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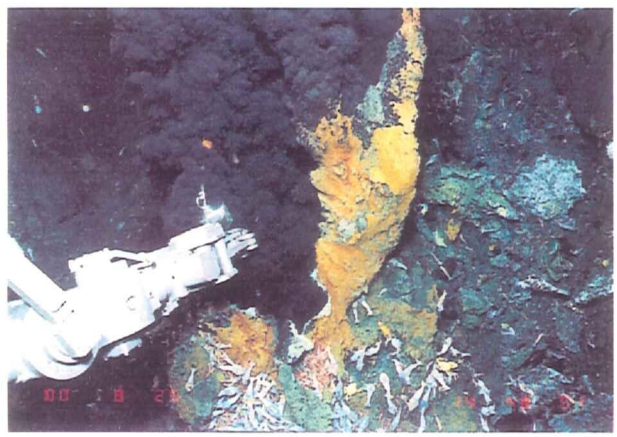
Onboard Report
of
the KR00-05 Indian Ocean Cruise
(Rodriguez Triple Junction)

Deep Tow

ROV *Kaiko*



Discovery of the first hydrothermal vent in the Indian Ocean

August 3 - September 2, 2000
R/V *Kairei* - ROV *Kaiko* - *Deep Tow*

JAMSTEC
ORI, University of Tokyo
Hokkaido University
Chiba University

Okayama University
Osaka City University
University of Tsukuba

Contents

・CruiseID: KR00-05

・Title of the cruise: Report of the KR00-05 Indian Ocean Cruise (Rodriguez Triple Junction)

・Chief scientist: Jun Hashimoto

・Research area: Indian Ocean Cruise (Rodriguez Triple Junction)

・Cruise period: 2000/07/20 - 2000/09/02

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R/V *Kairei* Crew

Sadao ISHIDA (Captain)

Shinya RYONO (Chief Officer)

Rikita YOSHIDA (2nd Officer)

Naoto KIMURA (3rd Officer)

Kohta IZAWA (Junior 3rd Officer)

Kuniharu TABUCHI (Chief Engineer)

Kiyonori KAJINISHI (1st Engineer)

Kazunori NOGUCHI (2nd Engineer)

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Masamoto TAKAHASHI (Chief Electric Operator)

Hiroyasu SAITAKE (2nd Electric Operator)

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Kazuo ABE (Able Seaman)

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Hatsuo ODA (Able Seaman)

Yukihito FUJIMURA (Ordinary Seaman)
Masaru MURAO (Chief Oiler)
Tuneo HARIMOTO (Oiler)
Takeshi FUKUBARA (Oiler)
Tomoyuki HASHIMOTO (Fire Man)
Yuichi ISHII (Fire Man)
Kaoru TAKASHIMA (Chief Steward)
Shinichi AMASAKI (Steward)
Yoshinobu HASATANI (Steward)
Matsuto SASAKI (Steward)
Tomoya ONO (Cook)

Deep Tow Operation Team

Motoyuki MIYAMOTO (Marine technician)
Naotaka TOGASHI (Marine technician)
Akira SO (Marine technician)
Kumiko FUKAI (Marine technician)
Kei SUMINAGA (Marine technician)

ROV *Kaiko* Operation Team

Kazuyoshi HIRATA (Operation Manager)
Mitsuhiro UEKI (Pilot and Mechanics)
Kiyoshi TAKISHITA (Pilot and mechanics)
Toshinobu MIKAGAWA (Pilot and Mechanics)
Atsumori MIURA (Pilot and Mechanics)
Homare WAKAMATSU (Pilot and Mechanics)
Dai YAMANISHI (Pilot and Mechanics)
Katsutoshi KITAMURA (Pilot and Mechanics)
Atsushi TAKENOUCHI (Pilot and Mechanics)

Cruise Operations

03 August, 2000

8:00	Embark scientific party and deep tow operation team at Port Headland
11:00	Transit to the Rodriguez Triple Junction from Port Headland
19:00	Scientific meeting

04 August, 2000

19:00	Scientific meeting

05 August, 2000

08:30	Free fall of *Deep-Tow* cable
19:00	Scientific meeting

06 August, 2000

19:00	Scientific meeting

07 August, 2000

19:00	Scientific meeting

08 August, 2000

13:00	Lectures on hydrothermalism by Prof. GAMO (Geochemistry), Prof. OHTA (Biology), Prof. YAMAGUCHI (Biology) and Prof. CHIBA (Geochemistry)
19:00	Scientific meeting

09 August, 2000

19:00	Scientific meeting

10 August, 2000

16:20	Arrive at the Rodriguez Triple Junction
16:35	Topographic survey using the *SeaBeam 2100* (KR00-05-SB01), and hydrographic observation using XBT
19:00	Scientific meeting

11 August, 2000

4:02	Finish KR00-05-SB01

	6:39	Start KR00-05-TY01
	8:14	Finish KR00-05-TY01
	12:01	Start KR00-05-TY02
	18:01	Finish KR00-05-TY02
	19:30	Scientific meeting
	19:55	Start KR00-05-SB-02
12 August, 2000		
	4:00	Finish KR00-05-SB02
	7:00	Start KR00-05-TY03
	11:46	Finish KR00-05-TY03
	13:31	Start KR00-05-TY04
	17:39	Finish KR00-05-TY04
	19:30	Scientific meeting
	20:06	Start KR00-05-SB03
13 August, 2000		
	5:46	Finish KR00-05-SB03
	8:29	Start KR00-05-DT01
	9:50	Recognize sea floor
	16:12	Finish KR00-05-DT01
	18:18	Start KR00-05-SB04
	19:30	Scientific meeting
14 August, 2000		
	9:48	Finish KR00-05-SB04
	11:20	Tension test of cable
	13:46	Start KR00-05-DT02
	14:57	Recognize sea floor
	16:13	Finish KR00-05-DT02
	20:29	Start KR00-05-SB05
	19:00	Scientific meeting
15 August, 2000		
	4:03	Finish KR00-05-SB05
	7:58	Start KR00-05-DT03
	9:07	Recognize sea floor

	13:25	Finish KR00-05-DT03
	13:30	Start KR00-05-TY05
	16:09	Finish KR00-05-TY05
	16:34	Start KR00-05-SB06
	19:00	Scientific meeting
16 August, 2000		
	4:45	Finish KR00-05-SB06
	8:08	Start KR00-05-TY06
	9:20	Recognize sea floor
	10:47	Finish KR00-05-TY06
	10:53	Start KR00-05-DT04 (recognize water shimmering ?)
	12:44	Finish KR00-05-DT04
	12:52	Start KR00-05-TY07
	14:04	Finish KR00-05-TY07
	14:12	Start KR0-05-DT05
	14:30	Abnormal situation of vehicle
	15:15	Finish KR00-05-DT05
	15:39	Start KR00-05-SB07
	19:00	Scientific meeting
17 August, 2000		
	6:14	Finish KR-00-05-SB07
	8:13	Start KR00-05-DT06
	9:21	Recognize sea floor
	16:18	Finish KR00-05-DT06
	17:53	Start KR00-05-SB08
	19:00	Scientific meeting
18 August, 2000		
	3:19	Finish KR-00-05-SB08
	9:06	Start KR00-05-DT07
	10:08	Recognize sea floor
	11:38	Finish KR00-05-DT07
	11:44	Start KR00-05-TY08

	14:31	Finish KR00-05-TY08
	14:36	Start KR00-05-DT08
	16:21	Finish KR00-05-DT08
	19:11	Start KR00-05-SB09
	19:00	Scientific meeting
19 August, 2000		
	3:32	Finish KR-00-05-SB09
	7:52	Start KR00-05-DT09
	9:06	Recognize sea floor
	16:22	Finish KR00-05-DT09
	18:22	Start KR00-05-SB10
	19:00	Scientific meeting
20 August, 2000		
	3:11	Finish KR-00-05-SB10
	7:58	Start KR00-05-DT10
	9:00	Recognize sea floor
	11:52	Finish KR00-05-DT10 (DT10: DT10-1, 2)
	11:53	Start KR00-05-TY09 (TY09: DT3, 4)
	12:20	Finish KR00-05-TY09
	12:22	Start KR00-05-DT11 (DT11: DT10-5)
	13:05	Finish KR00-05-DT11
	13:07	Start KR00-05-TY10 (TY10: DT10-6, 7)
	13:32	Finish KR00-05-TY10
	13:34	Start KR00-05-DT12 (DT12: DT8, 9)
	16:09	Finish KR00-05-DT12
	19:00	Scientific meeting
21 August, 2000		
	7:30	Switch operation equipment from *Deep Tow* to ROV *Kaiko*
	13:00	Briefing of ROV *Kaiko*
22 August, 2000		
		ROV *Kaiko* operation was cancelled due to bad sea condition.
	12:59	Start KR00-05-SB11

19:00 Scientific meeting

23 August, 2000

3:58 Finish KR00-05-SB11

ROV *Kaiko* operation was cancelled due to an accident around the main cable.

19:00 Scientific meeting

23:16 Start KR00-05-SB12

24 August, 2000

2:46 Finish KR00-05-SB12

ROV *Kaiko* operation was cancelled due to bad sea condition.

19:00 Scientific meeting

25 August, 2000

8:45 Start 10K#167 dive

10:16 Recognize sea floor

14:08 Discovery of large black smoker

16:48 Finish 10K#167

19:00 Scientific meeting

21:34 Start KR00-05-SB13

26 August, 2000

4:10 Finish KR00-05-SB13

9:00 Start 10K#168 dive

10:24 Recognize sea floor

15:00 Finish 10K#168 dive

19:00 Scientific meeting

19:11 Start KR00-05-SB14

27 August, 2000

0:49 Finish KR00-05-SB14

10:14 Start 10K#169

11:32 Recognize sea floor

16:20 Finish 10K#169

19:00 Scientific meeting

19:52 Start KR00-05-SB15

28 August, 2000

ROV *Kaiko* operation was cancelled due to bad sea condition.

3:09 Finish KR00-05-SB15

16:32 Start KR00-05-SB16

19:00 Scientific meeting

29 August, 2000

3:29 Finish KR00-05-SB16

8:58 Start 10K#170

10:30 Recognize sea floor

16:24 Finish 10K#170

19:00 Scientific meeting

22:01 Start KR00-05-SB17

30 August, 2000

ROV *Kaiko* operation was cancelled due to bad sea condition.

13:51 Finish KR00-05-SB17

Transit to Port Luis

31 August, 2000

Transit to Port Luis

9:00 Public lectures concerning Hakuho Knoll and the Kairei Hydrothermal Field by Prof. GAMO (Geochemistry), Prof. OHTA (Geological setting), Dr. Tsuchida (Biology) and Dr. Okudaira (Lithology)

01 September, 2000

Transit to Port Luis

9:00 Scientific meeting

02 September, 2000

10:00 Arrive at Port Luis

16:45 scientific party and deep tow operation team disembark

Preface

Since the initial discoveries of indications for hydrothermal activity in the northwestern Indian Ocean (Rozanova and Baturin, 1971; Baturin and Rozanova, 1975), many geochemical, geological and geophysical indications of hydrothermalism were reported from the Indian Ocean (Herzig and Plüger, 1988; Jean-Baptiste *et al.*, 1992; Scheirer *et al.*, 1996; Scheirer *et al.*, 1998; Lalou *et al.*, 1998; Halbach *et al.*, 1998; German *et al.*, 1998; Plüger *et al.*, 1990; Münch *et al.*, 1999). Furthermore, barnacles thought to be an indication of hydrothermal activity were collected from the South East Indian Ridge (Southward *et al.*, 1997). However, location of active hydrothermal vents and associated biological communities has not been realized. The Indian Ocean was the last major ocean basin to be investigated for hydrothermal activity (Southward *et al.*, 1997), and the mid-ocean ridges in the Indian Ocean is the sole modern migration pathway between the diverse vent fauna of the Atlantic and Pacific oceans (Tunnicliffe and Fowler, 1996).

In 1993, the KH93-3 cruise using the R/V *Hakuho-maru* was conducted near the Rodriguez Triple Junction. This is the first intensive research at mid-oceanic ridge conducted by the Japanese scientist group. During the cruise, a series of deep-sea hydrocast and deep-sea TV observation surveys searching for hydrothermalism and associated biological communities was also carried out (Tamaki and Fujimoto, 1995). And significant hydrothermal plumes were found in the central Indian Ridge segment (Gamo *et al.*, 1996). In 1998, two dives of a submersible "*Shinkai 6500*" during INDOYO cruise (MODE '98 leg. 3) were focused on a knoll near the Rodriguez Triple Junction where the most dense portion of hydrothermal plume observed during the KH93-3 cruise. Although the search for active hydrothermalism was not successful during two dives, two dead shells of vesicomyid clams which is well known as a typical member of the hydrothermal vent community were found and captured at the southwestern part of the knoll. Furthermore, the light transmission anomalies were commonly observed at the dive site (Fujimoto *et al.*, 1999)

Following to these efforts in the area close to the Rodriguez Triple Junction of Indian Ocean, a series of research cruise, termed as the KR00-05 cruise, using the R/V

"*Kairei*" and the ROV "*Kaiko*" was planned in order to search for hydrothermal vents and associated biological communities. This cruise was conducted at the small Knoll, termed as the Hakuho Knoll, located approximately 22 km north of the Rodriguez Triple Junction (same target survey area of the INDOYO cruise) from 3 August to 2 September, 2000, as a part of InterRidge Project. Prior to the "*Kaiko*" dives, topographic survey using SeaBeam 2100 on the "*Kairei*", tow-yo observations using a deep tow camera system equipped with water sampler, CTD and transmissometer, biological and geological observations using a deep tow camera system were conducted as a series of pre-site survey. During the cruise, four dives of the "*Kaiko*" were realized with marvelous results including the first discovery of biological communities associated with hydrothermal vents in the Indian Ocean.

The samples and data will be processed in land-based laboratories in many institutions. We are anticipating that many scientific reports and synthesis will be published in very near future.

We, the shipboard scientists of the KR00-05 cruise, express our sincere thanks to the crews of the "*Kairei*", the "*Kaiko*" operations team and the "*Deep Tow*" operations team for their cooperation during the cruise. We are especially grateful to the Captain of the "*Kairei*", Sadao ISHIDA, the Chief Engineer of the "Kairei", Kuniharu TABUCHI, the operation manager of the "*Kaiko*", Kazuyoshi HIRATA, and the Chief of the "*Deep Tow*" operations team, Motoyuki MIYAMOTO for their enthusiastic help. Our thanks are also extended to the researchers of the KH93-3 and INDOYO cruises for allowing us to use their data.

Jun HASHIMOTO
(Japan Marine Science and Technology Center)

1. Previous Studies

1.1. Geological and geophysical studies

The Rodriguez Triple Junction (70°E, 25°S) is one of the best exposed R-R-R triple junction, which has been controlling the evolution of the major portion of the Indian Ocean (e.g., Briais, 1995). At the Triple Junction, the central Indian Ridge (CIR) and Southeast Indian Ridge (SEIR) both with moderate spreading rate (half-spreading rate = about 25mm/yr) meet the ultra-slow spreading Southwest Indian Ridge SWIR. It is expected that the thermal condition of the mantle just beneath the Triple Junction could be different from those of any normal ridges, and it must be reflected on the composition of magmas released at the Triple Junction. The volcanism is active in both CIR and SEIR, while inactive in SWIR (Fujii, *et al.*, 1995). The morphological characteristics of the segmentation of the CIR from the Triple Junction to the Egeria Transform Fault system (20°30'S) are analyzed by Briais (1995), as illustrated in Figure 1.1.1. The morphology of the CIR is generally similar to that of a slow-spreading center, despite an intermediate spreading rate at these latitudes. The axis is marked by an axial valley 5-35 km wide and 500-800 m deep, sometimes exhibiting a 100-600 m-high neovolcanic ridge. It is offset by only one 40-km offset transform fault (at 22°40'S), and by nine second-order discontinuities (Non Transform Discontinuity: NTD), with offset varying from 4 to 21 km, spreading segments 28 to 85 km long. As shown in Figure 1.1.2, the nine NTDs and the Gemino Transform Fault divided the area into eleven segments (Segment 1 to Segment 11). The morphological variations of the CIR axis may be explained by an increase in the crustal thickness in the northern segments relatively to the Triple Junction area. Variations in crustal thickness could be related to a broad bathymetric anomaly centered at 19°S, 65°E, which probably reflects the effect of the nearby Réunion hotspot, or an anomaly in the composition of the mantle beneath the ridge near 19°S (Briais, 1995).

The study area (69°59'E, 25°17'S - 70°05'E, 25°21'S) is located at Segment 1 (Figure 1.1.2). There is a topographic high and a wide graben-like structure elongated from northwest to southeast having water depth 2300 m at the shallowest peak and 2800 at the graben site. Topographic high elongates NW-SE, parallel to the spreading axis

and have some notable dome and spur structure. The shallower dome-like structure, volcanic cone, may be results of the younger basaltic magma extrusion (Gamo *et al.*, 1998). Furthermore, it is suggested that the volcanism contains two stages; sea-floor stage and the following volcanic cone stage (Nakata et al., 1995). The volcanic cone consists of basaltic rocks with various features, such as pillow lobe pile, pillow breccia, hyaloclastite, and sheet flow. The cones are inactive, but nearly "zero-aged", because fresh, glassy surface remains and sediment cover is thin less than several cm. On the other hand, at the graben site, relatively thick sediments are deposited.

Takamoto OKUDAIRA
(Faculty of Science, Osaka City University)

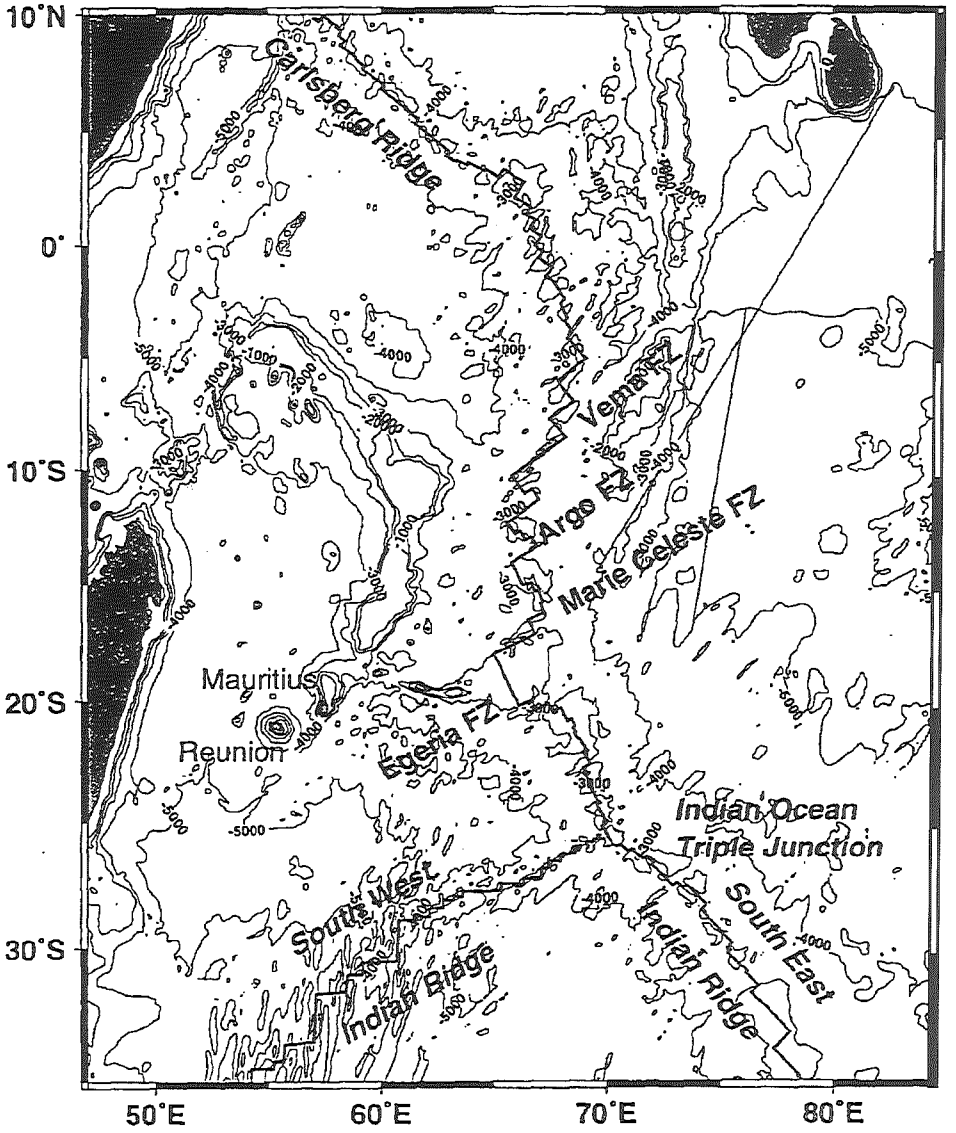

Figure 1.1.1. Bathymetric map of the Indian Ocean (modified from Briais, 1995)

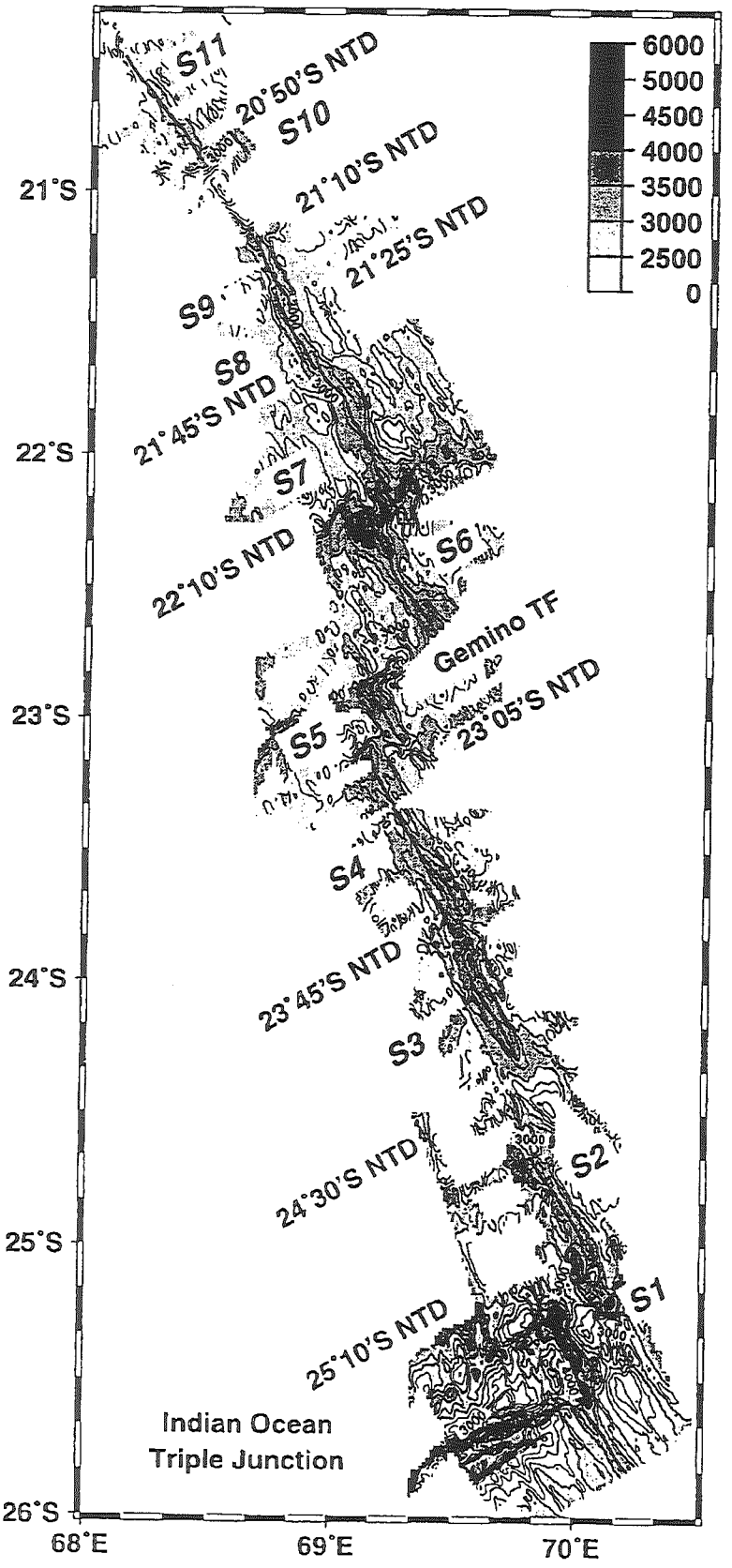

Figure 1.1.2. Bathymetry of the Central Indian Ridge between 20°20'S and 26°S from Seabeam compilation (Briais, 1995). Contour interval is 500 m. Bold line is inferred location of spreading ridge. S1 to S11 are second order segments. NTD denotes Non Transform Discontinuity; TF. Transform fault.

1.2. Geochemical studies

Submarine hydrothermal vents at plate spreading centers emit hot and anoxic fluids, which mix turbulently with ambient seawater as they rise upward, forming hydrothermal plumes at some level where neutral buoyancy is attained. The plumes are then dispersed along isopycnal surfaces. In efforts to locate the very point of hydrothermal venting zone, detailed geochemical mapping of the plumes from research vessels provides indispensable information before direct observations by ROV and/or manned submersibles. Useful indicators to be measured are CH_4, manganese, iron, helium-3, light transmission, pH etc. However, much less works of such geochemical mapping have been done in the Indian Ocean than those in the Pacific and Atlantic Oceans, and no hydrothermal active site has been located by submersibles so far in the Indian Ocean.

At the Rodriguez Triple Junction (RTJ; ~25°32'S, ~70°02'E), geochemical surveys have been done twice so far. In 1993, water column anomalies of light transmission, Mn, Fe, Al and CH_4 concentrations were searched in detail for the first time during the KH-93-3 cruise of *R/V Hakuho Maru* (Ocean Research Institute, The University of Tokyo) (Gamo *et al.*, 1996; Tamaki and Fujimoto, 1995). Significant hydrothermal plumes were found at 2,200 - 2,400 m depth in the northern part of the first central Indian Ridge (CIR) segment (25°18-20'S) approximately 12 miles north of the RTJ (Fig.1). Intensive tow-yo observations (4 times) using a Seabird CTD (SBE-9 plus) rosette multi-sampling system installed with a Sea Tech transmissometer revealed that the plumes show temporal as well as spatial variations, suggesting somewhat episodic behavior of the hydrothermal activity. Discrete water samples within the plumes were enriched in Mn, Fe, and CH_4 with the maximum concentrations of 9.8 nM, 40.2 nM and 3.3 nM, respectively (Gamo et al., 1996).

Judging from the spatial and chemical characteristics of the plumes, we concluded that the hydrothermal plumes observed were discharged from the eastern off-axis wall or axial high at a depth of <2,800 m, several miles eastward from the center of the CIR rift valley. The conclusion is based on the following plume characteristics.

(i) Anomalies of light transmission, Mn, Fe and CH_4 concentrations are significant only in the eastern slope area of the CIR segment, while the observations performed in the rift valley of the segment failed to detect any indication of hydrothermal plumes.

(ii) Chemical characteristics of the observed hydrothermal plumes, particularly CH_4/Mn and Fe/Mn ratios, suggest that the age of the plume becomes younger as we go more eastward from the rift valley to the off-axis area.

Based on the above results, two dives (dive #456 (observer: S. Ohta) and the dive #457 (observer: T. Gamo)) of the submersible *Shinkai 6500* were devoted for the reconnaisance of hydrothermal activity around the RTJ (Fig.1) during the MODE'98 Leg-III cruise in 1998 (Fujimoto et al., 1998). These dives have made tremendous progress in approaching hydrothermal active sites in this area, although the very point could not be reached by this mission. During the dive #456, dead heaps of 2 species of the giant white clams (Calyptogena) were found at the southwestern flank of the topographic high (25°18.62'S, 70°01.57E), suggesting recent existence of chemosynthetic ecosystems characteristic of hydrothermal activity at this location. However, no additional visual signature for hydrothermal activity on the seafloor was obtained through the two dives.

Water column light transmission anomalies were commonly observed by a Sea Tech 25cm transmissometer attached to *Shinkai 6500* during its descending and ascending during both dives. The anomalies appeared at depths of 2200~2400 m, almost the same depth as that observed during the *Hakuho-Maru* cruise in 1993. This suggests the transmission anomaly observed in 1998 could be regarded as hydrothermal plumes. The data also implies the continuation of hydrothermal activity between 1993 and 1998. The maximum transmission anomaly was ~0.5% (at a depth of 2200 m) at the leaving point of the dive #457 (25°18.62'S, 70°01.92'E). This anomaly is about 5 times larger than that observed during the KH-93-3 cruise, probably because the surveyed area is very close to a hydrothermal field.

Toshitaka GAMO
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1.3. Biological studies

1.3.1. Historical background of the deep-sea hydrothermal vent communities in the Indian Ocean

The Indian Ridges, together with the Arctic and Antarctic Ridge, remained to be surveyed for the occurrence of hydrothermal vent communities. Japanese scientists have been engaged extensively in the exploration and survey of hydrothermalism in back arc basins and on volcanic arcs in the Western and the Central Pacific, together with the cold seepage along the subduction zones. Vent fields of the Eastern Pacific and Central Atlantic have been also extensively pursued mainly by European groups (see reviews by Tunnicliffe, 1991; Tunnicliffe and Fowler, 1996). The finding of active hydrothermalism and vent-associated biological communities in the Indian Ocean has been highly expected to depict the global distribution map of the chemosynthetic biological communities. The essential concerns of marine biologists are, 1) what kind of biological communities are found in the vent fields on the mid-oceanic ridges in the Indian Ocean? 2) is the faunal composition or the lineage of the Indian Ocean hydrothermal vent communities either related more to the Atlantic-type or to the Pacific-type, or else completely new ones?

In 1993, during the KH-93-3 cruise of Hakuho-maru, Ocean Research Institute, the University of Tokyo, intensive surveys using tow-yo operation of CTDT-multi-rosette system (operated mainly by geochemical party), and following operations of deep-tow observation platform called DESMOS (operated mainly by biological party) were conducted to locate the presence of hydrothermal plumes and present-day hydrothermalism on a eastern crestal ridge at 25°19'S, 70°03'E on the 1st segment of the Central Indian Ridge (CIR) near the Rodriguez Triple Junction. Although a clear hydrothermal plume was found around the area at the water depths between 2200 and 2400m, the direct bottom surveys failed to locate the vent sites on the projected area (Tamaki *et al.*, 1993; Tamaki and Fujimoto, 1995; Gamo *et al.*, 1996).

Later, massive sulfide deposits containing entombed worm tubes have been found near the Rodriguez Triple Junction at 23° to 24°S (Halbach *et al.*, 1996). In 1996, a new species of the stalked barnacle *Neolepas* (Cirripedia: Pedunculata) was collected

by dredge on the Southeast Indian Ridge, which is an intermediate-rate spreading center (Scheirer *et al.*, 1996a & b), and thought to constitute strong evidence for the presence of active venting (Southward *et al.*, 1997: concerning the barnacle, see review by T. Yamaguchi).

The first manned submersible investigations of the mid-ocean ridges in the Indian Ocean were carried out in September-October 1998 during the INDOYO cruise with the submersible *Shinkai 6500* and the *R/V Yokosuka*. The cruise objectives were to obtain detailed information about accretionary processes along the South-west Indian Ridge (SWR) and to locate hydrothermal vent sites in the Indian Ocean. The SWIR, separating the African and Antarctic plates, opens at the ultra-slow half rate of 7 to 8mm/year. A series of transmissiometers mounted on the TOBI-deep tow sidescan and the tow cable during the preceding FUJI cruise documented several signals interpreted as hydrothermal plumes (German *et al.*, 1998). However, no indication of hydrothermal activities were found other than the extinct sites on the Mt. Jourdanne, and we moved to the CIR near the triple junction. Two dives were focused on the crestal volcanic knoll at 25°19'S, 70°03'E, where the most fresh hydrothermal plume observed in 1993 had been expected to converge from the analysis of CH_4/Mn ratio (Gamo *et al.*, 1996). During the dive#456 of *Shinkai 6500* (observer S. Ohta) heaps of dead shells were found just on the landing site of bare flat lava with intense ferro-manganese encrustation (25°18.618'S, 70°01.572'E, 11:11 2576m). The collected shells (two half valves) were revealed to belong to two new species of the giant clam, *Calyptogena* (Ohta, 1998b & c). Based on the observations, 1) degree of encrustation of ferro-manganese oxides and degree of shell erosion differed from heap to heap, 2) many conjugated and rather intact shells, and 3) the bed seems to be arrayed on a supposed fault plane adjacent to a distinct and sharp escarpment, the heap can safely be regarded as *in situ* biological communities bound to historical hydrothermal activity of not so long ago. Three wide grabens found on the southwestern flank below the crest were very shallow and flat. Two of them were dipping to the crest, and one was dipping toward the skirt. The site where dead community of *Calyptogena* was situated at the junction of the toe of mixture of debris and sheet flows and relatively large stand of sediment. Pronounced vertical escarpments of the 20 to 70m in altitude were found a few hundred meters apart and trending parallel to the array of the *Calyptogena* beds. Rather near to the dead *Calyptogena* beds, we

found a small scarp supposedly composed of or covered by sulfides or greenish-brown clay minerals. The main body of chimney-like structure fallen into the deep during sampling, and the retrieved blocks from the second small "chimney-like" structure revealed to be of almost pure manganese precipitates. And, during this and the following dive #457, transmission anomalies of 0.5% were observed at the end of both dives. This anomaly was significant, about 5 times larger than those observed in 1993, probably because the surveyed area is much closer to a venting site. In addition, the CTD attached to *Shinkai 6500* detected bottom temperature anomalies of about 0.05°C at a location close to that of the observed transmission anomalies (Sohrin, 1999). These observations suggested the existence of current hydrothermal activity around the survey area. High density of predatory fishes (such as *Acanthonus armatus* and *Halosauropsis macrochir*?, deep-sea cod of *Lepidion*-type, *Bathysaurus*, brotulids and macrourids in the order of abundance), and suspension feeders (such as *Marianactis*-type sea anemones and scalpellids), and occurrence of vent-affiliated species (such as the deep-sea galatheid *Munidopsis*) in the survey area supported the near-by occurrence of unequivocal present-day hydrothermalism. Low density of vent-phobic organisms such as echinoderms in general (with the exception of brisingid asteroid and some synaptid holothurian) also support this idea.

At that stage, occurrence of *Calyptogena* probably as one of the dominant and influential species at the vent sites suggested the idea that vent communities expected on the mid-oceanic ridges in the Indian Ocean might be more related to those of the Pacific than to those of the Atlantic; in other words, the main propagation rout of possible Indian vent organisms might either be via the mid-oceanic ridge connecting the Indian Ocean and the Pacific, or via any other possible route including cold seeps along subduction zones (see also Hessler and Lonsdale, 1991). Therefore direct finding and characterization of hydrothermal vent communities became more and more expected to depict the global distribution map of chemosynthetic communities and their propagation mechanisms and evolution.

This historical background was the greatest incentive to realize the present cruise for the direct finding of the hydrothermalism and vent-associated biological communities in the Indian Ocean.

On the other hand, the biological team of the Ocean Research Institute, the University of Tokyo conducted general deep-sea ecological surveys in the Indian Ocean, from the bayhead of the Bay of Bengal to the equatorial area during KH76-W, and in the eastern half of the Indian Ocean during the trans-world cruise KH8X-Y. And we had experienced to search and observe the biological communities on ridge axis with manned submersible during the MODE '98 Leg 3 (Ohta, 1998a & b). Those data and background knowledge together with that of H.M.S. *Challenger* and Royal Indian Survey Ship *Investigator* might afford sound bases for appreciation of the finding of chemosynthetic biological communities in the Indian Ocean.

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1.3.2. Historical studies on the deep-sea hydrothermal vent barnacles

Hydrothermal vent barnacles of the Pacific:

The first deep-sea hydrothermal vent barnacle, *Neolepas zevinae* Newman, 1979 (suborder Scalpellomorpha) was described from the 10°N on the East Pacific Rise, at depths of approximately 2,100 m (Newman 1979, 1997). The *Neolepas* is the most primitive living scalpellomorph known. Scalpellomorph have the peduncle as well as the capitulum armored with eight calcareous capitular plates. They appeared in the Triassic (Buckeridge and Grant-Mackie 1985) and are near the base of the clade that gave rise to the first sessile barnacles, the brachylepadomorphs. *Neolepas rapanuii* Jones, 1993 was known from near Easter Island and other members of this group have been found in the Lau, North Fiji, Manus Basins, Okinawa Trough, Izu-Mariana Ridge and off North Island of New Zealand (pers. obs.; Newman and Ross 1998, W.A. Newman, J.S. Buckeridge, pers. comm.).

The second deep-sea hydrothermal vent barnacle, *Neoverruca brachylepadoformis* Newman, 1989 (suborder Verrucomorpha) was described from the Mariana Back-Arc Basin, west Pacific, at depths of approximately 3,600 m. Verrucomporphs are asymmetrical sessile barnacles. The *Neoverruca* is distinguished from all previously known verrucomorphs in having basal whorls of imbricating plates surrounding the wall and an opercular plates incuding a median latus. The basic organization of the armament is identical to that of the Brachylepadomorpha, but during ontogeny one side becomes asymmetrical in all Verrucomorpha. Therefore, *Neoverruca* is the most primitive living Verrucomorpha, represents the "missing link" between the suborder Brachylepadomorpha and the remainder of the Verrucomorpha.

The third deep-sea hydrothermal barnacle, *Eochionelasmus ohtai* Yamaguchi, 1990 (suborder Balanomorpha) wad described from the North Fuji Back-Arc Basin, southwest Pacific, at depth of approximately 1,900 m (Yamaguchi and Newman 1990, Galkin 1992). It is distinguished from its only close relative, *Chionelasmus darwini*, an Indo-West Pacific bathyal species, in having multiple whorls of unspecialized basal imbricating plates, which is a generalized or primitive morphological character (Yamaguchi and Newman 1990, Yamaguchi 1998). Therefore it was evaluated as the

most primitive living member of the suborder Balanomorpha. *Eochionelasmus* represents the most primitive living balanomorphs. Since then, *Eochionelasmus ohtai* has been discovered at two other hydrothermal sites; one at the Lau Basin (west of the Tonga Islands; Desbruyères et al. 1994) and the other from the Manus Basin (north of Papua New Guinea; Tufar 1990, Galkin 1992a,b). These are back-arc basins, separated from the North Fiji Basin by approximately 1200 km east and 3000 km northwest respectively. Back-Arc Basins are, unlike mid-oceanic ridges, discreet unites unconnected with each other. Despite this, the three populations of *Eochionelasmus* differ little in external appearance, except for some small but distinct difference in the ontogenetic development of the imbricating plates in the Manus population. Therefore, while it has been concluded that the North Fiji and Lau Basins populations represent the same form *E. ohtai ohtai*, *E. ohtai manusensis* Yamaguchi and Newman is being proposed for the Manus population (Yamaguchi and Newman, 1997, Hashimoto *et al.*, 1999). *Eochionelasmus paquensis* Yamaguchi and Newman, 1997 was described from 17°S of East Pacific Rise, near Easter Island and is not only the first record of a sessile vent barnacle from the East Pacific, it also the first from a mid-ocean ridge. This discovery corroborates the hypothesis that biotic exchange between mid-ocean ridges and back-arc basins occurs relatively infrequently or was curtailed a long time ago (Yamaguchi and Newman 1997).

The fourth deep-sea hydrothermal vent barnacle, an extant representative of the Brachylepadomorpha, *Neobrachylepas relica* Newman and Yamaguchi, 1995 (Suborder Brachylepadomorpha) has been discovered from hydrothermal vents in the Lau Back-Ark Basin, at the depth of approximately 1750-1890 m. The suborder, comprising the earliest sessile barnacles, appeared in the Jurassic. It underwent a modest diversification before the close of the Cretaceous, when it began to decline concomitant with the origin and diversification of modern sessile barnacles (Verrucomorpha and Balanomorpha) as well as certain shell-crushing predators, and it has been absent from the fossil record since the Miocene. Thus *Neobrachylepas* is unique among previously known hydrothermal vent barnacles, *Neolepas*, *Neoverruca* and *Eochionelasmus*, in being the only known living member rather than simply the most primitive living member of its respective suborder. The Lau Basin fauna includes representatives of all four of these suborders and thus represents the most diverse cirriped fauna of any known

hydrothermal vent community.

Hydrothermal barnacles of the Indian Ocean:

The first biological evidence of hydrothermal venting on the Southeast Indian Ridge of the Indian Ocean was reported by Southward *et al.* (1997). The evidence was reported the occurrence of a new species of the *Neolepas* from 2770 to 2800 m depth at the 41°14.95'S, 79°06.04'E, near the Amsterdam-St. Paul Plateau.

