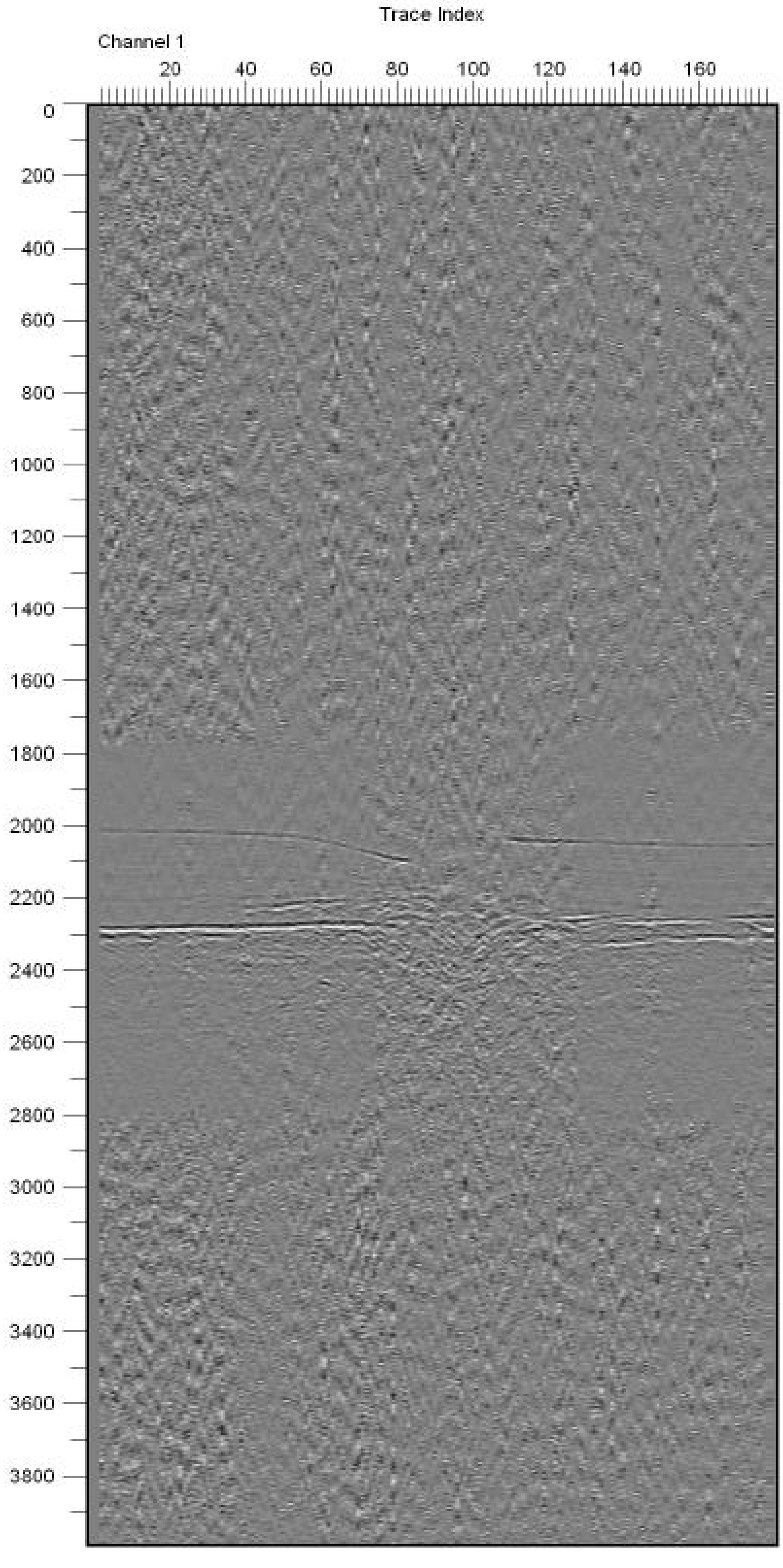

Figure 5-3-6. Seismic profile Line E-F.

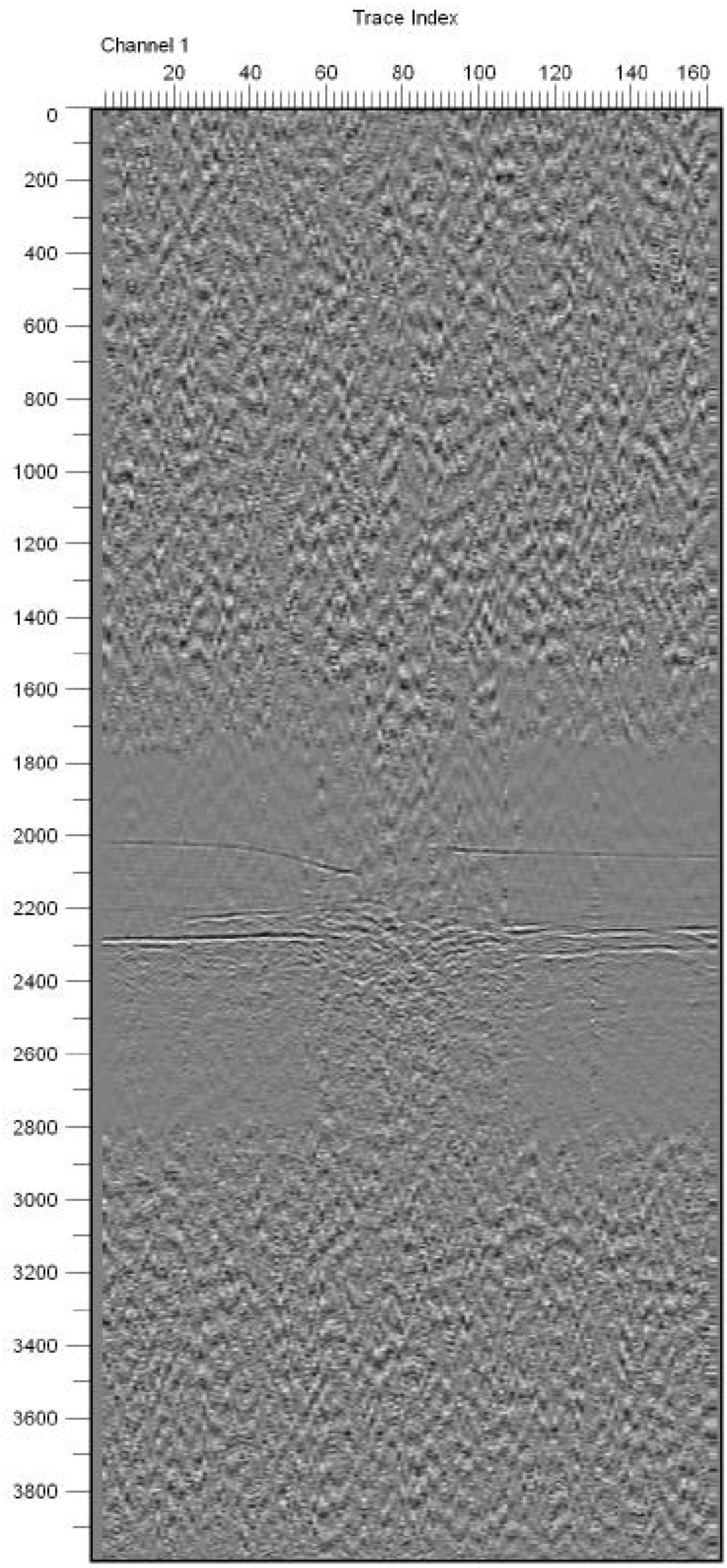

Figure 5-3-7. Seismic profile Line E'-F'.