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2. Methods

2. 1. 4000m-class deep tow camera system

The 4000m-class deep tow camera system was developed in 1982 to carry out site surveys associated with the manned submersible *Shinkai 2000*. The system is composed of the underwater unit and the onboard unit. A color video camera of underwater unit transmitted video signals through a 4500m long coaxial cable. The average swath of the video camera is approximately 2.2m, when the underwater unit is towed about 3m above the seafloor. During this cruise, the deep tow camera system with a developed water sampling unit was used for tow-yo surveys. The positions of both ship and underwater unit are fixed by means of D-GPS (WGS 84) and transponder navigation in SSBL (Super short base line) method, respectively. The receiving frequency of the transponder was 14.5 kHz and the transmit frequency was 13.0 kHz. The details of the camera system are as follows;

(1) Underwater unit

Underwater unit includes an ultra high sensitive (super-HARP) color video camera (minimum luminous intensity: 0.1 lux), a black and white video camera, four underwater lights (Deep Sea Light 250 W), two still cameras (Benthos model: 372A), two strobe lights (Benthos model: 382), a CTD (SeaBird model: SBE9plus; Temperature, Range: -5.0 to +35¡, Resolution: 0.0003¡, Initial Accuracy: ±0.001¡; Conductivity, Range: 0.0 to 7 S/m, Resolution: 0.00004S/m, Initial Accuracy: 0.0003S/m; Oxygen, Range: 0 to 15ml/l , Resolution: 0.01ml/l , Initial Accuracy: 0.1ml/l; Transmissometer, Water path: 25cm , Wavelength: 660nm , Initial Accuracy: <0.3%full-scale), a DO-meter (SeaBird model: SBE13-02), a transmissometer (Alphatracka model: MK II), an altimeter (Datasonic model: PSA-900D), an acoustic transponder (OKI model: SB-1017A, U/C: 700 C/C-16) and a releaser (InterOcean model: MR5000B). It can also be equipped when necessary with a dredge box and/or a responder. These equipments are installed on an open frame made of iron pipe. The weight of this unit is 500 kg in water, 700kg in air. Dimensions of this unit are 3500mm in length, 1100mm in width, 1450mm in height.

Attached direction of the color video camera viewing frame is vertical and it is

usually used to observe seafloor. The black and white video camera is used to monitor the forward direction, usually to watch for obstacles. During a series of the tow-yo surveys of this cruise, the black and white video camera was used for monitor of the water sampling unit.

(2) Onboard unit

The onboard unit consists of an electric communication part, a power supply part, a CTD control part, a picture conversion part, a super impose part and a video recording part. These parts are installed in a container, which is well air conditioned to prevent moisture damage. The electric power adjustment, the controlling of video and still cameras and the CTD operation take place in this container. The super impose system can display nine items (date, time, survey line number, altitude, cruse number, CTD depth, salinity, temperature and photo number) overlaid on the video image. The video image can be recorded simultaneously on up to two video cassette recorders.

(3) Water sampling unit

Twelve Niskin bottles (2.5 litters) installed in an open iron frame are used for this sampling unit. A stepping motor with the internal batteries (DC15V) is used for the trigger part. The trigger is actuated by the electric signal (400 mA/5s) through a coaxial cable from the onboard unit of the deep tow camera system. Dimensions of this unit are 2250mm in length, 1150mm in width and 615mm in height.

The water sampling unit attached with the underwater unit of the deep tow camera system is shown in Fig. 2.1.1.

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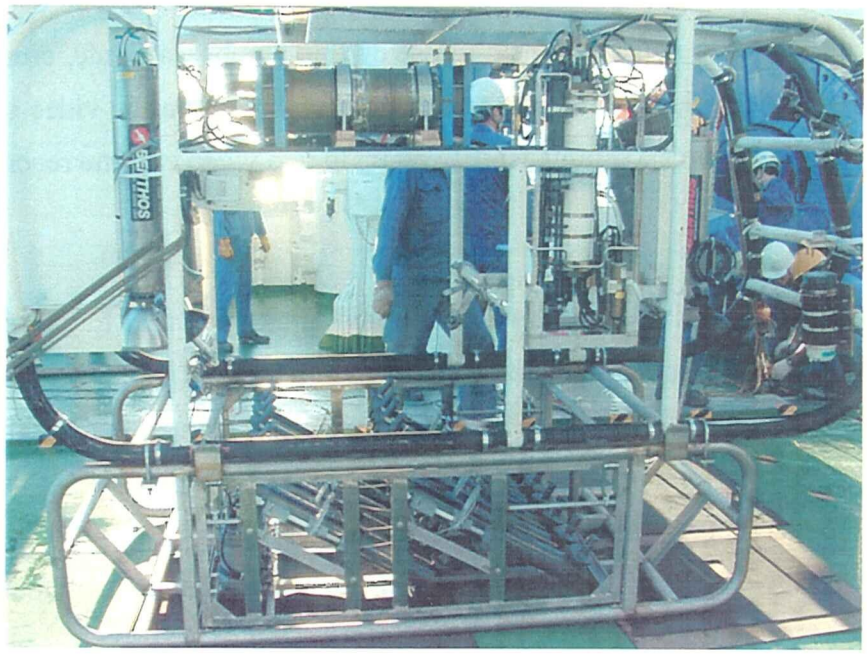


Fig. 2.1.1 4000m-class deep tow camera system attached with the water sampling system.

2. 2. R/V "*Kairei*" / ROV "*Kaiko*"

2. 2. 1. R/V "*Kairei*"

The deep-sea research vessel "*Kairei*" (meaning "ridge") is designed to engage in surveying deep-sea bottoms such as trenches by serving as the exclusive mother ship for the 10000m-class remotely operated vehicle "*Kaiko*" (meaning "trench") which entered service in 1995. In addition, the "*Kairei*" is equipped with varied devices for studying deep-sea bottom surface layers, faults and other geological morphologies, making it fit for integrated research in trenches and other sea floor areas of the world.

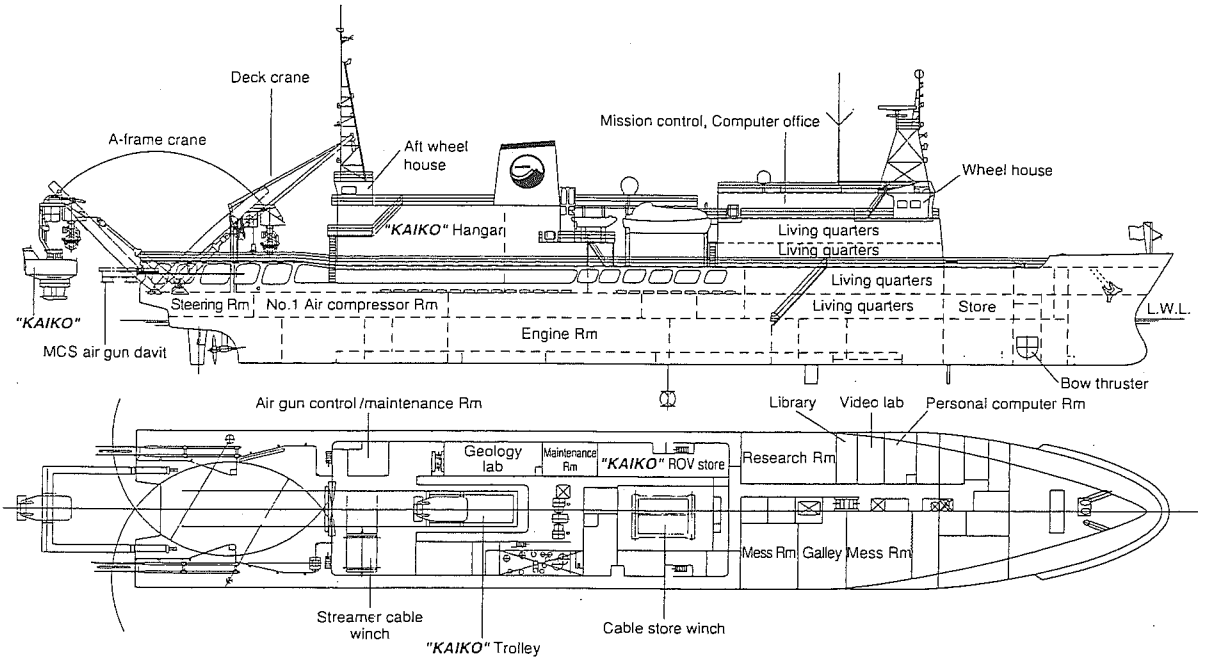


Fig. 2. 2. 1. General arrangement of the R/V "*Kairei*"

The principal particulars of the "*Kairei*" are as follows;

- •Length: 105 m
- •Breadth: 16.0 m
- •Depth: 7.3 m
- •Draft: 4.5.
- •Gross tonnage: 4628 tons
- •Service speed: 16.7 knots
- •Endurance: approx. 9600 nautical miles (approx. 17800 km)
- •Main engine: Diesel engines, 2×approx. 2206kW×600 rpm
- •Propulsion system: Twin CPP, Bow thruster, Joystick control system
- •Complement: Crew 29, Scientists and others 31 / Total 60

The main equipments of the "*Kairei*" are as follows;

(1) Exploration equipments

- multi-channel seismic profiler
- sub-bottom profiler
- gravity meter
- three-component magnetometer
- psiton core sampler
- observation winch (fitted with heave damper)
- sediment sampler

(2) Exploration support equipments

- acoustic navigation device
- multi-narrow beam echo sounder (SeaBeam 2100)
- radio navigation device (GPS, etc.)
- XBT
- LAN system
- satellite image receiving device (NOAA, GMS, etc.)

(3) Laboratories, etc.

- mission control & computer office
- geophysics laboratory
- chemistry & biology laboratory
- research room
- geology laboratory
- gravuty meter room
- video laboratory
- personal computer room
- library

2. 2. 2. ROV "*Kaiko*"

The 10000m-class ROV "*Kaiko*" system has been developed for use in deep-sea research that has not been possible by the existing manned submersibles for reason of ocean depths or sea floor topographies. The system will also be used for pre-site surveys for the manned submersible *Shinkai 6500*.

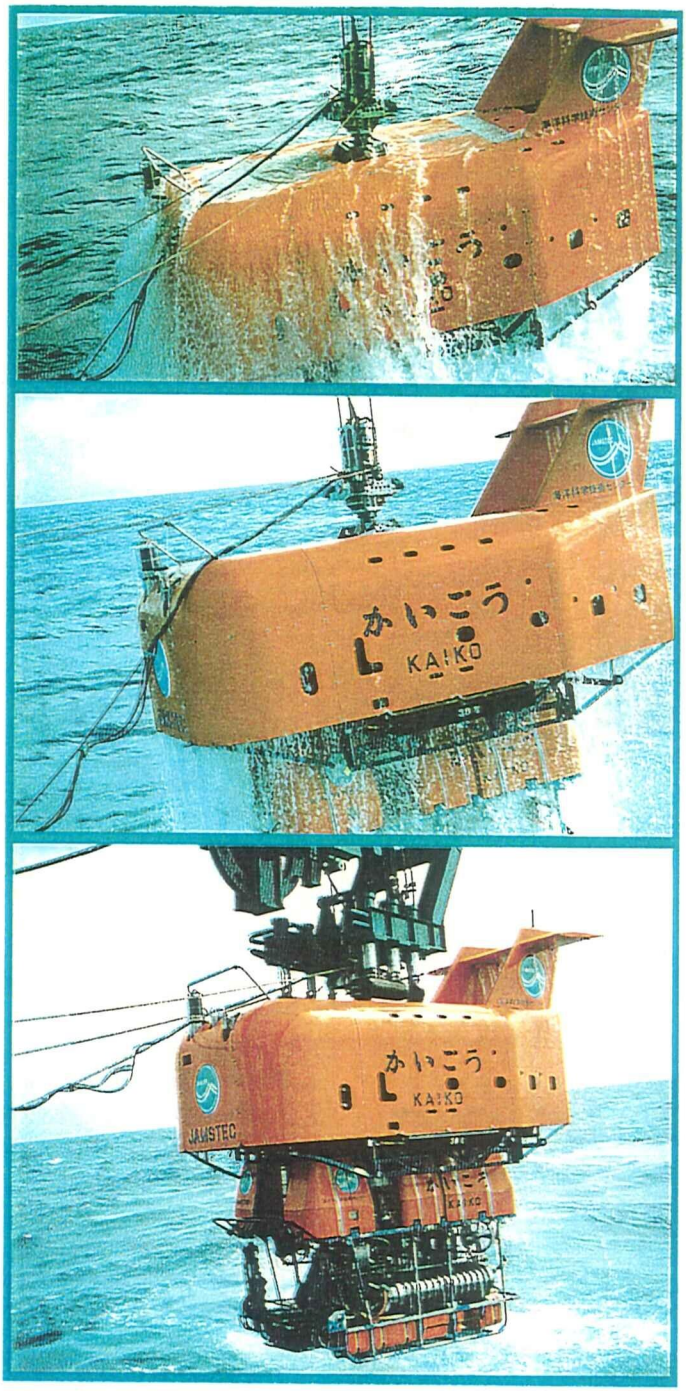
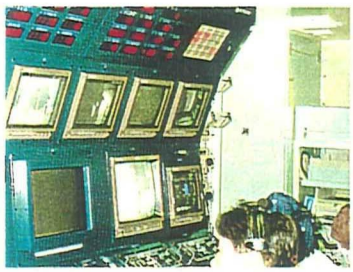


Fig. 2. 2. 2. The ROV "Kaiko"

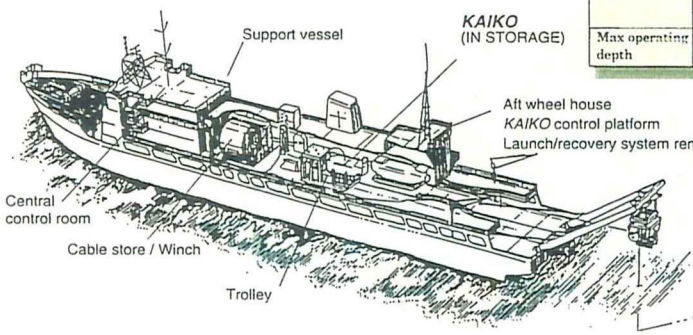


KAIKO Control Platform

Four operators steer *KAIKO* while monitoring video and other information sent real time from *KAIKO's* TV camera and sensors.

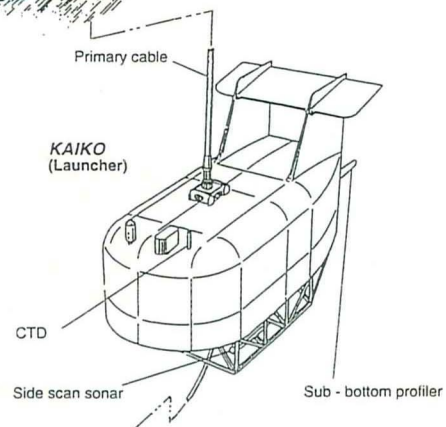
Principal Items of Vehicle and Lancher

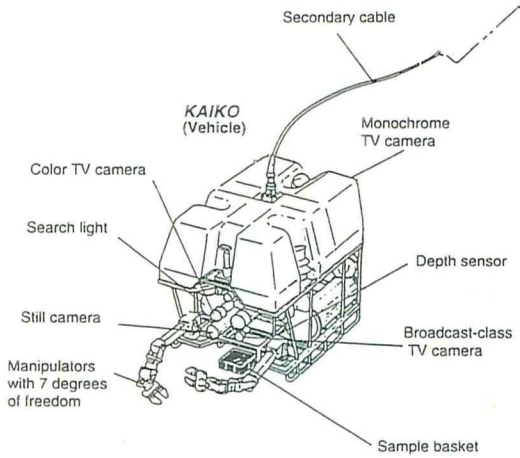
	Vehicle	Launcher
Dimensions L×W×H(m)	3.1×2.0×2.3	5.2×2.6×2.0
Weight	5.4 tons in air -10kg in water	5.1 tons in air 3.1 tons in water
Power	Electro-hydraulic (45kw)	—
Speed	2 knots	1.5 knots (tow speed)
Propulsion	4 horizontal thrusters 3 vertical thrusters	—
Equipment	· Broardcast-class TV camera · 3 color TV camera · Monochrome TV camera · Still camera · Obstacle avoidance sonar · Altitude sonar · Depth sensor · 2 manipulators	· Side scan sonar (range: 1,000m each side) · Sub-bottom Profiler · CTD · Obstacle avoidance sonar · Altitude sonar · Depth sensor · LBL receiver · SSBL receiver
Max operating depth	About 11,000m	



Cable Store/Winch

A reel of 12,000m primary cable
Drum Width: 4,500mm
Drum Diameter: 4,544mm





■CTD

To measure seawater Conductivity, Temperature and Depth

■Side Scan Sonar

To measure sea floor topography by transmitting fan beam underwater acoustic waves and receiving the reflections.

■Sub-Bottom Profiler

To measure the stratum about 30m down beneath the sea floor using underwater acoustic waves.

Fig. 2. 2. 3. The main components of the "*Kaiko*".

2. 3. Methods for water chemistry

2.3.1. Tow-yo observation and hydrothermal plume sampling

The JAMSTEC 4000 m-class Deep Tow camera system (see section 2.1) was towed by R/V *Kairei* at a speed of 0.5-0.7 knot, drawing a saw-toothed pattern within an appropriate depth interval like yo-yo playing to obtain two dimensional parameter anomalies along the ship track (tow-yo observation). Hydrothermal plume samples were taken with 12-liter Niskin bottles attached to the 4000 m-class Deep Tow camera system, when the CTD transmissometer detected significant transmission anomalies during the tow-yo operations.

2.3.2. Hydrothermal fluid sampling

Hydrothermal (black smoker) fluid samples were taken with Alvin-type samplers. The Alvin-type titanium syringe sampler (Von Damm *et al.*, 1985) was developed by B. Walden of the Alvin operation group in 1981, for the purpose of taking venting fluid samples by the submersible *ALVIN* (Woods Hole Oceanographic Institution). One syringe (115 mm i.d., 170mm long) can hold about 750 mL of venting fluid. A spring-loaded piston is drawn in and secured by means of a firing pin and valve system attached to the main body of the sampler. A T-handle is attached to the sampler and an approximately 30 cm long snorkel leads from the inlet valve. The snorkel must be properly inserted inside an orifice or fissure of fluid venting in order to take original fluid samples.

Although this sampler needs a hydraulic ram on the manipulator to push the triggering pin forward 2 to 3 cm, *Kaiko* manipulators (arms) are not equipped with such an apparatus. Instead, we altered the triggering system of the sampler by attaching two metal disks (~100 mm in diameter), one for the valve cylinder body and the other for the actuating pin. The left arm of the *Kaiko* holds the T-handle of the sampler and the right arm nips the two disks to push the triggering pin into the valve cylinder.

The inside of the sampler was cleaned before each dive using NAPA Electric Motor Cleaner 765-1603 (Balkamp Inc., USA), and O-rings inside the sampler were greased using Shin-etsu G-30M Silicone Grease. The dead volume inside the sampler

was filled with ambient bottom seawater taken during the tow-yo observations.

2.3.3. Sediment sampling

Sediment samples were collected with a Masuda-type sediment sampler (Figure 2.3.1). This sampler is made from plexiglas pipe. One end of the pipe has a trigger mechanism to close a lid at the other end, which is kept open against tension of rubber tubing during sampling. This sampler is held open-end up on a sample basket of *Kaiko*, and sediment sample is scooped up from the seafloor by a manipulator. After sampling, the lid is closed by pushing the trigger pin. This sampler can also be used for ambient water sampling.

2.3.4. Shipboard chemical analysis

The hydrothermal fluid samples were analyzed for titration alkalinity, pH, dissolved silica, and NH_4. Methane and pH were measured for a part of the hydrothermal plume samples. Analytical methods are briefly described below.

A pH meter (Corning, Ion Analyzer 250) with a 3mm electrode (Iwaki) was used for pH measurement. Phtalate pH (=4.01 at 25°C) standard solution and phosphate pH (=6.86 at 25°C) standard solution (WAKO) were used for calibration.

Titration alkalinity was potentiometrically measured with the same pH meter and an auto-titrator (Metrohm, 665 Dosimat). The titrant was 0.1 mol/l HCl solution (WAKO, Factor (at 20°C) = 1.005). Alkalinity values were calculated using the usual Gran plot method (e.g., Gamo and Gieskes, 1992).

Silica concentration of the sample waters was measured by the following colorimetric silico-molybdate blue method method (e.g., Gamo and Gieskes, 1992). 0.5 ml of the sample water was mixed with 0.5 ml of deionized water and 1.0 ml molybdate in a plastic vial. After 15 min. 1.5 ml of reducing solution (metol-sulfite solution + oxalic acid solution + sulfuric acid) was added. Then, the vial was sealed and shaken. After less than 2 hours, absorption of visible ray at 812 nm for the solution in the vial was measured with a spectrophotometer (Shimadzu, UV-1200). CSK Inc. standard solutions for silicate were used for calibration. Salinity of the solution was adjusted to that of seawater. Detection limit during this cruise was approximately 2 μM.

Ammonia concentration of the sample waters was measured by the following colorimetric method (e.g., Gamo and Gieskes, 1992). 0.1 ml of the sample water was

diluted by 1.0 ml of deionized water in a plastic vial. 0.5 ml of phenol/ethanol (0.4 g / 50 ml), 0.5 ml of sodium nitroprusside solution, and oxidizing solution (sodium hypochlorite diluted with alkaline solution, making from trisodium citrate and sodium hydroxide) were added in turn. Whenever each solution was added, the vial was shaken. After less than 1 hour, absorption of visible ray at 640 nm for the solution in the vial was measured with a spectrophotometer (Shimadzu, UV-1200). Standard solutions were made from 1000 mM NH_3Cl stock solution. Detection limit during this cruise was approximately 10 μM.

Determination of methane was conducted using an automated methane analysis system (DKK corporation, GAS-1061). The scheme of the system is illustrated in Fig.2.3.2. The system consists of three parts, a purge unit, a trap unit, and a FID gas chromatograph (GC). An intelligent integrator (Shimadzu, CR-6A) was used to control the time of all the valve procedures sequentially. A constant volume (40 mL) of a seawater sample in the glass vial (B) was transferred into an extraction bottle (D) by replacement by hexane. Methane was stripped from seawater by continuous purging with helium gas and collected in a charcoal trap (G), which is cooled to –40°C by a thermoelectric refrigerator touching the trap. Methane was released by heating the trap to 120°C, injected into the GC (Yanaco, G250), and detected by the FID after separation by a packed column (Porapak Q 60/80 mesh, 3 mm i.d. X 4 m) at an oven temperature of 30°C. Sensitivity of the FID was calibrated every day using a working standard gas (120.4 ppm CH_4 in N_2 gas).

2.3.5. Plume observation during the *Kaiko* dives

A CTD system with an oxygen sensor, fluorometer and a transmissometer was mounted in the *Kaiko* launcher during the dives #167 and #170. The *in situ* data were recorded in a solid-state memory inside the CTD pressure housing and transferred to a personal computer after the dives. The CTD used was a SEALOGGER CTD SBE 25-02 (Sea-Bird Electronics). The conductivity sensor was a SBE 4C 6800 m. The temperature sensor was a SBE 3F 6800 m. The pressure sensor was a SBE 29. The dissolved oxygen sensor was a SBE 23B. The fluorometer was a Seapoint Chlorophyll Fluorometer (Seapoint Sensors, Inc). The transmissometer used was a WETLabs C-Star 25 cm. During the measurement, the submersible pump (SBE 5T) circulated seawater through the temperature, conductivity, dissolved oxygen, and fluorometer sensors. The ON/OFF

slide switch on the CTD pressure housing was manually turned on just before the launching of *Kaiko*, and turned off just after the recovery of *Kaiko* on board *Kairei*. The computer for data recovery and data processing on board *Kairei* was a VAIO PCG-733_A (SONY).

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Fig. 2.3.1 Masuda-type sediment sampler made of plexiglas pipe.

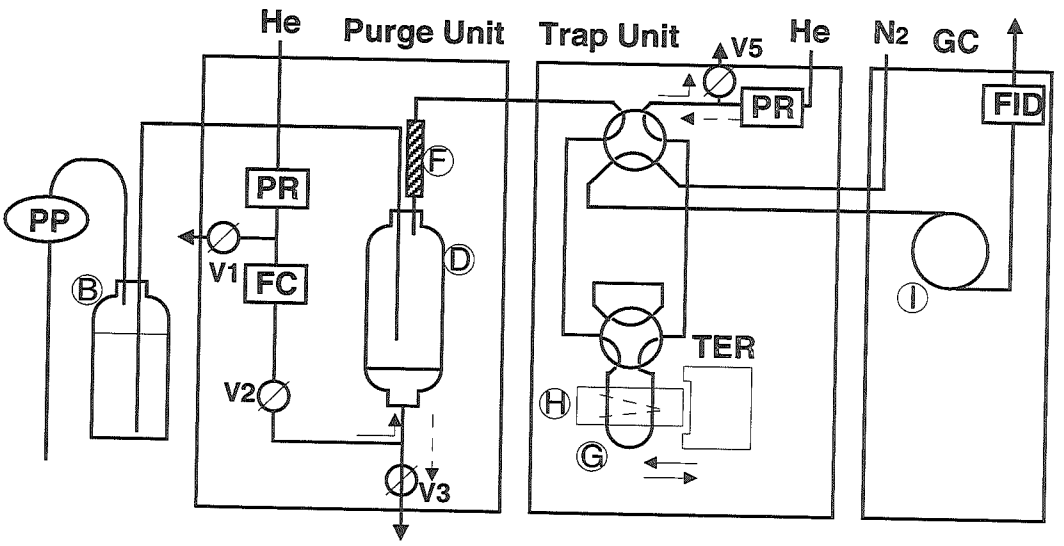

Fig.2.3.2. The automated methane analysis system (DKK corporation, GAS-1061)

3. Video Logs

3.1. Video logs of the tow-yo system operation

The tow-yo observation (see Section 2.3) was performed eight times (TY01~08) along the tracks shown in Fig.3.1.1 between 11th and 17th August. Temperature, salinity, dissolved oxygen and light transmission were measured with the CTD system (see Section 2.1.). Hydrothermal plume samples were taken during the first three tow-yo operations (TY02, 03, and 04). Tables 3.1.1., 3.1.2., and 3.1.3. are the logs for these tow-yo observations. Logs for the other tow-yo observations (TY04, 05, 06, 07 and 08) are included in those for the deep-tow TV surveys (see Section 3.2.).

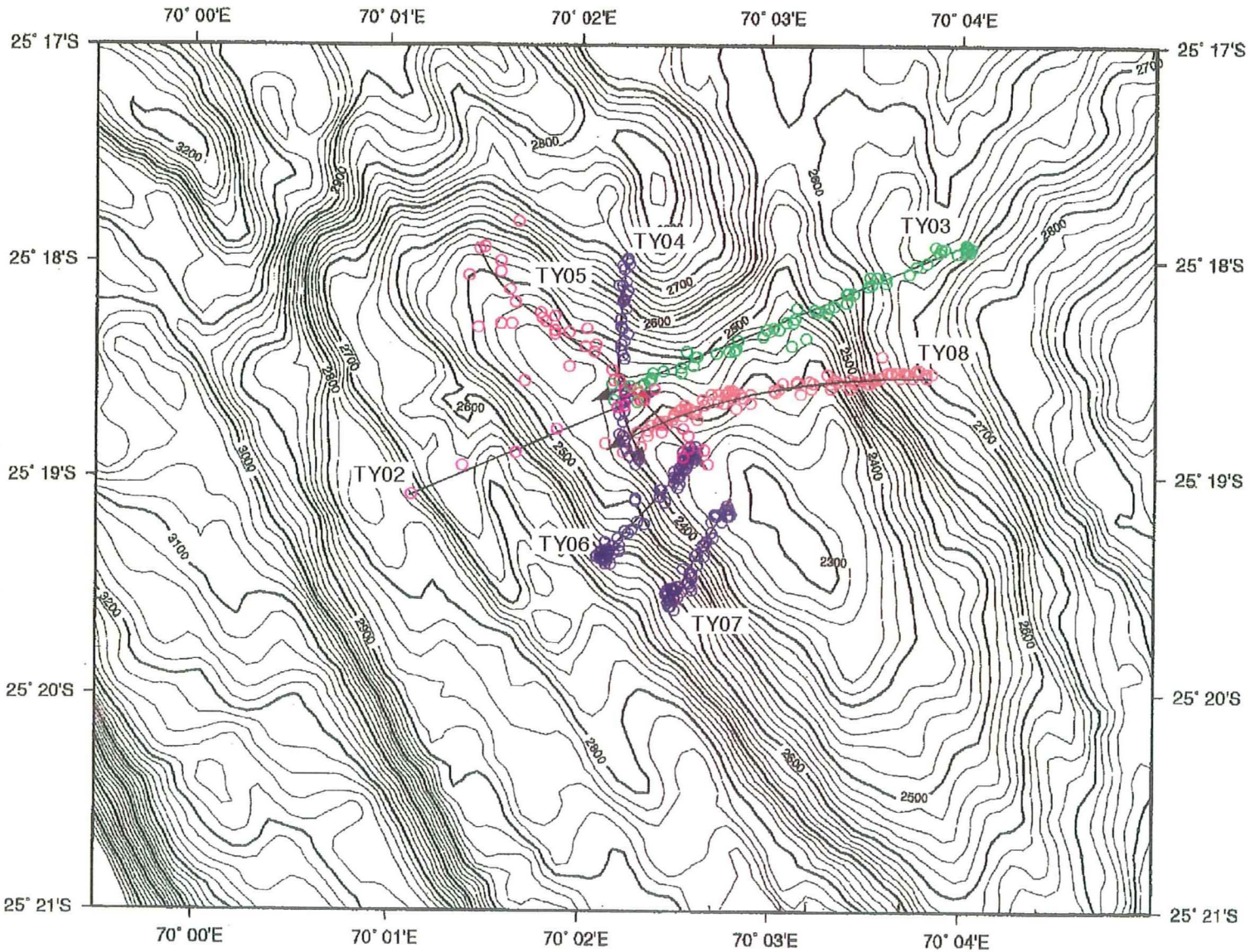

Fig. 3.1.1. Tow-yo observation tracks (TY02~08) between 11th and 17th August.

Table 3.1.1. Video logs for TY-01and 02 in 11 August, 2000.

Time	Observation	Positiion	Depth	Transmission Anomaly
6:30	Start KR00-05-TY01	(Interrupted by troubles in electrical system and transmissometer)		
9:17	Finish KR00-05-TY01			
	KR00-05-TY02			
12:00	Start D01			
13:22	Bottom in sight (Finish D01)			
13:27	Start U01			
|	|			
14:05	Finish U01			No
14:08	Start D02			
|	|			
14:36	Finish D02			No
14:41	Start U02			
|	|			
15:12	Finish U02			No
15:14	Start D03			
15:31	Water sampling No. 2 (TY02-2)	25° 19.06'S. 70° 01.11'E	2180 m	-0.05%
15:41	Finish D03			
15:43	Start U03			
15:56	Water sampling No. 3 (TY02-3)	25° 18.95'S. 70° 01.38'E	2143 m	-0.10%
16:07	Finish U03			
16:09	Start D04			
16:19	Water sampling No. 5 (TY02-5)	25° 18.88'S. 70° 01.66'E	2188 m	-0.10%
16:25	Finish D04			
16:28	Start U04			
16:39	Water sampling No. 7 (TY02-7)	25° 18.79'S. 70° 01.88'E	2171 m	-0.20%
16:39	Water sampling No. 9 (TY02-9)	25° 18.79'S. 70° 01.88'E	2171 m	-0.20%
16:49	Finish U04			
16:53	Start D05			
17:03	Water sampling No. 10 (TY02-10)	25° 18.67'S. 70° 02.21'E	2167 m	-0.30%
17:06	Water sampling No. 11 (TY02-11)	25° 18.64'S. 70° 02.25'E	2263 m	-0.20%
17:10	Finish D05			
17:13	Start U05			
17:19	water sampling No. 12 (TY02-12)	25° 18.61'S. 70° 02.39'E	2156 m	-0.40%
18:01	Finish KR00-05-TY02			

Table 3.1.2. Video log for TY-03 in 12 August, 2000.

Time	Observation	Positiion	Depth	Transmission Anomaly
6:58	Start KR00-05-TY03			
7:45	Start D01			
|	|			No
8:08	Finish D01			
8:13	Start U01			
|	|			No
8:31	Finish U01			
8:35	Start D02			
|	|			No
8:53	Finish D02			
8:55	Start U02			
9:03	Water sampling No. 12 (TY03-12)	25° 28.16'S, 70° 03.40'E	2239 m	-0.15%
9:13	Finish U02			
9:14	Start D03			
9:30	Water sampling No. 1 (TY03-1)	25° 18.28'S, 70° 03.12'E	2282 m	-0.15%
9:34	Finish D03			
9:35	Start U03			
9:41	Water sampling No. 3 (TY03-3)	25° 18.32'S, 70° 03.01'E	2240 m	-0.15%
9:52	Finish U03			
9:54	Start D04			
10:01	Water sampling No. 5 (TY03-5)	25° 18.40'S, 70° 02.70'E	2175 m	-0.35%
10:12	Finish D04			
10:13	Start U04			
10:21	Water sampling No. 6 (TY03-6)	25° 18.49'S, 70° 02.56'E	2188 m	-0.60%
10:27	Finish U04			
10:29	Start D05			
10:34	Water sampling No. 8 (TY03-8)	25° 18.52'S, 70° 02.37'E	2183 m	-0.70%
10:34	Water sampling No. 7 (TY03-7)	25° 18.52'S, 70° 02.37'E	2194 m	-0.70%
10:40	Water sampling No. 10 (TY03-10)	25° 18.57'S, 70° 02.34'E	2264 m	-0.40%
10:41	Water sampling No. 9 (TY03-9)	25° 18.57'S, 70° 02.34'E	2271 m	-0.20%
10:45	Finish D05			
10:48	Start U05			
10:54	Water sampling No. 11 (TY03-11)	25° 18.62'S, 70° 02.18'E	2213 m	-0.45%
11:55	Finish KR00-05-TY03			

Table 3.1.3. Video log for TY-04 in 12 August, 2000.

Time	Observation	Positiion	Depth	Transmission Anomaly
13:31	Start KR00-05-TY04, D01			
14:32	|	25° 17.99'S, 70° 01.52'E	2140 m	-0.10%
14:38	Finish D01 (2400 m deep)			
14:42	Start U01			
14:49	Water sampling No. 4 (TY04-4)	25° 18.01'S, 70° 01.63'E	2120 m	-0.15%
14:52	Finish U01 (2000 m deep)			
14:54	Start D02 (2000 m deep)			
14:58	|	25° 18.19'S, 70° 01.70'E		-0.20%
15:06	Finish D02 (2400 m deep)			
15:08	Start U02 (2400 m deep)			
15:16	Water sampling No. 2 (TY04-2)	25° 18.27'S, 70° 01.82'E	2168 m	-0.60%
15:17	Finish U02 (2171 m deep)			
15:24	Start D03 (2000 m deep)			
15:31	Water sampling No. 5 (TY04-5)	25° 18.38'S, 70° 01.97'E	2190 m	-0.80%
15:36	Finish D03 (2400 m deep)			
15:39	Start U03 (2400 m deep)			
15:47	Water sampling No. 6 (TY04-6)	25° 18.48'S, 70° 02.16'E	2196 m	-0.85%
15:53	Finish U03 (2000 m deep)			
15:55	Start D04 (2000 m deep)			
16:01	Water sampling No. 7 (TY04-7)	25° 18.61'S, 70° 02.25'E	2194 m	-0.60%
16:07	Water sampling No. 8 (TY04-8)	25° 18.61'S, 70° 02.32'E	2208 m	-1.00%
16:11	Finish D04 (2330 m deep)			
16:14	Start U04 (2330 m deep)			
16:19	Water sampling No. 9 (TY04-9)	25° 18.72'S, 70° 02.43'E	2205 m	-0.85%
16:26	Finish U04 (2000 m deep)			
16:28	Start D05 (2000 m deep)			
16:34	|	25° 18.82'S, 70° 02.56'E		-0.50%
16:38	Finish D05 (2300 m deep)			
16:41	Start U05 (2300 m deep)			
16:47	Water sampling No. 10 (TY04-10)	25° 18.92'S, 70° 02.71'E	2221 m	-0.40%
17:40	Finish KR00-05-TY-04	25° 19.30'S, 70° 03.09'E		

3.2. Video logs of the deep tow camera system operation

Remarks:

1. These video logs are originally compiled edition of 4 groups of observers (1. Hashimoto-Yamaguchi-captain-supporting staff in the rear bridge; 2. S. Ohta and collaborative members in the container lab of the 4000m-class deep tow camera system, 3. Marine Works team in the container lab of the 4000m-class deep tow camera system, and 4. supporting members in the Research Commanding Room). Sometimes items, terminology and identification are not always consistent.
2. With the exception of the video review done by S. Ohta, some amount of time lag and reading of depth occurs between the event and description.
3. Identification of images, especially of organisms is temporal and cursory one on board lacking no reliable references and based on instant response to real-time observations of the monitor screen.
4. Time range means the geological morphology during the time range is basically the same, and the indented events are observed in the setting.

VIDEO LOG (Aug. 13, 2000)

KR00-05-DT01

Time	Depth (m)	Description
08:22:07	0	DTV system launched
08:36	0	start of cable pay out
08:57:04	637	jellyfish
08:57:36	658	squid
08:57:46	665	squid
08:58:09	791	slender object
09:00:59	799	fish
09:02:46	872	jellyfish
09:05:46	997	fish
09:05		cable pay out 1000m
09:08:52	1122	shrimp
09:09:55	1169	jellyfish
09:12:11	1260	jellyfish
09:13		cable pay out 2000m
09:28:10	1917	fish
09:43:07	2501	winch slow
09:50:00	2573	recognized bottom; brecciated lava; thin sediment blanket 25°17.8783'S; 70°01.7078'E T=1.8℃, S=34.7
09:51	2570	start of DT01 transect

09:55:10	2565	pillow basalts covered with thin sediment
09:57:24	2558	a holothurian
10:03:58	2544	meandering trail of spatangoid
10:08:13	2530	a holothuria (20cm class)
10:10	2525	pillow lava and sandy sediment
		25°17.99'S, 70°01.76'E
10:12:32	2522	a brotulid fish (bythitid?; 20cm class)
10:12:58	2521	meandering trail of spatangoid
10:13	2500	steep wall
10:13:40	2522	meandering trail of spatangoid
10:22:22-22:34		sediment bottom
10:23	2491	steep wall of brecciated pillow basalt
10:23:15-24:37		sand & lava
10:23:42	2484	a red shrimp
10:23:52		a scarp
10:25:00-27:00	2345-1234	sand & lava
10:25:13	2481	pillow basalt
10:26:27	2474	a whip-like gorgonian
10:27	2472	steep wall
10:28:00-32:00		sediment blanket
10:30:00	2470	ripple-mark
10:32:00-33:40		sediment & pillow basalt
10:32:47	2466	pillow basalt
10:33:20	2466	a dark-colored holothurian
10:33:40		scarp
10:37	2452	25°18.18'S, 70°01.79'E
10:39:45-48:34	2447	steep wall composed of pillow basalt
10:45		a whip-like gorgonian
10:48:34-50:00		sediment blanket
10:48:55	2432	a fish
		25°18.25'S, 70°01.88'E
10:49:49	2431	a whip-like gorgonian
10:50:00-50:24		sediment blanket
10:51:00	2419	ripple mark
10:52:20	2438	pillow basalt
10:57	2446	25°18.31'S, 70°01.93'E
11:00	2464	brecciated rocks
		25°18.34'S, 70°01.95'E
11:02:10	2476	pillow lava
		25°18.37'S, 70°01.95'E
11:04:18		pillow lava
11:06	2471	almost at the way-point #2
		25°18.41'S, 70°01.99'E
11:07:20		ripple mark

11:08:15		pillow lava
11:09	2470	a whip-like gorgonian
11:12:38	2446	a red shrimp
11:13	2446	ripple mark
11:15:23		flash seldom works!! (film count ca. 717)
11:15:40		a fish
11:18	2424	a sea anemone?
11:26	2433	25°18.46'S, 70°02.18'E
11:32:30	2461	a bythitid fish?
11:32:50		ripple mark
11:34:40		brecciated lava?
11:37:25		a shrimp on sediment blanket
11:38	2464	ripple mark
11:42	2464	approx. 400m to the way-point #1
		25°15.50'S, 70°02.28'E
11:44	2459	a whip-like gorgonian on the surface of boulder
11:45	2454	25°18.48'S, 70°02.34'E
11:47	2458	good atmosphere (Prof. Yamaguchi; drunken?)
11:48	2472	ripple mark
11:53	2457	a white colored sea anemone (Actinostolidae?),
		brecciated basalt; approx. 300m to the way-point #1
		film # 677 flashed
12:01:00		film # 655 flashed
12:01	2441	a red shrimp
12:03:00-04:20		ripple mark
12:03	2430	approx. 200m to the way-point #1
		25°18.54'S, 70°02.48'E
12:04:00	2428	a fish
12:05:00-05:50		ripple mark
12:06:00	2430	a fish
12:06:40		fish; film #657 flashed
12:07	2436	ripple mark
12:08:30		ripple mark
12:09:20		pillow lava
12:10	2430	approx. 100m to the way-point #1
		25°18.54'S, 70°02.55'E
12:22:00-27:30		ripple mark
12:24:00		film #650 flashed
12:27	2425	steep wall
12:28	2408	steep wall
12:29:15-30:15		ripple mark
12:30:40	2398	film #649 flashed
12:32:10		black granular hyaloclastics on sediment (volcanic glass)
12:33:45		a shrimp

12:35:00		film #647 flashed
12:35:10-37:00		ripple mark
12:37	2382	25°18.64'S, 70°02.84'E
12:37:20-38:15		ripple mark
12:38:20		collapsed pillow lava
12:39:25		ripple mark
12:40:10		film #644 flashed
12:40:25		water temp value on TV monitor1.8℃=>1.9℃
12:40:45		water temp value on TV monitor 1.9℃=>1.8℃
12:43	2350	cable 20m up, camera system reset
		25°18.72'S, 70°02.83'E
12:44:30		film #642 flashed
12:44:50		vehicle 20m hoisted up [for system reset]
12:45:50		winch stop
12:46:15		CTD system reset
12:46:37		high voltage power source off
12:47:02		high voltage power source on
12:48:15		flash test #641 OK, #640 X, #639 X, #638 X
12:50:30		CTD on, file name DT01-3
12:50:50		film #637 X
12:59	2360	deep tow just above the bottom, ripple mark
		25°18.73'S, 70°02.98'E
13:06:00		film #636 flashed
13:07:00-10:20		ripple mark
13:11:05		ripple mark
13:12:20		ripple mark
13:14:05		film #634 OK
13:15:10		film #633 X
13:16:40		film #632 X
13:17:25		film #631 OK
13:17:35		film #630 X
13:17	2338	pillow lava
13:18	2335	pillow lava and sand with ripple mark
		25°18.82'S, 70°02.87'E
13:19:15		ripple mark
13:19:35		film #629 OK
13:20:10		film #628 X
13:21:20		ripple mark
13:24	2347	pillow basalt and sand with ripple mark
13:24:20		ripple mark
13:26:10		#624 OK
13:35:50	2371	a shrimp
13:38	2374	25°18.73'S, 70°02.53'E
13:40:20		ripple mark

13:41:20	2375	*Acanthonus armatus*
13:45:00		ripple mark
13:46:35	2400	jellyfish or tentacles of sea anemone (Cerianthidae?)
13:50:00		ripple mark
13:51:50-15:10		ripple mark
13:52	2412	almost on the way-point #1
13:55	2425	25°18.67'S, 70°02.67'E
13:57:25		debris of volcanic glass
13:59	2434	25°18.64'S, 70°02.64'E
14:03	2444	25°18.60'S, 70°02.65'E
14:04:15		corrugated pillow lava
14:08	2456	sand with ripple mark
14:10	2454	sand with ripple mark
		25°18.57'S, 70°02.63'E
14:16:00		ripple mark
14:17:50	2470	a large sea anemone
14:18	2470	sand with ripple mark
		25°18.54'S, 70°02.60'E
14:20:20	2477	a small shrimp on sand
14:20:31	2478	a shrimp
14:21:00	2476	a shrimp
14:22:57	2477	*Acanthonus armatus*
14:27:19		holothurian?
14:28	2488	sand with ripple mark
		25°18.45'S, 70°02.60'E
14:29:58	2490	a shrimp
14:32	2500	*Acanthonus armatus*
14:30:37		*Acanthonus armatus*
14:30:47	2495	*Acanthonus armatus*
14:32:17	2500	*Acanthonus armatus*?
14:33:06	2501	*Acanthonus armatus*
14:34:20		minute white crater
14:40	2534	broken pillow lava
14:38:35		small white crater
14:43:00		small white crater
14:43	2544	barnacles?
14:44:35		*Acanthonus armatus*
14:47:47	2560	a shrimp
14:48	2559	25°18.31'S, 70°02.50'E
14:52	2579	sandy bottom
14:57	2600	
14:58	2606	boulder covered with thin sediments
15:01	2632	meandering trail of spatangoid
15:00:35	2623	*Acanthonus armatus*

15:00:35	2634	meandering trail of spatangoid
15:04:49	2656	meandering trail of spatangoid
15:05	2657	sandy bottom without ripple mark
15:05:43	2665	a red aristeinid shrimp (*Benthesicymus*?)
15:06	2666	hydrozoan? (small-sized *Branchiocerianthus*?)
15:07:17	2673	*Acanthonus armatus*
15:08:24-09:07	2677	long parallel lines (ripples?); sometimes they cross
15:09	2686	25°18.18'S, 70°02.44'E
15:11:24-12:52	2699	ripple mark
15:12	2701	trace
15:13	2714	*Acanthephyra*?
15:14:30	2713	a red shrimp
15:14:30	2720	meandering trails produced by gastropod and spatangoid
15:16	2719	dead shells?
15:17:28	2718	a fish
15:18	2722	fine sediment bottom
		increasing numbers of epibenthos?
15:21	2730	25°18.10'S, 70°02.30'E
15:26	2726	a shrimp on the sediment without ripple mark and rock
15:25:16	2724	meandering trace of spatangoid
15:25:52	2727	*Acanthonus armatus*
15:28:53	2730	scarp
15:29	2729	boulders on the sediment bottom
15:30:33	2732	cable haul in started
		25°17.99'S, 70°02.32'E
15:44	1983	cable length 2000m
15:51:43	1505	a fish
16:03	685	cable length 700m
16:12:20	63	high voltage power supply off

VIDEO LOG (Aug. 14, 2000)

KR00-05-DT02

Time	Depth (m)	Description
13:37	0	DTV launched
13:46	16	DTV main switch on; cable pay out started
14:03:42	375	a white lucent shrimp
14:05:16	450	a shrimp or a squid ejected cloud
14:06:32		siphonophore (jellyfish)
14:09:28	621	siphonophore (jellyfish)
14:11:10	663	fish
14:12:30	698	siphonophore
14:13:06	722	a lantern fish
14:14:03	765	a lantern fish
14:14:46	798	sergestid(?) shrimp
14:15:14	817	fish
14:16:32	873	copepod
14:17:29	912	compound tunicate
14:18:55	979	jellyfish
14:19	998	cable payout 1000m
14:22:34	1139	shrimp
14:23:22	1165	an undulating fish swam across (10cm class?)
14:24:10	1205	???
14:27:35	1352	shrimp (sergestid?, red)
14:28:33	1398	ctenophore (bat-shaped)
14:30:42	1490	shrimp
14:41	1998	cable payout 2000m
14:41:50	2001	siphonophore
14:46:15	2195	deep tow entered into transmission anomaly layer
1448	2280	light transmission anomaly of -0.2% 25°17.99'S, 70°01.99'E
14:50	2400	large-sized suspended particles increased
14:53:27	2530	jellyfish?
14:54	2564	DTV altitude: approx. 100m
14:57:10	2630	recognized bottom
14:57:15-13:00	2638	deep tow just above the bottom; sea floor is basically a sediment flat dipping toward north with a low lava flow; 25°18.02'S, 70°01.99'E
14:58:04	2639	rather irregular boulders of aa-lava type; this might be a small lava flow half buried by silt; now DTV hovering; ordered towing velocity to be kept at 0.5kt
14:59:38	2848	biogenic structures on sediment surface
15:03:47	2640	a small lava flow composed of aa-type irregular boulders
15:05:50-06:16	2637	a fish lying on bottom (raised a cloud when flew away)

15:08:45	2632	meandering trace of spatangoid; boulder-size aa-lava flow
15:11:00	2623	aa-lava-type boulders are scattered; vehicle seems to started cruising over the floor toward south (up-slope trip)
15:11:31	2621	meandering trace of spatangoid
15:12:58	2617	a typical pillow lava
15:13:25-17:00	2616-00	climbing obliquely a gentle up-slope (right-side up-hill) with irregular large boulders
15:16:54	2596	an animal!
15:16:28	2598	heap of pillows; the end of slope=edge of a sand flat
15:17:00-17:55	2600-2595	a rippled sand bench
15:17:55-19:21	2594-2588	climbing straight a steep slope composed of irregular boulders in the lower part, and larger round pillows in the upper part
15:18:27	2593	a brisingid asteroid perching on a pillow [photo shot!] 25°18.02'S, 70°02.06'E
15:19:21-35:12	2588-70	entered into a sand flat
15:19:26-20:22	2588	a lava flow composed of aa-lava type irregular pillows
15:21:30	2590	meandering trace of spatangoid (irregular sea-urchin: ﾌﾞﾝﾌﾞｸ)
15:21:40	2588	a black elasipod holothurian (ca. 30cm; 5-6 pairs of long dorsal processes) probably belonging to the genus *Benthodytes* ; a few small lava flow from the right
15:23:30	2588	strided over a lava flow composed of pillows (flowing from right to left)
15:24:08	2582	a red shrimp in swimming (or blown of) (body coloration suggest it to be *Nematocarcinus*)
15:24:51	2582	meandering trace of a spatangoid; the animal itself never seen
15:25:10-27:37	2678-2575	moving along the skirt of a scarp composed of rather angular blocks; the wall stand to the left
15:28:40	2577	meandering trail of spatangoid
15:31:40	2569	a fish
15:31:45	2570	a red shrimp
15:33:37	2570	seeing a steep slope to the right 25°18.18'S, 70°02.13'E
15:34:04	2570	a small lobate lava flow (up=>down)
15:34:57	2571	meandering trace of a spatangoid
15:35:12-35:14	2570-66	a steep scarp composed of rugose pillows
15:35:14-46:32	2566-2568	a sand bench
15:35:15-36:32	2564-59	a lava flow dams a sediment forming a bench
15:36:32-37:55	2559-52	a large lava flow composed of typical pillows (from lower right to upper left)
15:37:55-39:31	2559-62	a lava flow of pillow flowing from upper left to lower right
15:39:56	2561	a sergestid shrimp

15:40:15	2555	an asteroid
15:42:13	2563	a fish
15:42:40-43:30	2561-56	seeing a skirt of a lava flow front to the right side
15:43:47	2557	a small lava flow flowing from the right to left
15:44:15-	2557-	striding over several lava flows flowing from the right to left
15:44:40	2552	a fish??
15:46:37-46:50	2550-44	climbing straightly a scarp composed of pillows & angular blocks
15:46:52	2544	on a sandy bench
15:47:22-48:40	2544-32	climbed a few steps of pillows
15:48:40-49:22	2532-36	a flat bench
15:49:22-52:25	2536-25	climbing several steps of pillows and angular blocks
15:50:07	2530	a bythitid fish (not typical *Acanthonus armatus*) and a shrimp
15:50:21	2531	a small fish
15:51:39	2528	a tiny shrimp-like organism
15:52:25-52:45	2525-2524	onto a sand flat
15:52:45-	2524-	a down-slope
[end of cassette 1A/3 at 15:33:00]		
15:53	2517	up-slope
	2519	pillow lava
15:53:30	2521	white-stuff
		[start of cassette 2A/3 from 15:54:10]
15:54:10-55:45	2515-2515	following just the edge of sand moat and a down-scarp
15:54:42	2515	a dark purple elasipod holothurian
15:55:40-56:20	2515	ripple sandy flat 25°18.30'S, 70°02.24'E
15:56:20-57:00	2516	striding over a lava flow composed of pillows
15:56:52	2512	an orange sea anemone
15:57:20	2511	rippled sandy flat
15:58:59	2512	a large fragment of pillow lava (fallen down from the right clifff)
15:59:50	2505	over a skirt of a lava flow (extruded from the right wall)
16:00:20-02:20	2504-08	strided over a tongue of brecciated pillow lava fallen from the right wall
16:02:14	2506	animal trace? (hahaha in katakana)
16:02:20-05:24	2508-2504	following the skirt of a lava flow (fallen from the right-hand wall)
16:06:18	2505	strided over a lava flow (flowing from upper left to lower right)
16:05:55	2505	a white sea anemone
16:06:52-07:40	2505-02	climbing a scarp made of rugose pillows
16:07:40-08:20	2502-2497	sandy flat with ripples
16:08:20-15:42	2497-72	steep up-slope of pillows & angular blocks (consisting of several steps)
16:09:50	2481	scarp composed of large angular blocks 25°18.43'S, 70°02.32'E
16:11:35		scarp

16:11:56		small craters on sediment pocket
16:12	2478	still continues steep slope
16:15:42-20:31	2477-68	rippled sandy flat
16:16:44	2477	strong ripple mark
16:17	2475	a shrimp
16:18:18	2474	donut-shaped animal trace
16:19:09	2474	a sea-pen *Umbellula* sp. ("fusa-umiera")
16:19:45	2474	ripple mark
16:22:25	2448	a lava flow of rugose pillows flowing from the left to right 25°18.54'S, 70°02.41'E
16:22:55-25:20	2447-32	rippled zone continues; basically following the skirt of wall of right-hand
16:25:50-26:20	2432-26	a steep slope of breccia; and then into rather narrow sand bench
16:26:40-30:40	2423-06	fundamentally ripped slope zone; however up-slope inclination is rather steep with several inconspicuous steps
16:28:58	2414	a black halosaurid fish (*Halosauropsis macrochir*?)
16:30:25	2408	talus of breccia (tongue of lava flow from the right-hand)
16:30:42-31:20	2405-	striding over a rather large talus of breccia (ditto)
16:31:52	2402	striding over a small talus of breccia (ditto)
16:33:22	2400	ditto
16:33:45	2396	ditto
16:33:50	2395	a white fish (Notacanthidae: "soko-gisu"? or *Aldrovandia*?)
16:33:55-34:15	2395-94	following the edge of a lava flow (flowing from right to left)
16:34:15	2380	still continue rippled sandy flat
16:39:10	2380-86	following the edge of a lava flow (flowing from right to left)
16:40:30	2384	small scale lava flow on which a white sea anemone attaches; it flow from upper right to the lower left
16:41:11	2381	following the edge of a lava flow (flowing from right to left)
16:41:18	2382	striding over a small talus of breccia (ditto) 25°18.55'S, 70°02.65'E
16:43:12-53:30	2380-72	following along the skirt of a wall composed of breccia bottom feature is basically large boulder-size breccia with intermittent sand pocket
16:45:53	2372	lava pillow? (peculiar!)
16:53:30-	2373	rippled sandy zone
16:56:00	2370	crossing over a small lava flow (left to right)
16:56:18	2369	crossing over another small lava flow (right to left)
16:58	2368	ripple mark 25°18.82'S, 70°02.67'E
17:02:40-03:28	2352-47	gentle up-slope of brecciated lava flows & flat lava surface; sediment very thin
17:03:28-08:56	2347-30	pure rippled sand zone
17:04:28	2344	a black halosaurid fish
17:08:56-09:11	2328	an up-step composed of breccia

17:09:11-10:07	2327-	rippled sandy zone
17:11:24	2320	crossing over a lava flow
17:11:30	2315	crossing over another lava flow
17:12:24-13:50	2308-08	following the skirt of lava flow (basically composed of large angular blocks)
17:13:50-13:57	2308	sandy floor predominates
17:14:52	2312	crossing over a lava flow
17:15	2313	25°18.94'S, 70°02.79'E
17:15:27	2311	crossing over a skirt of an escarp
17:15:30	2312	rippled sandy bench, seeing pillow dam to the left
17:16:23-17:27	2311-12	following a rather flat topography with occasional outcropping of breccia mounds or scarps
17:17:12	2313	a red aristeinid shrimp
17:17:40-	2312	almost pure rippled flat with occasional outcropping breccia mounds and/or small-scale brecciated lava flows
17:20	2300	ripple mark is pronounced; the wave lines are oriented horizontal on the screen; therefore dominant current producing the current must be NW-SE (summit-skirt) in direction around here 25°19.01'S, 70°02.84'E
17:22:30	2299	two black halosaurid fishes (*Halosauropsis macrochir*?)
17:22:49	2299	a black halosaurid fish (*Halosauropsis macrochir*?); two of the 3 halosaurid fish facing lower left corner of monitor; therefore it is likely that the bottom water current flows from NE to SW now; ripple mark around here is rather irregular and is very hard to determine the dominant flow direction
17:24:00	2300	ripple mark around here is reminiscent of "radula of gastropod"; dominant flow must be upper-lower (NW-SE) in sense
17:25:30-26:30	2299-94	gentle up-slope; sediment thickness decreased; flat surface of lava flow is studded with pebble and granule-sized hyaloclastics
17:26:35-27:35	2594-90	slope starts from sheet-flow lava in the lower part, pillows in the middle and large angular blocks in the upper part
17:27:35-28:00	2590	rippled sand pocket
17:28:00	2590-2580	hovering over a steep lava up-step
17:30	2280	25°19.06'S, 70°02.93'E
17:29:40-32:20	2280-77	bare smooth lava surface
17:33:20-34:10	2777	rippled sand pocket
17:33:40	2777	again bare lava surface; rather brecciated; with sporadic rippled sand pocket
17:34:00-35:30	2275	rippled sand flat
17:35:35	2276	cable hauling started 25°19.13'S, 70°02.92'E
17:42	1986	cable length 2000m
17:57	977	cable length 1000m
18:13:45	18	main power supply off

VIDEO LOG (Aug. 15, 2000)

KR00-05-DT03

Time	Depth (m)	Description
07:54:54		DTV system launched
07:58:57	12	DTV system switch on; no problems pronounced thermocline around 150mwith salinity maximum of ca. 35.7
08:00	12	cable pay out started
08:15:07	422	jellyfish
08:16:25	479	small fish
08:17:03	500	T=11.6℃; S=35.0
08:17:55	550	jellyfish
08:18:50	577	fish
08:21:04	670	fish
08:21:46	201	fish
08:23:13	764	shrimp
08:24:16	804	fish
08:25:16	845	a shrimp ejected luminescent cloud
08:25:17	847	another shrimp ejected luminescent cloud
08:25	850	oxygen max layer
08:26:02	877	a jellyfish
08:26:20	893	a jellyfish?
08:26:30	900	4-armed-organism (took a photo)
08:28:57	1000	cable length 1000m; jellyfish
08:29:57	1042	a large fish (*Taaretonbenia*??)
08:31:15	1100	a fish?
08:32:23	1140	small round organism
08:33:23	1182	jellyfish
08:34:54	1250	jellyfish
08:36:10	1302	jellyfish
08:37:58	1382	shrimp
08:38:35	1406	fish
08:40:05	1470	jellyfish
08:42:27	1570	jellyfish
08:43:15	1600	jellyfish
08:44:54	1675	jellyfish?
08:46:03	1721	shrimp
08:46:48	1753	shrimp
08:48:24	1819	jellyfish
08:51:05	1928	shrimp
08:51:31	1947	jellyfish
08:53:49	2040	jellyfish
08:52	1998	cable length 2000m
08:56	2150	light transmission anomaly of – 0.2%

		25°18.62'S, 70°01.34'E
08:58:26	2228	jellyfish
	2250	transmission anomaly of -0.2%
	2340	transmission anomaly of -0.1%
08:58	2250	light transmission normal
09:00:14	2300	jellyfish
09:00:57	2329	entered into 2nd transmission anomaly layer
09:01	2340	light transmission anomaly of - 0.1%
09:02:39	2396	end of 2nd transmission anomaly
09:07:12	2582	recognized bottom; deep tow just above the bottom; 0.5kt cruising start
09:07:25-15:46	2593-98	collapsed small lava flow and a large pillow, sediment blanket with ripple mark; vehicle is in a huge trough-like moat filled with sediment, and it requires some time to be effectively towed T=1.8℃, S=34.7 25°18.62'S, 70°01.40'E
09:09:20	2597	ripple mark
09:09:50	2597	angular blocks of basalt
09:10:16	2599	a brinsingid asteroid (slender multi-armed sea-star) perching on a pillow on a lava flow; basalt is almost bare
09:11:45	2596	a round pillow basalt
09:12:32	2598	pillow basalt
09:13:15-15:46	2598	ripple mark
09:14:19	2598	shadow of a fish (probably a rattail)
09:15:46		ripple mark (chaotic pattern)
09:16:40	2603	a fish
09:17:14		ripple mark (upper right-lower left on TV monitor)
09:18:02		ripple mark (upper left-lower right)
09:18:29		ripple mark (left-right)
09:18:56		ripple mark (upper right-lower left)
09:19:15		ripple mark (left-right)
09:19:33	2606	lebensspuren (trace produced by biotic activity)
09:19:52		ripple mark (upper left-lower right)
09:20:13	2606	fish
09:22	2596	large angular block (breccia) on the sedimentary bottom
09:22:51	2595	trace (meandering trail of spatangoid [irregular sea-urchin ﾌﾞﾝﾌﾞﾘ])
09:24	2592	increasing suspended substance
09:24:43	2593	ripple mark
09:25:03	2593	a red aristeinid shrimp; entering into lava flow
09:25:19	2591	a fish
09:26	2589	gentle up-slope

09:27:14	2588	rock to the left
09:27:50	2587	heap of black granular hyaloclastics (volcanic glass)
09:28:55	2779	ripple mark (upper left-lower right)
09:29:04		scarp (10m in altitude)
09:31:49	2569	"segment layer" [?]
09:32:01	2569	a red aristeinid shrimp
09:32:10	2563	a red aristeinid shrimp
09:32:32	2565	dead shell of Calyptogena sp.
		25°18.62'S, 70° 01.54'E
09:33:03	2564	dead shells of *Calyptogena* sp.
09:33:54	2567	dead shells of *Calyptogena* sp.
09:34	2561	numerous dead white clams
09:35:09		dead shell of *Calyptogena* sp.
09:36:22	2538-2558	escarpment (20m in altitude!)
		25°18.62'S, 70°01.57'E
09:37:07	2544	a whip-like gorgonian
09:39	2535	climbing up escarpment
09:41:00	2529	basalt around here are darker in hue
09:42	2519	climbing up an escarpment
09:42:12	2523	meandering trail of spatangoid
09:44	2505	steep escarpment
09:46	2487	steep escarpment edge; vehicle climbed over several repetitions of scarp-and-moat structure; scarp consists of talus zone of medium-sized breccia at the toe, heap of large angular block of collapsed pillow basalts in the middle portion, and round and/or lobate pillows at the top which dam the sandy sediment; moat (micro-terrace) is filled with relatively thick sandy sediment.
		25°18.62'S, 70°01.67'E
09:47:54	2482	meandering trail of spatangoid
09:50	2464	an escarpment
09:51:20	2464	sedimentary bottom with meandering trails of spatangoids
09:52:33	2460	ripple mark (upper left-lower right)
09:52	2458	boulders on the sedimentary bottom
09:55	2453	cobble
09:59:19	2464	meandering traces produced by spatangoids on sedimentary bottom
09:59:55	2461	a large sea anemone on pillow lava
10:00:09	2460	typical pillow lava
10:02:49	2448	a fish
10:04	2444	a white asteroid
10:07:33	2422	circular animal trace
10:05	2434	a white sea anemone on pillow lava
10:09:30	2398	breccia zone
10:10	2401	steep slope

10:10	2594	a brisingid asteroid
10:11:30	2393	pillow lava zone
10:12:35	2395	ripple mark (upper-lower)
10:13	2396	25°18.63'S, 70°01.90'E
10:13:15	2396	pillow lava zone
10:15:58	2393	a whip-like gorgonian
10:18:10	2407	ripple mark (upper left-lower right)
10:22:10	2434	a whip-like gorgonian
10:22:25	2434	meandering trail of spatangoid
10:24:22	2436	a red aristeinid shrimp
10:34	2416	25°18.62'S, 70°02.12'E
10:37:24	2427	"hige-kurage" ["kuda-kurage" ???]
10:40:45	2434	lava zone
10:42:20		scarp
10:44:00	2431	steep slope down (looking rocks to the right)
10:45:47	2430	huge rock
10:46	2428	steep slope up
10:48	2431	steep slope composed of lobate pillow basalts
		25°18.64'S, 70°02.26'E
10:50	2430	a holothurian on pillow basalt [?!]
10:50:11	2429	two whip-like gorgonians
10:51:30	2426	pillow basalt zone
10:56	2411	steep slope up
11:00:00	2402	a large red sea anemone
		25°18.62'S, 70°02.39'E
11:00:20-01:00		ripple mark
11:00:53	2402	a large sea anemone
11:02:50-03:00	2394	ripple mark (upper-lower on TV monitor)
11:06:30-06:55		ripple mark
11:07	2388	water temperature up to 1.9°C (pointed by captain)
11:08:40	2399	ripple mark-09:20 (upper-lower)
11:15:50	2408	ripple mark on sand
		25°18.62'S, 70°02.55'E
11:19:50	2426	clot of white stuff
11:20	2435	steep slope down
11:21:25-23:00		ripple mark
11:24:00-24:30		ripple mark
11:25:25	2445	a cutthroat eel *Synaphobranchus bathybius*? ("soko-unagi")
11:27:25		basalt escarp to the right
11:28:00	2443	ripple mark
		25°18.63'S, 70°02.67'E
11:32:50	2432	clot of white stuff
11:33	2430	sandy bottom
11:37	2407	gentle up-slope, cutthroat eel?

11:37:45	2401	a cutthroat eel *Synaphobranchus bathybius*?
11:39	2398	ripple mark
11:44:10	2380	ripple mark (upper-lower)
		25°18.62'S, 70°02.84'E
11:46:58	2365	ripple mark (upper right-lower left) trapping much white stuff
11:50:00-52:00	2361	broken pillow
11:52:20	2361	ripple mark (upper-lower)
11:56:45	2361	ripple mark (upper right-lower left)
11:57	2361	ripple mark
11:58:30	2363	broken pillows
12:07	2372	sandy bottom with ripple mark
12:13:15	2357	white powder
11:14:50	2349	rocky zone
11:15:45	2350	increased the white powder
12:16	2353	white particles increase on the bottom
		25°18.63'S, 70°02.94'E
12:19:29	2346	*Acanthonus armatus*
12:20:27	2349	*Acanthonus armatus*
12:23	2350	blanketed with white stuff
12:31:35	2367	a red aristeinid shrimp
12:34	2375	ship speed 0.7 knots
12:35	2377	blanketed with white stuff
12:37:15	2373	pillow basalts hemming low terrace
12:39	2370	pillow
12:41	2377	25°18.73'S, 70°02.76'E
12:42:35	2375	broken pillow
12:45:18	2377	a red aristeinid shrimp (*Benthesicymus*? or *Hepomadus*?)
12:46:20		ripple mark
12:48:35	2373	white stuff? or jellyfish?
12:49:45-50	2366	broken pillows
12:50:55-51:20	2366	ripple mark (upper left=>lower right)
12:52:05	2365	a fish or a shrimp
12:56	2372	25°'18.76S, 70°02.60'E
13:00:50	2366	round pillow
13:02	2373	ripple mark
13:03:40	2368	*Acanthonus armatus*
13:03:58		*Acanthonus armatus*
13:04	2360	low terrace approx. 5m
13:06:40	2358	a red aristeinid shrimp
13:07	2352	steep slope covered with pillow basalts
13:09	2338	pillow
13:10	2338	25°18.83'S, 70°02.47'E
13:12:29	2351	a fish
13:13:12		a halosaurid fish (*Halosauropsis macrochir*?)

13:14:30	2349	ripple mark
13:15	2340	broken pillow basalts
13:15:40	2337	
13:17	2321	boulders
13:18	2328	finished DT03 transect
		25°18.86'S, 70°02.39'E
13:24:13	2356	front of pillow lava flow
13:24:13	2356	a red aristeinid shrimp
13:26:00	2341	end of bottom deep-tow

KR00-05-TY05-U01

13:27	2335	25°18.93'S, 70°02.32'E
13:31	2377	start TY05-U01 operation
		ship speed 0.7 knot, wire pay out rate 0.7m/s
13:33:00	2318	light transmission anomaly of -0.4 %
13:33:25		ditto -0.1%
13:34:05	2263	ditto -02%
		25°18.92'S, 70°02.28'E.
13:34	2247	ditto -0.1%
13:35:30	2209	ditto resumed to normal level
13:39	2100	25°18.91'S, 70°02.26'E
13:41	2000	stopped cable pay out at 2000 m

KR00-05-TY05-D02

13:44:10	2000	start of TY05-D02 operation
		25°18.85'S, 70°02.23'E
		ship speed 0.7 knot, wire pay out rate 0.7m/s
13:50:40	2263	light transmission anomaly of less than -0.1 %
13:51:10	2283	ditto -0.2%
13:51	2209	ditto -0.3% (max –0.4 %)
		25°18.81'S, 70°02.24'E
13:52:20		ditto -0.4%
13:53	2361	end of TY05-D02 operation

KR00-05-TY05-U02

13:55:50	2360	start of TY05-U02
		25°18.79'S, 70°02.24'E
		ship speed 0.7 knot, wire pay out rate 0.7m/s
13:57:00	2310-2320	light transmission anomaly of -0.2 %
13:58:30		ditto resumed to normal level
14:04	2000	end of TY05-U02 operation
		25°18.70'S, 70°02.23'E

KR00-05-TY05-D03

14:06	2000	start of TY05-D03 operation
		25°18.68'S, 70°02.21'E
		ship speed 0.7 knot, wire pay out rate 0.7m/s
14:10:10	2188	light transmission anomaly of -0.05%
14:10	2196	ditto -0.1%
14:11:20	2239	ditto resumed to normal level
14:11:55	2268	ditto increasing again
14:12	2264	ditto -0.3%
		25°18.84'S, 70°02.24'E
14:13:15	2312	ditto -0.3%
14:14	2343	ditto -0.2%
14:15:25	2386	ditto resumed to normal level
		25°18.86'S, 70°02.24'E
14:16	2400	end of TY05-D03 operation
		25°18.61'S, 70°02.24'E

KR00-05-TY05-U03

14:18	2400	start of TY05-U03 operation
		25°18.60'S, 70°02.25'E
		ship speed 0.5 knot, wire pay out rate 0.7m/s
14:20	2303	light transmission noisy
14:21	2300	light transmission anomaly of -0.3 %
		25°18.56'S, 70°02.23'E
14:30	1833	ship cruising velocity 0.5 knot
14:32	1800	end of DT\TY05-U03 operation
		25°18.43'S, 70°02.23'E

KR00-05-TY05-D04

14:34	1800	start of TY-D04 operation
		25°18.43'S, 70°02.24'E
14:43:28	2169	light transmission anomaly of –0.2%
		25°18.34'S, 70°02.24'E
14:45	2264	ditto -0.2%
		25°18.33'S, 70°02.24'E
14:46	2297	ditto resumed to normal level
14:49	2400	end of TY05-D04 operation
		25°18.31'S, 70°02.26'E

KR00-05-TY05-U04

14:51	2400	start of DT\TY05-U04 operation
		25°18.30'S, 70°02.26'E
14:5?	22??	light transmission anomaly of -0.1~-0.2%?

15:00	2065	LTA noisy but supposedly normal level
		25°18.??'S, 70°02.??'E
15:02	2000	end of DT\TY05-U04 operation
		25°18.19'S, 70°02.23'E

KR00-05-TY05-D05

15:04	2000	start of TY-D05 operation
		25°18.18'S, 70°02.24'E
15:10	2229	light transmission anomaly of -0.05%
		25°18.15'S, 70°02.24'E
15:10	2249	ditto -0.1%
		25°18.15'S, 70°02.24'E
15:11	2281	ditto resumed to normal level
15:17	2500	end of TY05-D05 operation
		25°18.11'S, 70°02.27'E

KR00-05-TY05-U05

15:20	2500	start of TY05-U05 operation
		25°18.08'S, 70°02.27'E
15:25	2292	light transmission anomaly of -0.05%?
		25°18.03'S, 70°02.24'E
15:26	2238	ditto -0.1%
		25°18.02'S, 70°02.26'E
15:27	2240	ditto resumed to normal level
15:31	2060	end of TY05-U05 operation
		25°18.00'S, 70°02.24'E
		start cable haul in
15:32	1995	cable length 2000m
15:53	984	cable length 1000m
16:09	44	main power supply off

VIDEO LOG (Aug 16, 2000)

KR00-05-TY06-D01

Time	Depth (m)	Description
08:08	13	DTV system main switch on
08:10	23	cable pay out started
08:41	1000	cable length 1000m
09:05	1998	cable length 2000m
09:08	2138	light transmission anomaly of -0.1%
		25°19.36'S, 70°02.14'E
09:09	2180	ditto -0.1%
09:11	2257	ditto -0.05%, back to normal
09:13	2339	second anomaly -0.1%
		25°19.36'S, 70°02.13'E
09:14	2400	ditto -0.1%
09:16	2462	ditto -0.1%
09:17	2486	ditto resumed to normal level
09:19	2598	just above the bottom; end of TY06-01 operation

KR00-05-TY06-U01

09:24	2583	start of TY06-U01 transect
		25°19.36'S, 70°02.13'E
09:29	2413	light transmission anomaly of -0.05%
		25°19.35'S, 70°02.16'E
09:30	2334	ditto -0.1%
09:32	2278	ditto -0.05%
09:35	2180	ditto resumed to normal level
09:36	2142	second anomaly -0.05%
		25°19.34'S, 70°02.20'E
09:37	2071	ditto resumed to normal level
09:41	2000	end of TY06-U01 transect
		25°19.30'S, 70°02.21'E

KR00-05-TY06-D02

09:44	2000	start of TY06-D02 transect
		25°19.27'S, 70°02.24'E
09:48	2136	light transmission anomaly of -0.1%
		25°19.25'S, 70°02.23'E
09:48	2159	ditto -0.15%
09:49	2180	ditto resumed to normal level
09:52	2295	second anomaly -0.1%
		25°19.24'S, 70°02.27'E
09:53	2333	ditto -0.1%
09:55	2400	ditto -0.1%

09:55	2440	ditto resumed to normal level
09:58	2500	end of TY06-D02 operation
		25°19.20S, 70°02.30'E

KR00-05-TY06-U02

10:01	2500	start of TY06-U02 operation
		25°19.20'S, 70°01.31'E
10:03	2427	light transmission anomaly of -0.1%
		25°19.20'S, 70°02.33'E
10:05	2341	ditto -0.1%
10:06	2268	ditto -0.1%
10:08	2190	ditto -0.1%
10:10	2111	ditto -0.3%
		25°19.14'S, 70°02.42'E
10:11	2073	ditto resumed to normal level
10:13	2000	end of TY06-U05 operation
		25°19.09'S, 70°02.42'E

KR00-05-TY06-D03

10:16	2000	start of TY06-D03
		25°19.06'S, 70°02.47'E
10:19	2089	light transmission anomaly of -0.2%
		25°19.04'S, 70°02.47'E
10:20	2111	ditto -0.3%
10:20	2120	ditto resumed to normal level
10:21	2151	ditto **-0.6%**
		25°19.03'S, 70°02.46'E
10:21	2184	ditto **-0.7%**
10:22	2198	ditto -0.3%
10:22	2215	ditto **-0.6%**
10:22	2228	ditto -0.3%
10:23	2244	ditto **-0.8%**
		25°19.03'S, 70°02.49'E
10:23	2268	ditto -1.0%
10:24	2300	ditto -0.1%
10:26	2335	end of TY06-D03 operation
		25°19.00'S, 70°02.50'E

KR00-05-TY06-U03

10:28	2322	start of TY06-U03 operation
		25°19.00'S, 70°0.2.50'E
10:31	2242	light transmission anomaly of -0.3%
		25°18.96'S, 70°02.52'E
10:32	2213	ditto **-0.5%**

10:33	2198	ditto -0.3%
10:33	2183	ditto -0.2%
10:33	2171	ditto -0.3%
10:34	2138	ditto **-0.5%**
10:36	2105	ditto resumed to normal level
10:37	2050	end of TY06-U03 operation
		25°18.94'S, 70°02.57'E

KR00-05-TY06-D04

10:40	2050	start of TY06-D04 operation
		25°18.93'S, 70°02.57'E
10:42	2150	light transmission anomaly of -0.3%
		25°18.94'S, 70°02.58'E
10:43	2185	ditto -0.2%
10:44	2203	ditto -0.4%
		25°18.93'S, 70°02.57'E
10:44	2219	ditto **-0.5%**
10:44	2244	ditto -0.3%
10:45	2254	ditto **-0.5%**
10:45	2266	ditto -0.3%
10:46	2288	ditto -0.3%
10:47	2323	ditto -0.1%
10:47	2338	end of TY06-D04 operation
		25°18.89'S, 70°02.60'E

KR00-05-DT04

10:47:00	2340	recognized bottom; T=1.8℃, S=34.7
10:49:10		**shimmering water ???**
10:53	2338	deep tow just above the bottom, shimmering
		25°18.89'S, 70°02.63'E
10:53	2338	start DT04, pillow lava
		25°18.87'S, 70°02.59'E
10:58	2339	down-slope
10:59:35	2427	sediment blanket
11:10:00	2342	white stuff
11:12	2328	up-slope
11:12:12	2326	on a spur composed of lobate lava
11:13:25	2310	on a spur composed of lobate lava
11:15:00		on a spur composed of lobate lava
11:17:10	2302	on a spur composed of lobate lava
		100m to the north of the way-point #2
11:18	2308	approx. 100m NE of the way-point #2
		25°18.95'S, 70°02.56'E
11:20:59	2316	white stuff

11:21	2321	down-slope
11:25	2336	a rattail (macrourid fish)
		25°18.97'S, 70°02.52'E
11:25:30	2335	a rattail (*Nezumia*-type) in a ripple zone
11:27:45	2327	a rattail (*Nezumia*-type)
11:30:30	2325	a white sea anemone (medium-sized) (Actinostolidae?)
11:33:00	2326	many basaltic boulders & rippled sediment
11:33:30	2337	white stuff; ripple mark
11:34	2333	up-slope, huge pillow lava
11:37	2327	huge pillow
11:38	2332	broken pillow
11:38:50-44:50		angular blocks of basalt
11:42:11	2330	rattail
11:44:51	2334	ripple mark (upper-lower)
11:52:12	2347	a fish
11:52	2348	down-slope
		25°19.17'S, 70°02.53'E
11:54	2352	broken lava
11:56	2371	
12:00	2394	pillow lava
12:05	2413	25°19.27'S, 70°02.47'E
12:06	2414	a living *Calyptogena*? [=> actinian] stands on sediment
		25°19.30'S, 70°02.52'E
12:06:10	2412	a white actinian
12:09:52	2433	bottom texture seems to be changed
		T=1.80℃, S=34.725, LT=84.311
12:12	2437	
12:13:10	2436	a fish?
12:14:00	2438	?? (white string passed by)
12:14:50	2446	a sea anemone
12:15:13	2451	a sea anemone
12:18:32	2480	a red shrimp
12:19:25	2489	a galatheid? (white object);
		T=1.75℃, LT=84.31
12:22:48	2512	a shrimp or a fish
12:23:12	2516	a sea anemone?
12:24:21	2526	a fish
12:24:38	2523	a halosaurid fish
12:25:00	2530	white blotch
12:25:31	2531	an aristeinid or nematocarcinid red shrimp on sandy bottom
12:28:35	2542	ripple zone; speckled with white macula
12:29:20	2546	ripple (upper right=>lower left)
12:31:42	2556	an asteroid (Goniasteridae?)
12:33:02	2566	a red aristeinid shrimp (*Benthesicymus*?)