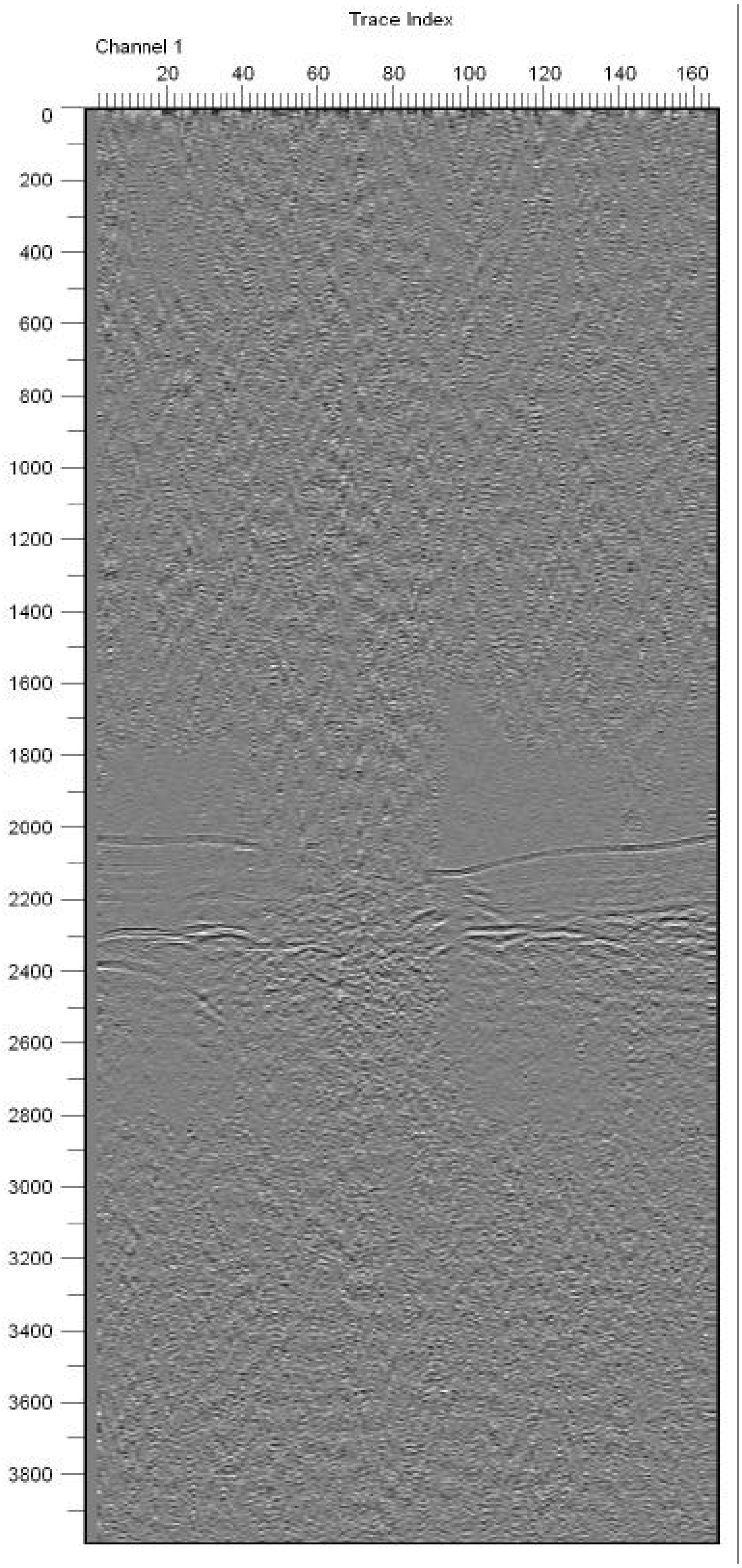

Figure 5-3-8. Seismic profile Line G-H.

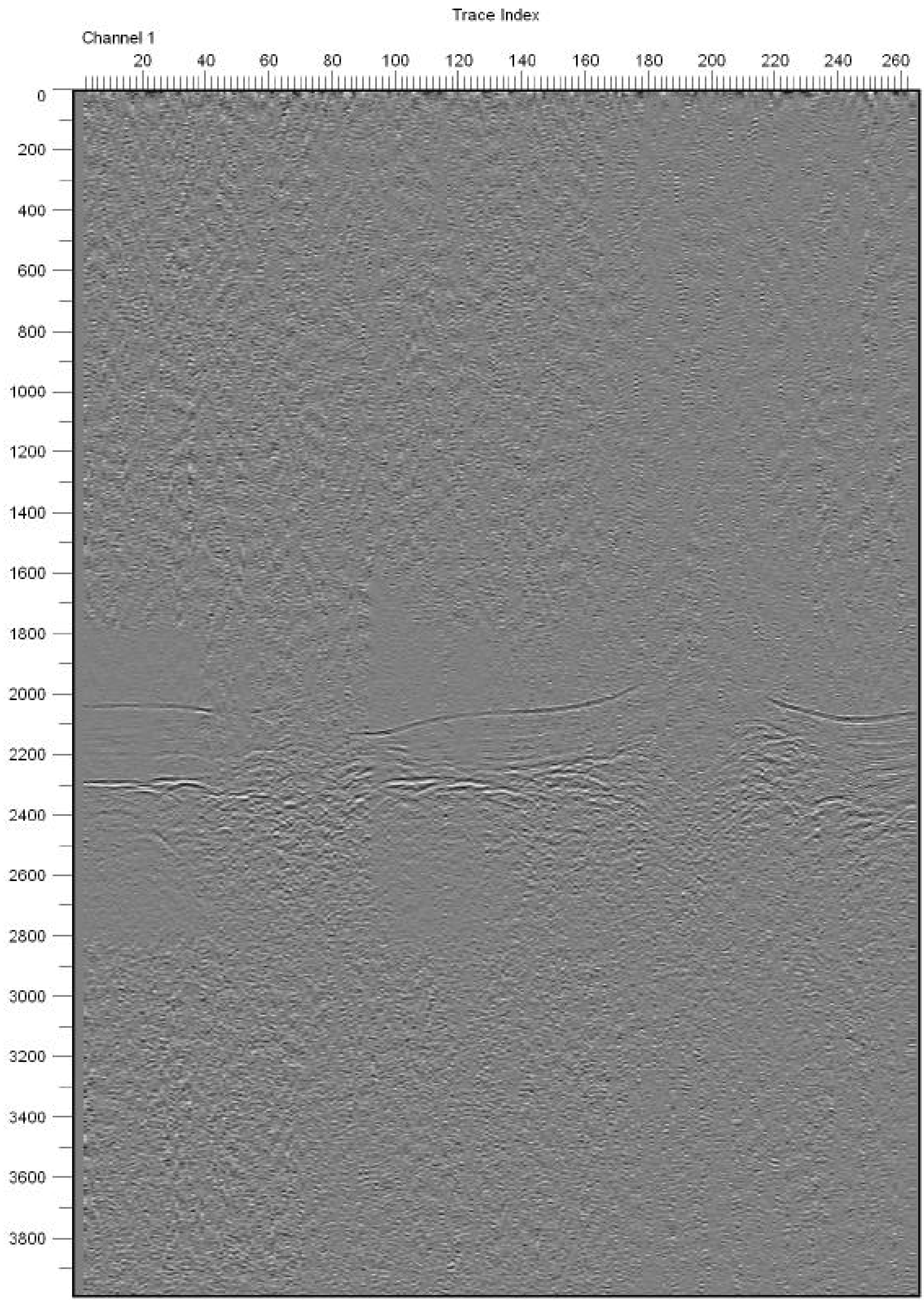

Figure 5-3-9. Seismic profile Line G'-H'.