12:33:10	2566	a red shrimp
12:33:30	2567	a red aristeinid shrimp
12:34:50	2572	red object passed just in front of camera
12:36:00	2579	a red aristeinid shrimp
12:39	2593	sandy bottom covered with thin and fine sediment
12:39:20	2591	flat rock powdered
12:40:10	2593	a rattail (silver-white; *Nezumia*-type?)
12:43:35	2596	white object passed just in front of camera
12:45		10m hoisted up for the following Tow-yo operation
12:45	2593	finished DT04 transect
		25°19.52'S, 70°02.47'E

KR00-05-TY07-U01

12:53	2574	start of DT/TY07-U01 operation
		25°19.55'S, 70°02.46'E
12:57	2380	light transmission anomaly of -0.05%
12:58	2352	ditto -0.1%
12:59	2305	ditto -0.1%
13:00	2288	ditto -0.05%
		25°19.58'S, 70°02.46'E
13:02	2177	ditto -0.2%
		25°19.59'S, 70°02.47'E
13:03	2144	ditto -0.1%
13:04	2086	ditto resumed to normal level
13:06	2000	end of TY07-U01operation
		25°19.57'S, 70°02.52'E

KR00-05-TY07-D02

13:08	2000	start of TY07-D02
		25°19.56'S, 70°02.51'E
13:11	2133	light transmission anomaly of -0.1%
13:12	2176	ditto -0.3%
		25°19.55'S, 70°02.54'E
13:13	2193	ditto -0.2%
13:13	2206	ditto -0.1%
13:13	2224	ditto resumed to normal level
13:20	2500	end of TY07-D02 operation
		25°19.48'S, 70°02.55'E

KR00-05-TY07-U02

13:22	2500	start TY07-U02 operation
		25°19.46'S, 70°02.57'E
13:25	2400	light transmission anomaly of -0.05%
13:26	2343	ditto -0.1%

13:27	2302	ditto -0.1%
13:28	2260	ditto -0.05%
13:29	2218	ditto -0.1%
13:30	2192	ditto -0.2%
		25°19.42'S, 70°02.60'E
13:30	2163	ditto -01.%
13:31	2148	ditto -0.1%
13:32	2114	ditto resumed to normal level
13:35	2000	finish TY07-U02 operation
		25°19.40'S, 70°02.65'E

KR00-05-TY07-D03

13:36	2000	start of TY07-D03 operation
		25°19.40'S, 70°02.65'E
13:41	2220	light transmission anomaly of -0.2%
		25°19.36'S, 70°02.89'E
13:42	2238	ditto -0.1%
13:43	2273	ditto -0.05%
13:45	2350	ditto -0.05%
13:46	2346	end of TY07-D03
		25°19.36'S, 70°02.68'E

KR00-05-TY07-U03

13:48	2328	start of TY07-U03
		25°19.30'S, 70°02.68'E
13:50	2260	light transmission anomaly of -0.05%
13:51	2207	ditto -0.1%
		25°19.26'S, 70°02.69'E
13:52	2152	ditto resumed to normal level
13:55	2050	end of TY07-U03 operation
		25°19.21'S, 70°02.78'E

KR00-05-TY07-D04

13:57	2050	start of TY07-D04
		25°19.20'S, 70°02.76'E
14:00	2175	light transmission anomaly of –0.1%
		25°19.19'S, 70°02.77'E
14:01	2209	ditto -0.2%
14:02	2254	ditto -0.05%
14:04	2297	end of TY07-D04 operation
		25°19.19'S, 70°02.78'E

KR00-05-DT05

14:05:30	2294	T=1.8℃, S=34.7; CTD reset

14:07:35	2304	a red shrimp; ripple mark & large angular boulders
14:12:30	2300	start of DT05 operation; lava 25°19.18'S, 70°02.81'E
14:17:50	2297	rather pleated lava
14:24	2298	cemented joints
14:29	2285	trouble of camera angle? or suspension bridle?
14:30:50	2283	started hauling in of the DT system 25°19.18'S, 70°02.70'E Something wrong happened; the position of suspended chain on the TV monitor is abnormal. We decided to retrieve the DTV system right now. [Later on board it was found that supporting ropes of the DT frame are twisted severely around the main cable, and the lower tip of the main cable was severely kinked at several points within 10m from the tip.]
14:37	1991	cable length 2000m
14:58	990	cable length 1000m
15:15	45	main power supply off

VIDEO LOG (Aug. 17, 2000)

KR00-05-DT06

Time	Depth (m)	Description
08:05	0	DTV system hoisted up
08:07:45	0	DTV system launched
08:13:40	9	DTV system main switch on
08:15	14	start of cable pay out
08:28:11	275	siphonophore and a jellyfish
08:28:41	299	jellyfish
08:30:27	377	jellyfish
08:34:53	555	siphonophore
08:35:33	600	jellyfish
08:39:36	748	jellyfish
08:3916	757	jellyfish
08:41:07	835	jellyfish
08:42:51	909	jellyfish
08:45	997	cable pay out 1000m
08:4522	1014	jellyfish
08:45:47	1032	jellyfish
08:47:35	1106	fish
08:48:34	1145	fish
08:48:46	1156	red organism
08:50:35	1232	jellyfish
08:51:39	1274	jellyfish
08:52:48	1316	fish
08:56:20	1466	jellyfish
09:09	1996	cable pay out 2000m
09:10:28	2049	red shrimp?
09:11:04	2073	red organism
09:11:35	2097	jellyfish
09:14	2214	light transmission anomaly of -0.1%
09:15	2220	ditto -0.1 %
		25°18.46'S, 70°02.24'E
09:16	2308	ditto -0.1%
09:17	2327	ditto resumed to normal level
		25°18.46'S, 70°02.22'E
09:21:10	2460	recognized bottom, start of DT06 transect
		25°18.46'S, 70°02.24'E
		round & angular boulders and slabs scattered on the
		sediment with white material; vehicle landed on just the
		side of a lava flow
09:23:00		CTD reset OK
		small white craters on smooth sediment

09:25:15		many small white craters;
		scour mark pronounced around pebbles; no ripple mark
09:25:53	2467	ripple mark
09:27:15	2468	fish-scale-like (imbricating) ripple mark
09:28:35	2468	lave flow & pillows (DTV not effectively towed yet)
		25°18.47'S, 70°02.25'E
09:29:14	2467	cracked pillow lava zone & their close-up photo
09:29:55	2465	DTV is on the lava flow
09:31:07	2464	moved slowly into rippled zone; DTV started moving
09:32:15-32:55	2463-64	slope (up to the left);
		debris of minute hyaloclastics=>lava flow=>rippled sand
09:32:55-34:15	2465-61	rippled sand scattered with pebble-size hyaloclastics
09:34:15-35:25	2462	crossing obliquely a rather flat lava flow (brecciated)
09:35:25-37:20	2462-57	regularly rippled sand zone
09:35:35	2462	a red shrimp on rippled sediment (probably *Nematocarcinus*)
09:36:35	2455	passing by a lava flow front
09:37:20-38:20	2457	crossing over a lava flow (composed mainly of pillows);
		sediment cover is rather thick;
		ship speed 0.8 knots
09:38:20-40:40	2452-59	entered into a rather flat sandy zone; only weakly rippled but
		biogenic small craters are abundant
09:39:11	2459	a red aristeinid shrimp (*Benthesicymus* sp.?)
09:39:20	2455	a rattail (macrourid fish)
09:40:40-44:35	2452-32	up-slope crossing over a huge lava flow; composed of rather
		intact pillows and very large angular boulders
		25°18.52'S, 70°02.29'E
09:44:35-47:10	2443-31	marked ripples on the sandy bottom; ripples trap much white stuff
09:45:11-	2443	lava flow (pillows and large angular blocks)
09:45:39	2439	a minute white rod passed by the camera (not fish or shrimp)
09:46	2436	pillows
09:46:50	2432	a sea anemone [no video record during around here]
09:47:10-50:44	2431-18	large-scale lobate lava flow front
09:47:59		up-slope
09:49:05	2422	another large-scale lobate lava flow front
09:49:45	2418	typical pillow lava; no sediment cover;
09:50:30	2422	down-slope
09:50:50-	2425	entered into sediment stand with ripples
09:51:03	2422	ripples, gentle up-slope
09:51:34	2419	a fish (slender brotulid)
09:51:32-52:30	2421-	climbing a small scarp composed of intact pillows;
09:51:37	2422	a nematocarcinid shrimp on sediment among pillows
09:51:52	2414	a narrow bench of rippled sand and solitary pillows
09:52:22-55:05	2416-00	skirt of steep slope; start of ascent
09:54	2401	round pillows

09:54:35	2397	a red aristeinid shrimp pillows and sand pockets (occasionally rippled)
09:55	2396	still up-slope; probably this slope consists of a few alteration of scarp-&-small bench (= a lava flow) units
09:55:05	2398	a narrow sand bench
09:55:24-56:50	2399-92	climbing a slope composed of pillows
09:56:47	2390	a nematocarcinid shrimp
09:56:50-	2392	entered into rippled sand bench
09:57:15	2390	well-defined ripples in a small sand pocket
09:57:22-58:00	2390	skirt of a slope
09:57:37	2386	a nematocarcinid shrimp flown away (on the slope)
09:58:27-	2384	entered into a sand bench
09:58:20	2380	a small and very slender fish flew away
09:58:25-	2381	began to climb a slope over a skirt of steep slope composed of well brecciated basalt
09:59:25	2375	pillows, pillows, pillows
09:59:58	2373	a small slender fish
10:00	2372	pillows and large angular boulders, still up-slope 25°18.85'S, 70°02.39'E
10:00:27-	2375	brim of rippled sand bend
10:00:43	2377	skirt of a slope composed of large angular blocks
10:01:27	2377	still along the skirt of a slope
10:01:37	2379	a nematocarcinid shrimp?
10:02:04	2379	a halosaurid fish (*Aldrovandia affinis*?)
10:03:23	2384	between 10:00:27 and 03:23 we followed a skirt of a lava flow
10:03:40	2381	entered into rippled sand moat
10:04:30	2385	flew over very flat lava flow in the sandy moat
10:05:20	2385 moat	flew over another flat lava flow (composed of p0illows) in the sandy
10:05:24	2382	a white object on a pillow; vehicle flying over the 3rd flat lava flow composed of pillows and rather round blocks
10:05:50-06:10	2382	100% rippled sand zone
10:06:12-07:36	2382-78	a slope of pillows
10:07:36-10:12:37	2378-76	basically in a huge sandy moat
10:08:36	2379	a nematocarcinid shrimp
10:09:20	2377	ripple mark
10:09:45	2375	100% sedimented floor
10:10:40-11:35	2375	traversing obliquely a huge lava flow (bar-like lava flow)
10:12:02	2373	striding another long lava flow
10:12:27	2374	ripple mark (upper left-lower right)
10:12:14	2376	striding other long lava flow
10:12:37-14:52	2374	strided over a huge lava flow composed of very large angular blocks and pillows
10:13:27	2370	a white slender fish (*Aldrovandia*?), pillow

10:14:53	2380	entered into sandy moat with ripple mark (left-right cusp line)
10:15	2377	25°18.75'S, 70°02.50'E
10:15:50	2377	base of a slope
10:15:43	2381	a white sea anemone?
10:16:00	2376	outcropped lava basement is studded with granular hyaloclastics
10:16:55-18:25	2378-82	end of lava flow and entered into rippled sandy zone
		[video cassette change1A/4=>2A/4]
10:17:40	2382	**[cassette 2A/4 recording start]**
		rippled sand trapping much white stuff
10:18:29-19:27	2382	skirt of a lava flow composed of large angular blocks
10:19:17	2375	middle portion of the lava flow slope is composed of rather small brecciated basalt and occasionally studded with pebble-size hyaloclastics
10:19:27	2377	rippled sandy bottom
10:21:55	2767	flying over a flow of pillows & lobate lava
10:22:27-23:15	2367	again striding over a flow of large pillows
10:23	2366	pillows and brecciated basalt to the left and rippled sand to the right
10:24:00-24:20	2366	striding over a pillow lava flow (projected from the left side)
		T=1.83℃, S=34.72, LT=84.238
10:24:25	2363	entered again into rippled sand zone
10:24:45	2367	increased the amount of white stuff on rippled sediment
10:27:15-27:56	2357	striding over a lava flow composed of typical pillows
10:27:50	2354	probably a nematocarcinid shrimp on sandy pocket
10:28:05	2356	rather irregular lobate lava flow
10:28:10	2355	a white sea anemone
10:28:25	2357	lava flow of severely brecciated angular boulders
10:28:51-	2362	a black halosaurid fish (*Halosauropsis macrochir*?)
10:28:17	2364	very flat lava plane; only thinly covered by sediment
10:29:30-30:45	2364-57	rippled sand zone; very flat
10:29:22	2365	two bizarre, but probably biogenic mounds
		T=1.85℃, S=34.7334, LT=84.261
10:30:45	2357	pillows appeared abruptly; and gentle up-slope starred: this slope is rather gentle and occurs many rippled sand pockets
		25°18.87'S, 70°02.61'E
10:31:45-	2344	rippled sandy zone
10:33:45	2335	100% sand coverage
10:32:01	2341	ordered reducing the ship velocity
		25°18.89'S, 70°02.62'E
10:33:45-34:22	2339-37	basalt plane studded with granular hyaloclastics; and strided a rather flat lava flow
10:34:25-44	2339	regular ripple mark (upper left=>lower right)

10:36:50		T=1.84℃, S=34.7233, LT=84.238;
		no temperature anomaly around here
10:37:00	2333	striding over a cracked pillows
10:37:28	2336	rather flattened sheet flow of lava
10:38:03	2333	striding over again and again a flat brecciated lava flow
10:38:09-43:50	2334-25	rippled sand floor
10:39:50	2330	perfectly smoothed sediment floor
10:40:20	2327	100% sandy stand with ripples
10:41:11	2324	a fish (probably *Synaphobranchus bathybius* or *Halosauropsis?*)
10:43:22	2322	ripple mark (upper left-lower right)
10:43:50	2325	a long and slender lava flow composed of brecciated angular blocks
10:44:20-	2325	rather flat surface of lava flow; and then into rippled sandy flat
10:44:35	2321	a sea anemone?
10:45:20-45:40	2321	striding over a sharply brecciated lava flow
10:47:00	2316	continue the sandy flat; left-side is a skirt of lava flow
		25°19.01'S, 70°02.75'E
10:47:15-48:10	2315	over a step of pillows onto rippled sandy flat
10:48:10-	2314-	rippled sand zone
10:49:20	2312	ripples
10:50:00	2310	climbed a step of large breccia
10:50:45-11:01:00	2312-02	sandy flat; looking always a skirt of breccia slope to the left
10:52:12-52:45	2511	striding over a brecciated lava flow
10:53:20	2305	again striding over a small-scale lava flow
10:53:30	2310	ripple mark (as that observed on the bottom of river) (upper-lower)
10:55:15	2302	sediment carpet with ripples
		T=1.82℃, S=34.7238, LT=84.262
10:56:55	2305	a red shrimp
10:58:01	2302	over a very narrow lava flow
10:59:	2302	sandy bottom; ripple mark (left-right)
10:59:54	2302	a fish (*Acanthonus armatus*)
11:00	2301	change course to the way-point #3
11:01:10-03:25	2303-00	outcropping of a flat lava flow; weak up-slope of hyaloclastics; actually no sediment cover
11:03:25	2300	became ripple-sand covered flat floor
11:04:12-05:00	2297-95	again flat lava flow surface devoid of sediment; granular hyaloclastics stud the surface
11:04:12	2297	an asteroid (Goniasteridae?)
11:05:00-08:15	2295-91	a gentle up-slope of irregular boulders and pillows
11:05:25	2295	a short whip-like gorgonian
11:08:15-	2290	sandy floor
11:10	2289	sandy bottom
		25°19.14'S, 70°02.90'E

11:11:35-12:30	2287	zone of pleated sheet flow & pillows
11:13:33	2287	a jellyfish
11:13:45	2285	a ledge composed of lobate pillows
11:14	2286	broken lava
11:14:30	2288	bare basement lava:
11:15:15	2287	a tentacle of some organism
11:16-17:12	2286	rippled sand
11:17:12-19:25	2286	bare lava surface
11:19:25	2286	a pocket of rippled sand
11:20:10	2286	bare sheet flow
11:21:28	2286	a descending step; therefore the area between 11:11:35-11:21:30 is the shallowest portion of this saddle topography
11:22:50	2293	rippled sand moat
11:23:05	2293	a shrimp
11:23:21	2288	steep up-slope (or overhang) of brecciated pillow
11:24:08	2286	a transparent shrimp (like "yume-ebi")
11:26:30	2288	a narrow sand bench
11:26:55		descent along a scarp
11:27:00	2290	flying over a narrow lava flow
11:27:25	2290	flying over a upright scarp
11:28:10	2290	again flying over a upright brecciated scarp
11:30:00-31:40	2292	entering into sandy flat
11:31:50-32:10	2288-92	moved over sandy ripple floor into breccia zone
11:32	2293	steep wall of brecciated pillow basalt 25°19.21'S, 70°02.81'E
11:32:40	2296	a whip-like gorgonian
11:33:40-34:05	2285	ascending along a scarp of 10m high
11:34:05		flying over a groove topography
11:36:17	2289 20m	start of descending along a slope of brecciated angular blocks ca
11:38:05	2308	a sand bench
11:38:20-	2287	zone of large angular blocks; a large lava flow
11:40:10	2302	a whitish sea anemone on columnar angular block
11:41	2300	flying over a huge lava flow
11:42:39	2301	flying over a sand bench
11:42:45	2301	again flying over a huge lava flow
11:43:45	2300	a whip-like gorgonian
11:44:03	2299	a nematocarcinid shrimp in a small sand bench
11:44:15-	2300	start of down-slope along angular blocks
11:45:17-48:20	2306-16	a gently down-sloping sand bench (rippled)
11:48:20-47:25	2316-22	down-slope composed angular blocks
11:47:40-51:45	2324-33	rippled sand moat
11:48:15	2324	huge lobate flow

11:48:30	2321	a black halosaurid fish (*Halosauropsis macrochir*?) on a lobate pillow
11:48:40-48:50	2320	flying over a lava flow composed of brecciated pillow
11:48:43	2319	a white fish (rattail?)
11:49:20	2325	a fish
11:50	2329	breccia on the sandy bottom
11:50:24	2327	a black halosaurid fish (*Halosauropsis macrochir*?)
11:50:35	2330	striding over a brecciated lava flow
11:51:45	2333	an (two?) elongated lava flow(s)
11:52:25-59:45	2330-2386	long down-slope over brecciated lava
11:59::45-	2386	rippled sand moat
12:00:08-	2385-	large angular boulders; and again start down-slope 25°19.27'S, 70°02.59'E
12:01:19	2391	rippled sand moat
12:01:32-05:20	2392-2421	began down-slope over brecciated boulders
12:01:32	2394	a whitish object (lower right corner on monitor)
12:02:00	2388	on a flat lave (sheet flow) T=1.80℃, S=34.7244, LT=84.287
12:05:20	2421	rippled sand zone
12:06:10	2424	on a flat lava flow covered by sand with pebble-sized hyaloclastics; white powder is trapped in ripple mark
12:07:25	2424	on a flat lava surface; poor sediment cover; however, **the surface seems to be tinted brownish**
12:07:22	2426	surface of flat lava apparently covered by brown fluffy substance sediment cloud stirred by suspended chain is apparently dark
12:08:20	2426	flat lava flow is more and more coated with brown fluffy material
12:10:04	2427	a black halosaurid fish (*Halosauropsis macrochir*?)
12:11:35	2435	a small white sea anemone T=1.8℃, S=34.7; LT=84.286
12:12	2433	sand with pebble to granule-sized hyaloclastics
12:12:16	2435	several minute sea anemones
12:15:08	2446	a fish on the floor studded with hyaloclastics and pebbles 25°19.31'S, 70°02.46'E
12:15:30	2454	flat lava surface seems to be covered by yellowish-brown slabs
12:17:15	2455	T=1.79℃, S=34.72, LT=84.287 no pronounced thermal anomaly was detected
12:17:40	2459	a rattail (macrourid fish; *Nezumia*-type) on sand bottom with brecciated sheet flow; presence of fish suggests no present active venting: surface of lava somewhat not flat but brecciated
12:20:57-28:50	2483	five large sea anemones [this site situates in a gorge-like structure]
12:21:00		**sea anemones #1 & #2**
12:21:15	2492	**sea anemone #3**

12:21:22	2498	**sea anemone #4**
12:28:50	2458	**sea anemone #5** 25°19.32'S, 70°02.41'E; 25°19.34'S, 70°02.43'E T=1.79℃, S=34.725, LT=84.287
12:22	2497	**a small sea anemone on sand with breccia**
12:23:54	2510	**cassette 3A4 recording start** **[end of cassette 2A/4]**
12:24:00	2511	**[start of cassette 3A/4]**
12:24:00	2512	medium-sized (ca. 20-30cm) breccia are scattered on Fe coated brown sand
12:28:37	2558	**two small anemones;** bottom inclination increased around here; in a gorge and talus topography?
12:28:45	2563	yellow round object on rock (?)
12:28	2549	broken lava, brownish alteration in color
12:28:55	2561	**many small sea anemones on brown slab**
12:29:41	2563	**swarm of small sea anemones** **25°19.33'S, 70°02.31'E**
12:30:00	2566	**whitish stain on rock and many sea anemones** **25°19.31'S, 70°02.31'E; 25°19.32S, 70°02.31E** T=1.76℃, S=34.7251, LT=84.335
12:30:42	2570	**basalt blocks are altered in tint** (ferro-manganese coating?); and intense white stain or powder around basalt rocks
12:30:53	2572	a black halosaurid fish (*Halosauropsis macrochir*?); occurrence of fish does imply no active hydrothermalism?
12:31:30	2572	**numerous small sea anemones**
12:32:16	2580	**numerous small sea anemones;** sea floor around here is paved with cobble-size breccia
12:33:23	2580	**thick yellowish brown material cover the floor**
12:34:00	2585	T=1.76℃, S=34.725, LT=84.31
12:35:33	2591	a white snake-like organism ("nyoro-nyoro": fish? genge?); numerous small sea anemones
12:33:48	2586	a shrimp?
12:34:33	2591	a white snake-like organism ("nyoro-nyoro": fish? genge?)
12:35:25	2593	an angular boulder traps white stuff beneath it
12:35:45	2591	**numerous small sea anemones attached on an angular boulder**
12:35:59	2595	a white halosaurid fish (*Aldrovandia affinis*?)
12:36:03	2595	a white snake-like fish swam across ("nyoro-nyoro"=genge!?)
12:36:30	2593	**sulfide structure ???** (small "chimney"?)
12:36:50	2595	possibly altered rock to the left

12:37:25	2594	**sea anemones;**
		sediment cover around here must increased around here
		25°19.31'S, 70°02.25'E
12:40:28	2591	*Acanthonus armatus*
12:43	2588	change course and back to the hydrothermally altered area
		25°19.35'S, 70°02.20'E
12:46	2592	something white
12:46:05	2588	a halosaurid fish (*Aldrovandia*?)
12:48	2588	ripple with red Fe deposits
12:50:15	2596	a red shrimp
12:52	2593	25°19.37'S, 70°02.12'E
13:00	2642	25°19.37'S, 70°02.08'E
13:14	2650	sand with breccia
		25°19.43'S, 70°02.02'E
13:08:20	2646	a fish (Notacanthidae?) on sand bottom with breccia
13:14	2629	25°19.42'S, 70°02.12'E
13:20:35	2622	a sea anemone?
13:21	2625	white burrows of sand dweller
13:22	2628	25°19.49'S, 70°02.16'E
13:24	2632	a fish (*Acanthonus armatus*) on sand
13:25:53	2629	a fish
13:26	2631	**red Fe deposits on sand**
		25°19.47'S, 7002.21°'E
13:27	2626	**rich Fe deposits of sand**
13:27:30	2625	a fish
13:29	2635	white unknown animals? on surface
13:31	2636	**red flocculent matters on sand surface**
13:33	2632	**small area of white stained sand**
		25°19.49'S, 70°02.27'E
13:33:13	2635	**fluid venting??: white depression of a series of several holes**
13:36:10	2639	brown boulder
13:37:20	2644	a small sea anemone
13:39:30	2640	T=1.76℃, S=34.7251, LT=84.311
13:41	2640	ditto
13:45	2622	decrease red flocculent matter on sand
		25°19.52'S, 70°02.39'E
13:47	2619	changed the direction of ship
		breccia in sand are encircled by white scour
13:51:50	2595	a large gorgonian and a sea anemone
		25°19.50'S, 70°02.50'E
13:53:27	2593	a red shrimp on sand
13:55:05	2590	a red shrimp
13:56	2578	breccia in sand are encircled by white scour

13:58:54	2553	a halosaurid fish (*Aldrovandia*?)
14:00	2535	scarp composed of large breccia;
		a shrimp
		25°19.44'S, 70°02.2'E
14:01:30	2535	a shrimp
14:02	2532	sand with white stuff
14:03:46	2518	a notacanthid? fish
14:04	2516	white altered sand of small area
14:04	2509	rippled sand
14:12	2474	sand and breccia
		25°19.37'S, 70°02.61'E
14:18	2453	breccia
14:24	2446	rippled sand
		25°19.31'S, 70°02.57'E
14:24:47	2445	a halosaurid fish (*Halosauropsis*?)
14:26	2433	breccia
14:27:15	2427	flat lava bench, granular hyaloclastics
14:30	2422	on flat lava bench; brown-stained sand;
		a white small sea anemones
14:31	2416	**sea anemones**
14:34	2444	pillow
		25°19.28'S, 70°02.46'E
14:36:20-36:20	2455	a whitish sea anemone
14:36:25	2454	sea anemones (or scalpellid barnacles?)
14:36:47	2454	a white sea anemone
14:37:01	2449	a white sea anemone
14:37	2453	**many sea anemones** and a fish (*Aldrovandia affinis*?)
		25°19.22'S, 70°02.45'E
14:38:09	2452	**numerous white small sea anemones attached to a large flat boulder**
14:38:45	2450	a large sea anemone
14:38:57	2448	**many white small sea anemones**
14:39:59	2454	**numerous white small sea anemones**
14:40:26	2453	**many sea anemones**
		25°19.22'S, 70°02.47'E
14:40:38	2453	**brown-stain**
		T=1.80℃, S=34.7247, LT=84.287
14:41:20	2460	**numerous sea anemones**
		25°19.24'S, 70°02.36'E
14:42:10	2469	a rattail (=macrourid) fish
14:43:20	2470	**white stain and sea anemones**
14:44	2473	**many sea anemones**
14:45:13	2487	a rattail (=macrourid) fish
14:47:30	2517	a sea anemone

14:48	2525	decreased the number of sea anemones
14:48:05	2520	*Acanthonus armatus*
14:49:30	2536	a fish (*Bathysaurus* sp.: "shinkai-eso") and sea anemones
14:50:42-51:30	2548	**numerous small sea anemones**
		25°19.25'S, 70°02.26'E
14:53	2564	**many sea anemones**
14:53	2562	a red aristeinid shrimp (*Benthesicymus*?)
14:53:24-54:20	2562	**numerous small sea anemones**
14:55:59	2563	a shrimp
14:56	2565	red sand
14:57:16	2563	a fish at lava flow front
15:00	2571	sandy bottom
		25°19.28'S, 70°02.23'E
15:00:23	2567	a red shrimp
15:02-03:40	2571	ripple mark
15:05	2574	cobble-sized basaltic rocks
15:08	2569	huge pillow
15:09:38	2573	a white halosaurid fish (*Aldrovandia affinis*?)
15:11:00	2569	entered into lava zone
15:12	2567	boulders on sedimentary bottom
15:14:38	2555	a fish (eel-form)
15:14:50	2557	a fish (eel-form)
15:15	2557	pillow on the sediment
		25°19.31'S, 70°02.07'E
15:15:00	2557	??galatheid??
15:15:26	2556	slender & "hira-hira" object
15:18:02	2548	a whip-like gorgonian
15:22	2549	ripple mark
15:26:09	2552	"hikari-mono"
15:27	2553	ripple
15:30	2556	end of DT06 transect
		25°19.11'S, 70°02.04'E
		T=1.78℃, S=34.7250, LT=84.287
15:31:58	2553	a shrimp
15:32	2556	start of cable haul in
15:37	2356	light transmission anomaly of -0.1%
		25°19.08'S, 70°01.96'E
15:37	2347	ditto -0.2%
		25°19.06'S, 70°01.99'E
15:39	2295	ditto **-0.5%**
		25°19.06'S, 70°01.95'E
15:40	2252	ditto -0.4%
15:41	2210	ditto resumed to normal level
15:46	1995	cable length 2000m

16:02	996	cable length 1000m
16:18	24	main switch off

VIDEO LOG (Aug.18, 2000)

KR00-05-DT07

Time	Depth (m)	Description
09:01:05	0	DTV launched
09:06:40	14	DTV main power supply on
09:08	14	cable pay out started
09:23:00	420	siphonophore
09:27:07	582	siphonophore
09:27:26	594	siphonophore
09:28:50	654	jellyfish
09:29:40	693	jellyfish
09:30:58	747	fish
09:31:34	773	fish
09:31:47	783	jellyfish
09:33:47	868	jellyfish
09:33:59	875	fish
09:34:20	892	jellyfish?
09:34:52	914	jellyfish
09:36:36	989	jellyfish
09:36	998	cable length 1000m
09:37:03	1007	fish
09:37:40	1033	fish
09:39:06	1093	fish
09:40:10	1136	fish
09:42:39	1244	fish (*Gonostoma*?)
09:52:44	1660	fish
09:58:58	1931	fish ("iwashi")
09:59:53	1966	jellyfish
10:00	1995	cable length 2000m
10:01:15	2022	"hige-kurage"
10:02:27	2072	red object
10:03:20	2110	fish
10:07:43	2283	jellyfish
10:08	2314	bottom recognized; sandy bottom with white burrow? and ripples; no transmission anomaly 25°19.16'S, 70°03.24'E
10:09:24	2320	start of towing; T=1.87℃, S=34.723, LT=84.458
10:11:46	2319	ripple mark (upper right-lower left)
10:15:34	2321	ripple mark (upper left-lower right); wave length of ripple=ca. 25cm
10:17:05	2315	breccia or angular basalt zone, no sediment

10:18:46	2316	a fish
10:20:50	2316	sand pocket
10:21	2309	steep cliff of breccia
10:21:45	2316	sand with ripples
10:23	2316	a fish
10:25:20	2315	scarp composed of angular block of basalt to the left
10:25	2315	50m to the first locality
10:25	2293	breccia cliff up
10:25	2310	breccia and sand with ripple
10:26	2299	a red swimming galatheid on breccia cliff;
		almost on the first landmark
		25°19.09'S, 70°03.30'E
10:26:40	2299	a pillow lava with slivers and corrugation
10:27:07	2302	a red shrimp
10:29:30	2300	rippled sand zone
10:30:40	2306	angular blocks of basalt
10:31:10	2305	scarp
10:33:20	2309	white stuff trapped among ripples
10:3:55	2311	surface of flat lava flow
10:3538	2317	ripple mark (upper-lower)
10:39:30	2318	pillow basalt
10:39:58	2313	a gorgonian?? (white, flexible (kune-kune))
10:40:00	2317	a fish (*Aldrovandia affinis*?)
10:41:43	2316	a whip-like gorgonian on breccia attached on 5m scarp
10:42:45	2312	rippled sand pocket or gully (debris flow corridor)
10:44:01	2314	ripple mark (upper left-lower right)
10:45:30	2322	ripple mark (wave length=ca. 15cm)
10:45:43	2328	a red aristeinid shrimp on rippled sand
		25°18.97'S, 70°03.43'E
10:48:42	2326	a shrimp
10:58:00-11:02	2348	100% sediment coverage;
		parallel and very regular ripple (wave length.=ca.25cm)
		25°18.90'S, 70°03.49'E
10:59	2351	a fish (*Aldrovandia affinis*?) [ca. 40cm long]
11:02	2370	breccia and sand with ripple
11:03:50	2397	down-slope of rippled sand with occasional pillows
11:04:50	2388	sand with ripples; white stuff trail parallel lines perpendicular to
		the wave line
11:05:40	2392	pillow basalts dam up (or hem) sand moat
11:06:45	2400	lava flow front
11:07:50	2410	
11:08	2413	25°18.81'S, 70°03.57'E
11:08:15	2412	rippled sand zone
	2451	steep slope down

11:10:00	2423	a red aristeinid shrimp
11:10:43	2430	ripple mark
11:12:00	2433	descent over a scarp of 5m in altitude
11:13:20	2440	
11:13:45	2450	a red aristeinid shrimp among large angular blocks of basalt
11:14:55	2461	an orange-colored sea anemone
11:15	2476	breccia
11:15:25	2468	a gap between lava flows [spur-and-groove structure]
11:16:30	2488	down-slope of basalt with thin sediment
11:18		25°18.76'S, 70°03.64'E
11:18	2520	a shrimp
11:18:20	2510	a dark violet-colored deimatid holothurian (*Benthodytes*?)
11:19:30	2520	a shrimp (*Nematocarcinus* sp.) stands on sand
11:20:40	2530	an asteroid
11:21:20	2626	meandering track of spatangoid
11:20:50		huge lobate lava flow
11:21:55	2528	*Acanthonus armatus*
11:22:30	2530	lava flow
11:23:09	2536	escarp of ca. 7m in relative altitude
11:23:48	2545	lobate pillow
11:25:18	2564	very flat bench topography, sandy floor with granular pebbles
11:26	2574	sandy bottom
11:26:30-	2580	several whip-like gorgonians (dead)
11:27:22	2587	2 whip-like gorgonians
11:27:25	2590	meandering track of spatangoid; 100% sand coverage
11:28:19	2596	2 whip-like gorgonians
11:28	2599	sunken twig??? [=> probably whip-like gorgonian]
11:28:40	2603	meandering track of spatangoid
11:29	2604	trace
	2605	pillow lava
11:29:50-	2617	down-slope or escarp over pillows (ca. 10m)
11:31:30	2627	sand moat full of meandering trails of spatangoid
11:32	2629	breccia on sedimentary bottom
11:32:00	2628	an ophiuroid
11:32:50	2634	a whip-like gorgonian
11:33:25	2633	2 whip-like gorgonians; up-slope
11:33:45	2632	a whip-like gorgonian
11:34	2636	25°18.65'S, 70°03.74'E
11:34:30		a whip-like gorgonian
11:35:01	2640	ascent seeing a huge lobate lava flow to the right
11:35:37	2334	scarp composed of large angular basalt
11:36:00	2640	ca. 20m descent over a scarp
11:36:45	2660	
11:37:00	2664	a holothurian (purplish orange-colored; probably *Benthodytes*)

11:37:11	2662	a holothurian (slender & black-colored)
11:37:55		a red shrimp (*Nematocarcinus* sp.)
11:38:20	2664	*Acanthonus armatus* (or *Squalogadus modificatus*)
		& whip-like gorgonian
11:38	2663	end of DT07 transect
		25°18.62'S, 70°03.78'E

KR00-05-TY08-U01

11:44	2665	start of TY08-U01 transect
		25°18.60'S, 70°03.80'E
11:53	2280	light transmission anomaly of -0.05%
		25°18.54'S, 70°03.85'E
11:54	2238	ditto -0.05%
11:57	2136	ditto resumed to normal level
		25°18.52'S, 70°03.82'E
12:00	2000	end of TY08-U01 transect
		25°18.52'S, 70°03.82'E

KR00-05-TY08-D02

12:02	2000	start of TY08-D02 transect
		25°18.52'S, 7003.81°'E
12:08	2249	light transmission anomaly of -0.03%
		25°18.54'S, 70°03.78'E
12:08	2308	ditto -0.03%
12:11	2360	ditto resumed to normal level
12:15	2500	end of TY08-D02 transect
		25°18.56'S, 70°03.76'E

KR00-05-TY08-U02

12:17	2500	start of TY08-U02
		25°18.56'S, 70°03.76'E
12:21	2362	light transmission anomaly of -0.05%
		25°18.53'S, 70°03.70'E
12:23	2292	ditto -0.05%
12:25	2185	ditto -0.05%
12:29	2000	end of TY08-U02
		25°18.56'S, 70°03.61'E

KR00-05-TY08-D03

12:31	2000	start of TY08-D03
		25°18.58'S, 70°03.63'E
12:36	2189	light transmission anomaly of -0.05%
		25°18.54'S, 70°03.55'E
12:38	2264	ditto -0.05%

12:41	2369	ditto -0.05%
12:42	2388	ditto resumed to normal level
		25°18.56'S, 70°03.52'E
12:43	2400	end of TY08-D03
		25°18.57'S, 70°03.52'E

KR00-05-TY08-U03

12:44	2400	start of TY08-U03
		25°18.57'S, 70°03.52'E
12:49	2213	light transmission anomaly of -0.05%
		25°18.58'S, 70°03.46'E
12:51	2126	ditto -0.2%
		25°18.55'S, 70°03.43'E
12:52	2976	ditto resumed to normal level
		25°18.58'S, 70°03.40'E
12:55	2000	end of TY08-U03
		25°18.58'S, 70°03.38'E

KR00-05-TY08-D04

12:56	2000	start of TY08-D04
		25°18.59'S, 70°03.36'E
12:59	2100	light transmission anomaly of -0.2%
		25°18.57'S, 70°03.3'E
13:00	2125	ditto -0.1%
13:01		ditto resumed to normal level
13:03	2236	ditto -0.03%
		25°18.57'S, 70°03.29'E
13:04	2322	ditto -0.03%
13:05	2330	on bottom pillow, end of TY08-D04

KR00-05-TY08-U04

13:07	2320	start of TY08-U04
		25°18.60'S, 70°03.28'E
13:13	2085	light transmission anomaly of -0.2%? (noise?)
		25°18.62'S, 70°03.21'E
13:15	2000	end of TY08-U04
		25°18.59'S, 70°03.13'E

KR00-05-TY08-D05

13:17	2000	start of TY08-D05
		25°18.61'S, 70°13'E
13:20	2103	light transmission anomaly of -0.1%
		25°18.63'S, 70°03.12'E
13:22	2211	ditto -0.05%

13:25	2300	end of TY08-D04
		25°18.60'S, 70°03.02'E

KR00-05-TY08-U05

13:27	2300	start of TY08-U05
		25°18.62'S, 70°03.02'E
13:34	2000	end of TY08-U05
		25°18.59'S, 70°02.93'E

KR00-05-TY08-D06

13:36	2003	start of TY08-D04
		25°18.63'S, 70°02.89'E
13:40	2134	light transmission anomaly of -0.1%
		25°18.67'S, 70°02.87'E
13:41	2185	ditto -0.15%
		25°18.60'S, 70°02.82'E
13:42	2232	ditto -0.2%
		25°18.62'S, 70°02.81'E
13:43	2250	ditto -0.1%
13:44	2287	ditto -0.1%
13:47	2384	end of TY08-D04
		25°18.61'S, 70°02.75'E

KR00-05-TY08-U06

13:50	2376	start of TY08-U06
		25°18.64'S, 70°02.78'E
13:52	2304	light transmission anomaly of -0.3%
		25°18.64'S, 70°02.77'E
13:53	2254	ditto -0.15%
	2230	ditto -0.8%
		25°18.64'S, 70°02.74'E
13:54	2198	ditto **-0.8%**
13:55	2175	ditto **-0.8%**
	2163	ditto -0.3%
13:56	2124	ditto -0.2%
		25°18.65'S, 70°02.67'E
13:59	2000	end of TY08-U06
		25°18.64'S, 70°02.62'E

KR00-05-TY08-D07

14:01	2000	start of TY08-D07
		25°18.73'S, 70°02.62'E
14:05	2148	light transmission anomaly of **-0.6%**

14:05	2162	ditto **-0.7%**
		25°18.67'S, 70°02.57'E
14:06	2188	ditto **-0.6%**
		25°18.62'S, 70°02.81'E
14:07	2219	ditto -0.4%
14:08	2258	ditto -0.2%
14:09	2310	ditto -0.2%
14:10	2332	ditto -0.1%
14:12	2374	end of TY08-D07

KR00-05-TY08-U07

14:14	2351	start of TY08-U07
		25°18.69'S, 70°02.52'E
14:17	2241	light transmission anomaly of -0.2%
14:18	2195	ditto **-0.5%**
		25°18.74'S, 70°02.48'E
14:19	2182	ditto -0.2%
14:19	2148	ditto -0.1%
14:21	2102	ditto back to normal
14:22	2050	end of TY08-U07
		25°18.76'S, 70°02.44'E

KR00-05-TY08-D08

14:24	2051	start of TY08-D08 operation
		25°18.75'S, 70°02.45'E
14:26	2163	light transmission anomaly of -0.1%
14:27	2179	ditto -0.2%
14:27	2190	ditto -0.3%
		25°18.76'S, 70°02.40'E
14:28	2221	ditto -0.1%
14:31	2324	ditto -0.05%
14:32	2341	end of TY08-D08 operation
		25°18.79'S, 70°02.40E

KR00-05-DT08

14:34:40	2349	*Acanthonus armatus*
14:39:35	2366	rippled sand
14:36:36	2351	start of DT08 operation
		25°18.81'S, 70°02.34'E
14:37:44	2356	*Acanthonus armatus*; large angular basalt blocks
14:38	2359	basaltic boulders on the sedimentary bottom
14:40	2368	ripple
14:42	2369	a bythitid fish (*Acanthonus armatus*)
14:42:53	2370	*Acanthonus armatus* or (*Squalogadus modificatus*)

14:23:15	2364	angular basaltic boulders
14:43:53	2361	*Acanthonus armatus* among breccia zone; no sediment
14:44:40	2347	flank of lava flow composed of angular blocks
14:45:09	2349	a large sea anemone
14:46:10	2360	down-slope paved with large angular blocks
14:46:29	2363	a rattail; no sign of hydrothermalism
14:47:04	2366	a large sea anemone of ca. 15cm in diameter
14:47:35	2370	a white holothurian?
14:49:00	2380	a red shrimp
14:49:44	2388	entered into rippled sand zone
14:50	2388	ripple
14:50:45	2391	gentle slope of large angular blocks
14:51:37	2389	a round pillow lava
14:52	2397	cobbles
14:53:15	2400	a huge lobate pillow on a slope
14:54:30	2409	a large whitish sea anemone of ca. 20cm in diameter
14:55:03	2413	a large whitish sea anemone
14:55:24	2414	*Acanthonus armatus*
14:56:45	2423	entered into sandy zone
14:57:48	2427	*Halosauropsis*?
14:57:54	2428	ditto
14:58:23	2425	dam (outer rim of sandy moat) composed of pillow lava
14:58:49	2424	*Acanthonus armatus* or *Squalogadus*?
14:59:42	2429	moat filled with sediment
15:00	2431	breccia
		25°18.92'S, 70°02.16'E
15:00:15	2430	outer rim of the sandy moat
15:00:55	2432	down-step
15:01:03	2442	entered into sandy zone
15:03	2446	ripples
15:04:39	2445	a red aristeinid shrimp *Benthesicymus*?
15:06:40	2443	a bar (elongated lava low) composed of pillows
15:08	2447	a red shrimp *Benthesicymus*?
15:08:10	2444	moat of sand
15:09:38	2446	down a scarp composed of broken pillow
15:09:42	2449	a rattail (macrourid fish)
15:10:21	2451	a rattail (macrourid fish)
15:11:14	2442	a glass sponge?
15:12:08	2461	a red shrimp
15:12:20	2460	pile of hyaloclastics
15:13:15	2466	breccia on the sediment
15:13:35	2466	breccia zone (angular blocks of ca. 50cm)
15:15	2473	25°18.98'S, 70°02.04'E
15:15:10	3473	descent over a down-slope