Seismic profiles are interpreted as follows based on commonly-observed features (Figure 5-3-10). Volcanic material is abundant in the sediment layer beneath the knoll but not centered at the crest. This is distributed in the narrow zone suggesting fissure eruption. Oceanic crust is depressed there. The volcanic material is lying horizontally on the oceanic crust to limited extent apart from the knoll.

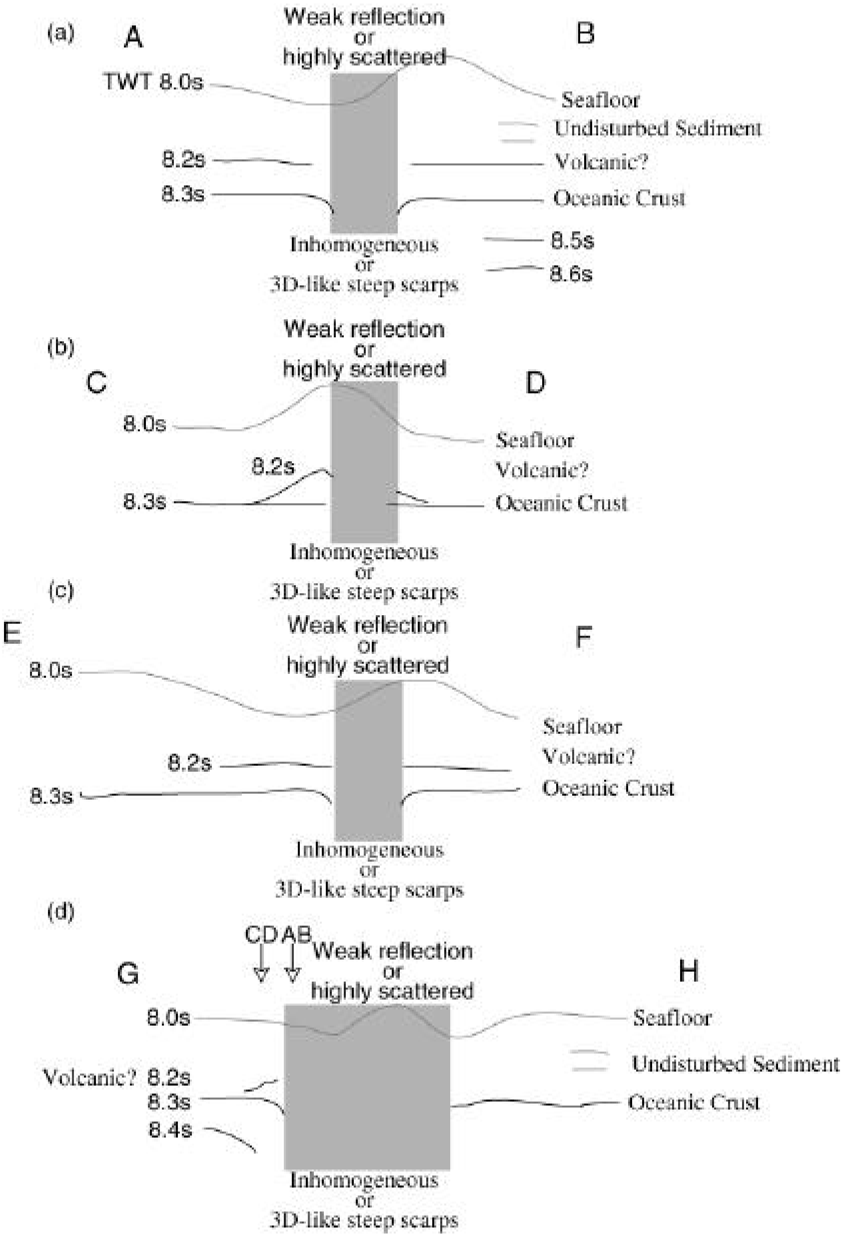

Figure 5-3-10. Interpretations of the seismic profiles. (a) Line A-B (Yukawa Knoll: NNW to SSE). (b) Line C-D (Yukawa Knoll: WSW to ENE). (c) Line E-F (North Yukawa Knoll: NW to SE). (d) Line G-H (North Yukawa Knoll: SW to NE). AB and CD show the cross points at Line A-B and C-D, respectively. Note that shape and scale are inaccurate because of TF's poor ability in illustration.

5-4. Bathymetry

by Fujiwara, Hirano & Kodera

During the YK05-06 cruise, bathymetric survey using a SeaBeam 2112 was conducted throughout all the survey tracks (Figure 5-4-1). Survey ship tracks were designed to fill gaps of the previous bathymetric measurement in the KR03-07 and KR04-08. Unfortunately, due to bad weather conditions in the first half of the cruise, dramatically increase of data could not accomplished. Detailed survey was carried out over each submerisible's dive site and OBEM station. Measurements of the sound velocity profile in the water column using an expendable bathothermograph (XBT) were made at three stations (See Section 2-2). The multi-narrow beam echo sounder provides a detailed morphological characterization of the seafloor, which will be used to unravel tectonic evolution and crustal structure in the northwestern Pacific.

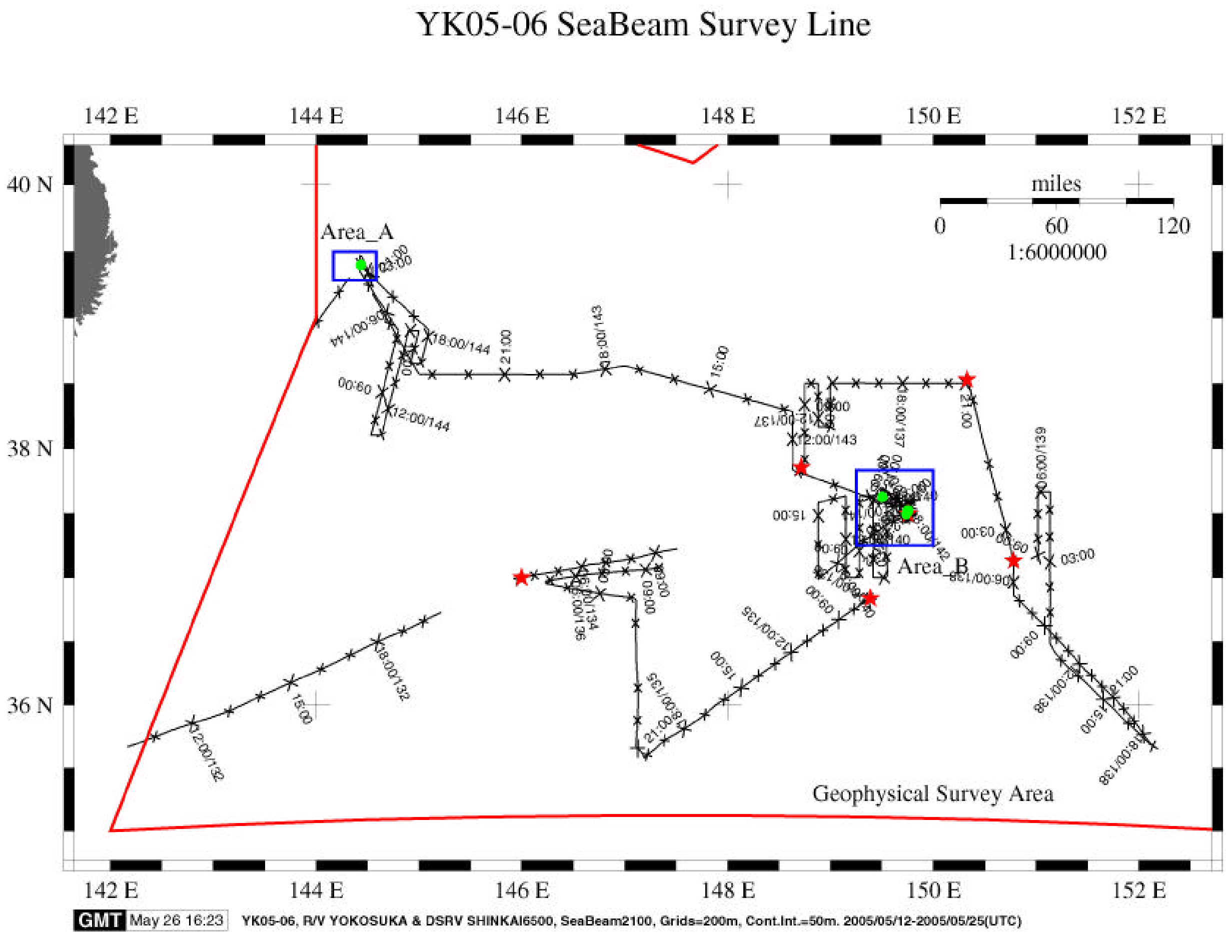

Figure 5-4-1. Ship tracks of the bathymetric survey. Red lines delineate the survey area in the YK05-06 cruise. Blue boxes indicate the Shinkai 6500 dive area and green circles indicate dive sites. Red stars show OBEM stations.

Figure 5-4-2 shows a bathymetric map in the B-area (around 150°E near the Yukawa Knoll). Also the morphology has been described in the previous cruise reports. The figure revealed detailed morphology of the Nosappu Fracture Zone proposed by Nakanishi [1993]. The fracture zone extends in the center of the survey area trending NNW-SSE direction associated with steep scarps and ridges. In the northern portion, linear seafloor fabric sub-perpendicular to the fracture zone was found on both sides of the fracture zone. The topographic fabric is sub-parallel to the magnetic lineation (See Section 5-5), therefore is inferred to be originated from a mid-ocean ridge where the oceanic crust was created.

In the southern potion, there is a triangle-shaped basin. The basin shows relatively high back-scatter intensity (Figure 5-4-3). Small knolls were indentified in the basin. These small knolls have a few kilometers in diameter and a few hundred meters in relative height. Most of the knoll associates a depression at the rim. One of the knoll is the Yukawa Knoll located at 37°30'N, 149°44'E. Very young (~0-1 Ma) volcanic rocks have been dredged on this knoll in KR04-08 cruise in 2004 [Hirano et al., 2005]. Three Shinkai 6500 dives were devoted to the Yukawa knoll (#877) and other knolls (#878, and #879) in this basin for the purpose of geological observation and rock sampling.

Newly obtained bathymetric data during the YK05-06 cruise are distributed to the southeast and to the northwast of the B-area (Figures 5-4-1 and 5-4-2). There already has been SeaBeam coverage in the southwest of the Yukawa Knoll, but the area was surveyed again for magnetic data coverage. Basically the newly obtained area shows continuation of the morphology previous described (Figure 5-4-2).

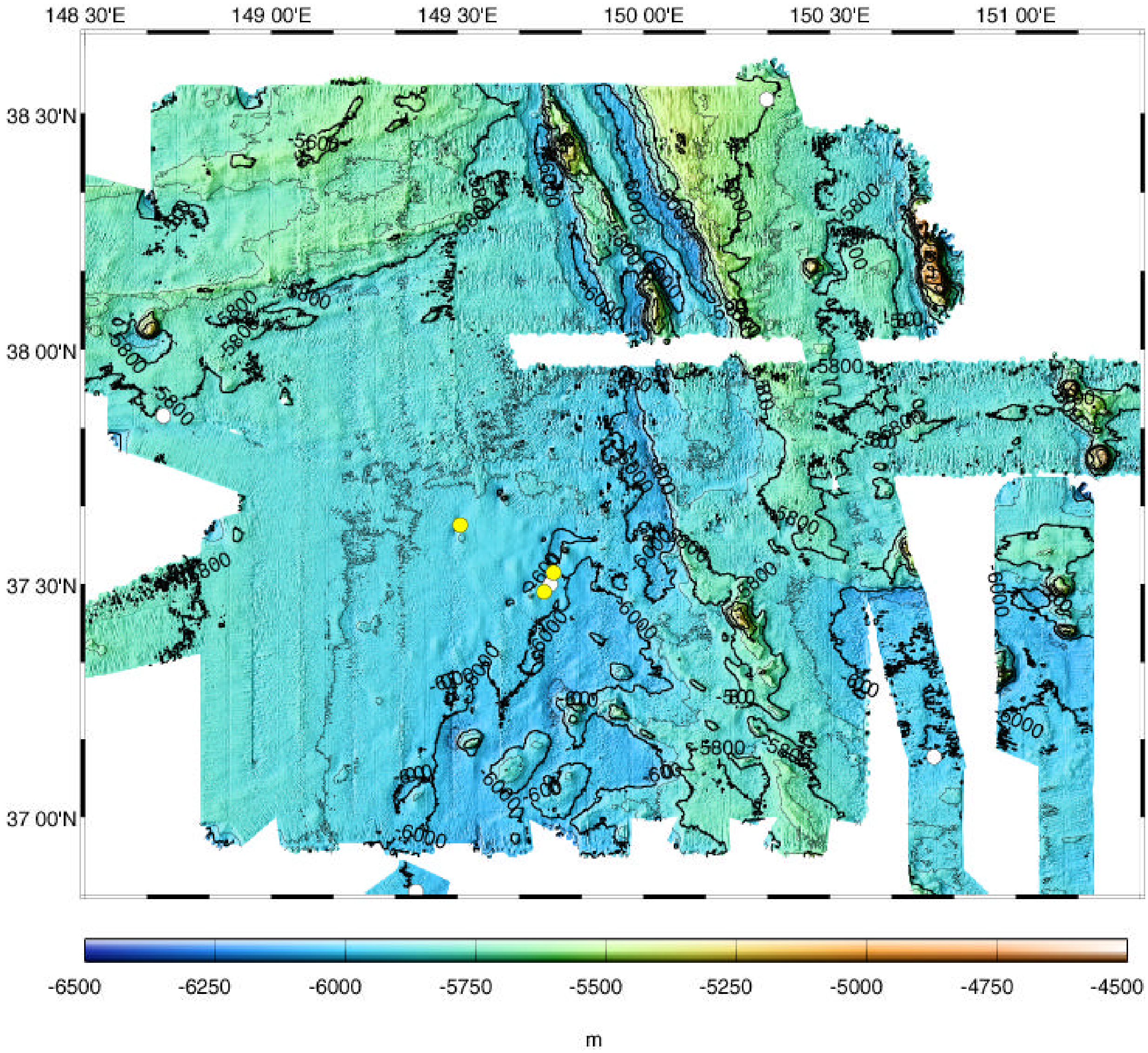

Figure 5-4-2. Bathymetric map of the B-area. Contour interval is 100 m. Yellow circles indicate Shinkai 6500 dive sites. White circles show OBEM stations.

Figure 5-4-3. Back-scatter image of the B-area. Dark color indicates high back-scatter intensity.

5-5. Magnetic Anomalies **by Fujiwara**

During the YK05-06 cruise, geophysical surveys, whose items included were gravity and geomagnetics, were conducted aboard the R/V Yokosuka. The aim of the geophysical surveys was to provide a detailed geophysical characterization of the lithosphere in the northwestern Pacific on and off-axis ridge flanks, which will be used to unravel tectonic evolution and crustal structure.