15:16:10	2496	a red shrimp and a rattail
15:16:45	2500	debris flow of cobbles and pebbles
15:17:34	2507	a fish; sandy zone
15:18:50	2507	*Acanthonus armatus*
15:19:35	2516	a shrimp
15:19:48	2516	*Acanthonus armatus*
15:19:50	2518	lava table
15:19:50-20:	2525	sediment color changed around here; brown Fe stain
		25°19.04'S, 70°01.99'E
15:20:22	2522	a fish
15:20:50	2530	a sea anemone
15:21:10	2535	lava table as if washed by debris flow
15:23:35	2561	talus composed of medium-sized breccia
15:22:53	2556	*Acanthonus armatus*
15:25:21	2577	a red shrimp
15:26:10-30:15	2586	entered into a huge moat of sand
15:26:23	2587	a red aristeinid shrimp *Benthesicymus*?
15:29	2612	25°19.06'S, 70°01.87'E
15:29:19	2611	*Acanthonus armatus*
15:30:14	2620	a shrimp
15:31:11	2627	a shrimp
15:31:51	2634	*Acanthonus armatus*
15:33	2642	ripple
15:35:35	2659	end of DT08 operation; CTD reset
		25°19.11'S, 70°01.85'E
15:36:01	2660	start of DTV haul in
15:43	2351	light transmission anomaly of -0.03%
		25°19.13'S, 70°01.77'E
15:46	2217	ditto -0.05%
15:49	2099	ditto resumed to normal level
15:51	1997	cable length 2000m
16:07	996	cable length 1000m
16:21:35	73	main switch off

VIDEO LOG (Aug. 19, 2000)

KR00-05-DT09

Time	Depth (m)	Description
07:46:45	0	DTV system launched
07:52:30	13	DTV system main switch on
07:54	15	start of cable pay out
07:58:59	107	siphonophore
08:07:18	359	jellyfish
08:09:36	457	jellyfish?
08:09:54	467	jellyfish
08:11:16	526	jellyfish
08:11:41	542	jellyfish
08:13:29	624	jellyfish
08:16:02	722	siphonophore
08:16:19	735	jellyfish
08:19:10	852	jellyfish
08:19:24	861	jellyfish
08:22	997	cable length 1000m
08:22:48	1004	jellyfish
08:28:58	1268	shrimp
08:30:00	1311	jellyfish
08:32:43	1430	fish
08:37:03	1606	jellyfish
08:46	1995	cable length 2000m
08:46:56	2009	shrimp
08:47:24	2028	siphonophore
08:56	2365	actually no light transmission anomaly
08:57:24	2421	a shrimp
09:05:52	2739	on the bottom soft sediment paved with large breccia of basalt 25°17.70'S, 70°01.13'E
09:09:40	2740	DTV system towing start T=1.74℃, S=34.7258, LT=84.531 Cloud of sediment hardly settles, hence the sediment seems to be relatively fine.
09:11:54	2723	hyaloclastics and small boulders
09:13:24	2731	a trail of a gastropod
09:15:22	2727	meandering trail of spatangoid
09:16:00	2723	a whip-like gorgonian
09:17:02	2723	trail of a gastropod
09:17:23	2722	an orange sea anemone on angular boulder; up-slope; bottom seemingly very smooth studded with hyaloclastics
09:20	2719	many traces

09:20:03	2717	"Sitzmark" of an asteroid
09:20:41	2716	meandering trace of spatangoid
09:21:30	2715	complicate meandering trail of spatangoid
09:21:44	2712	a sea anemone
09:23	2707	fine sediment
		25°17.75'S, 70°01.13'E
09:24:28	2702	a shrimp?
09:25:15	2700	completely smoothed sediment floor with occasional angular blocks
09:26:20	2692	small step and then sandy flat
09:27:25	2686	meandering trace of spatangoid & pillow lava
09:28	2683	trace
09:28	2675	trace
09:30:07	2664	a red shrimp
09:30:33	2660	pillows & angular blocks
09:31	2661	basalt on the sedimentary bottom
09:31:36	2657	a small fish
09:31:57	2655	*Acanthonus armatus*? (shorter than 10cm)
09:34	2645	breccia, holothurian and traces
09:34:11	2645	a purple elasipod holothurian (*Benthodytes*?)
09:34:35	2647	fan-shaped gorgonian? or antipathalian coral?
09:35:50	2644	many meandering traces of spatangoid on the fine sediment
09:36:36	2636	breccia scattered
09:37:48	2625	a fish
09:39:20	2619-15	climbing a scarp composed of blackish colored large breccia, and
		then flying into sandy floor with meandering trace of spatangoid
09:40	2618	25°17.84'S, 70°01.25'E
09:41:58	2610	nanja-monja (shrimp?? or sea anemone??)
09:43:03	2604	a red nematocarcinid shrimp
09:43:16	2604	meandering trace of spatangoid
09:43:23		trenches produced by some shrimp
09:44:30	2592	outcropping of basalt as a ledge
09:45:13-45:35	2585	climbed two small scarps
09:47:38	2572	a fish
09:49:33	2560	a whip-like gorgonian
09:50	2559	a trace
09:50:57	2551	a red shrimp
09:51:49	2546	a red aristeinid shrimp (*Benthesicymus*?)
09:52:09	2545	*Acanthonus armatus*
09:53	2541	blackish colored rocks on the sedimentary bottom
		25°17.93'S, 70°01.32'E
09:55:20-	2529	up-slope (20m up)
09:56:00	2524	nanja-monja2 (holothurian?)
09:56:00	2518	full of meandering traces of spatangoid and then up-slope of breccia
09:56:20	2522	*Acanthonus armatus*

09:58:00	2505	pillows-sand zone
09:58	2493	slope, black pillow
09:59:40	2493-85	climbing a scarp composed of large brecciated basalt
10:00	2489	steep cliff of breccia
		25°17.99'S, 70°01.36'E
10:01:30	2479	tongue of a lava flow (brecciated)
10:02:10	2484	ripple zone between lava flows
10:05:10	2483	rock
10:06:23	2482	heap or scarp of angular blocks
10:07:22	2477	a sea anemone and a whip-like gorgonian on brecciated pillow
10:08:52	2477	a sea-pen (*Pennatula*)
10:12:10	2478	sand zone without ripple
10:13:28	2472-68	scarp of breccia and then into sandy zone
		25°18.09'S, 70°01.47'E
10:15	2469	[sea urchin on sand ?=> probably meandering trace of spatangoid]
10:15:02	2468	a holothurian on sediment
10:15:43	2467	an orange-red sea anemone on breccia
		25°18.11'S, 70°01.49'E
10:16:49	2463	a halosaurid fish and nanja-monja
10:21	2455	a gorgonian on breccia
10:27:22	2455	two red shrimps (*Nematocarcinus* sp.) on breccia
		25°18.19'S, 70°01.55'E
10:28:30	2460	*Nematocarcinus* sp.
10:29:25	2450	a holothurian
10:31:51	2445	*Nematocarcinus* sp.
10:33:20	2438	brecciated pillow, a whip-like gorgonian
10:34:10	2433	a whip-like gorgonian
10:36:20	2420	after 10m of climbing into sandy zone
10:37:20	2420	T=1.82℃, S=34.725, LT=84.506
10:38	2415	25°18.28'S, 70°01.66'E
10:42:15	2420	sandy flat
10:42:38	2420	a yellowish-brown calyx-shaped object (probably sponge) on rock
10:43	2420	pillow
10:43	2421	a fish
		25°18.33'S, 70°01.69'E
10:44:10	2418	*Acanthonus armatus*
10:45:20	2420	a holothurian *Benthodytes* sp. ("hirata-soko-namako"-rui)
10:47:40	2412	three gorgonians
		25°18.35'S, 70°01.71'E
10:49:38	2412	a yellowish brown organism (calyx-shaped sponge?)
10:52	2412	trace
10:54	2399	steep slope of breccia
10:56:00	2400	pillow flow & sand
10:57	2400	pillow

10:57:41	2397	*Nematocarcinus*? on rippled sand
10:58:30	2400	a red aristeinid shrimp (*Benthesicymus*?)
11:01:30	2391	rippled sand
		25°18.45'S, 70°01.83'E
11:02	2386	the way-point #2; steep wall of pillow
		25°18.49'S, 70°01.35'E
11:03:24	2383	a whip-like gorgonian on a scarp
11:04:43		arrived at the way-point #2
11:08:35	2394	a purple holothurian (*Benthodytes*?)
11:09:31	2397	an ophiuroid on rippled sand
11:12	2394	breccia of steep slope
11:14:00	2400	a nematocarcinid shrimp
11:14:48	2402	a nematocarcinid shrimp
11:16	2405	pillow
		25°18.57'S, 70°01.95'E
11:16:10	2403	an ophiuroid
11:18:00	2403	pillows & pillows
11:28	2420	25°18.55'S, 70°01.98'E
11:32:10	2415	a white fish
11:33	2405	pillow
11:35	2415	huge pillow lava
11:35:18	2411	a whip-like gorgonian
11:35:55	2415	something on a rock
11:37	2415	a whip-like gorgonian
11:39	2423	ripple
11:44:38	2422	*Acanthonus armatus*
11:45	2424	gentle slope down
		25°18.42'S, 70°01.99'E
11:46	2423	huge pillow lava
11:47	2421	broken pillow
11:50	2440	a fish?
11:51	2451	slope down
11:54:10	2470	flat sandy floor without ripple, biogenic craters, large angular blocks
11:54:48	2471	a shrimp?
11:55:34	2474	a whip-like gorgonian
11:56:07	2474	two sea anemones, two flexible projections on a boulder
11:57:40	2780	a white object on a lava flow table
11:58:20	2789	sandy zone with occasional micro-craters
11:59:20	2496	a nematocarcinid shrimp
12:00	2500	large lobate lava (broken)
		25°18.28'S, 70°02.04'E
12:02:20	2500	outcropping of lava table
12:04:40	2505	rippled sand

12:05	2507	broken lava
12:07:00	2504	a shrimp passed by in front of camera
12:08:20	2502	slope of large breccia
12:11:38	2516	a whip-like gorgonian
12:14:50	2536	slope of breccia into sandy zone
12:15	2536	25°18.16'S, 70°02.07'E
12:16	2543	arrived at landmark #3; sand and brecciated blocks
		25°18.12'S, 70°02.07'E
12:17:00	2547	sand fill on an apron
12:18:30	2551	a halosaurid fish
12:20:00	2562	large angular blocks on sandy floor
12:20	2571	a shrimp
12:18:23	2549	a halosaurid fish
12:20:49	2568	a nematocarcinid shrimp and meandering trace of spatangoid
12:21:47	2580	a halosaurid fish (*Halosauropsis*?)
12:22:26	2583	a shrimp?
12:23:40	2590	flat sandy zone
12:24:05	2593	a red nematocarcinid shrimp
12:24:40	2591	a red nematocarcinid shrimp
12:24:45	2600	pillow lava flow
12:25:10	2599	star-shaped traces of echiuran worm
12:28:30-30:20	2615-40	steep down-slope; a shrimp, sand
		25°17.98'S, 70°02.06.'E
12:29:00	2630	sand & basaltic boulders
12:30:20	2648	a red shrimp
12:30:20	2446	a fish?
12:31:05	2648	a white fish (*Bathysaurus* sp. "shinkai-eso")
12:31:48	2653	a rattail & a nematocarcinid shrimp
12:35:20	2667	*Acanthonus armatus*
12:36:09	2666	an asteroid (Brisingidae?) or compound sea anemone
		Anthomastus attached on a basaltic boulder
12:38:20	2676	a huge lava flow (surface is composed of 10-100cm breccia)
12:40:30-42:50	2662-70	up-slope onto a lava table
12:42	2665	down-slope to the right
12:44:15	2676	typical pillows
12:44:45	2672	two long whip-like gorgonians
12:45	2673	pillow
		25°17.86'S, 70°02.10'E
12:47	2681	pillow, approx. 320m to the way-point #3
12:48:15	2676	on the front of a large-scale lava flow
12:50:10	2690	descending the lava flow
12:52	2691	approx. 150m to the way-point #3
12:54	2680	a sea pen?

12:54:00	2690	complicate but marvelously regular meandering traces of spatangoid
12:54:25	2688	a holothurian?
12:54:58	2680	a shrimp
12:55:00	2680	a scale worm?
12:55:30	2680	a whip-like gorgonian
12:56:56	2670	a small tadpole-shaped fish
12:58:10	2663	mumumu! "tofu" is swimming!?
13:00	2658	almost the way-point #3; outcrops (right side) 25°17.71'S, 70°02.12'E
13:06:45	2671	a fish
13:06	2666	sea anemones
13:06:41	2669	a fish
13:11	2699	unknown animal traces, burrows?
13:12	2685	sand bottom with pillow 25°17.63'S, 70°02.26'E
13:13:53	2685	pillows
13:15:50-22:35	2700-66	steep down-slope
13:16	2706	in midway of steep down-slope
13:17:20	2717	down-slope of pillows & angular blocks, covered relatively thick sediment
13:18	2719	still in midway steep slope down
13:19:40		T=1.78℃, S=34.7253, LT=84.556
13:20	2745	mada-mada steep slope-down
13:21:50	2763	dipping slacked
13:22:35	2766	onto sand bottom with occasional meandering traces of spatangoid 25°17.65'S, 70°02.24'E
13:24:25	2768	meandering trace of spatangoid
13:25:14	2774	*Acanthonus armatus*
13:25:58	2775	*Acanthonus armatus*
13:28:42	2779	brecciated (large angular block) zone
13:29:45	2793	a macrourid fish
13:30:40	2800	sandy floor with occasional angular blocks
13:31	2807	sand bottom
13:31:25	2805	a purple elasipod holothurian (*Benthodytes*?)
13:32:35	2810	a jellyfish?
13:32:54	2816	a jellyfish?
13:33	2815	approx. 100m to the way-point #4
13:34:23	2820	a patch of brown grains; suspended particles rather thick
13:36:00	2812	slender (brotulid?) fish
13:37:35	2805	in a flat and smoothed sandy zone

13:39:20	2806	DTV system just on the way-point #4
		25°17.68'S, 70°02.39'E
13:40:15	2808	*Acanthonus armatus*
13:40:29	2814	*Acanthonus armatus*
		T=1.74℃, S=34.7259, LT=84.556
13:42	2802	pillow
13:45:13	2805	a white animal? (sea anemone?)
13:46:40	2810	beautiful pillow lava
13:50:09	2793	a fish (*Acanthonus armatus*)
		25°17.75'S, 70°02.48'E
13:54:48	2778	a shrimp?
13:57:00	2766	a shrimp
14:00:20	2763	*Acanthonus armatus*
		25°17.82'S, 70°02.59'E
14:01:20	2757	*Acanthonus armatus*
14:01:56	2757	*Acanthonus armatus*
14:03:05	2749	a fish
14:04	2753	sandy bottom
14:05:30	2745	a fish?
14:08:15	2742	a shrimp?
14:10	2745	a shrimp
14:11:20	2734	a whip-like gorgonian
14:13:20	2732	pillows
14:14:03	2727	a very long whip-like gorgonian
14:14:43	2723	*Acanthonus armatus*
14:15	2726	breccia
		25°17.89'S, 70°02.72'E
14:15:24	2723	a jellyfish
14:19:00	2704	zone of pillows & large angular blocks
14:24:10	2670	climbing a slope of medium-sized breccia
14:25:50	2650	a scarp (steep outcrop of breccia)
		25°17.93'S, 70°02.82'E
14:27:00	2632	a scarp
14:27:38	2626	a whip-like gorgonian on the scarp
14:29:00	2618	looking a steep scarp to the left
14:30	2606	steep outcrop of breccia
		25°17.98'S, 70°02.77'E
14:30:40	2605	a whip-like gorgonian
14:31:20	2600	*Acanthonus armatus*
14:34	2582	up-slope of breccia
14:35:45	2570	a jellyfish; still climbing a steep slope
14:38	2540	steep outcrop of breccia
14:40	2517	steep outcrop of breccia
14:40:45	2520	a whip-like gorgonian

14:41	2510	25°18.01'S, 70°02.97'E
14:42:00	2515	a fish
14:43	2479	steep escarpment
		25°18.04'S, 70°02.95'E
14:43:40	2482	passing the "special point"
14:44:50	2475	a round pillow
14:46:15	2462	pillows; probably at the top of the saddle
14:47:40	2471	a whip-like gorgonian
14:48:10	2472	at last into a rippled sand zone
14:49:00	2472	DTV 180m apart from the "special point #2"
14:49	2468	edge of escarpment
14:50	2466	a whip-like gorgonian
14:50:16	2466	!!mumumu!! fan-shaped gorgonian? or sea-fern?
14:51	2463	an asteroid
14:51:00	2464	rippled sandy zone
14:52	2454	25°18.09'S, 70°03.02'E
14:54:00	2448	T=1.83℃, S=34.725, LT=84.531
14:54	2440	approx. 100m to "Tokuiten" (special way-point)
14:54:50	2448	a whip-like gorgonian
14:55:55	2458	rippled sandy zone
14:56	2459	ripple
14:56:00	2458	a whip-like gorgonian?
14:58	2480	ripple
14:58:15	2475	pillow zone
14:59:00	2475	rippled sandy zone
15:00:00	2480	cruising over the special point #2;
		[the special point #2 locate somewhat to the east of the saddle];
		full of meandering traces of spatangoids
15:00	2480	pillow lava
		25°18.13'S, 70°03.07'E
15:03	2498	trace of spatangoid
15:03:13	2499	an ophiuroid
15:05	2500	trace of spatangoid
15:07:34	2498	a shrimp
15:07:14	2494	a whip-like gorgonian
15:07:42	2497	a lucid shrimp
15:08:25-11:35	2503-04	in a sand stand
15:11:35	2504	end of the sand zone; white vertical streaks (non ripple)
15:12	2502	outcrop
15:13:15	2504	again in sandy zone
15:14:00	2501	approx. 500m to the way-point #5
15:15	2498	trace
		25°18.25'S, 70°03.20'E
15:16:00	2494	rippled sandy flat & pillows

15:21	2448	gentle slope
15:22:26	2440	*Acanthonus armatus*
15:23:35	2431	a lava flow
15:25:00	2416	brecciated basalt zone
15:25:25	2411	climbing a scarp of 15m in relative altitude
15:25:28	2408	a whip-like gorgonian
15:25:38	2408	a whip-like gorgonian
15:27	2392	approx. 280m to the way-point #5
15:30	2388	pillow lava
		25°18.38'S, 70°03.23'E
15:32:04	2380	white objects (sea anemones) among crevice
15:32:20	2380	a whip-like gorgonian
15:33:10	2374	a large-scale lava flow
15:33:25	2371	a fish
15:34:10	2367	on a lava table (sheet flow)
15:34:34	2363	a whip-like gorgonian
15:34:54	2363	approx. 100m to the way-point #5
15:37	2360	a scarp (pillow wall)
		25°18.45'S, 70°03.25'E
15:38:37	2345	a red aristeinid shrimp *Benthesicymus*?
15:38:58	2345	a yellowish brown calyx(or fan)-shaped sponge?
15:40	2331	on the way-point #5; end of DT09 transect
		25°18.48'S, 70°03.24'E
15:42	2315	CTD reset for ascending vertical mode
15:43	2315	start of cable haul in
??:??	2250	light transmission anomaly of -0.1%??
		25°18.64'S, 70°03.26'E
15:52	1998	cable length 2000m
16:22	40	main switch off

VIDEO LOG (Aug. 20, 2000)

KR00-05-DT10 (DT10-1 and 2 on video tapes)

Time	Depth (m)	Description
07:53:03	0	DTV system launched
07:58:18	13	DTV system main switch on
08:00	15	cable pay out start
08:14:30	400	jellyfish
08:15:48	453	siphonophore
08:19:20	605	jellyfish
08:19:34	614	siphonophore
08:20:44	663	siphonophore
08:22:15	726	jellyfish
08:22:54	754	jellyfish
08:23:15	771	jellyfish
08:24:36	825	jellyfish
08:26:01	883	siphonophore
08:32	998	cable length 1000m
08:32:30	1148	jellyfish
08:36:24	1308	siphonophore
08:38:05	1374	jellyfish
08:42:21	1542	shrimp
08:49:19	1823	jellyfish
08:53	1993	cable length 2000m
08:53:15	1999	siphonophore
08:59	2250	no light transmission anomaly
08:59:20	2260	siphonophore
09:00	2290	bottom recognized;
09:01:20	2295	start DT10 transect rippled sandy sediment trapping much white stuff 25°19.24'S, 70°03.24'E
09:09:50	2295	rippled sand
09:06:15	2281	gentle up-slope toward the summit; almost completely paved with large angular blocks of basalt
09:07:50	2277	sand zone scattered with pebbles, around which white scours develop
09:10:15-10:26	2276	regular parallel ripple mark trapping white stuff; wave length of ripple=ca. 30cm
09:11:07	2272	a jellyfish?
09:11:58	2270	a macrourid fish and boulder-sized brecciated basalt
09:13:43	2260	climbed ca. 5m scarp composed of brecciated basalt
09:14:15-15:40	2260-61	vast sandy zone with regular ripple mark
09:15:41	2255	climbed an escarp of 5m in altitude

09:17:35	2252	angular block boulders (30-100cm) & pillows
		T=1.82℃, S=34.7241, LT=84.408
09:18:45	2250	pillows & rippled sand
09:19	2246	weathered huge basalt, almost top of the mound
		25°19.24'S, 70°03.15'E
09:20:40	2245	angular blocks; no remarkable biota around here!
09:21:50	2249	down-slope of angular large blocks
09:22:15-24:00	2250-55	rippled sandy zone; very regular (wave front vertical on TV) and trapping white stuff
09:24:00	2256	pillow lava
09:25:00	2257	angular block zone (=a huge lobate lava flow)
09:25:15-25:52	2262	rippled sand zone, w.l.=20cm
09:26:50-27:20	2264-72	down-slope (8m down)
09:27:25-29:20	2272-70	rippled sandy zone
09:29:03	2270	an ophiuroid
09:29:20-31:50	2270-68	flat table of lava flow studded with hyaloclastics; no sediment
09:31:50-33:25	2268-85	down-slope of large angular blocks
		25°19.34'S, 70°03.09'E
09:33:25-39:00	2285-85	rippled sandy zone
09:35:45	2285	a bar-like structure of lava flow on sandy floor
09:37:30	2284	a bar-like structure of lava flow on sandy floor
09:39:00	2280	cruising over a huge lava flow; surface is broken
09:40:30	2277	descent over the lava flow (ca. 5m down along the scarp)
09:42:45-45:35	2284-87	large angular blocks & pillows
09:44	2283	a sea anemone
09:46:15	2287	entered into a zone of rippled sand and pillows
		25°19.42'S, 70°03.05'E
09:48:15	2284	flat lava table studded with granular hyaloclastics; no sediment
09:49:05	2284	typical pillow
09:49:35	2283	a nematocarcinid shrimp *Nematocarcinus* on a sand pocket
09:50:25-51:	2280-2305	down-slope composed of large (ca. 1m) angular blocks
09:51	2305	approx. 20m steep escarpment
09:54:40	2316	pillow lava flow
09:55:55	2317	angular block zone
09:57:10	2310	a lava flow composed of pillows
09:57:45	2310	pavement of angular blocks
09:57	2311	a whip-like gorgonian
10:00:00	2325	climbed a step of several meters
10:00:08	2323	a red shrimp on a large block
10:01	2328	25°19.55'S, 70°03.00'E
10:04:03	2354	entering into rippled sand moat
10:04:30	2356	basalt zone (up-sloping)
10:05:26-05:45	2356-50	climbing a escarp
10:06:50	2360	climbing a scarp of lava flow

10:07:04	2361	a whip-like gorgonian
10:08:52	2371	small bench composed of lava flow (pillows)
10:09:40	2377	sand pocket
10:11:27	2381	a black halosaurid fish (*Halosauropsis macrochir*?)
10:12:20	2382	ripple sand pocket
10:13:35-17:20	2389-30	down-slope composed of large brecciated blocks
10:16	2424	breccia
10:17:20	2430	entering into rippled sand moat
10:19:25	2447	red object
10:20:15	2452	many columnar angular blocks
10:22	2457	breccia, approx. 500m to #2 marker
		25°19.72'S, 70°02.86'E
10:22:10	2460	in a rippled sand zone
10:22:25-27:20	2465-85	down-slope of angular blocks
10:27:20	2487	entered into sandy flat (ripple weak)
10:28:55	2490	pavement of angular blocks
10:29:39	2494	a fish?
10:30	2500	breccia
		25°19.80'S, 70°02.83'E
10:30:15	2508	entered into rippled sand flat
10:31:45	2520	sand & angular blocks
10:32	2525	sand with ripple
10:32:53	2526	a red shrimp
10:32:50	2526	small escarp (steep outcrop of breccia)
10:33:40	2525	a whip-like gorgonian
10:34:15	2533	sand pocket scattered with angular boulders
10:34:45	2532	1m step of lava low into a sandy flat
10:36:12	2544	a fish on sand (*Acanthonus armatus*)
10:38:00	2557	sand flat (weakly rippled)
10:39:38	2564	a tongue of lava flow
10:40:00	2561	on a flat lava flow covered by sediment
10:40	2562	approx. 200m to the way-point #2; sand with ripple
		25°19.89'S, 70°02.79'E
10:41	2558	pillow in the sand
10:41:18	2558	*Acanthonus armatus* on sand
10:41:50	2558	a lava flow
10:42:28	2561	yellowish brown calyx-shaped sponge attached to boulder
10:43	2555	breccia
10:44:12	2564	a lava flow (lobate or pillow shaped)
10:44:50	2568	a fish on sand (*Acanthonus armatus*);
		almost on the way-point #2
		25°19.93'S, 70°02.74'E
10:47:05	2586	sand & angular boulders
10:48:31	2599	a small tadpole-shaped fish flown away leaving a cloud

10:49:39	2610	outcrop of flat lava apron
10:49:40	2620	vehicle just on the way-point #2; changed her course
10:51:06	2637	*Bathysaurus* sp. ("shinkai-eso"), ca. 30cm long
10:51:51	2642	*Acanthonus armatus*
10:52 30	2643	a fish
10:53:00	2649	on a very flat lava plane; sediment cover very thin
10:53:42	2662	*Acanthonus armatus*
10:55:55	2675	completely flat topography; 100% sand cover; this plane must correspond to the dead *Calyptogena*-site to the north-west (difference in depth is ca. 100m); then the topography gently dipping to the south
10:57	2668	25°20.01'S, 70°02.68'E
10:59:32	2697	trail of gastropod
11:00:48	2706	*Acanthonus armatus*; sand
11:05:05	2698	meandering trace of spatangoid
11:08:50	2704	it seems that DTV started effective cruising; the iron tip of the pendant chain (suspended from DTV) does not dip into the sediment; so the sediment thickness must be less than 2cm
11:12:23	2697	trail of gastropod
11:12:56	2695	*Acanthonus armatus*
11:13	2695	white long track
11:15:34	2692	edge of lava flow; sand flat=>slope of breccia 25°20.07'S, 70°02.80'E
11:16:42	2683	debris flow zone
11:18:00	2681	a few marked streaks on TV monitor (ripples?)
11:19:10	2678	a white stuff passed by in front of camera
11:20:20	2671	a white (lucid) shrimp?
11:20:30	2672	a red shrimp
11:21	2666	slope of sand 25°20.07'S, 70°02.82'E
11:22:55	2663	still continues the sandy zone;
11:24:00	2645	outcrop of breccia; front of a lava flow
11:24:55	2643	climbing a scarp Kairei is 350m apart from the Tokuiten (special way-point) #1 Tow-yo point
11:26:25-28:00	2634-10	climbing a steep-slope
11:27:00	2623	a white holothurian (anterior brim purple; *Benthodytes typica*?)
11:28:00	2610	into rippled sandy zone
11:30	2603	25°20.05'S, 70°02.89'E
11:30:05	2601	a small shrimp
11:30:20	2596	a shrimp
11:30:32	2592	scarp composed of medium-sized angular blocks
11:31:37		climbing a steep slope

11:32:13	2577	entered into sandy floor
11:33:45	2570	a white halosaurid fish (*Aldrovandia affinis*? "tokage-gisu")
11:34:10	2566	a scarp (steep slope of brecciated basalt)
11:34:28	2566	at the margin of a sand-covered bench
11:36:50	2355	a flow of pillow lava
11:38:50-39:40	2546-45	rippled sand zone
11:39:40	2545	wall of lava flow to the left 25°19.96'S, 70°02.96'E
11:41:42	2535	full of angular blocks over a lava flow
11:42:00	2533	a red aristeinid shrimp *Bentesicymus*?
11:42:23	2532	rippled sand pocket
11:44	2530	blackish fishes, *Bentesicymus*?
11:43:30	2530	a white fish *Bathysaurus* sp. ("shinkai-eso")
11:44:10	2529	a black halosaurid fish (*Halosauropsis macrochir*?; "kuroobi-tokage-gisu")
11:44:35	2523	a red shrimp
11:45	2520	gentle slope and basalt wall
11:45:40	2512	a long and brilliant white whip-like gorgonian (over 1m long)
11:46:10-48:00	2510-2496	Kaiyo is approx. 280 m to the Tokuiten (special way-point) #1 Tow-Yo point; rippled sand zone
11:48:00	2496	breccia zone
11:48:57-52:45	2490-64	climbing over a lava flow composed of angular blocks
11:50	2475	brecciated basalt
11:51:12	2466	a white & long whip-like gorgonians [non "conger eel"] 25°19.92'S, 70°03.02'E
11:51:24	2470	a white & long whip-like gorgonians [non "conger eel"]
11:52:00	2465	very angular basalt blocks
11:52:45	2464	vehicle arrived at the Tokuiten (special way-point) #1 Tow-yo point; end of DT10

KR00-05-TY09-U01 (DT10-3 on video tapes)

11:54	2460	start of TY09-U01 (Tow-yo mode)
11:58:30	2328	light transmission anomaly of-0.03% (max. -0.1%) 25°19.88'S, 70°03.09'E
12:00	2228	ditto -0.03%
12:03:30	2145	ditto resumed to normal level
12:07:30	2000	end of TY09-U01 (Tow-yo mode) transect 25°19.93'S, 70°03.18'E

KR00-05-TY09-D02 (DT10-4 on video tapes)

12:11:29	2000	start of TY09-D02 (Tow-yo mode) 25°19.81'S, 70°03.20'E

12:16	2180	light transmission anomaly of -0.05%
		25°19.79'S, 70°03.24'E
12:18	2269	ditto -0.05%
12:20:30	2335	bottom, end of TY09-D02 (Tow-yo mode) transect
		25°19.77'S, 70°03.28'E
12:21:55	2325	paved with angular blocks (20-100cm)
12:21:00	2323	a whip-like gorgonian

KR00-05- DT11 (DT10-5 on video tapes)

12:22:00	2323	start of DT11 (Deep-tow mode)
		25°19.78'S, 70°03.31'E
12:23:20	2341	front of a lava flow
12:25:12	2338	rippled sand zone (very regular, parallel)
12:28:15	2335	upper surface of lava flow; large blocks but not typical pillow and not typical brecciated angular blocks; sediment cover very thin
12:30	2334	sand with ripple
12:33	2322	altered breccia
		25°19.73'S, 70°03.43'E
12:30:06-33:00	2331	rippled sand zone
12:33:12	2321	ripples trap much white stuff
12:33:30	2315	ascend over a scarp of 10m high (=a lava flow)
12:35:40-41:20	2309-14	sand with ripples reminiscent of fish-scale (as if imbricating)
12:39:22	2310	appeared angular blocks (an elongated lava flow), and then into rippled sand
12:40:35	2313	a lava flow tongue composed of altered breccia, and then into sand
12:41:20	2310	front of a lava flow; probably this point is almost the peak of the volcanic knoll
12:42:54	2318	over the lava flow, entering into rippled sand zone
12:44:15-46:45	2324-23	(a lava flow & rippled sand) x 2 units
12:46:45	2327	onto sand zone regularly ripped (w.l.=25cm)
12:47:19	2326	front of a lava flow (brecciated)
12:48:04	2323	pillow lava flow
12:49:45	2321	top of a lava flow
12:50	2319	25°19.68'S, 70°03.53'E
12:50:15	2320	rippled sand
12:50:35	2324	a lava flow
12:51:20	2316	a stalked glass sponge? (attached onto lava)
12:51:30	2316	a scarp
12:53	2326	pillow
12:53:30	2327	a whip-like gorgonian
12:54	2323	vehicle is about 300m apart from the special way-point) #2 Tow-Yo point
12:55:36	2325	a whip-like gorgonian

12:57:40	2333	Kairei just on the special way-point #2
12:58	2335	ripple mark
12:58:55	2339	"nanja-monja" (slender white object)
13:00	2343	vehicle approx. 125m to the special way-point #2 (Tow-Yo point); rippled floor; 25°19.637S, 70°03.66'E
13:01:50	2347	flank of a lava flow
13:02:50	2344	a lava flow
13:03:17	2348	meandering track of spatangoid x 2
13:03:55	2346	front of a lava flow
13:04:45	2341	over a lava flow
13:05:35	2353	radiating ripples around a pillow
13:06	2359	vehicle arrive at the special way-point #2 Tow-Yo Point 25°19.59'S, 70°03.71'E end of DT11

KR00-05-TY10-U01 (DT10-6 on video tapes)

13:07	2360	start to TY10-U01 (Tow-Yo up-mode) 25°19.60'S, 70°03.72'E
13:11:30	2218	very feeble light transmission anomaly of less than -0.05% (from bottom to 2270m deep), and then resumed to normal level 25°19.59'S, 70°03.74'E
13:15:10	2115	LTA keep normal level
13:18:18	2000	end of TY10-U01 (Tow-yo up-mode) 25°19.57'S, 70°03.76'E

KR00-05-TY10-D02 (DT10-7 on video tapes)

13:20	2000	start to TY10-D02 (Tow-yo down-mode) 25°19.55'S, 70°03.77'E
13:28	2287	light transmission anomaly of -0.03% 25°19.53'S, 70°03.85'E
13:29	2339	ditto -0.03%
13:30	2363	ditto -0.03%
13:32	2425	ditto resumed to normal level
13:32:40	2424	bottom, end of TY10-D02 (Tow-yo down-mode) transect

KR00-05- DT12 (DT10-8 and 9 on video tapes)

13:33:15	2422	rippled sand & front of a lava flow
13:34:05	2421	start of DT11 (Deep-tow mode); breccia 25°19.51'S, 70°09.89'E
13:36:40	2433	a yellowish brown calyx-shaped sponge on a rock
13:37	2433	rippled sand zone

13:39:07	2432	a scarp of lava flow flank (composed of pillows)
13:40:30	2423	a whip-like gorgonian on fresh pillow
13:40:48	2422	on a lava flow
13:41:30	2418	full of pillows
13:42:45	2420	rippled sand zone
13:43:30	2420	full of meandering traces of spatangoids on sand
13:44:32	2425	pillows
13:44:55	2426	a whip-like gorgonian
13:47:00	2435	rippled sand zone
13:47	2433	pillow
		25°19.47'S, 70°04.07'E
13:48:16	2436	white round object (hyaline sponge attached to rock?)
13:50	2447	steep outcrop of breccia
13:51:20	2449	descending a scarp of the lava flow
13:52:27	2448	a whip-like gorgonian (very long; ca. 1m)
13:53	2443	a whip-like gorgonian (short) on pillow
13:54	2457	slope down of pillow
13:56:40-59:35	2472-77	sand zone; with meandering trails of spatangoid
		25°19.45'S, 70°04.14'E
13:58:05	2477	a mound (biogenic) with white scour mark around it
13:59:35	2479	climbing a lava flow
14:00	2474	over pillows of the lava flow
14:00:20	2475	a slender sea anemone
14:01	2480	Kairei is just on the way-point #3; change her course
14:06:55	2525	large boulders or pillows in sandy zone
14:08:55	2542	rippled sandy zone
14:10	2540	DTV approx.150 m to the way-point #3; pillows
14:10.27	2540	a yellow round object
14:11	2546	DTV approx. 100 m to the way-point #3
14:11:43	2542	a white sea anemone
14:14:29	2559	a whip-like gorgonian attached to a pillow lava
14:14:38	2559	descending along a scarp
14:14:53	2566	a whip-like gorgonian on the scarp
14:15:02	2556	a whip-like gorgonian on the scarp
14:17:00	2562	flown onto sand & breccia zone
14:19:10	2561	climbing a lava flow
14:20	2564	breccia
		25°19.32'S, 70°04.30'E
14:21:55	2566	striding over a lower skirt of a lava flow
14:22	2560	steep slope
14:25	2560	DTV seems to be turning its course
14:27	2569	up-slope of breccia
		25°19.70'S, 70°04.28'E
14:28:30	2575	pillows in ripped sand zone

14:32:53	2578	ripples & lava flow front
14:33	2576	boulder-sized basalt
14:34:35	2568	an orange-colored large sea anemone
14:35:15	2867	cobble-size hyaloclastics are studded on the wall of basalt
14:36	2562	up-slope of breccia
14:39	2541	up-slope
14:41	2531	cobble-sized breccia of basalt
		25°19.24'S, 70°04.20'E
14:42:53	2545	a white (lucent) shrimp in water column
14:46	2574	ripple mark on the sandy bottom
14:47:05-58:10	2575-46	rippled sand zone
14:50	2582	ripple mark
14:50:05	2582	a patch of yellow substance
14:52:20	2572	meandering trace of spatangoid
14:54:10	2566	a red shrimp swimming (*Benthesicymus*?)
14:54:50	2565	meandering trace of spatangoid
14:55:01	2561	meandering trace of spatangoid
14:55:35	2559	a red aristeinid shrimp *Bentesicymus*?
14:56:36	2552	a red shrimp or a jellyfish passed by
14:58	2547	many traces on the sandy bottom
14:59:20	2544	a white (lucent) shrimp passed by
15:00	2543	traces and ripple
		25°19.20'S, 70°04.03'E
15:02:25	2533	a black halosaurid fish (*Halosauropsis macrochir*?)
15:02:34	2533	a lucid white holothurian with purple brim (*Benthodytes typica*?)
15:03:11	2534	a red shrimp
15:08:41	2499	at last pillow lava and rippled sand zone
15:10:00	2491	on a lava flow
15:11:20	2488	again over a lava flow
15:13	2498	basalt wall
		25°19.20'S, 70°03.90'E
15:14:42	2503	a whip-like gorgonian (flexible)
15:16:00	2506	approx. 1100m to the way-point #1
15:16:25	2507	granules of hyaloclastics on wall
15:18:05	2499	a scarp
15:19:02	2486	scarp or up-slope of breccia
15:20:55	2468	sand fill with meandering trails of spatangoids
15:21	2468	up-slope of breccia
15:23-27	2460	into rippled sandy zone
15:24:02	2457	a red nematocarcinid shrimp
15:25:20	2456	continuation of rippled sand
15:26	2444	rippled sand
15:27	2439	pillow lava
		25°19.24'S, 70°03.76'E

15:29	2426	end of DT12
15:30	2416	start of cable haul-in (Tow-yo up-mode)
		25°19.22'S, 70°03,71'E
15:32	2338	light transmission anomaly of -0.05%
		25°19.22'S, 70°03.69'E
15:35	2221	ditto resumed to normal level
		25°19.21'S, 70°03.65'E
15:40	2000	end of Tow-yo up-mode operation
		25°19.20'S, 70°03.61'E
15:41	1976	cable length 2000m
15:55	999	cable length 1000m
16:09:18	80	main switch off

3.3. Video logs of the *Kaiko* operation

Kaiko #167 (Aug. 25, 2000)

Time	Depth (m)	Description
08:35	0	surfaced
10:05	2502	vehicle deployed
10:13	2642	bottom observed
		25°19.49'S, 70°02.22'E
10:16	2656	arrive at the sandy bottom
		25°19.48'S, 70°02.22'E
10:30	2651	sandy bottom
		25°19.47'S, 70°02.29'E
10:34	2656	landing and change head
		25°19.46'S, 70°02.29'E
10:36	2655	fish, floc
10:38	2652	slender fish
10:40	2652	25°19.4'S, 70°02.27'E
10:42	2651	close up deposit
		25°19.48'S, 70°02.24'E
10:47	2648	two antipathalian corals and barnacles on angular rocks
10:48	2648	landing
		25°19.46'S, 70°02.22'E
10:51	2648	collect a rock with barnacles
		25°19.47'S, 70°02.22'E
10:54	2645	*Acanthonus armatus*
10:56	2643	shrimp
10:59	2642	rock bed
11:00	2642	25°19.45'S, 70°02.15'E
11:02	2647	gorgonian
11:03	2642	a halosaurid fish, *Aldrovandia affinis*?, rock bed
11:05	2641	sea anemone
11:06	2641	landing, close up a large sea anemone, barnacles, sea-fern or some coelenterata on rocks
		25°19.43'S, 70°02.15'E
11:11	2640	cnidaria?
		25°19.43'S, 70°02.15'E
11:12	2639	gorgonian
11:15	2638	fish
11:17	2631	scalpellum
		25°19.42'S, 70°02.19'E
11:22	2636	25°19.42'S, 70°02.21'E
		white altered area and bank

11:24	2634	white altered area and bank
		25°19.42'S, 70°02.21'E
11:27	2633	landing near white altered area?
		25°19.41'S, 70°02.23'E
11:30	2633	rock
		25°19.41'S, 70°02.24'E
11:39	2641	25°19.41'S, 70°02.26'E
11:42	2640	an aristeinid shrimp
11:44	2640	*Acanthonus armatus*、change head
11:45	2639	a red aristeinid shrimp
11:49	2635	house
11:51	2636	landing
		25°19.42'S, 70°02.24'E
11:57	2630	*Acanthonus armatus*
12:03	2614	3 cnidarians on rock
		25°19.34'S, 70°02.21'E
12:07	2610	small, white objectives on rock
12:09	2613	ctenophore
12:13	2616	*Nematocarcinus* and scalpellum
12:14	2618	sulfide deposit
		25°19.33'S, 70°02.25'E
12:16	2620	sulfide deposit?
		25°19.34'S, 70°02.25'E
12:22	2620	same location, a piece of rock sampled
12:24	2620	dead gastropod, greenish staining on sediment
12:32	2620	white patches scattered
		25°19.36'S, 70°02.28'E
12:34	2621	*Bathysaurus* sp.
12:35	2613	shrimp
12:38	2617	gorgonians
12:39	2596	an halosaurid fish
12:41	2576	steep slope
12:44	2545	asteroid, change heading
		25°19.32'S, 70°02.35'E
12:46	2549	*Acanthonus armatus*
12:50	2569	*Bathysaurus* sp.
12:52	2592	25°19.31'S, 70°02.34'E
12;54	2608	increase number of sea anemones
12:55	2604	many sea anemones
		25°19.28'S, 70°02.28'E
13:04	2605	*Nematocarcinus* sp., *Munidopsis* sp.
		25°19.28'S, 70°02.24'E
13:07	2605	*Munidopsis* sp.