Geomagnetic total force data were obtained by using a surface-towed proton precession magnetometer PROTO10 (Kawasaki Geol. Eng. Co.). The sensor was towed 300 m behind the ship. The data were collected every 20 seconds in transit and at nighttime SeaBeam surveys. Due to bad weather conditions in the first half of the cruise, the magnetometer was towed only a few days (Figure 5-5-1). Survey ship tracks were designed to fill gaps of the previous magnetic measurement in the KR03-07 and KR04-08. After positioning correction taking into account the sensor cable length, the geomagnetic total force anomaly was calculated by subtracting the International Geomagnetic Reference Field (IGRF) 9th generation [IAGA, 2003] as the reference field.

Vector magnetic field data were collected using a shipboard three-component magnetometer, Tierra Tecnica SFG-1212. The data were collected with a sampling rate of 8 Hz throughout the cruise. "Figure-8 turn"s (a ship runs along an 8-shaped track consisting of two circles) were made for calibration of the ship's magnetic effect (Figure 5-5-1) [Isezaki, 1986]. The turns were made at two locations: (14th May 13:25-14:35 LT (GMT+10); 37°04'N, 146°14'E, 24th May 11:00-11:10 LT (JST); 39°11'N, 144°33'E). The IGRF 9th model was also employed as the reference magnetic field for calculation of vector geomagnetic anomaly and "Figure-8" calibration. Magnetic vector anomalies will be utilized to map the strike directions of lineated magnetic boundaries, which are commonly representing lithological boundaries, geomagnetic reversals, or topographic offsets of magnetized layers due to faults.

Figure 5-5-2 shows a magnetic total force anomaly map in the B-area (around 150°E near the Yukawa Knoll). The magnetic data used in this map were from YK05-06, KR04-08, and KR03-07 merged with data from the National Geophysical Data Center (NGDC). In this map, Japanese Lineations trending ENE-WSW is clearly identified. The Nosappu Fracture Zone offsets the oceanic lithosphere right-laterally by ~250 km. Crustal ages of the west side are estimated to be M15 (142 Ma)~ M13 (139 Ma). Crustal ages of the east side are estimated to be M12 (137 Ma)~ M11 (133 Ma). The age difference between the both sides is ~5 m.y.

Amplitude of the magnetic anomaly lineation in the east side of the fracture zone (> 500 nT peak-to-trough) is higher than in the west side (< 300 nT) (Figure 5-5-2). In consideration of paleo-ridge-transform geometry, the oceanic crust in the east side was created at outside corner, whereas the crust in the west side was created at inside corner of the mid-ocean ridge in the vicinity of the fracture zone. Thus, the magnetic anomaly amplitudal difference may be caused by preferential emplacement of extrusive basaltic layer to the outside corner. Extrusive basalts are known to be highly magnetized, and they contribute to a large part of the magnetic signal.

Petit-Spot rocks sampled in KR03-07 and KR04-08 were found that to have very high magnetization (~60 A/m) [Obi et al., 2004]. Petit-Spot may produce particular magnetic anomaly, if significant volume exists. However apparently, original magnetic lineation seems to be not disorganized by such newly erupted volcanism (around the yellow circles in Figure 5-5-2).

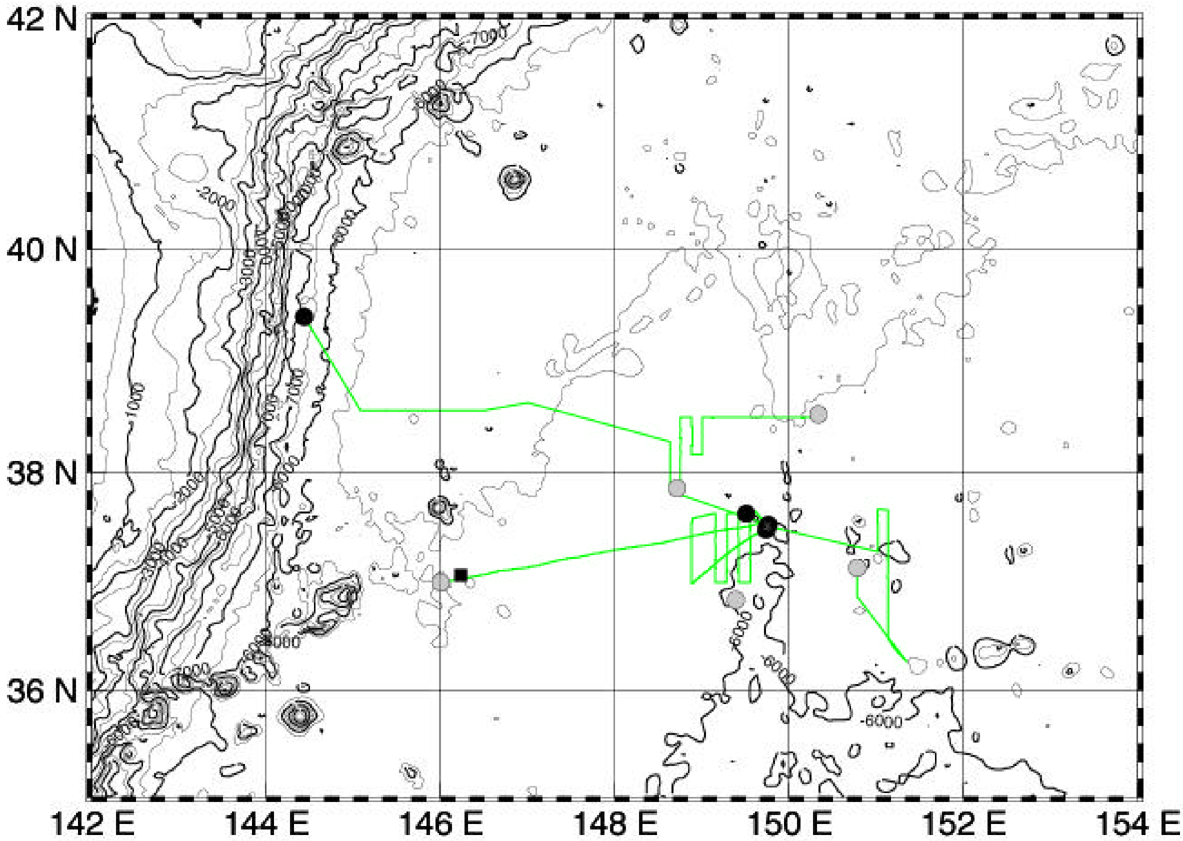

Figure 5-5-1. Ship tracks which total force magnetic data were obtained using a proton magnetometer measurement. Vector magnetic data were collected throughout all the survey tracks (See Figure 5-4-1). Black squares indicate locations of "Figure-8 turn". Black circles show Shinkai 6500 dive sites and gray circles show OBEM stations.