13:11		*Munidopsis* sp.
13:12	2602	a red aristeinid shrimp
13:13	2600	*Acanthonus armatus*
		25°19.27'S, 70°02.25'E、
13:14	2600	a halosaurid fish
13:16	2600	many sea anemones
13:17	2600	white patches
		25°19.27'S, 70°02.24'E
13:28	2595	turbidity increased
		25°19.28'S, 70°02.27'E
13:33	2590	a dead valve of *Bathymodiolus* or *Calyptogena*
		25°19.27'S, 70°02.30'E
13:47	2583	a bathysaurid fish *Bathysaurus* sp.
13:55	2572	25°19.25'S, 70°02.35'E, change heading to North
14:00	2537	25°19.24'S, 70°02.36'E
14:05	2520	very slender anguilliform fish
14:08	2486	25°19.25'S, 70°02.39'E
14:10	2482	many sea anemones, white patches
14:14	2478	25°19.29'S, 70°02.31'E
14:15	2465	asteroids (*Henricia*-type)
14:16	2460	*Munidopsis* sp., sea anemones
		25°19.191'S, 70°02.394'E
14:19	2453	landing, set 10K#167-1 marker
		25°19.177'S 70°02.400'E
14:24		Bresiliid shrimp
14:30		dead chimney
		25°19.156'S, 70°02.426'E
14:32		**large active chimney!!, black smoker!!**
14:41		an eelpout ("genge")
14:45		Temperature measurement, bythograeid crab, *Neolepas*, and gastropods
14:48		finished
15:04		another site in valley floor
15:13		macrourid fish
15:15	2426	another hydrothermalism
		25°19.141'S, 70°02.244'E
15:19	2428	chimney aggregation
15:23		off bottom

Kaiko #168 (Aug. 26, 2000)

Time	Depth (m)	Description
8:59	0	surfaced
10:12:30	2522	altitude 132m
10:15	2522	vehicle deployed
10:23	2642	muddy bottom observed
		Acanthonus armatus, anthipathalian coral
		25°19.48'S, 70°02.27'E
10:26	2651	snake fish
10:27	2651	tow *Acanthonus armatus* and white halosaurid fish
10:29	2650	five *Acanthonus armatus*
		25°19.46'S, 70°02.29'E
10:31	2647	white halosaurid fish
10:34	2642	25°19.44'S, 70°02.30'E
10:35	2633	
10:36	2630	*Acanthonus armatus*
10:37	2624	snake fish
10:39	2618	snake fish
10:40	2617	25°19.41'S, 70°02.31'E
10:41	2607	25°19.39'S, 70°02.31'E
10:43	2605	close up *Acanthonus armatus*
10:48	2604	aristeinid shrimp
10:49	2601	aristeinid shrimp
		25°19.43'S, 70°02.35'E
10:54	2586	*Acanthonus armatus*
10:55	2581	25°19.40'S, 70°02.38'E
10:58	2577	black sediment?
10:59	2572	*Acanthonus armatus*
11:00	2571	25°19.39'S, 70°02.41'E
11:00	2567	white halosaurid fish
11:01:39	2561	*Acanthonus armatus*
11:02:08	2558	*Acanthonus armatus*
11:05	2546	25°19.40'S, 70°02.41'E
11:07-08	2539	rattails
11:10	2529	ophiuroidea
		25°19.34'S, 70°02.38'E
11:12	2516	black halosaurid
11:13	2514	snake fish
11:15	2503	sea anemone
11:16	2501	25°19.33'S, 70°02.40'E
11:17	2488	sea anemone

11:20	2473	25°19.28'S, 70°02.38'E
11:22	2460	black halosaurid
11:25	2457	25°19.27'S, 70°02.38'E
		climbing slope
11:28	2458	black halosaurid
11:29	2455	*Munidopsis*?
11:30	2456	25°19.22'S, 70°02.38'E
11:31	2454	red aristeinid shrimp
11:35	2441	black halosaurid
		25°19.20'S, 70°02.38'E
11:36	2433	deep-sea lizardfish
11:37	2429	black halosaurid
11:39	2420	aristenid shrimp, sea anemone, black halosaurid
11:40	2422	25°19.15'S, 70°02.40'E
11:41	2428	sea anemone
11:45	2419	25°19.17'S, 70°02.43'E
		sea anemone
11:50	2416	25°19.20'S, 70°02.49'E
11:55	2446	25°19.21'S, 70°02.46'E
11:58	2456	*Acanthonus*
12:00	2456	25°19.208'S, 70°02.438'E
12:01	2454	increase number of sea anemones
14:04	2455	cutthroat eels
14:05	2452	*Nematocarcinus*
		25°19.212'S, 70°02.419'E
12:10	2448	25°19.191'S, 70°02.389'E
12:15	2444	25°19.168'S, 70°02.416'E
12:20	2455	25°19.155'S, 70°02.374'E
12:22	2451	black smoker and aggregation of bresiliid shrimps
		25°19.150'S, 70°02.391'E
12:25	2449	25°19.138'S, 70°02.398'E
12:30	2448	Temperature measurement by RMT thermometer
		25°19.138'S, 70°02.398'E
12:32	2449	Temperature measured
12:35	2449	Water sampling
		25°19.137'S, 70°02.396'E
12:40	2446	25°19.145'S, 70°02.405'E
12:45	2449	25°19.145'S, 70°02.405'E
12:50	2450	25°19.145'S, 70°02.405'E
12:55	2449	water sampled?
		25°19.145'S, 70°02.405'E
13:00	2448	25°19.149'S, 70°02.403'E

13:05	2449	25°19.149'S, 70°02.403'E
13:08	2450	sampling by suction sampler
13:10	2452	sampling of *Neolepas* in vain
		25°19.157'S, 70°02.400'E
13:15	2446	large chimney
		25°19.163'S, 70°02.383'E
13:19	2440	*Acanthonus armatus*
13:20	2435	25°19.151'S, 70°02.399'E
13:25	2435	chimney aggregate with bresiliid shrimps, settlement of trap
		25°19.165'S, 70°02.410'E
13:32	2435	sampling of dead chimney
13:35	2433	10K#168-1, 2
		25°19.163'S, 70°02.395'E
13:39	2436	collecting a zoarcid fish
13:44	2435	collecting zoarcid fish and bythograeid crabs
13:47	2434	gastropods looks like *Alviniconcha*, aggregated
13:50	2433	25°19.155'S, 70°02.386'E
13:55	2420	25°19.164'S, 70°02.388'E
14:00	2453	aggregation of dead chimneys
		25°19.161'S, 70°02.374'E
14:04	2452	suctioned of many bresiliid shrimps
		25°19.158'S, 70°02.396'E
14:07	2449	*Neolepas* sampling
14:10	2449	25°19.159'S, 70°02.379'E
14:15	2434	*Alviniconcha* like gastropods sampling
		25°19.159'S, 70°02.379'E
14:20	2433	Finish sampling
		25°19.167'S, 70°02.396'E
14:25	2430	another aggregate of active black smoker
		25°19.161'S, 70°02.268'E
14:37	2453	black halosaurid fish
14:40	2450	25°19.167'S, 70°02.396'E
14:45	2444	bacteria mat in rocks, many sea anemones
		25°19.159'S, 70°02.389'E
14:50	2434	mytilids and gastropods, clear water simmering
		25°19.157'S, 70°02.406'E
14:53	2432	*Neolepas* sampling
14:55	2432	Mytilid sampled
		25°19.168'S, 70°02.396'E
15:00	2427	off bottom
		25°19.159'S, 70°02.398'E

Kaiko #169 (Aug. 27, 2000)

Time	Depth (m)	Description
10:12	0	surfaced
11:23	2381	vehicle deployed
11:32	2521	bottom observed
		25°19.25'S, 70°02.30'E
11:33	2528	spiny eels
11:34	2528	landing
		25°19.25'S, 70°02.25'E
		sampling a rock
11:39:40	2522	a patch of sea anemone
11:40	2520	25°19.22'S, 70°02.30'E
		a fish spiny eels?
11:41	2515	aristeinid shrimp
		rock bed
11:44:13	2503	bresiliid shrimp?
11:45:13	2496	snake fish
11:46	2490	25°19.21'S, 70°02.35'E
11:49	2482	landing and sampling a rock
		25°19.20'S, 70°02.34'E
11:55:10	2477	snake fish
		25°19.19'S, 70°02.33'E
12:00	2458	white bacterial mat
		25°19.14'S, 70°02.38'E
12:05	2449	*Munidopsis* sp., many sea anemones
		25°19.15'S, 70°02.39'E
12:06	2443	*Phymorhynchus* sp., and egg masses
		25°19.15'S, 70°02.39'E
12:08	2442	bresiliid shrimps and mussels
12:10	2442	sampling of mussels, and sea anemones
		25°19.16'S, 70°02.40'E
12:14	2439	sampling finished
12:15	2439	25°19.16'S, 70°02.40'E
12:16	2438	chimneys and many bresiliid shrimps
12:20	2437	close up of chimneys
		25°19.15'S, 70°02.39'E
12:25	2442	25°19.15'S, 70°02.39'E
12:27	2447	coarse sand with rocks, decrease sea anemones
12:30	2436	large fragment of broken chimneys
		25°19.14'S, 70°02.40'E
12:35	2437	25°19.16'S, 70°02.40'E
12:40	2436	increase number of sea anemones

		25°19.15'S, 70°02.42'E
12:43	2450	black halosaurid
12:45	2450	25°19.20'S, 70°02.38'E
12:50	2458	25°19.20'S, 70°02.37'E
12:55	2434	25°19.18'S, 70°02.41'E
13:00	2454	out of hydrothermalism
		25°19.19'S, 70°02.44'E
13:03	2463	black halosaurid
13:05	2459	25°19.21'S, 70°02.40'E
13:07	2445	increase sea anemones, bresiliid shrimps
13:10	2446	25°19.15'S, 70°02.36'E
13:11	2446	relevant site recognized
13:15	2450	water sampling, prepared
		25°19.17'S, 70°02.37'E
13:22	2449	25°19.16'S, 70°02.34'E
13:24	2450	start first water sampling (red grip), well done!
13:30	2449	second trial of water sampling
		25°19.17'S, 70°02.36'E
13:33	2450	start second water sampling (black grip)
		25°19.17'S, 70°02.35'E
13:39	2449	trial for temperature measurement with RMT thermometer
		25°19.16'S, 70°02.35'E
13:40	2450	start measurement
13:42	2450	sampling of inner surface of chimneys
		25°19.16'S, 70°02.35'E
13:50	2450	sampling of rock
13:55	2448	25°19.16'S, 70°02.36'E
14:00	2434	25°19.17'S, 70°02.37'E, 10K#168-1, 2, and trap visible
14:03	2435	*Alviniconcha* aggregation
14:07	2434	approach to trap
		25°19.17'S, 70°02.35'E
14:10	2435	trap recovered
14:15	2434	25°19.17'S, 70°02.36'E
14:16	2434	sediment sampling by M type corer
14:19	2436	fully occupied by sediment
		25°19.17'S, 70°02.36'E
14:25	2434	25°19.18'S, 70°02.36'E
14:26	2429	large old chimney
14:37	2425	huge aggregate of shrimp chimney
		25°19.17'S, 70°02.37'E
14:45	2419	out of hydrothermalism
		25°19.17'S, 70°02.40'E
14:47	2425	large hole

14:50	2448	25°19.16'S, 70°02.37'E
14:52	2453	change sediment type to coarse sand in the hole
15:00	2419	return to 14:37 position
		25°19.17'S, 70°02.40'E
15:01	2417	dead chimney
15:03	2418	set marker near chimney aggregate
15:04	2418	10K#169-1, placed on dead chimneys
		25°19.15'S, 70°02.37'E
15:05	2420	off bottom

Kaiko #170 (Aug. 29, 2000)

Time	Depth (m)	Description
8:58	0	surfaced
10:13	2336	vehicle deployed
10:24	2461	bottom observed
		25°19.16'S, 70°02.33'E
10:28	2474	sea anemones
10:30	2468	white halosaurid
		landing on gravel bottom
		25°19.16'S, 70°02.34'E
10:32	2461	white halosaurid and sea anemones
		bresiliid shrimp
10:33	2457	*Neolepas* sp.
10:33	2454	#168-1 marker observed
10:35	2449	25°19.17'S, 70°02.37'E
10:38	2444	chimney actively venting
10:40	2456	25°19.17'S, 70°02.36'E
10:46	2450	25°19.15'S, 70°02.37'E
10:51	2435	zoarcid fish collected
10:52	2436	25°19.17'S, 70°02.42'E
10:59	2436	25°19.16'S, 70°02.41'E
11:04	2436	bythograeid crab collected
11:05	2436	25°19.16'S, 70°02.41'E
11:06	2436	bythograeid crab collected
11:10	2437	bythograeid crab collected
11:11	2437	bythograeid crab collected
		25°19.16'S, 70°02.41'E
11:15	2347	bythograeid crab collected
11:21	2346	bythograeid crab collected
		25°19.16'S, 70°02.41'E
11:24	2436	two bythograeid crab collected
11:25	2436	two bythograeid crab collected
11:27	2436	bythograeid crab collected
11:31	2436	25°19.15'S, 70°02.39'E
11:37-42	2436	*Alviniconcha* collected
11:51	2435	25°19.16'S, 70°02.34'E
11:53	2435	*Alviniconcha* collected
12:01	2435	*Alviniconcha* tried, in vain
12:04	2435	chimney C-01 collected
12:05	2435	25°19.16'S, 70°02.37'E
12:10	2436	Temperature measurement in crevice
12:11	2436	ditto, on shrimps

12:12	2436	ditto, on crabs, RMT thermometer fallen
12:15	2436	25°19.16'S, 70°02.37'E
12:20	2436	close up of gorgonians?
		25°19.16'S, 70°02.38'E
12:25	2439	tried sampling of gorgonians?
		25°19.16'S, 70°02.38'E
12:30	2437	25°19.15'S, 70°02.42'E
12:40	2431	25°19.14'S, 70°02.41'E
12:42	2428	10K#169-1 chimney recognized
12:43	2419	10K#169-1 marker recognized
12:45	2422	25°19.14'S, 70°02.43'E
12:50	2422	on bottom, tried water sampling
		25°19.16'S, 70°02.44'E
12:53	2423	start water sampling, but aborted
		25°19.16'S, 70°02.44'E
13:00	2423	restart, but stuffed by rock piece?
		25°19.16'S, 70°02.44'E
13:09	2423	tried measuring water temperature
		25°19.16'S, 70°02.44'E
13:11	2423	start measuring
		25°19.16'S, 70°02.44'E
13:20	2422	recognize *Phymorhynchus*? gastropods
13:24	2422	sample *Phymorhynchus*? gastropods
		25°19.17'S, 70°02.43'E
13:26	2422	crabs, *Alviniconcha*, *Bathymodiolus*, sampled
13:30	2422	25°19.16'S, 70°02.43'E
13:34	2422	deploy 10K#170-1
13:35	2422	25°19.16'S, 70°02.43'E
13:37	2422	off bottom

4. Preliminary Results

4.1. Mapping of the Hakuho Knoll and the Kairei Field

Seabeam surveys during the KH-93-3 cruise of the *Hakuho Maru* of the Ocean Research Institute located a volcanic knoll on the eastern crestal ridge of the northern extremity of the first segment of the Central Indian Ridge, around which apparent hydrothermal plume was found. The INDOYO cruise of the *R/V Yokosuka* focused also to this area for the survey of modern hydrothermalism with a feeble success of collecting semi-fossilized *Calyptogena* shells. These situations are already reviewed in the chapter of historical works.

At the onset of this cruise multi-narrow-beam (SeaBeam 2100 system on *R/V Kairei*) was carried out anew to obtain better image of the volcanic knoll. The first working map was prepared cruising along-axis of the Segment I of the Central Indian Ridge on August 10, 2000 just prior to tow-yo and deep-tow surveys. Due to shortage in time and computer ability, the contour was depicted based on 100x100m quadrat. Later, on Aug. 14, a new transect crossing perpendicularly the crestal volcanic knoll at 6-knot cruising speed was established, and contours were depicted on 10x10m quadrat base. After the correction of sound velocity based on deep-sea XBT and CTD observations of the tow-yo system, the fine second version of the precise mapping was prepared. Thereafter the operations of tow-yo system, deep-tow system and the ROV *Kaiko* were planned consulting with this map (Fig. 4.1.1).

The real-time dive logs of the deep-tow bottom observation platform prepared by 4 groups of participants (1. Hashimoto-Yamaguchi-captain-supporting staff in the after bridge; 2. S. Ohta and collaborative members in the 4k-DTV control container lab, 3. Marine Works team in the 4k-DTV control container lab, and 4. supporting members in the research commanding room) was compiled, reviewed and enriched by laboratory review of the VTR cassettes by S.O. Characterization of bottom features and encountered biota were noted beforehand, and later plotted as route map along each transect (*e.g.*, Figs. 4.1.2 & 4.1.3).

The SSBL subnavigation was not always reliable to obtain realistic tracks of the tow-yo, deep-tow systems and ROV *Kaiko*. For the case of tow-yo and deep-tow, it was not always so hard to follow the track, because they are passive vehicle, and the trails are rather conservative in nature. On the other hand, laborious and tedious procedures were required to construct the track charts of the ROV *Kaiko*. Super-imposed data of the main TV camera were often erased for "good images" for broad-casting purpose. Therefore dead-reckoning was done by the images of the so-called middle panoramic TV camera, on which the superimposed data (date, time, depth, vehicle heading, etc) could be read. However, dead-reckoning position fixing based on the heading and duration of the cruising of the ROV *Kaiko* is not always favorable because *Kaiko* has full-direction maneuverability with many thrusters. Images of the fore-looking sonar radar (VOAS) were photographed or recorded on cassette from time to time. These acoustic images were most reliable keys to get the disposition of edifices and to calibrate absolute distance.

4.1.1 The Hakuho Knoll

The volcanic knoll on the eastern crestal ridge of the northern extremity of the first segment of the Central Indian Ridge (CIR) was named as the "Hakuho Knoll" in commemoration of the preceding survey of the site on board R/V *Hakuho Maru* of the Ocean Research Institute, University of Tokyo as explained above.

The Hakuho Knoll is located around 25°19'S, 70°03'E, measuring about 7 by 3km trending roughly NW-SE, parallel to the spreading axis, and consists of NW peak (2380m) and SE peak (2280m). Both peaks are formed by lava flows to all directions brecciated more or less into large angular boulders or occasional pillow and lobate lavas. Sheet flows dominate around the summits of both peaks. Granular and glassy hyaloclastics are observed here and there. Fine sandy blanket is rather thick, and in many cases they are strongly ripped or having scour-and-trail marks trapping ample amount of white stuff. The peaks must be neovolanics on a few rather flat magma effusion between roughly 2500-2700m deep.

Grabens, fissures and faults are identified from the bathymetric map. The most prominent lineaments have NW-SE trend parallel to the spreading axis forming a notable topographic inflections. Direction of the graben is almost 330-340° with widths of several hundred meters at depths of 4200, 3000, 2750 and possibly 2500m. As a

whole, the SW and NE flanks of the Hakuho Knoll are cut by clear faults, showing strong debris flow features and gullies. The site where semi-fossilized *Calyptogena* shells were collected (and also ascertained during this cruise) situated at the junction of the toe of debris and sheet flows and sediment-filled trough-like graben demarcated by a sharp fault.

A different lineament having the trend of 45° can also be observed on the bathymetric map. The hydrothermal field uncovered this time corresponds to this topographic trend, and also to the overlay of neovolcanism on the older flat effusive regime. Diffuse Fe-oxide precipitates and occasional pockets of white precipitates extends further to the SW skirt of the Hakuho Knoll and into the trough-like graben at the depth of 2750m along this trend. The NW peak has an acute horny spur to the northeast, showing additional trend of faults.

4.1.2 The Kairei Field

Seabeam mapping didn't tell the active hydrothermal field at the depth around 2450m. It was partly due to the dimension of the hydrothermal field below the resolving power of the SeaBeam 2100 system using 2° beam, and very steep topography on which the field was nested. Special sound-velocity field and thick and dense hydrothermal plume might also be unfavorable for good resolution.

Fore-looking acoustic radar gave sometimes good scopes of the entire field, when the vehicle was hovering at an appropriate depth for a while. Fig. 4.1.4 was constructed primarily based on the superimposition of several acoustic radar images and compilation of track-chart analysis.

The hydrothermal field (the "Kairei Field" named after the R/V *Kairei* of JAMSTEC) situates at 25°19.17'S, 70°02.4'E between depths of 2450 and 2420m on the steep southwestern flank of the SE peak. Acoustic images revealed high-intensity reflection (black and purple) of NNW-SSE trending ridge-like array and NNE-SSW arrays, and shadows painted blue (Fig. 4.1.4). Representative active chimneys and chimney-complexes explored during this cruise are indicated with preliminary names. Active vents are seemingly arranged along two lines with NE-SW and N-S trends.

Kali Chimney and Kissho Chimney are well-defined and most active solitary chimneys. The former is lying on the bottom of a sharp crevice with a few main orifices, and the latter stands upright. The others are chimney complexes consisting of bundles

and ramifications of more or less active chimneys. Taishaku Chimney complex is rather complicate; it seems to be composed of SE part at the top of sharp crest and NW part on the sub-crestal level. Daikoku Tower is a huge senile chimney, now partially active on the northern flank and at the on the southwestern skirt. The Benten, Fudo and Fugen Chimney-complexes line in a different trend compared to that of the former series.

Probably the complex-type of chimney emits lower temperature effluent than that of the simple vent orifice. If the effluent types of the Kali, Kissho, Taishaku and that of Daikoku represent the succession of venting, we can see the series of stages within the range of 25m. Vent-associated organisms are thriving both in species composition and number of individuals especially on and around complex-type.

Sonar images suggest additional occurrence of chimneys (probably including both extant and extinct ones) especially to the NW of the present field. However, this is open to future works. High-frequency echo sounder may possibly be useful to detect strong black smokers.

The SWW skirt of the Kairei Field predominate gullies and debris flows with intense accumulation of white precipitates and sulfide slabs.

The preparation of the reliable track charts, field map and naming of the observation sites are urgently required, because it is indispensable to treat the samples and data, and the evaluation of the flux. Revised track charts of the ROV *Kaiko* are also attached for the sake of convenience and fruitful discussion (Figs. 4.1.5-4.1.8)

The names of chimneys and chimney complexes proposed here are preliminary ones, and verification of location and their span is required by further precise survey. However, preliminary naming will provoke keen observations and criticism in near future, to say nothing of new additions. For example, the antler-horn-shaped chimney complex encountered first during the dive #168 is ambiguous. Is it an active vents at the skirt of Daikoku Tower?

Suguru OHTA
(Ocean Research Institute, University of Tokyo)

Appendix

The etymology of the chimneys and chimney-complexes is introduced here very briefly. All of the names are gods and goddesses of originally Indian religions and legends.

(1) Kissho Chimney [<Sri Laksmi]

A single slender chimney emitting black superheated water. Laksmi was created and born in the sea filled with amrita which promises everlasting life. She is the wife of Visnu, and the symbol of good omen. She greeted us at the entrance of the Kaiyo Hydrothermal Field.

(2) Kali Chimney [<Parvati=Kali/ *kali*=black (feminine)]

A lying chimney in a crevice, emitting furious black water. Parvati is the wife of Siva (=Mahakala) and has several incarnations. *Kali* (black lady) is a phase in rage. The chimney emits furiously black smokes from a few main orifices.

(3) Daikoku Tower [Mahakala=Siva/ Skr. *maha*=great; *kala*=black (masculine)]

A large senile chimney, rather blackish in color covered by relatively sparse sea anemones and rimicarid shrimps. Radiating array of dead chimneys at the top remind us the multi-arms of the dancing Siva. Kali (=Parvati) is his wife.

(4) Fugen Chimney-complex [<Skr. Samantabhadra]

One of the Bodhi-sattovas symbolizing wisdom and virtue. He sits on the back of 6-tusk white elephant. The Fugen Chimney complex stand on a rock covered with innumerable white sea anemones, and the northeastern tip of the rock bears several dead chimneys reminiscent of ivory tusks.

(5) Taishaku Chimuney-complex [< Indra]

Principal god of Veda symbolizing thunder and bravery, now one of the principal guardians of Buddhism. He is armed with lightning and glares at the world on the top of a highland.

(6) Benten Chimney-complex [<Hind. Saraswati]

Originally a goddess of fertility and purification, now famous for the goddess of seven arts. She has eight arms, and sustains prosperous hydrothermal vent communities.

(7) Fudo Chimney complex [<Acalanatha=>a synonym of Siva]

In the far-eastern Buddhism, Siva manifests himself as a Buddha in rage bearing flames on his back. The chimney complex reminds us the attributes of the flames and swords of Acalanatha.

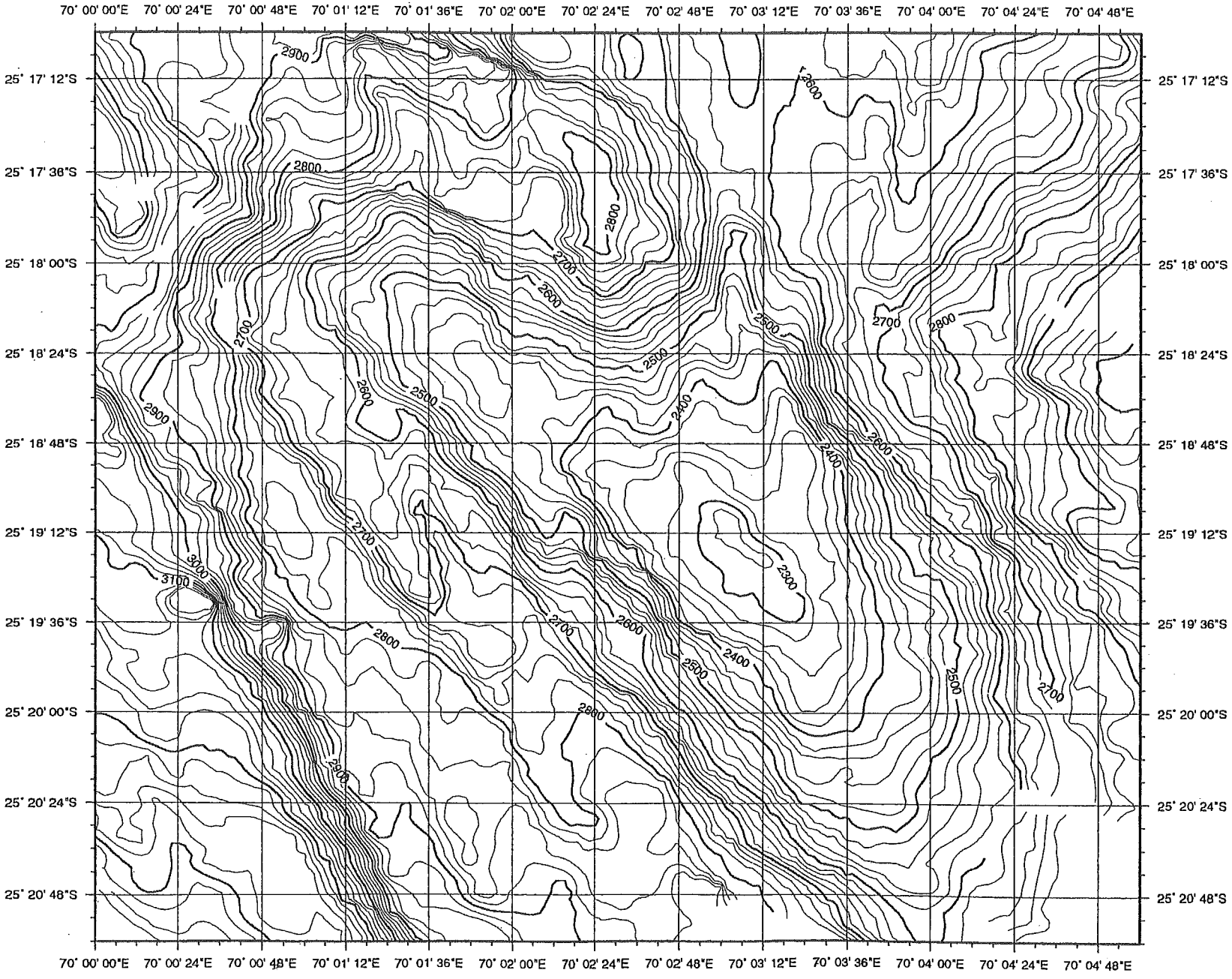

Fig. 4.1.1 Seabeam map of the Hakuho Knoll

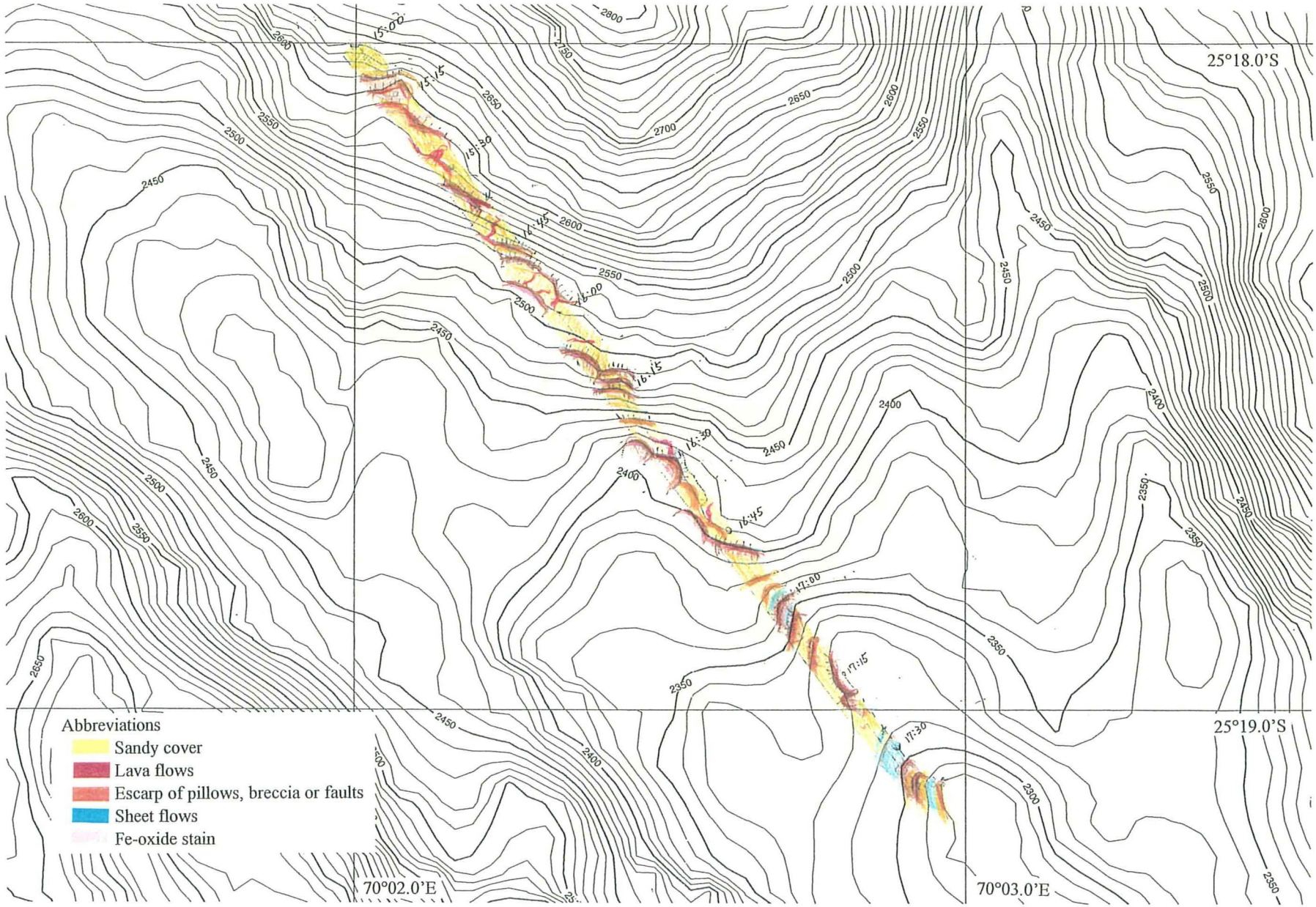

Fig. 4.1.2 Route map along the deep-tow operation KR00-05-DT01

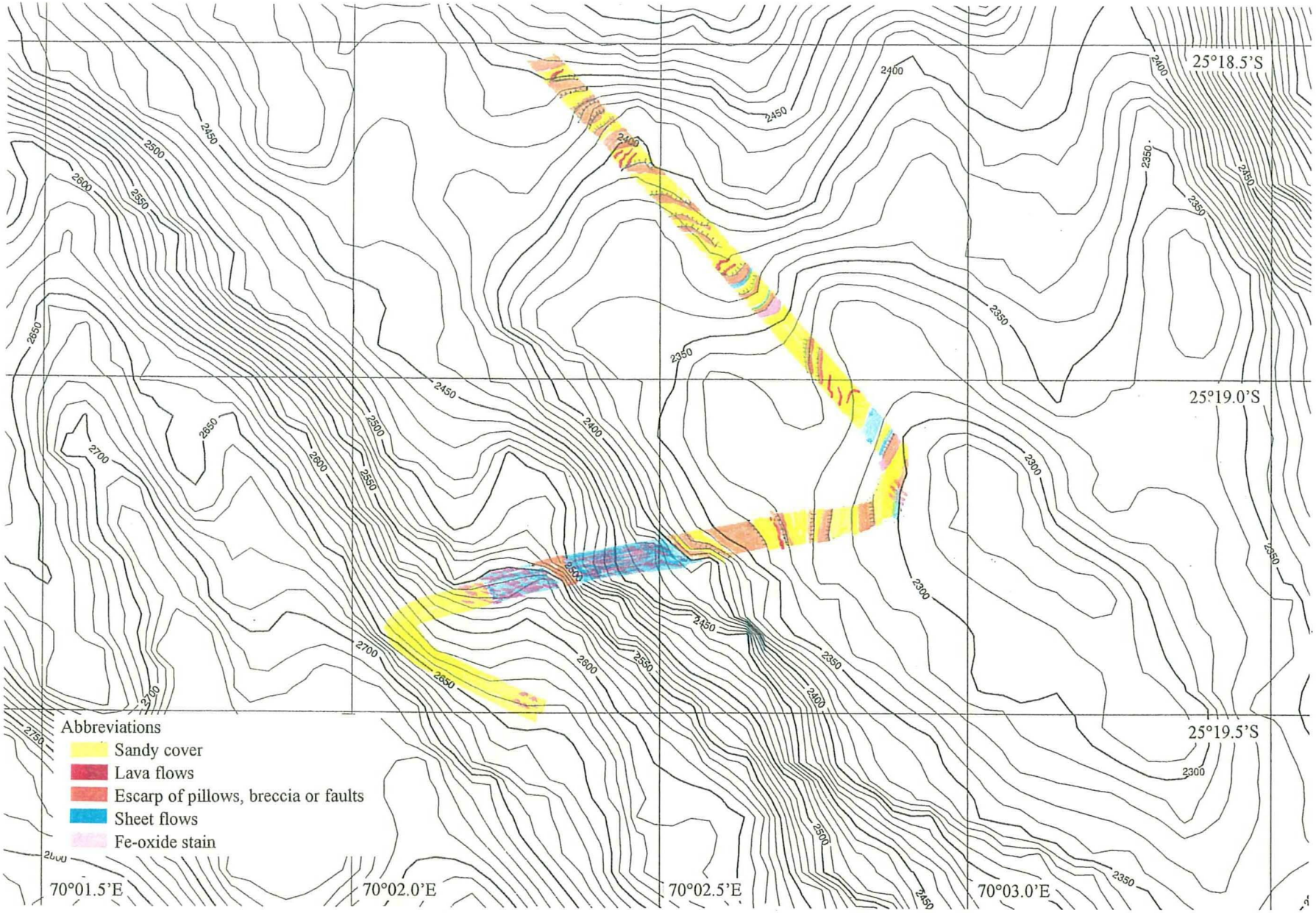

Fig. 4.1.3 Route map along the deep-tow operation KR00-05-DT06 (*partim*)

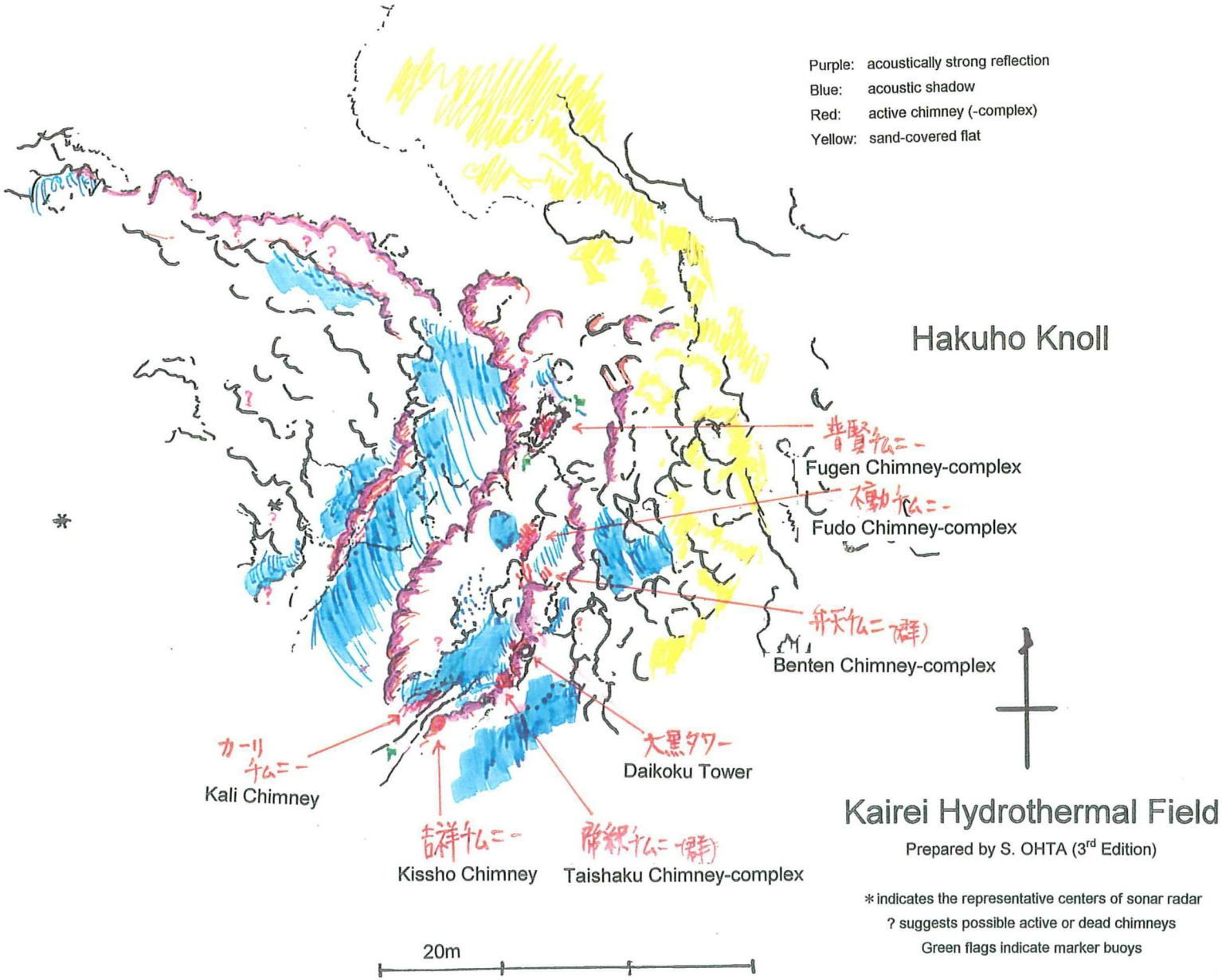

Fig. 4.1.4 Reconstructed map of the Kairei Hydrothermal Field

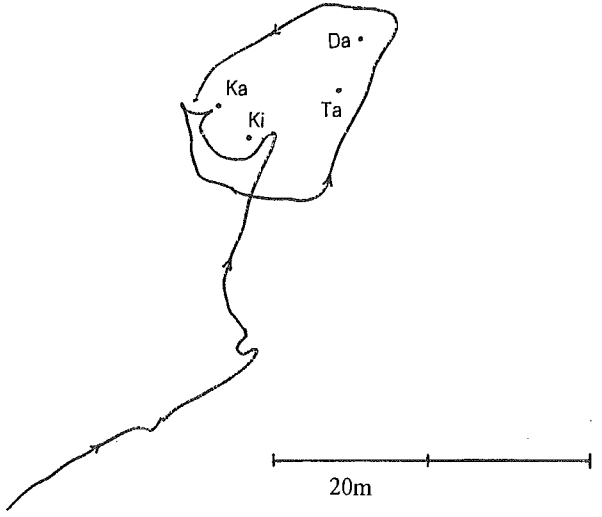

Fig. 4.1.5 Schematic track charts of the *Kaiko* Dives # 167 (*partim*)

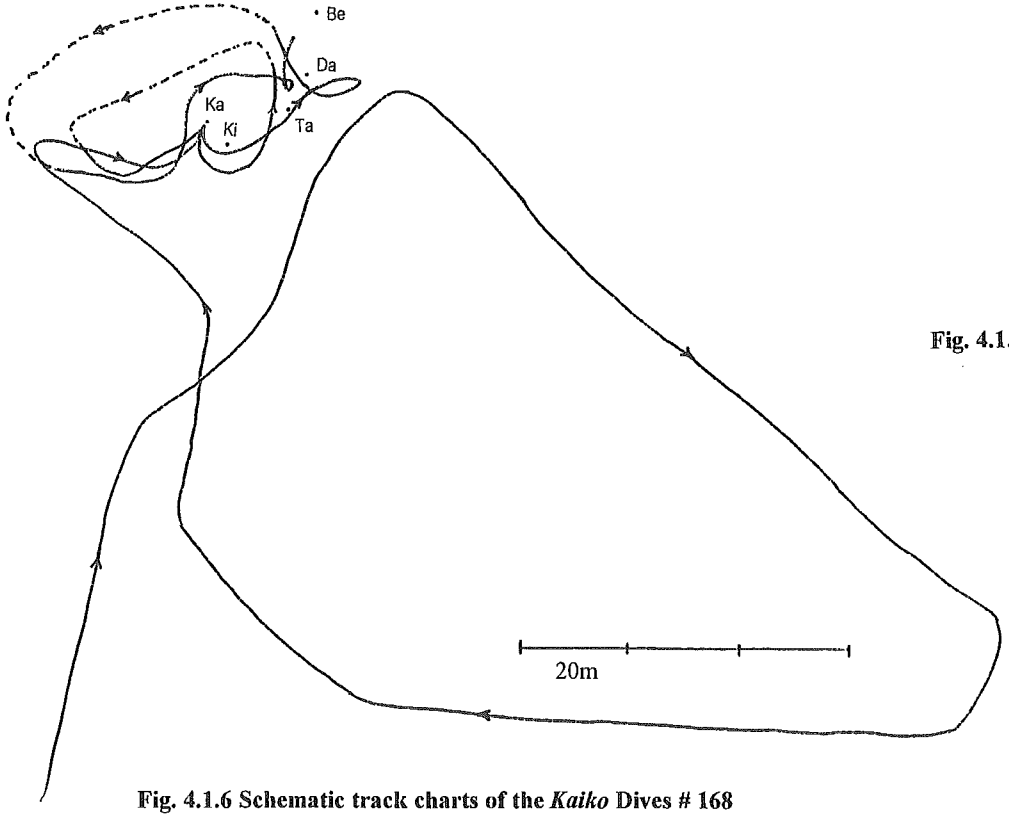

Fig. 4.1.6 Schematic track charts of the *Kaiko* Dives # 168

Abbreviations

Fg:	Fugen Chimney-complex
Fd:	Fudo Chimney-complex
Be:	Benten Chimney-complex
Da:	Daikoku Tower
Ta:	Taishaku Chimney-complex
Ki:	Kissho Chimney
Ka:	Kali Chimney
? :	Unnamed chimney-complex

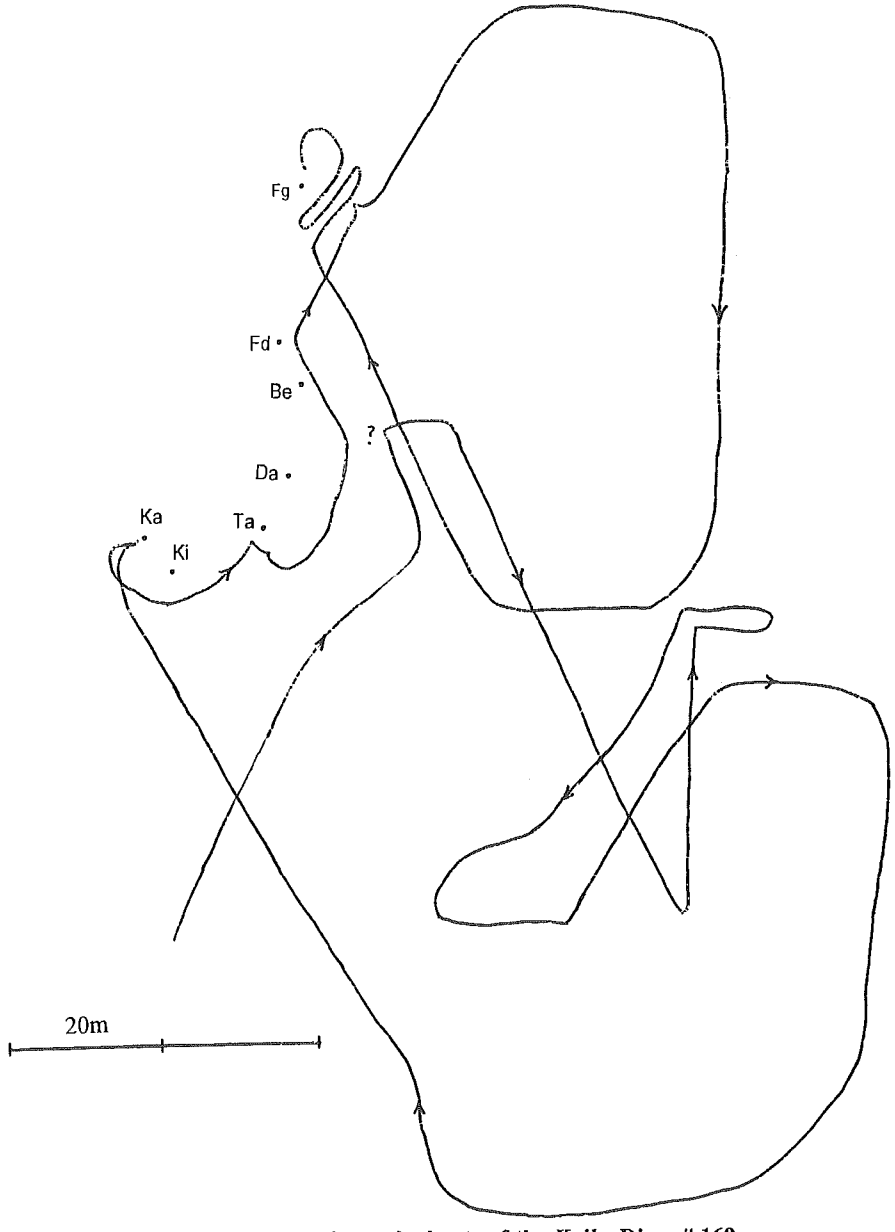

Fig. 4.1.7 Schematic track charts of the *Kaiko* Dives # 169

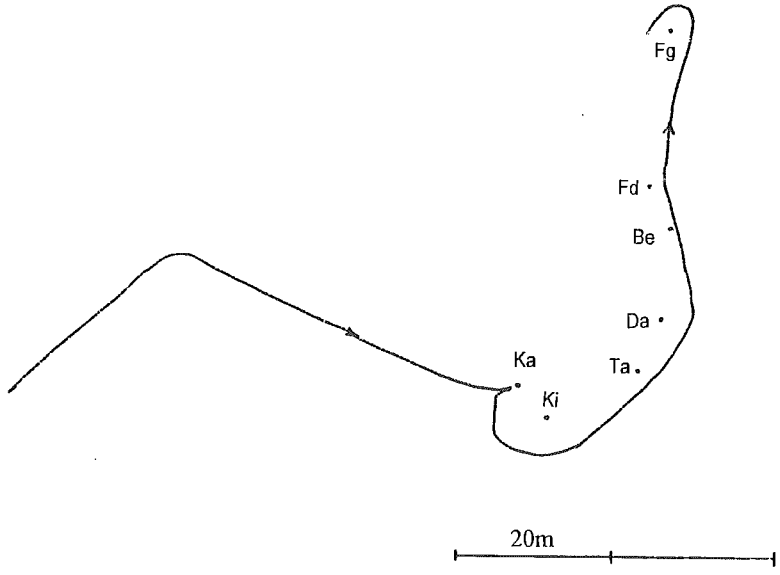

Fig. 4.1.8 Schematic track charts of the *Kaiko* Dives # 170 (*partim*)

Abbreviations

Fg:	Fugen Chimney-complex
Fd:	Fudo Chimney-complex
Be:	Benten Chimney-complex
Da:	Daikoku Tower
Ta:	Taishaku Chimney-complex
Ki:	Kissho Chimney
Ka:	Kali Chimney
? :	Unnamed chimney-complex

4.2. Geochemistry

4.2.1. Anomalies of light transmission and CH_4

Figures 4.2.1~4.2.6 show vertical profiles of light transmission for the eight tow-yo observations. The maximum transmission anomaly was 1.1% observed during the TY06-D03 (3rd downward operation of the TY06). Almost anomalies were observed at depths between 2100m and 2300 m, suggesting that hydrothermal venting sites might be at depths around 2400~2500 m, because the hydrothermal plume is known to appears at depths 200~300 m above the seafloor. Double or triple layered structure may be attributable to temporal variation of hydrothermal activity level and/or existence of two (or more) hydrothermal active fields.

Hydrothermal plume samples were taken during the TY02, 03, and 04, by actuating the Niskin bottles at almost the plume centers. Sampling points are shown by open circles with sample numbers in Figs. 4.2.1~4.2.3. Table 4.2.1 summarizes results of CH_4 and pH measurements, together with the light transmission anomaly values. Contents of dissolved methane vary ranging from 1.7 to 52.2 nM/kg. The measured methane content of ambient seawater was approx. 1.6 nM/kg (control sample: TY2-08). Although the methane contents of most samples are only slightly higher than that of the ambient seawater, five samples (show an order of magnitude higher values ranging from 21.2 to 52.2 nM/kg. These high values of dissolved methane are comparable to methane-rich plumes observed at southern EPR hydrothermal areas (Ishibashi et al, 1997), where vigorous magmatic budget was confirmed by previous studies, indicating the existence of active hydrothermal venting near the sampling area.

Figure 4.2.7 is the relationship between CH_4 concentration and transmission anomaly. It is obvious that the CH_4 concentration increases with increasing the light transmission, confirming that the observed transmission anomaly is due to hydrothermal activity, and its magnitude might be proportional to the distance from unknown hydrothermal venting sites. Two (or more?) straight lines in Fig. 4.2.7 imply dual or plural hydrothermal fluids with different characteristics, which may mean that the plumes derived from at least two sources, i.e. from more than two hydrothermal areas.

Figure 4.2.8 shows a map of light transmission anomaly (with a 0.2% anomaly contour) drawn by using maximum transmission anomaly values (figures in Fig. 4.2.8) for each upward and downward operation. Also included are the transmission data

obtained during lowering and ascending of the Deep Tow camera system (DT01~10). It should be noted that Fig. 4.2.8 is not a snapshot but a pile of all the data observed between August 11th and 20th.

Figure 4.2.8 implies:

a) The source of hydrothermal activity should be somewhere on the Hakuho knoll, because there is little indication of hydrothermal plume inflow from outside of the knoll.

b) It is most probable that hydrothermal venting fields exist somewhere on the ridge of the Hakuho Knoll where the strong transmission anomaly of >0.8% were observed. But bottom current system could horizontally shift the location of a plume center from that of the corresponding hydrothermal field, so slope zones of the knoll with depths of <2500 m should still be regarded as probable sites.

4.2.2. Sampling at the Kairei Field and shipboard analysis

Hot fluid samples were taken three times from the Kali Chimney, a typical black smoker with violent fluid eruption (see section 4.1). Sample #168A was taken during KAIKO dive #168, and samples #169A-1 (Alvin sampler with a red handle) and #169A-2 (black handle) during dive #169. It took 1 to 1.5 minutes for each sampling.

The Alvin sampler worked imperfectly for the samples #168-A, because the large spring for pulling out the piston was caught by the trigger disks by accident (sample volume obtained was ~200 mL). The samplers worked almost perfectly for the samples #169-A1 and #169-A2 (sample volume ~700 mL each).

Chimney fragments (hydrothermal precipitates) were also recovered from the Kali chimney (see sample list in the Appendix).

Temperature of venting fluid was measured by inserting a JAMSTEC high temperature (<400°C) Pt thermometer (RMT type of Rigosha Inc.) inside the chimney during the dives #167, #168 and #169 as shown in Fig. 4.2.9. The temperature was fairly constant: 359.3±0.1°C (averaged value for 8 seconds) for dive #167 (Aug. 25), 359.4±0.3°C (26 seconds) for dive #168 (Aug. 26), and 359.9±0.3°C (54 seconds) for dive #169 (Aug. 27).

Upon recovery of the KAIKO, the fluid samples were transferred from the Alvin samplers to sample bottles (styrol, polyethylene, and glass bottles) as soon as possible

as listed in Table 4.2.2 for chemical measurements on board the ship and in shorebased laboratories.

Bottom sediment was recovered using the M-type sampler at Taishaku chimney complex site. Seawater in the Masuda-type sediment sampler was also taken for pH, alkalinity, and major components analyses.

Table 4.2.3 summarizes the results of shipboard measurements of pH, alkalinity, Si and NH_4.

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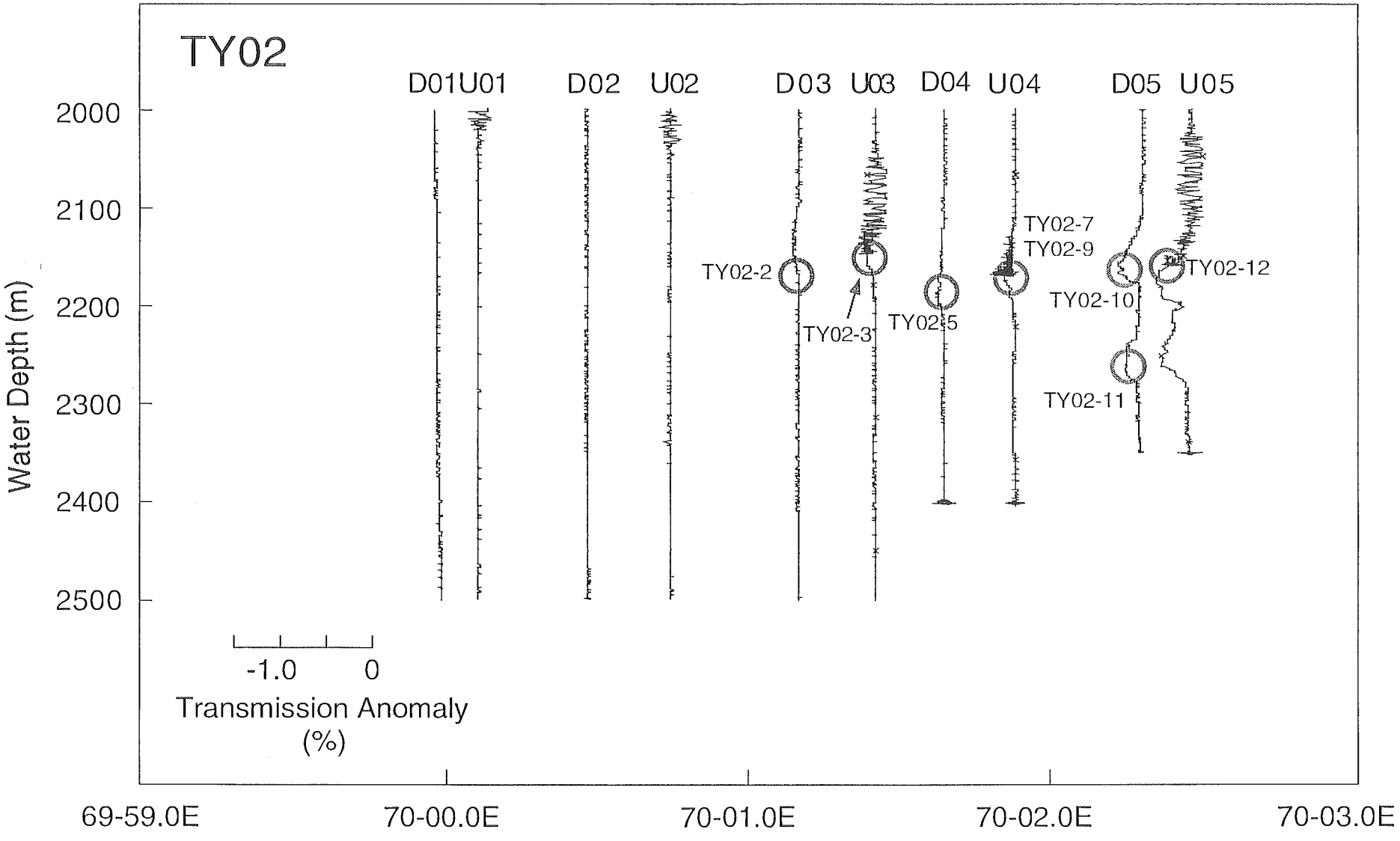

Fig. 4.2.1. Vertical profiles of light transmission for the TY-02 observation.
Open circles indicate water sampling points with sample numbers.

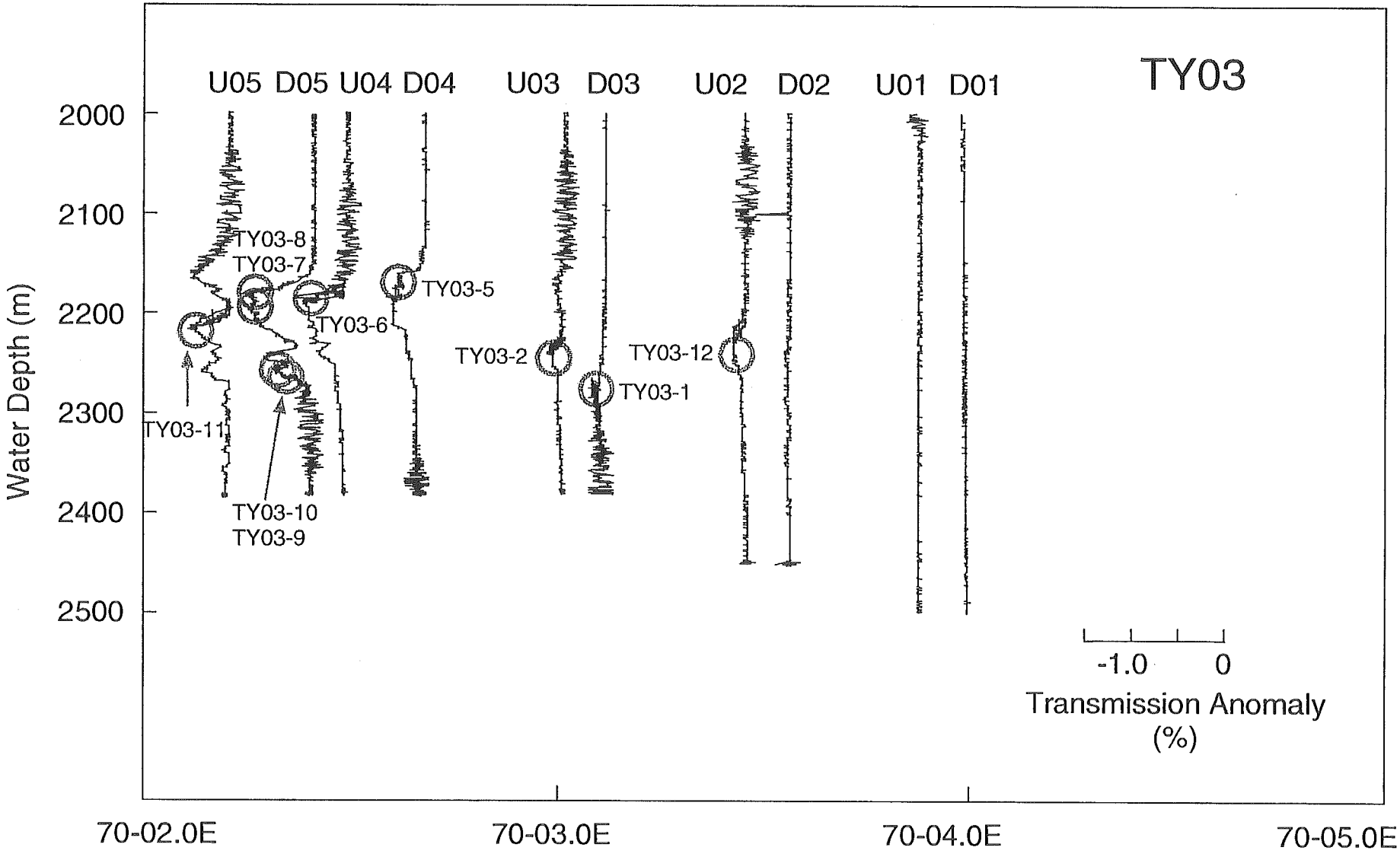

Fig. 4.2.2. Vertical profiles of light transmission for the TY-03 observation.
Open circles indicate water sampling points with sample numbers.

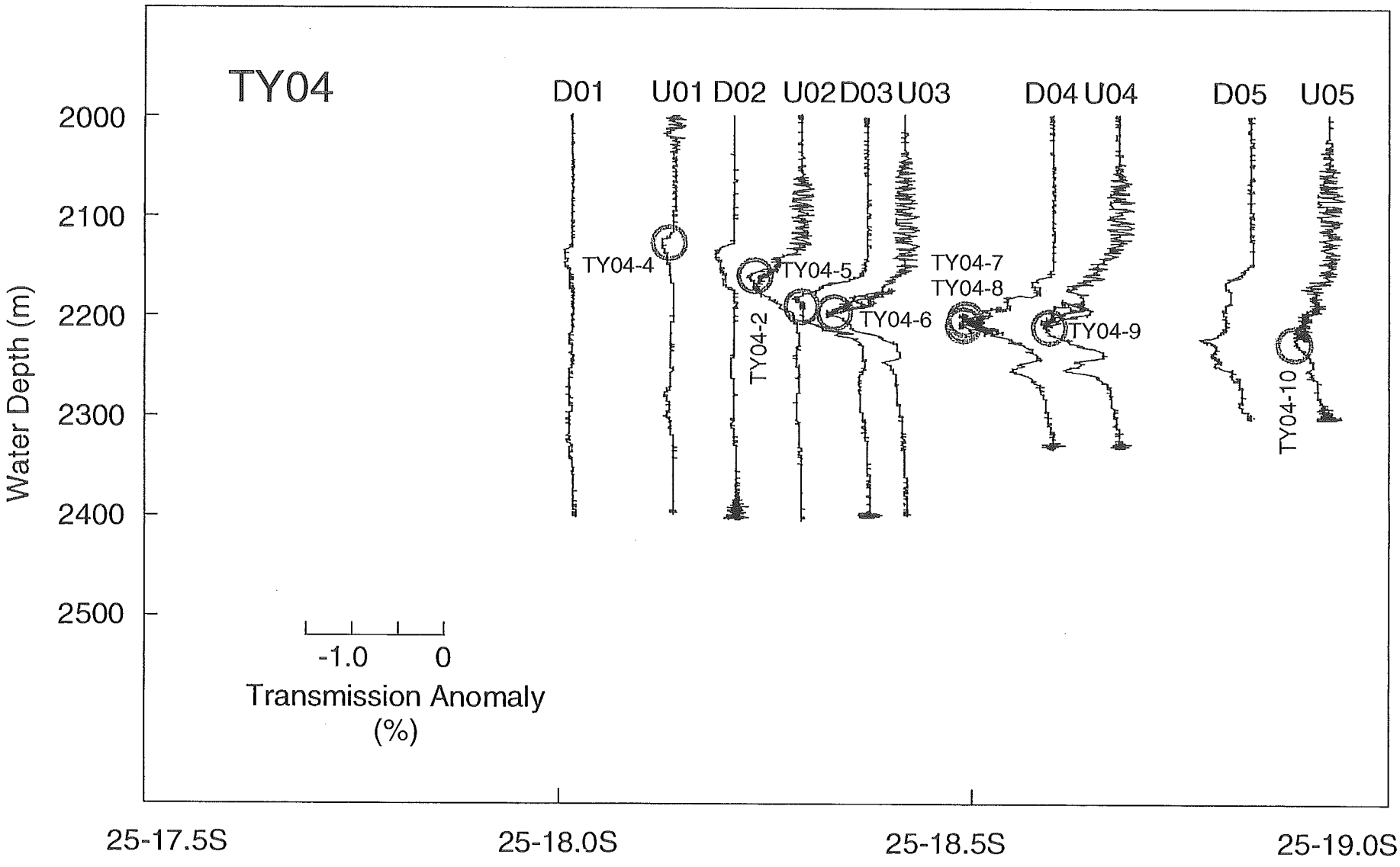

Fig. 4.2.3. Vertical profiles of light transmission for the TY-04 observation.
Open circles indicate water sampling points with sample numbers.

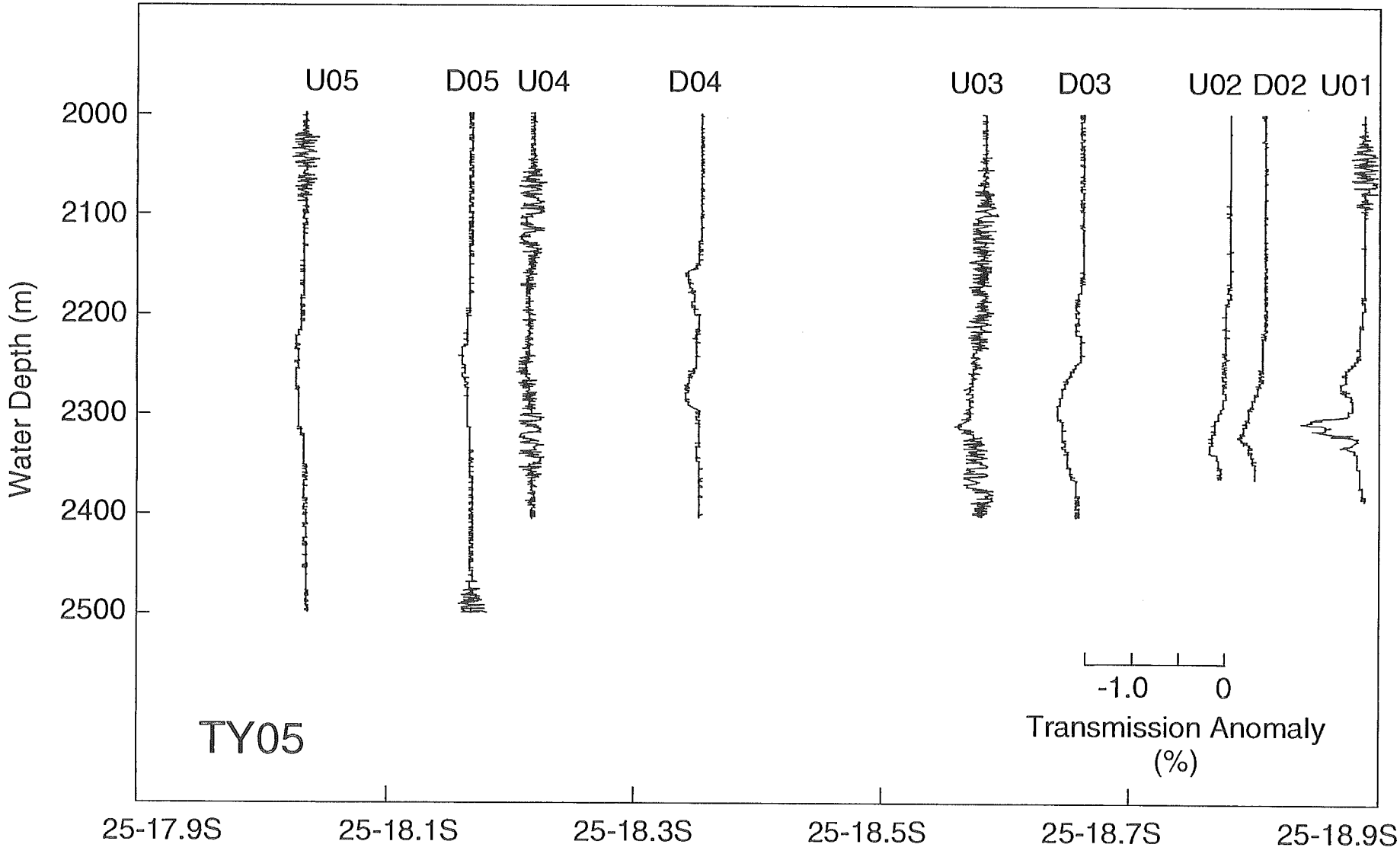

Fig. 4.2.4. Vertical profiles of light transmission for the TY-05 observation.

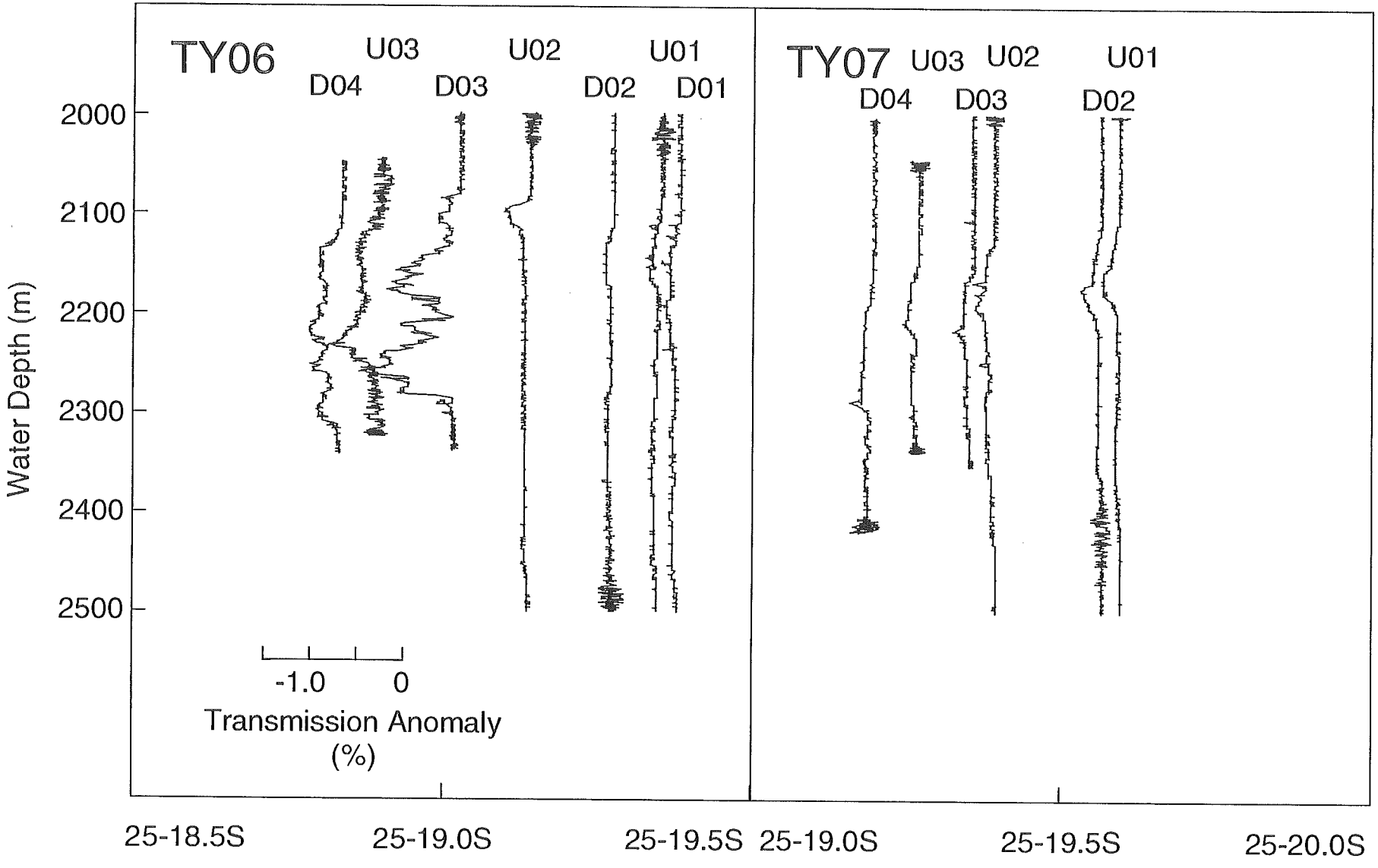

Fig. 4.2.5. Vertical profiles of light transmission for the TY-06 and 07 observation.

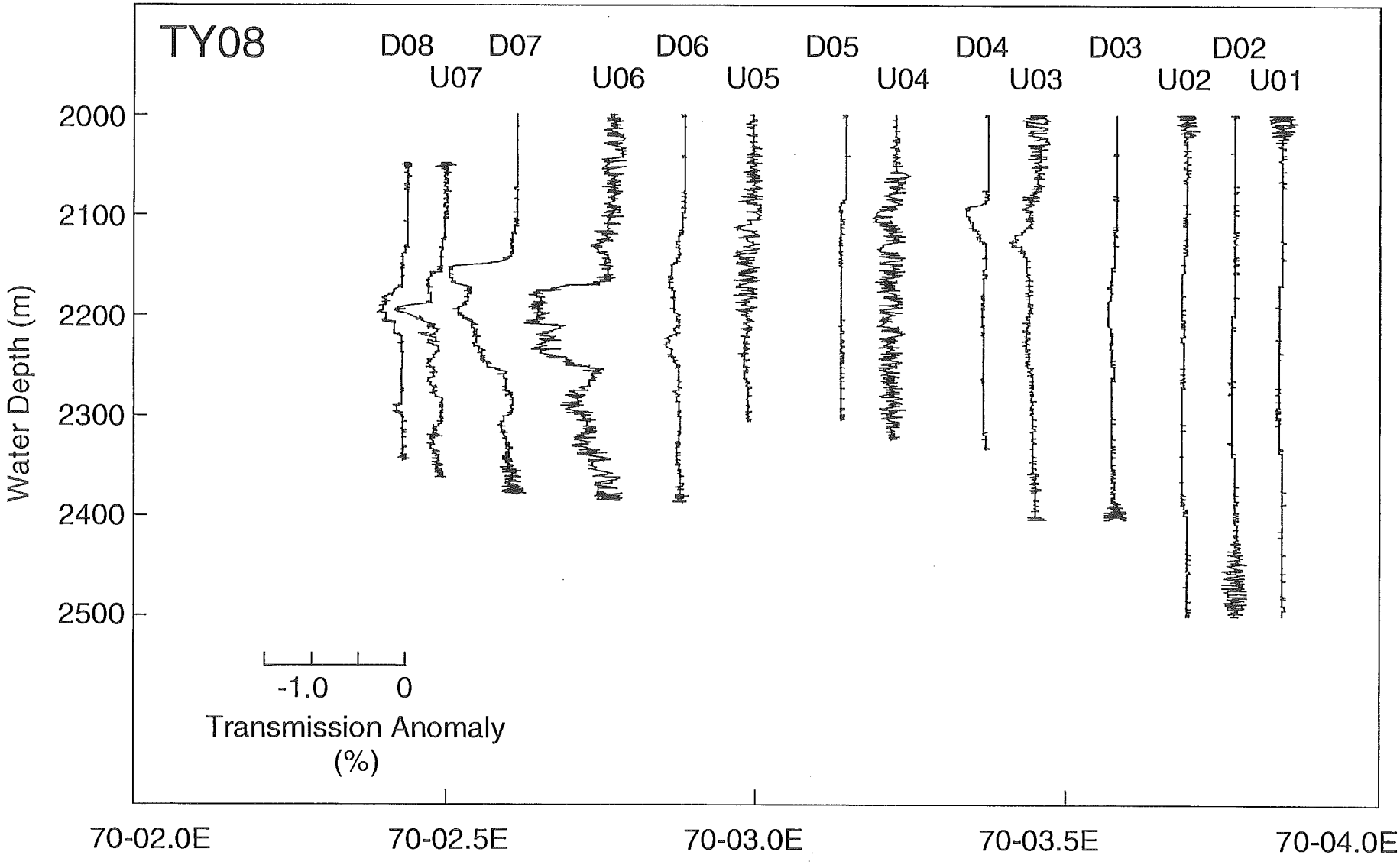

Fig. 4.2.6. Vertical profiles of light transmission for the TY-08 observation.

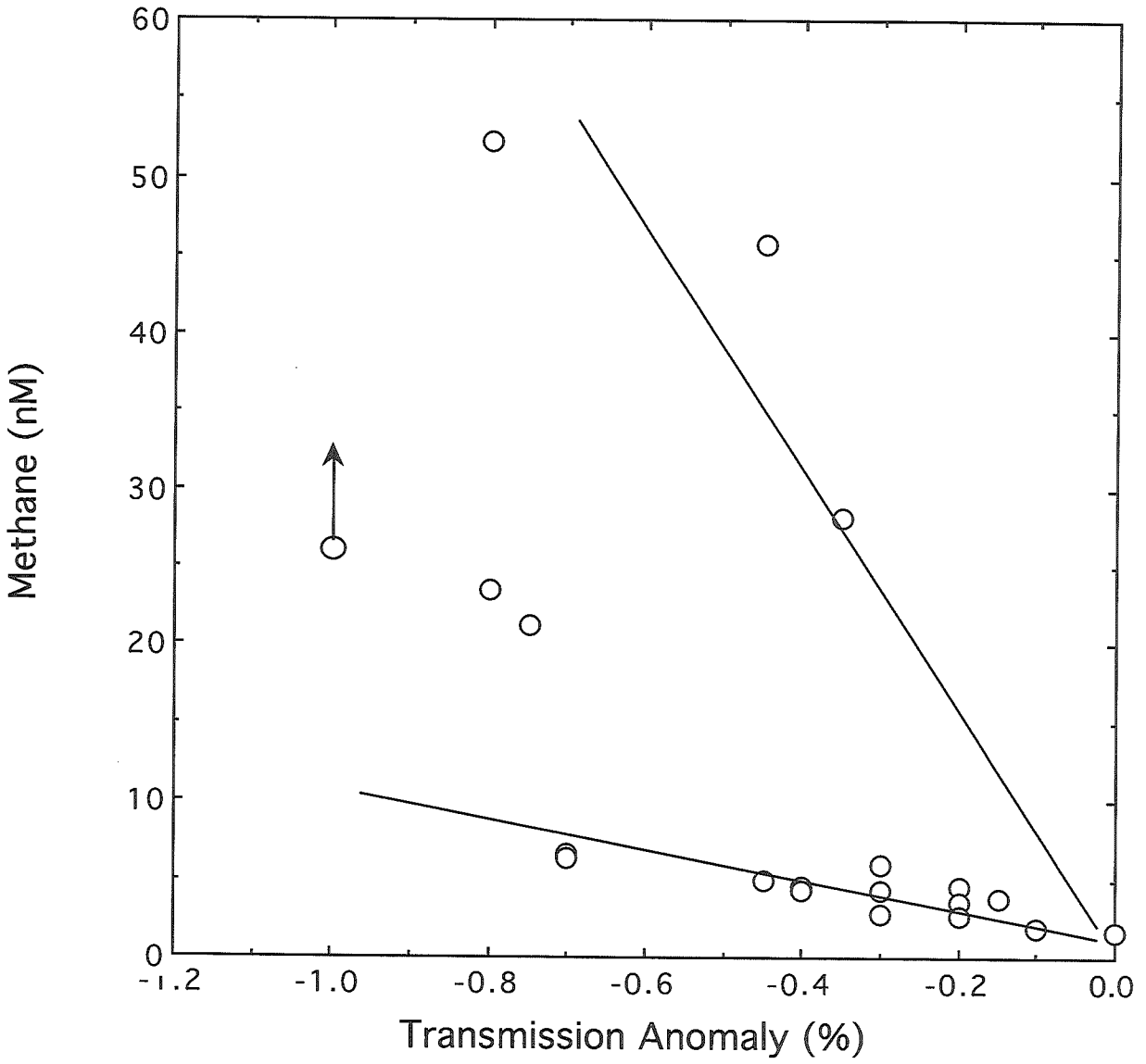

Figure 4.2.7. The relationship between CH4 concentration and transmission anomaly.