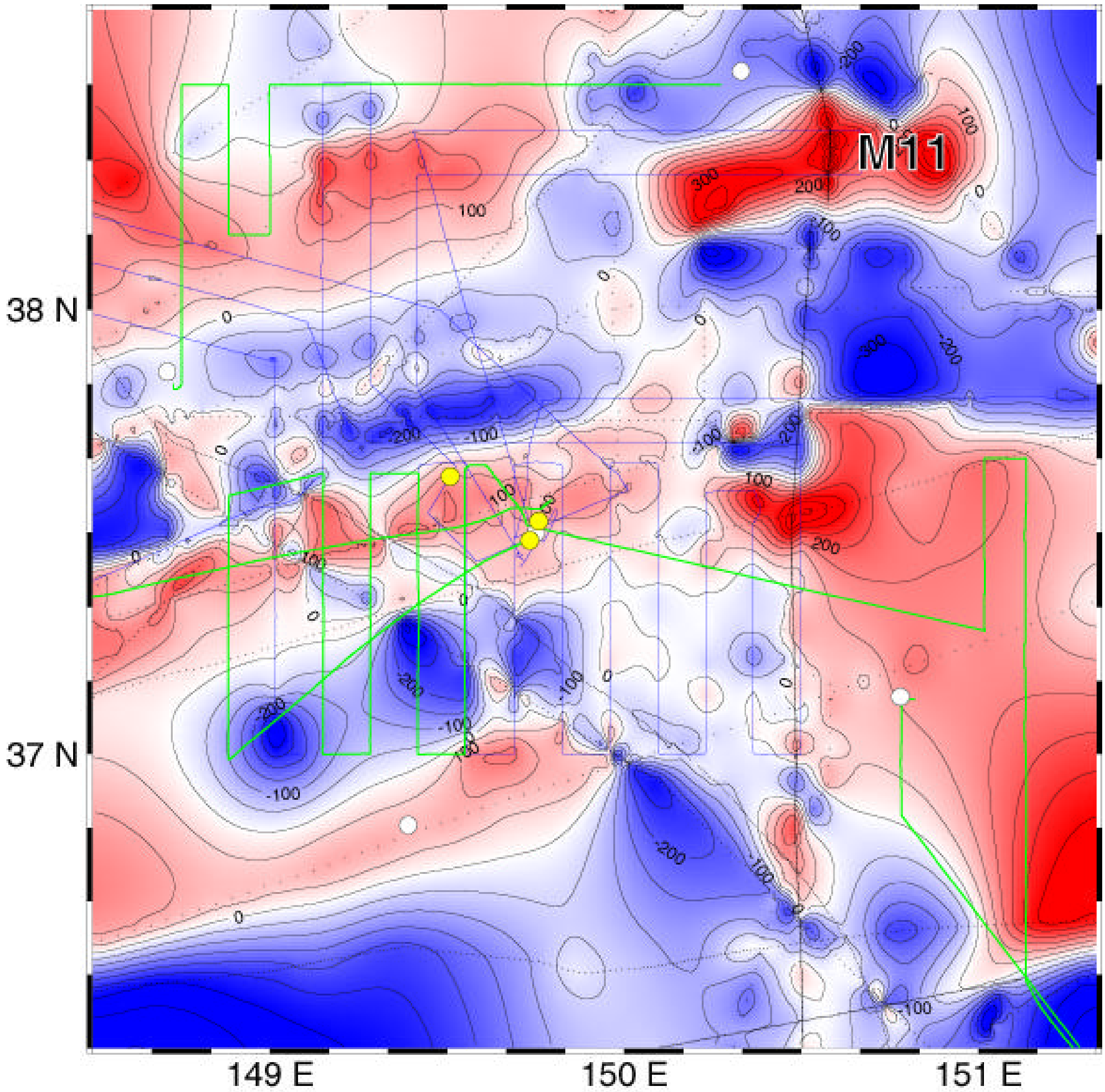

Figure 5-5-2. Magnetic anomaly map of the B-area. Contour lines are plotted every 50 nT. Red shade indicates positive anomaly and blue shade indicates negative anomaly. Green lines show ship tracks obtained in the YK05-06 cruise. Blue lines show the KR03-07 and KR04-08 ship tracks. Dotted lines correspond to ship tracks from NGDC data used in this compilation. Yellow circles mark Shinkai dives and white circles mark OBEM stations. White heavy white lines delineate the Nosappu Fracture Zone.

5-6. Gravity Anomalies **by Fujiwara**

Onboard gravity measurements were made using a LaCoste & Romberg S-63 air-sea gravity meter. The data were recorded every 1 minute, and were collected throughout the cruise. The system incorporates ship's position, speed, and heading through onboard LAN. The measured gravity value (10898.5 mGal) was tied to an absolute gravity value at the JAMSTEC pier in Yokosuka (979758.7 mGal) before departure. The "gravity tie" will be conducted again after arrival at the pier to estimate sensor drift of the gravity meter. Therefore, gravity data processing (readjustment of time difference, Etovos, drift, and reference gravity corrections) should be required onshore.

Shipboard gravity anomaly will be used for analysis of the crustal structure combined with bathymetry and seismic reflection data. Analysis of lithospheric flexure and deformation using satellite derived gravity anomaly combined with the shipboard gravity anomaly may be helpful.

6. Future Studies

6-1. Naoto Hirano

Eruptive styles on the Petit-Spot (Kaiko Knolls & eastern edge of Hokkaido Rise lava fields)

Investigation of the newly discovered lava fields on KR03-07 and KR04-08 cruises. Sampling will take place simultaneously as dive ascends and descends along each slope of high. An empty SAHF thermometer will be taken to test its ability to withstand pressures at nearly 6000 m depth.

Lavas are highly vesicular, despite 6 kbar hydrostatic pressure at eruption depth; this and the low viscosity of the lavas may form their peculiar morphology. We may observe collapsed structures of inflated pahoehoe lavas with botryoidal lavas located interstitially on the terrace below the flood lavas. The lava may form lobate structures and pyroclastic ejecta despite deep-submarine eruption conditions.

Newly discovering of the young lava field

We will report firstly young lava fields on the eastern tip of the Hokkaido Rise, NW Pacific after analyzing the radiometric ages and the preliminary data of bulk chemistry in the Tokyo Institute of Technology and University of Tokyo. The discovery of this young lava field and the Kaiko Lava Field will be breakthrough on the volcanology and the Earth Science.

Detail distribution of Kaiko Knolls lava field

Using on-board data we will firstly report detail distribution of the lava field based on the back-scan image and bathymetry by the Seabeam 2112 and obtaining samples by dredges.

High reflection areas in the backscatter image expecting the lava field appear are shown along some irregularly topographic highs and normal faults on the subducting Pacific Plate. KR03-07 cruise results on the last year show that the lava field is composed of two type lavas; one is vesicular lavas forming some topographic highs (possibly pillow lavas) and another is underlying sheet flow (dense and flood-like lavas). The latter would be concealed by topographic highs and pelagic mud.

"Which are Kaiko lava field in the Japan Trench accidental or common on the outer-rise?" The some dredges and seabeam data on this cruise should solve this problem.

This theme will be the main study of the young lavas on the Japan Trench and outer-rise. We should obtain answers of two questions about the source of magmas in the mantle and the cause of eruption.

Firstly we will solve the source mantle of this magma based on the geochemical studies of major and trace element compositions and radiometric isotopes. Each element trend along the differentiation line of magma can indicate the mineralogy of source mantle, which are a tool to consider the depth in the mantle. We think that the variation of obtained rocks such as ol-bearing basalt, cpx-bearing basalt, aphyric basalt and dolerite are useful to recognize the source mineralogy and depth. Sr, Nd, Pb and He isotopes would indicate source material in the mantle (primitive or depleted mantles).

The cause of eruption may be resolved by tectonophysics such as some bendings or fractures of oceanic plate. We will simulate some bendings of the flexural plate with decreasing pressure or fractures into lithosphere. The arrangements of lava field using backscatter on this cruise may also indicate the cause of eruption.

Using methods are

- ✧ Microprobe analysis for quenched glasses and minerals (by N. Hirano, N. Abe, A. Takahashi)
- ✧ XRF (by S. Haraguchi, N. Hirano, S. Machida, T. Ishii)
- ✧ Laser ablation ICPMS for bulk and glasses (by N. Hirano, A. Takahashi, T. Hirata, E. Takahashi)
- ✧ TIMS for noble gases (by J. Yamamoto, N. Hirano)
- ✧ TIMS for solid elements (by S. Machida, N. Hirano, J. Kimura)
- ✧ Ar-Ar dating (by N. Hirano, K. Nagao)

6-2. Natsue Abe

To achieve my research aims, I will take nest research plan.
1) Describe the ultramafic and mafic xenoliths in the basalts petrographically in detail.
2) Carry out the major and trace element measurements on the xenoliths and xenocrysts.
3) Compare these data with the data of subcontinental lithospheric mantle xenoliths and abyssal peridotites.

Main interest is mineral chemistry of the ultramafic and mafic xenoliths and/or xenocryst in the alkaline basalt. Especially chromian spinel with/without olivine phenocryst and also olivine xenocryst may tell us the origin of these minerals and host magma (e.g., Arai, 1994). In other words, mineral chemistry and detail description (petrography) of thin sections can tell us the condition of magma formation and capture of xenocrysts; e.g., PT conditions, H_2O content and so on. In addition to this, in situ trace-element analysis us ing by LA-ICPMS or SIMS will be taken on clinopyroxene in basaltic samples, and mineral and/or melt inclusions in phenocryst/xenocryst in basalts, and also detrital minerals in sediments. Then compositions of the equilibrium melt with such kind of minerals/melt inclusions will be estimated. Methods are:
1) Describe thin sections using by optical microscope
2) Major element analysis on minerals using by EPMA
3) Trace element analysis on minerals using by LA-ICPMS and/or SIMS

%% Xenoliths and xenocryst samples are mainly alkaline basalts from Dive #878, 879, 880 and some samples from Dive #877.

6-3. Teruaki Ishii
6-4. Stephanie Ingle
6-5. Shiki Machida

See details for chapter 1.

6-6. Kiyoshi Baba & Masahiro Ichiki (Future plan of the seafloor MT survey)

The OBEMs deployed in this cruise will be recovered in future cruises. For the four OBEMs at NWP0503 – NWP0506, which align in the cross-shape array around “Petit Spot” area, the recovery is scheduled during R/V Kairei KR05-11 cruise (Chief Scientist: Dr. Natsue Abe) in August, 2005. In the Kairei cruise, calibration of the OBEM positions will be carried out for all the six sites, which was not done in this YK05-06 cruise because of tight schedule. The recovery of the other two OBEMs at NWP0501 and NWP0502 has not been scheduled yet. As described in the section 1-3-6, we plan iterative long-term surveys to cover northwestern Pacific region in coming a few years. We need to write proposals to get cruises for further experiments as well as for the recovery of the two OBEMs.

The obtained data will be analyzed based on MT and geomagnetic depth sounding (GDS) methods. The time series data are processed and the MT and GDS responses are estimated. The obtained responses are then inverted into electrical conductivity models under various constraints, e.g., isotropy or anisotropy, and 1-D, 2-D, or 3-D heterogeneities. The conductivity structure models should be interpreted in terms of thermal effect, compositional effect, and so on, refering various independent informa tions.

6-7. Toshiya Fujiwara

We have collected intensive bathymetry, gravity, magnetics, and seismic reflection data in the B-area (around 150°E near the Yukawa Knoll) since 2003. Compilation of sort of geophysical data and analysis are useful to understand the geological background and geo-dynamics of the "Petit-spot".

6-8. Ayu Takahashi

1) Pacific plate, which underthrusting Japan Trench forms outer-rise. The volcanoes considered to be related to petit-spot were active at beginning of eastward slope of the outer-rise (Hirano et al., 2001). To certain depth of mantle, there is flow dragged by overlying lithosphere as it moves. The surface figure therefore governs the change of flow within the upper-most part of mantle. At beginning of plate flexure, slight upward mantle flow may cause melting on a small scale. Petrological properties of rock samples will show what kind of mantle material is melting that is indispensable for numerical simulation of magma generation. Thermal structure within mantle, as well as the depth of lithosphere behaves as elastic (or viscoelastic) presumed from OBEM and other geophysical data is also essential to numerical modeling.

2) Peperites were recovered from two knolls (Dive #878, #879). They may record a snapshot of the processes that occur prior to explosions, and which are otherwise not preserved in the resulting deposit. Its study can therefore provide information on the factors and mechanisms that influence the likelihood of explosions, and also constraints on its ages. Because factors which could influence fragmentation and mingling processes include volatile content of magma, collected samples (volatile-rich) during YK05-06 cruise may provide a window into magma and wet sediment interaction.

6-9. Naoki Takehara

See details for chapter 1.

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Appendix-1. Description of Rock Samples

A1-1. 6K#877

Sample No.	Rock type	Diameter(mm) X	Y	Z	Vesicularity	Wt(g)	Mn (mm)	Lithology and remarks	Color (inside the rock)
877-1-A		370	280	140			20-55	weak alteration, well-sorting, round, silt-matrix	
877-1-B		510	360	170			15-40	strong alteration	
877-1-C	Basalt	295	208	135			7	aphyric, with palagonization, mud, well-sorting, angular, normal grading, silt-matrix	
877-2-A	Pumice	165	104	88				weak alteration	White
877-Others									

A1-2. 6K#878

Sample No.	Rock type	Diameter(mm) X	Y	Z	Vesicularity	Wt(g)	Mn (mm)	Lithology and remarks	Color (inside the rock)
878-1-A	Manganese	180	100	60		600	50		Dark brown
878-1-B	Manganese	50	40	40		50	all?		Dark brown - black
878-2-B	Peperite	Huge				16000	100		
878-3-A	Basalt breccia	150	110	60	40	550	15	full of xenocryst in alkali-basalt, glassy-matrix.	Dark brown - pale browm
878-3-B	Basalt breccia	300	170	160	30	6800	0-15	ultra maffic xenolith(-35mm)	pale BR - DBR
878-3-C	Basalt breccia	140	120	75		750	0-15	abundant xenocryst in alkali basalt, peridotite xenolith(8mm), glassy matrix	pale BR - DBR
878-Unknown-1	Alkalic basalt	80	60	40	35	50		pyroxene xenocryst	DBR
878-Unknown-2	Pumice	190	100	80		1050		Round	White - DBR
878-Scoop-1-1	Alkalic basalt	90	65	45	40	80		with peridotite xenolith(30mm)	DBR - yellowish red
878-Scoop-1-2	Alkalic basalt	90	60	60	40	70		with xenocryst	DBR
878-Scoop-1-3	Alkalic basalt	65	50	35	40	40		with xenocryst, peridotite xenolith(5mm)	
878-Scoop-1-4		85	70	35				breccia basalt xenolith(12mm)	DBR - pale BR
878-Scoop-1-Ext.	lots of pebbles								
878-Scoop-2	Alkalic basalt pebbles	(max)60	50	40	35-40	total 50		xenocryst, peridotite xenolith	DBR

A1-3. 6K#879

Sample No.	Rock type	Diameter(mm) X	Y	Z	Vesicularity	Wt(g)	Mn (mm)	Lithology and remarks	Color (inside the rock)
879-1-A	Scoria	170	130	70		1500			DBR
879-1-B	Pumice	160	120	80		1400			pale BR - light BR
879-3-A	Pillow basalt	280	140	110	20	7000		with peperite, aphyric, with coral, week alteration on glass	DBR
879-3-B	Pillow basalt	Huge			30	18600	0-13	with peperite, aphyric, week alteration on glass	DBR - BL
879-4-A	Pillow? Basalt	120	110	80		900	0-10	with peperite, aphyric, week alteration on glass	DBR - BL
879-4-B-1	Basalt	110	90	60	35	500	5-10	with peperite, aphyric	BR
879-4-B-2	Basalt	70	40	40	30	50	3-10	with peperite, 1-3mm palagonite	DBR
879-5-A	Pumice	170	120	110		2300			
879-6-A	Pumice	250	150	150		3400			
879-6-B	Pumice	120	100	80		600	0-10		
879-6-C	Mn nodule	140	80	80		800			
879-Scoop-1	Pumice	170	130	60		900			
879-Scoop-2-A	Peperite	110	90	50		500	3	with basalt glass	pale BR
879-Scoop-2-B	Peperite	90	70	40		150	-5	with altered glass	
879-Scoop-2-C	Mn nodule	60	50	40		100			
879-Unknown-A	Scoria	80	40	40	45	30		glassy	DBR
879-Unknown-B	Pumice	85	50	30		50			

A1-4. 6K#880

Sample No.	Rock type	Diameter(mm) X	Y	Z	Vesicularity	Wt(g)	Mn (mm)	Lithology and remarks	Color (inside the rock)
880-1-A	Alkalic basalt	160	120	100	35	1900	0	with peridotite xenolith, aphyric, xenocryst	DBR
880-1-B	Alkalic basalt	150	140	110	30	2100	0	with tiny xenocryst layering of vesicle	DBR
880-1-C	Alkalic basalt	130	80	70	25	1000	0	with xenocryst layering of vesicle	DBR
880-1-D	Alkalic basalt	130	100	50	30	550	0	with xenocryst	DBR
880-1-E									
880-1-Others	Alkalic basalt fragments					225		pillow crust	
880-2-A	Alkalic basalt	180	100	90	30	1700	0	with peridotite xenolith, aphyric, xenocryst, glassy rim	DBR
880-2-B	Alkalic basalt	110	70	70	35	550	0	with xenocryst	DBR
880-2-C	Alkalic basalt	100	90	60	35	500	0	with xenocryst, glassy rim	DBR
880-2-D	Alkalic basalt	100	80	70	40	400	0	with xenolith(lherzolite), xenocryst	DBR
880-2-E	Alkalic basalt	85	65	50	35	180	0	with peridotite xenolith, xenocryst, glassy rim	DBR
880-2-Others	Alkalic basalt fragments					170	0	glassy crust, xenocryst	DBR
880-3-A	Basalt	150	140	70	3	3400	0	phyric, chilled margin	Dark gray
880-3-B	Basalt	170	160	100	1	3000	0	with xenocryst, chilled margin, curved surface	Dark gray
880-3-C	Basalt	130	75	70	1	1400	0	phyric, chilled margin, curved surface	Dark gray
880-3-D	Basalt	80	70	60	3	520	0	phyric, chilled margin	Dark gray
880-4-1	Pumice	90	75	60		(total) 650			Light gray
880-4-2	Pumice	110	50	50					Light gray
880-4-Others	Pumice								Light gray
880-Unknown-1	Alkalic basalt	70	70	70	35	300	0	with peridotite xenolith	DBR

880-Unknown-2	Alkalic basalt	60	50	40	15	100	0	with xenocryst	BR
880-Unknown-Extla	Basalt				35	450		with xenocryst	DBR
880-5	Basalt	340	230	180	25	10400	1-200	Mn coated, with peperite, aphyric	DBR - BL
880-6	Manganese	200	90	90		1800		with pebbles	DBR - BL

Appendix-2. Photos of Rock Samples

See your CD or DVD-ROM for details.

Appendix-3. List of Rock Party

A3-1. 6K#877

Sample No.	Rock type	Remarks	JAMSTEC	Titech	ORI
#877 R1-A	Mud stone		B	B	B
#877 R1-B			B	B	B
#877 R2-A			B	B	B
#877 R Others-A			B	B	
#877 R Others-B			B	B	
#877 R Others-C			B	B	
#877 R Others-D			B	B	
#877 R Others-extra			B	B	B

A: All, B: Block

A3-2. 6K#878

Sample No.	Rock type	Remarks	JAMSTEC	Titech	ORI
#878 R1-A	Manganese		B	B	B
#878 R1-B	Manganese		B	B	B
#878 R2-A			A	※for cutting after cruise	
#878 R2-B	Peperite		B	B	B
#878 R3-A	Basalt breccia		B	B	B
#878 R3-B	Basalt breccia	Ultra maffic xenolith	B	B	B
#878 R3-C	Basalt breccia	Xenolith	B	B	B
#878 SC1-S1A	Alkali basalt		B	B	B
#878 SC1-S1B	Alkali basalt		B	B	
#878 SC1-S1C	Alkali basalt		B	B	B
#878 SC1-S1D	Breccia		B	B	
#878 SC1-S1E	Breccia		B	B	
#878 SC1-extra	Pebbles		B		
#878 SC2-S2A	Alkaline basast pebbles		B	B	
#878 SC2-extra	Alkaline basast pebbles		B		
#878 Unknown1U-1-A	Alkali basalt		B	B	B
#878 Unknown1 extra	Alkali basalt		B		
#878 Unknown2	Pumice		B	B	B

A: All, B: Block

A3-3. 6K#879

Sample No.	Rock type	Remarks	JAMSTEC	Titech	ORI
#879 R1-A	Scoria		B	B	B
#879 R1-B	Pumice		B	B	B
#879 R3-A	Pillow basalt	Peperite	B	B	B
#879 R3-B	Pillow basalt	Peperite	B	B	B
#879 R4-A	Pillow(?) basalt	Peperite	B	B	B
#879 R4-B-1	Basalt	Peperite	B	B	B
#879 R4-B-2	Basalt	Peperite	B	B	B
#879 R5-A	Pumice		B	B	B
#879 R6-A	Pumice		B	B	B
#879 R6-B	Pumice		B	B	B
#879 R6-C	Mn nodule		B	B	B
#879 SC1	Pumice		B	B	B
#879 SC2-S2A	Peperite		B	B	B
#879 SC2-S2B	Peperite		B	B	
#879 SC2-S2C	Mn nodule		B	B	
#879 SC2-extra	Pebbles		B		
#879 Unknown1	Scoria		B	B	
#879 Unknown2	Pumice		B	B	

A: All, B: Block

A3-4. 6K#880

Sample No.	Rock type	Remarks	JAMSTEC	Titech	ORI
#880 R1 - A	Alkali basalt	Peridotite xenolith	B	B	B
#880 R1 - B	Alkali basalt		B	B	B
#880 R1 - C	Alkali basalt		B	B	B
#880 R1 - D	Alkali basalt		B	B	B
#880 R1 - E	Alkali basalt		B	B	B
#880 R1 - Others	Alkali basalt		B	B	
#880 R2 - A	Alkali basalt	Peridotite xenolith	B	B	B
#880 R2 - B	Alkali basalt		B	B	B
#880 R2 - C	Alkali basalt		B	B	B
#880 R2 - D	Alkali basalt	Lherzolite xenolith	B	B	B
#880 R2 - E	Alkali basalt	Peridotite xenolith	B	B	B
#880 R2 - Others	Alkali basalt fragments		B	B	
#880 R3 - A	Basalt		B	B	B
#880 R3 - B	Basalt		B	B	B
#880 R3 - C	Basalt		B	B	B
#880 R3 - D	Basalt		B	B	B
#880 R4	Pumice		B	B	B
#880 R5	Basalt	Thick Mn crust	B	B	B
#880 R6	Manganese	Pebbles	B	B	B
#880 Unknown U-1	Alkali basalt	Peridotite xenolith	B	B	
#880 Unknown U-2	Alkali basalt		B		
#880 Unknown extra	Alkali basalt		B	B	B

A: All, B: Block

Appendix-4. SCS Data

See your CD or DVD-ROM for details.

Appendix-5. Grid Data for Seabeam Mapping

See your CD or DVD-ROM for details.

Appendix-6. OBEM Check Sheets for Deployment

See your CD or DVD-ROM for details.