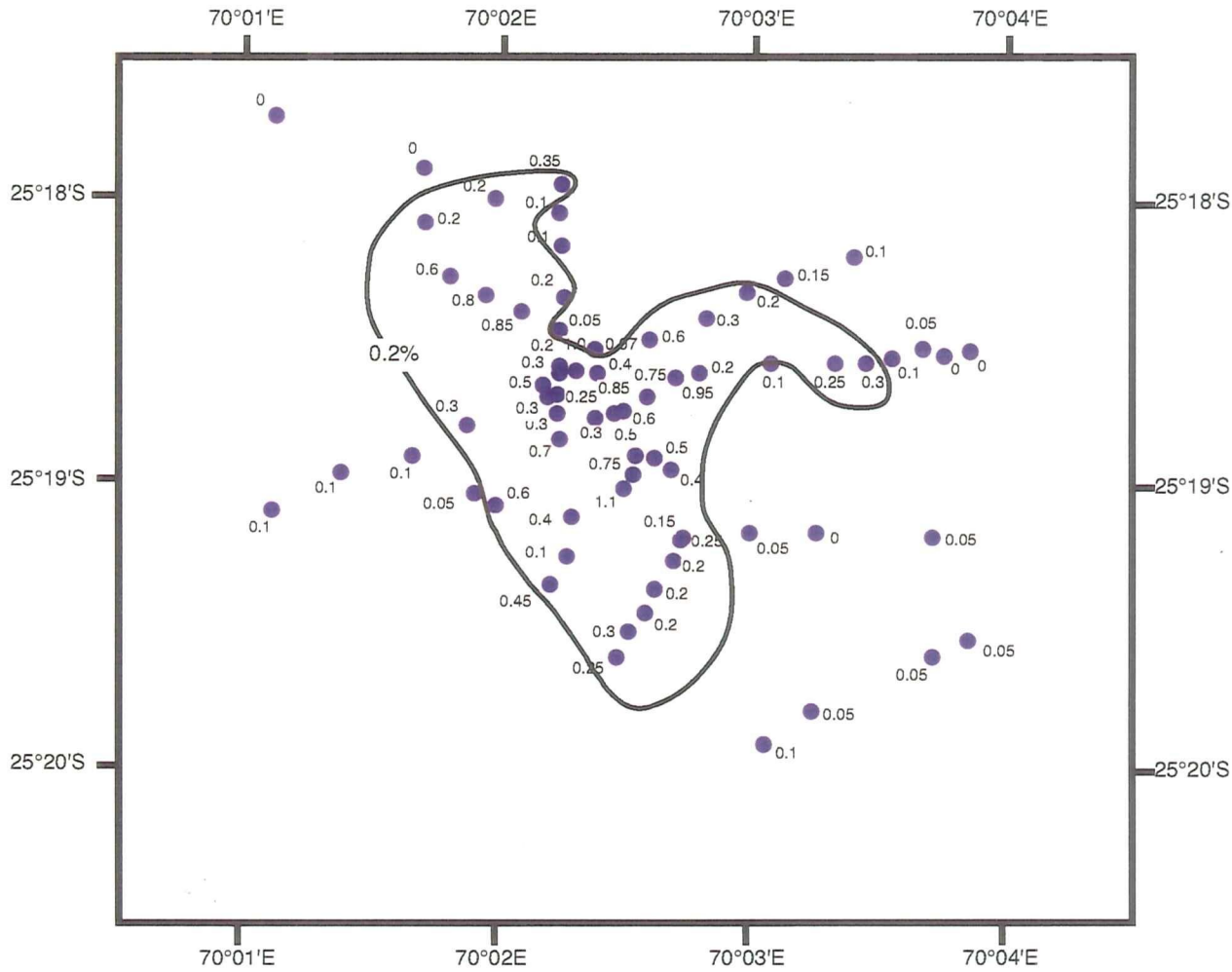

Figure 4.2.8. Map of light transmission anomaly with a 0.2% anomaly contour.

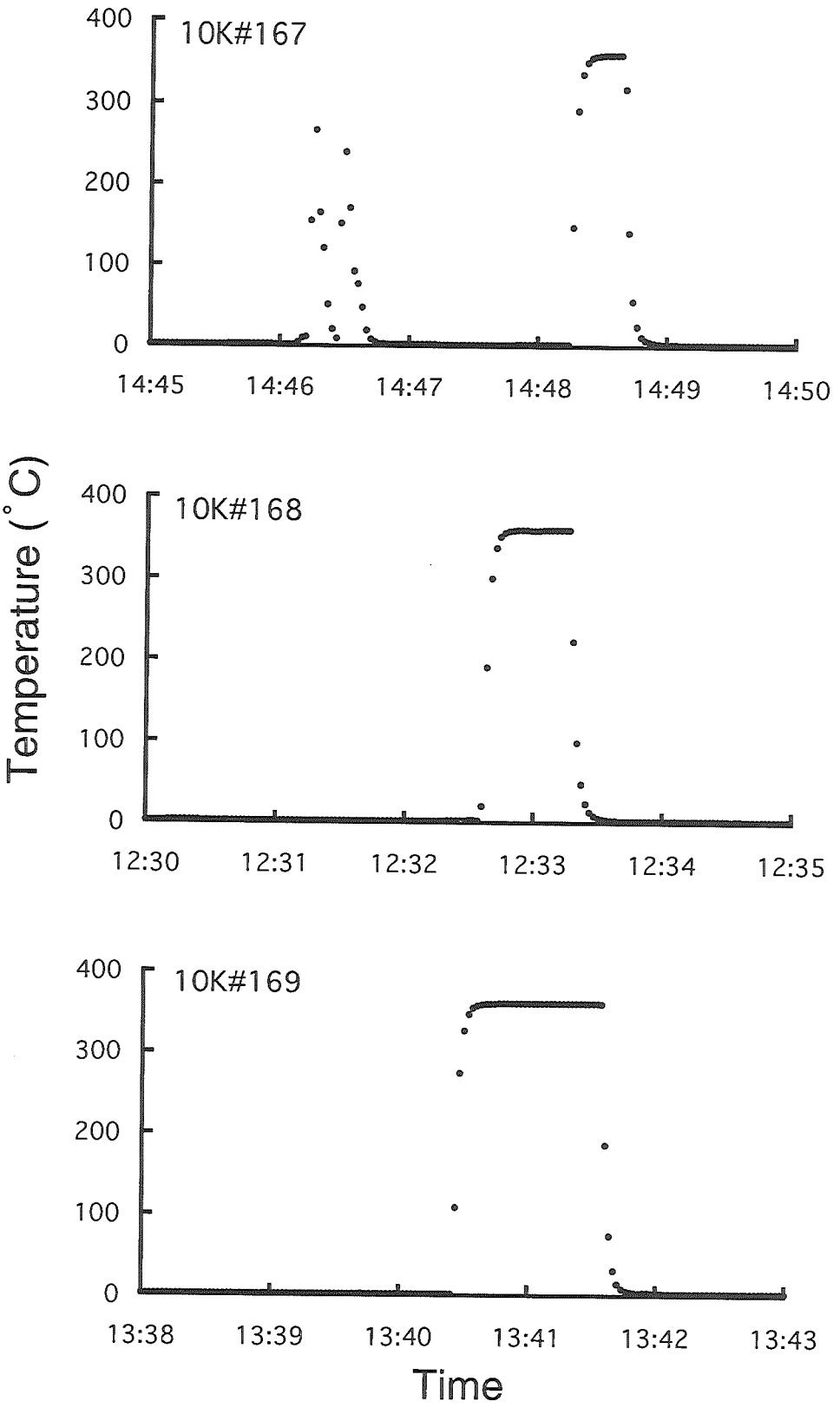

Fig.4.2.9. Water temperature of vent fluid measured by

Table 4.2.1 Methane concentrations and pH values in the plume samples

Sample	nM/kg	pH
TY2-02	1.85	7.792
TY2-03	2.72	7.802
TY2-05	2.63	7.798
TY2-07	2.84	7.798
TY2-08(Control)	1.61	7.798
TY2-09	4.32	7.807
TY2-10	5.92	7.808
TY2-11	3.51	7.805
TY2-12	4.25	7.813
TY3-1*	-	7.758
TY3-3*	-	7.771
TY3-4*	-	7.773
TY3-05*	28.17	7.783
TY3-06*	45.83	7.762
TY3-07	6.59	7.776
TY3-08	6.29	7.780
TY3-09	4.60	7.772
TY3-10	4.51	7.776
TY3-11	4.94	7.773
TY3-12	3.77	7.800
TY4-02*	-	7.783
TY4-04*	-	7.792
TY4-05*	21.16	7.780
TY4-07*	52.22	7.770
TY4-08*	>25.27**	7.770
TY4-09*	23.48	7.779
TY4-10*	-	7.780

*FID sensitivity was decreased to 1/100 because of high noise level.

**Trap temperature was not enough decrease.

-:under detection limit (<5nM/kg at sensitivity = 1/100)

Table 4.2.2. Water samples and chemical measurements on board taken by the Alvin sampler.

Bottles	item		reagents added	#168A	#168A-1	#168A-2	#168M
5 mL styrol	pH			○	○	○	○
25 mL styrol	alkalinity			○	○	○	○
10 mL vial	gas		Sat. HgCl2, 0.5 mL	○ ○	○	○	
10 mL vial	isotope of H2O				○	○	
20 mL vial	gas		Sat. HgCl2, 0.5 mL		○	○	
100 mL vial	gas		Sat. HgCl2, 0.5 mL		○	○	
30 mL poly.	H2S, S isotope		2N Zn(OAc)2, 1 mL	○	○	○	
40 mL Pb glass	He isotope			○	○	○	
10 mL poly.	Sr isotope				○	○	
50 mL poly.	Major elements	Filtrated		○	○	○	
50 mL poly.		Filtrated	6N HCl 0.1mL		○	○	
50 or 100 mL poly.					○	○	○

Table 4.2.3 Summarized results of shipboard measurements for pH, alkalinity, Si, and NH4.

Sample No.	#168A	#169A-1	#169A-2	#169M
pH	5.228	3.840	3.416	6.655
alkalinity (mmol/L)	0.406	-0.235	-0.419	1.818
Si (mmol/L)	6.9	14.9	15.6	0.137
NH4 (μmol/L)	22.0	6.2	4.4	2.7
Remarks	H2S smell black particles	H2S smell almost clear	H2S smell almost clear	 clear

4. 3. Biology

On the present expedition of the R/V *Kairei*, JAMSTEC, to the Central Indian Ridge, we successfully located a hydrothermal vent field, the Kairei Field (Fig. 4.3.1: 25°19.17'S, 70°02.40'E, 2,450 m), using a tow-yo system, a deep tow camera system, and the ROV *Kaiko*.

Research efforts were focused around the Hakuho Knoll, where a *Calyptogena* heap had already been found on the western slope. The knoll is located on the eastern crest of the axial valley, approximately 22 km north of the Rodriguez Triple Junction (Fig. 4.3.1). Four ROV dives were made on the western slope of the knoll. The Kairei Field is situated on the southwestern slope of the Hakuho Knoll, and dense hydrothermal vent communities were observed in a 40 m x 80 m area.

Species composition of the Kairei Field is preliminarily summarized in Table 4.3. It was similar at higher taxonomic levels to those of the TAG and the Snake Pit sites, in the Atlantic Ocean. Huge swarms of *Rimicaris* shrimp, known heretofore only from the Atlantic Ocean, were observed on the surface of active chimneys (Fig. 4.3.2), including black smokers (Fig. 4.3.3: The maximum water temperature was over 360°C). Sea anemones (Actiniaria) were abundant on bare rocks, 1-2 m from the black smokers to the margin of the field. Dense beds of *Bathymodiolus* mussel were observed between the *Rimicaris* swarms and sea anemone aggregations. Conversely, *Alviniconcha* snails, *Austinograea* crabs, previously known from the Pacific Ocean, were observed around the bases of chimneys and near crevices emitting heated effluent. Like in the case of Southward *et al.* (1997), *Neolepas* barnacles were also collected. Other organisms, polynoid polychaetes, *Phymorhynchus* snails, limpets, and zoarcid fish, were also observed.

To aid further surveys at the Kairei Field in future, the following description of distributions for each taxon was prepared. It will also be useful as a basis for understandings not only the uniqueness of the Kairei Field, but also the common features of hydrothermal vent fields in general.

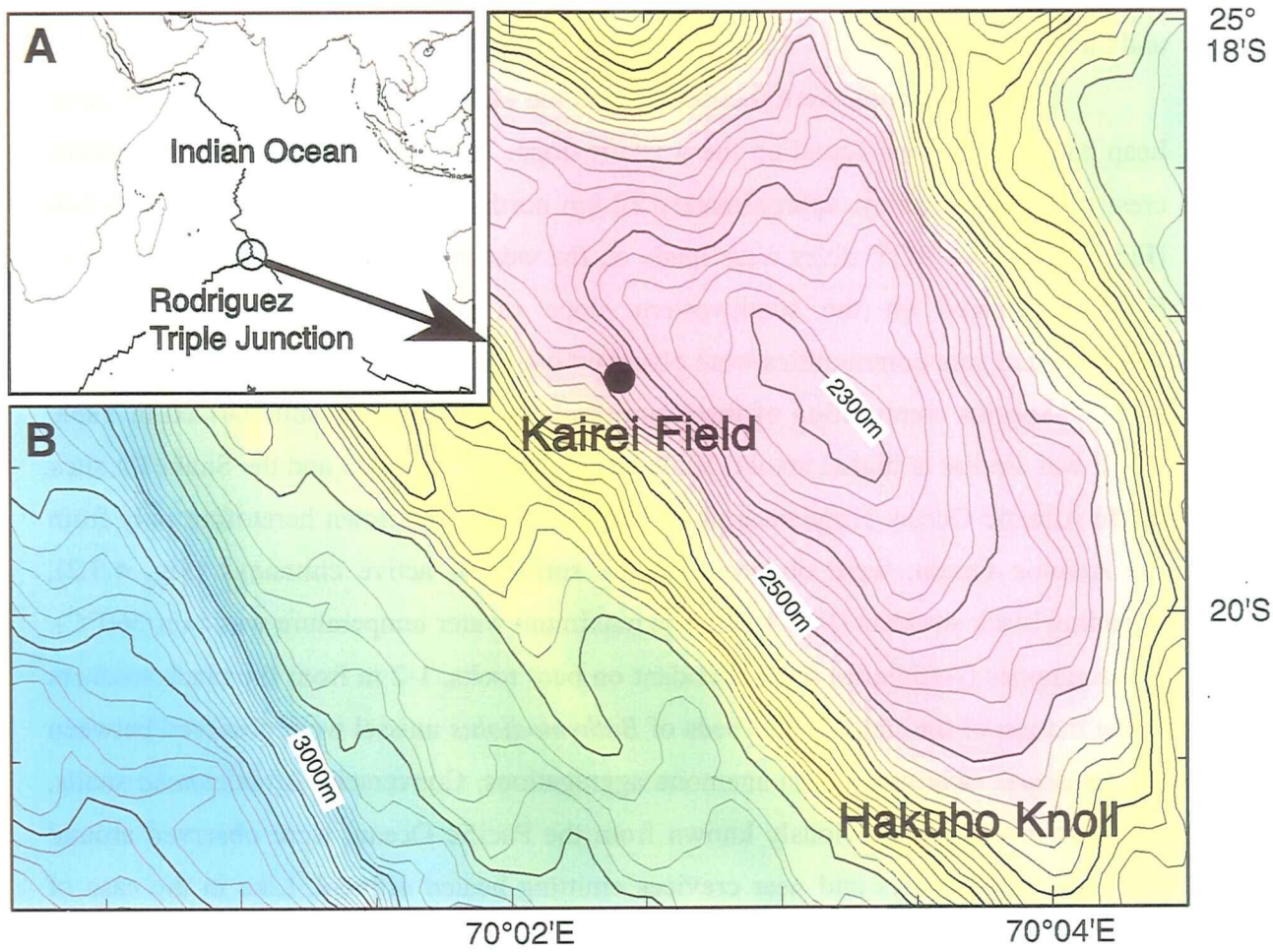

Figure 4. 3. 1. Location of the hydrothermal vent field (Kairei Field) on the Hakuho Knoll, near the Rodriguez Triple Junction in the Indian Ocean.

Table 4.3. Observed and collected species at the Kairei Field

CNIDARIANS

- Actinostolidae? gen. sp. 1
- Actinostolidae? gen. sp. 2
- Cerianthidae? gen. sp.*

POLYCHAETES

- Polynoidae gen. sp. 1
- Polynoidae gen. sp. 2
- Hesionidae? gen. sp.
- *Branchipolynoe* sp.

ARTHROPODS

- Copepoda
  - several species
- Cirripedia
  - *Neolepas* sp.
- Caridea
  - *Rimicaris* sp.
  - *Chorocaris* sp.
  - Bresiliidae? gen. sp.*
- Anomura
  - *Munidopsis* sp.
- Brachyura
  - *Austinograea* sp.

MOLLUSCS

- Gastropoda
  - *Olgasolaris* ? sp.
  - *Symmetromphalus*? sp.
  - *Lepetodrilus*? sp.
  - *Phymorhynchus* sp.
  - *Phymorhynchus*? sp.*
  - *Alviniconcha* sp.
  - *Desbruyeresia*? sp.
  - *Melanodrymia*? sp.
- Bivalvia
  - *Bathymodiolus* sp.

FISHES

- Zoarcidae gen. sp.

*: observed on video record

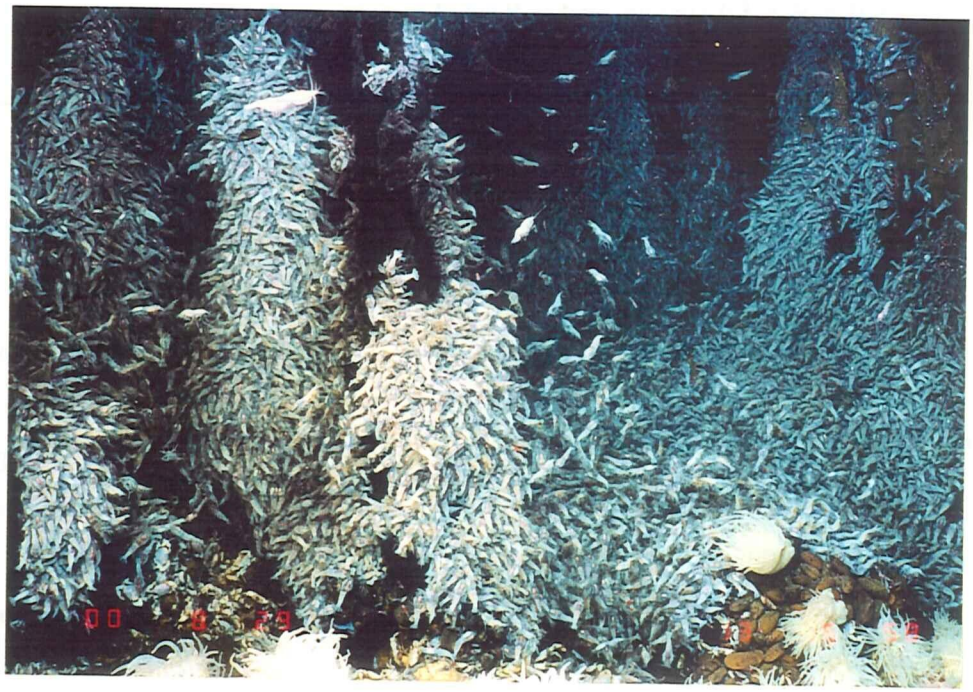

Fig. 4.3.2. Typical scene characterized by *Rimicaris* swarms and sea anemone aggregations at the Kairei field.

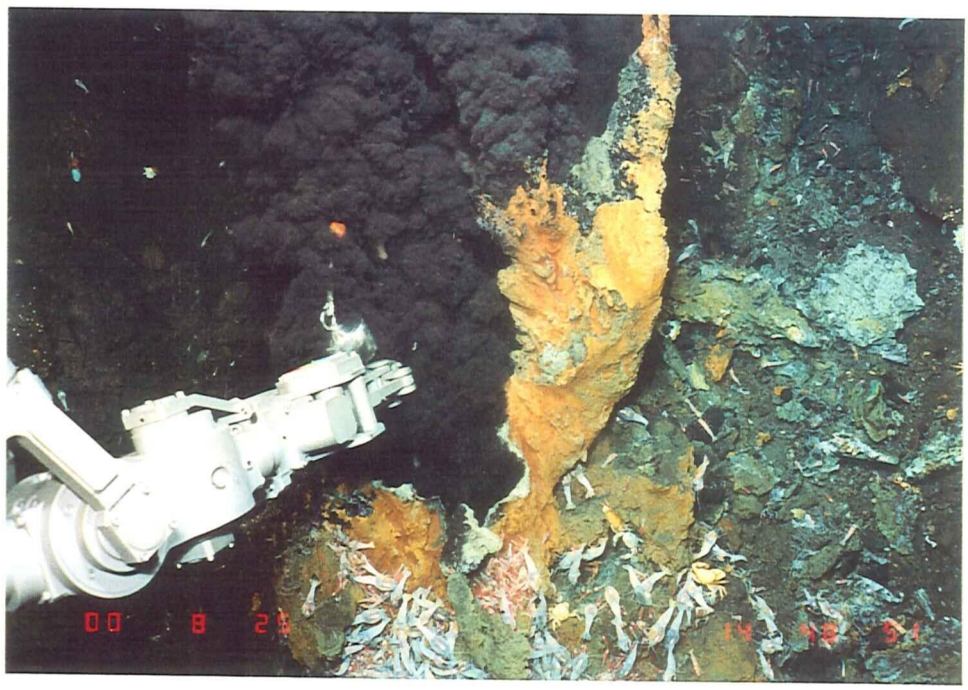

Fig. 4.3.3. Measuring the temperature of an active black smoker by the ROV *Kaiko*. The superheated water was over 360°C. *Rimicaris* and *Chorocaris* shrimps, and *Austinograea* crabs aggregated at the base of black smoker.

Cnidarians: Two separate actinostolid? and a cerianthid? species were recognized. Actinostolidae? gen. sp. 1 was the most numerically dominant sessile form. Many individuals tended to occur on altered basaltic rock near the active chimneys, and the number of them decreased along the distance from there. Actinostolidae? gen. sp. 2 was less numerous, and tended to occur on rocks where the density of Actinostolidae? gen. sp. 1 was lower. Cerianthidae? gen. sp. was rare, and no sample was collected during this cruise.

Polychaetes: Three species of free living polychaetes, namely, two polynoid species and one hesionid? species, were identified. One of the polynoid species was frequently observed beneath the *Rimicaris* swarms (Fig. 4.3.4). The hesionid? species was found during the sorting of rock debris, and thus, precise information on its ecology was not obtained. For parasitic species of polynoids, *Branchipolynoe* sp., two individuals were recognized from the mantle cavity of mussels.

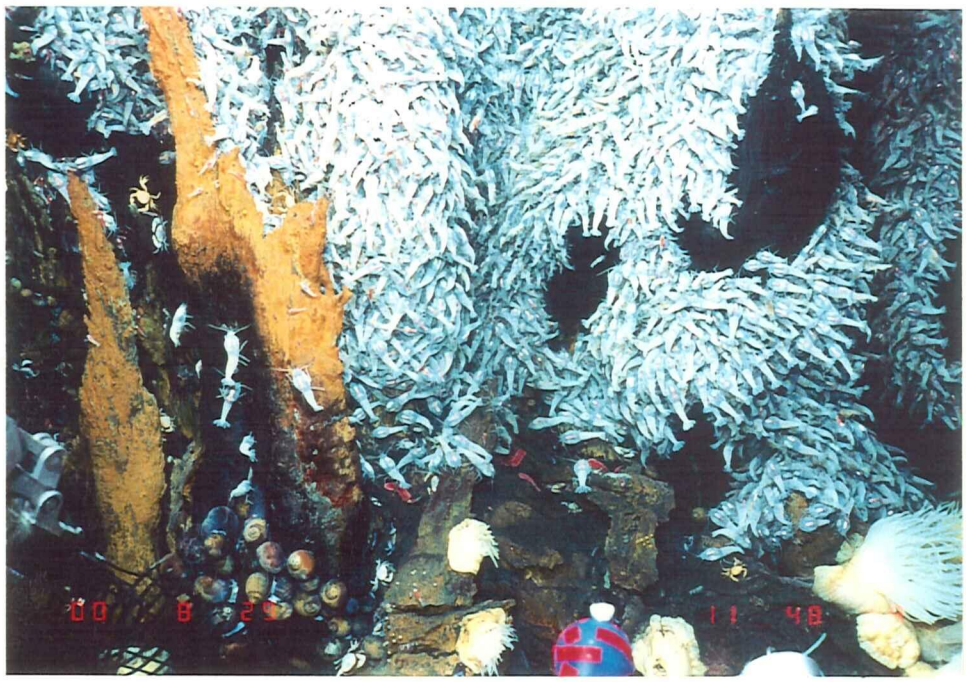

Fig. 4.3.4. Red polynoids beneath *Rimicaris* swarms were creeping on the chimneys.

Arthropods: *Rimicaris* swarms like those from the TAG site were observed. Two bresiliid species were provisionally identified in the swarm. One of them was referable to the genus *Rimicaris,* and represented by white, and larger shrimps. This species appeared to be distinct from *R. exoculata,* previously known from the Atlantic Ocean. The other species was *Chorocaris* sp., and was characterized by orange, and smaller shrimps. The micro-distribution pattern of *Rimicaris* sp. was slightly different from *Chorocaris* sp. (Fig. 4.3.5). *Rimicaris* sp. was the most dominant in number, and more than 70-80% of swarming shrimps appeared to be referable to this species. In *Rimicaris* sp., many individuals tended to occur on active chimneys and neighboring rocks, where the number of sea anemones (Actinostolidae? gen. sp. 1) decreased. Moreover, *Rimicaris* shrimps were sometimes found in the water column or on rocks, which were considerably distant from the swarms. All the shrimps seemed to be extremely sensitive to high temperature and strong water movement. Many dead individuals were observed on the bottom 2-3 m from active chimneys. Besides two bresiliid species in the swarm, one bresiliid? species was also observed near the active chimneys. *Austinograea* crabs were frequently observed near the base of chimneys or in small crevices, where mussels or *Alviniconcha* snails were dominant. *Munidopsis* squat lobsters were rarely found near mussel beds. Only a single cirriped species, *Neolepas* sp., which appears to be undescribed, occurred. Individuals were abundant on altered basaltic rocks that was 3-10 m from active chimneys, or around the edge of shimmering crevices surrounded by mussels (Fig. 4.3.6). This species appeared to be very close morphologically to *N. zevinae*, known from the north East Pacific Rise, and an undescribsed *Neolepas* sp. reported in Southward *et al.* (1997).

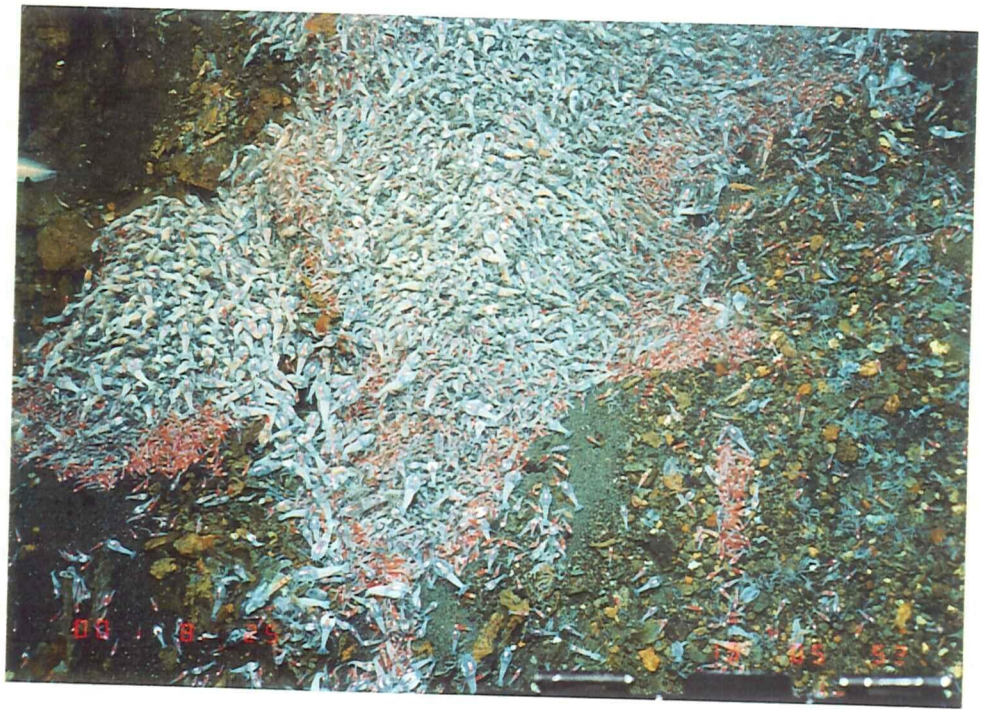

Fig. 4.3.5. Two bresillid species, namely, *Rimicaris* sp. (white and larger) and *Chorocaris* sp. (orange and smaller), occupies different areas on the sediment.

Fig. 4.3.6. The *Neolepas* cirripeds attached themselves to altered rock neighboring *Rimicaris* swarms, and sea anemone and mussel beds.

Molluscs: Some smaller species (three limpet species, and one provannid species, *Desbruyresia*? sp.) were collected besides the mussels and three large gastropod species (*Alviniconcha* sp. and two *Phymorhynchus* spp.). They were minor components of the field, and were hardly observed on video. From the site where clear water shimmered, or the outer margin of a *Rimicaris* swarm, high-density mussel beds were frequently observed (Fig. 4.3.7). From the morphology of mussels, it seems that they represent a single mytilid species, *Bathymodiolus* sp. The species is taxonomically close to an undescribed species in the Manus Basin. However, the bases of chimneys and the margin of crevices were occupied by *Alviniconcha* snails (Fig. 4.3.8). *Melanodrymia?* gastropods seemed to prefer course sediment, though our observations were not conclusive. Two species of *Phymorhynchus* snails were frequently observed on mussel beds and at the base of chimneys.

Fishes: Only a single zoarcid species was observed within the hydrothermally active area, and was somewhat rare in number. Individuals tended to escape the direct effects of the black smokers, and were frequently observed on rocks where mussels, crabs, and *Alviniconcha* snails lived (Fig. 4.3.9).

Fig. 4.3.7. The mussel beds occupied the flank of shimmering crevices surrounded by sea anemone aggregations. Note that *Rimicaris* shrimps occupy the water shimmering areas in the crevices.

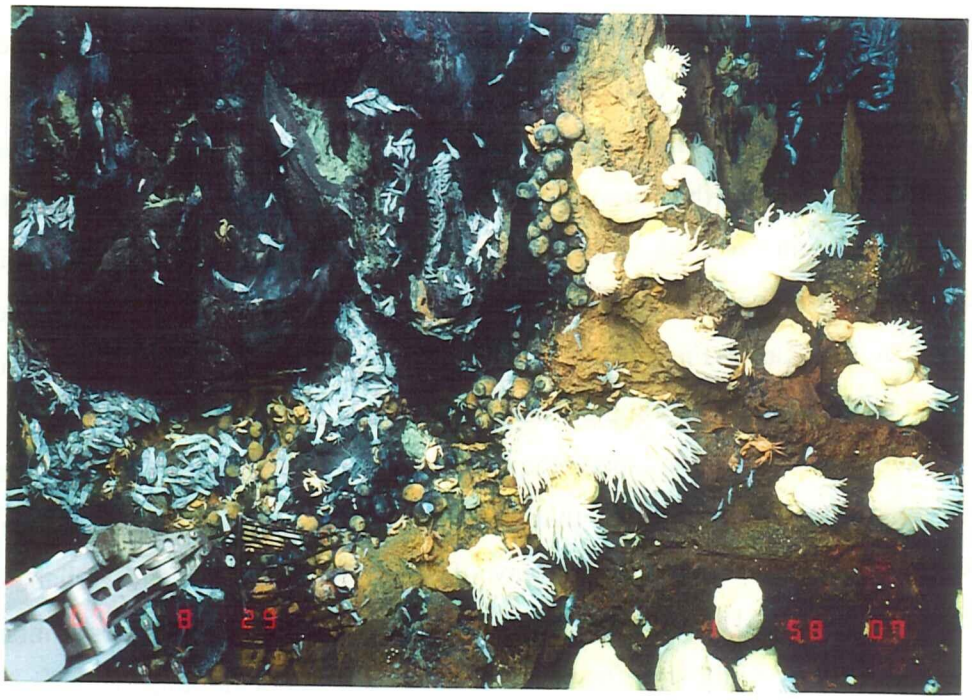

Fig. 4.3.8. Many *Alviniconcha* snails aggregated around the active chimneys. They occurred quite near the black smokers together with *Rimicaris* shrimps.

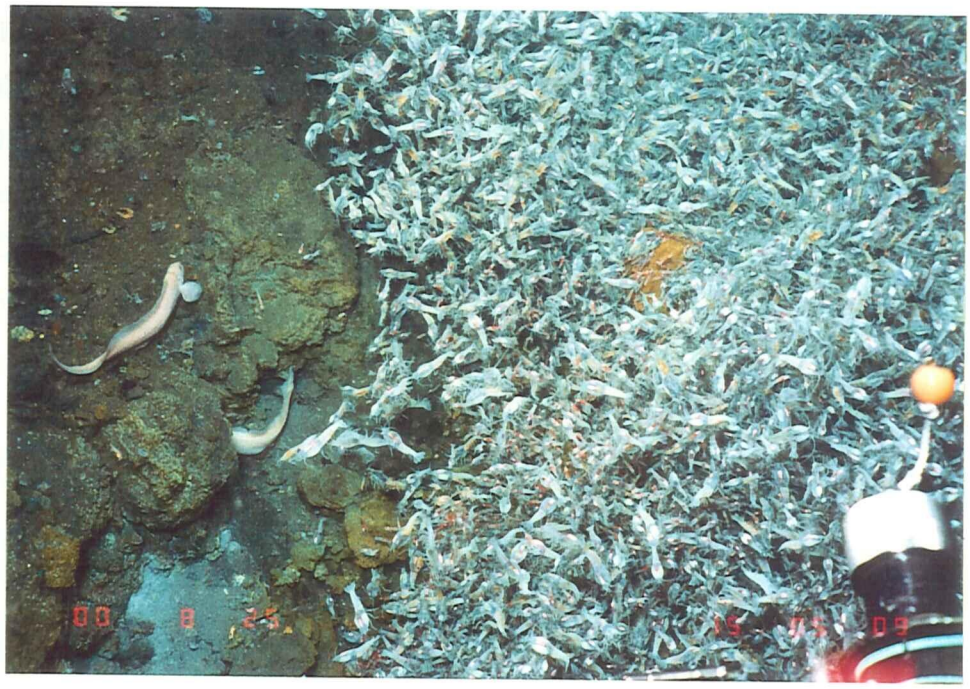

Fig. 4.3.9. Two zoarcid individuals near a *Rimicaris* swarms.

At higher taxonomic levels, the faunal composition of the Kairei Field closely resembles that of some Atlantic Ocean vent fields. This is very important, as basic knowledge of biogeography of vent organisms is limited. For example, some genera like *Alviniconcha*, *Austinograea*, and *Neolepas*, which had mainly been found from the Pacific Ocean, were also found at the Kairei Field. Their occurrence contradicts with the "resemblance" between the present field and the Atlantic vent fields. It also demonstrates the intermediate status of the faunal composition on the Kairei Field between the Pacific and the Atlantic Oceans. However, at the species level, the uniqueness of the Kairei Field might be emphasized. Closer taxonomic examination should be conducted on morphological and molecular levels.

From an evolutionary aspect, the discovery of the Kairei Field is noteworthy as it lends support to the hypothesis that communication between the Pacific and the Atlantic vent faunas had occurred by way of the western Pacific and Indian Oceans (Tunnicliffe & Fowler, 1996). Further examination of the living organisms inhabiting here will undoubtedly yield significant advances in our understanding of the evolution of deep-sea chemosynthesis-based communities.

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4.4. Petrography of the collected rock and chimney samples

Petrography of the rock and chimney samples collected by dives of RV Kaiko (Dives 10K#167, 10K168, and 10K169) are briefly described. The localities of the samples are illustrated in Fig. 4.4.1.

Rock samples

Sample 167-R01 are collected from southwestern slope of the Hakuho knoll during dive 10K#167, August 25, 2000. Locality of the sample is 25°19.46'S, 70°02.22'E (2648 m depth). Weight and dimensions of the sample are 1.9 kg and 15 x 10 x 7 cm, respectively. This is Ol+Pl-phyric basalt. MnO crust is up to 3 mm on top and side surfaces. The cut surface shows a up to 3 mm thick altered rim inside the MnO rind. Inside the altered part, fresh gray basalt is recognized. In mantle part of the fresh basalt, some vesicles are developed. The fresh basalt contains many olivine and plagioclase microphenocrysts. Any internal structure such as shape preferred orientation of plagioclase are not recognized.

Sample 167-R02 are collected from southwestern slope of the Hakuho knoll during dive 10K#167, August 25, 2000. Locality of the sample is 25°19.36'S, 70°02.28'E (2620 m depth). Weight and dimensions of the sample are 3.0 kg and 19 x 11 x 10 cm, respectively. This is altered hyaloclastic or autobrecciated basalt. MnO crust is not observed. Many angular clasts (up to 3 mm) of basaltic glasses and white altered basaltic glasses (?) are contained. Greenish mineral (Cu-bearing mineral ?) forms thin (up to 2 mm) layers. These layers are parallel to each others. However, in the hyaloclastic part, any internal structure, such as preferred orientation of the clasts, are not developed.

Sample 169-R01 are collected from southwestern slope of the Hakuho knoll during dive 10K#169, August 27, 2000. Locality of the sample is 25°19.25'S, 70°02.30'E (2528 m depth). Weight and dimensions of the sample are 2.8 kg and 13 x 12 x 9 cm, respectively. This is olivine basalt. MnO crust is not recognized. The cut surface is gray and fresh. There are many olivine phenocrysts and aggregates (up to 10 mm). Subordinate amount of pyroxene and plagioclase phenocrysts are also observed. A faint flow structure formed by preferred alignment of long axis of pyroxene and plagioclase grains.

Sample 169-R02 are collected from southwestern slope of the Hakuho knoll during dive 10K#169, August 27, 2000. Locality of the sample is 25°19.20'S, 70°02.34'E (2482 m depth). Weight and dimensions of the sample are 14 kg and 37 x 25 x 17 cm, respectively. This is altered olivine basalt. MnO crust is not observed. The cut surface is completely red color. There is no fresh part. Other petrographical features are similar to sample 169-R01.

Chimney samples

Sample 167-C01 are collected from western valley of the Kairei Field during dive 10K#167, August 25, 2000. Locality of the sample is 25°19.16'S, 70°02.43'E (2452 m depth). Many pieces of an active chimney were collected from a black smoker. Weight and dimensions of the sample are not measured. Concentric growth structure around conduit is observed in some pieces. Pyrite, chalcopyrite, and other Fe-S metals form the chimney fragments. Some pieces of the chimney have anhydrite developed the most inner part of the conduit wall. Green material (Cu-bearing metal) is also observed on the surface.

Sample 168-C01 are collected from western part of the Kairei Field during dive 10K#168, August 26, 2000. Locality of the sample is 25°19.17'S, 70°02.41'E (2452 m depth). Many pieces and big one were collected from one of the dead chimneys in the Kairei Field. Weight and dimensions of the sample are not measured. Pyrite, chalcopyrite, and other Fe-S metals form the chimney fragments. Some pieces of the chimney have anhydrite developed the most inner part of the conduit wall. Green material (Cu-bearing metal) is also observed on the surface.

Sample 169-C01 are collected from western valley of the Kairei Field during dive 10K#169, August 27, 2000. Locality of the sample is 25°19.16'S, 70°02.36'E (2441 m depth). A fragment of an active chimney rind was collected after hydrothermal fluid sampling. Weight and dimensions of the sample are 0.9 kg and 14 x 11 x 6 cm, respectively. Pyrite, chalcopyrite, and other Fe-S metals form the chimney. The sample have anhydrite developed the most inner part of the conduit wall. Green material (Cu-bearing metal) is also observed on the surface.

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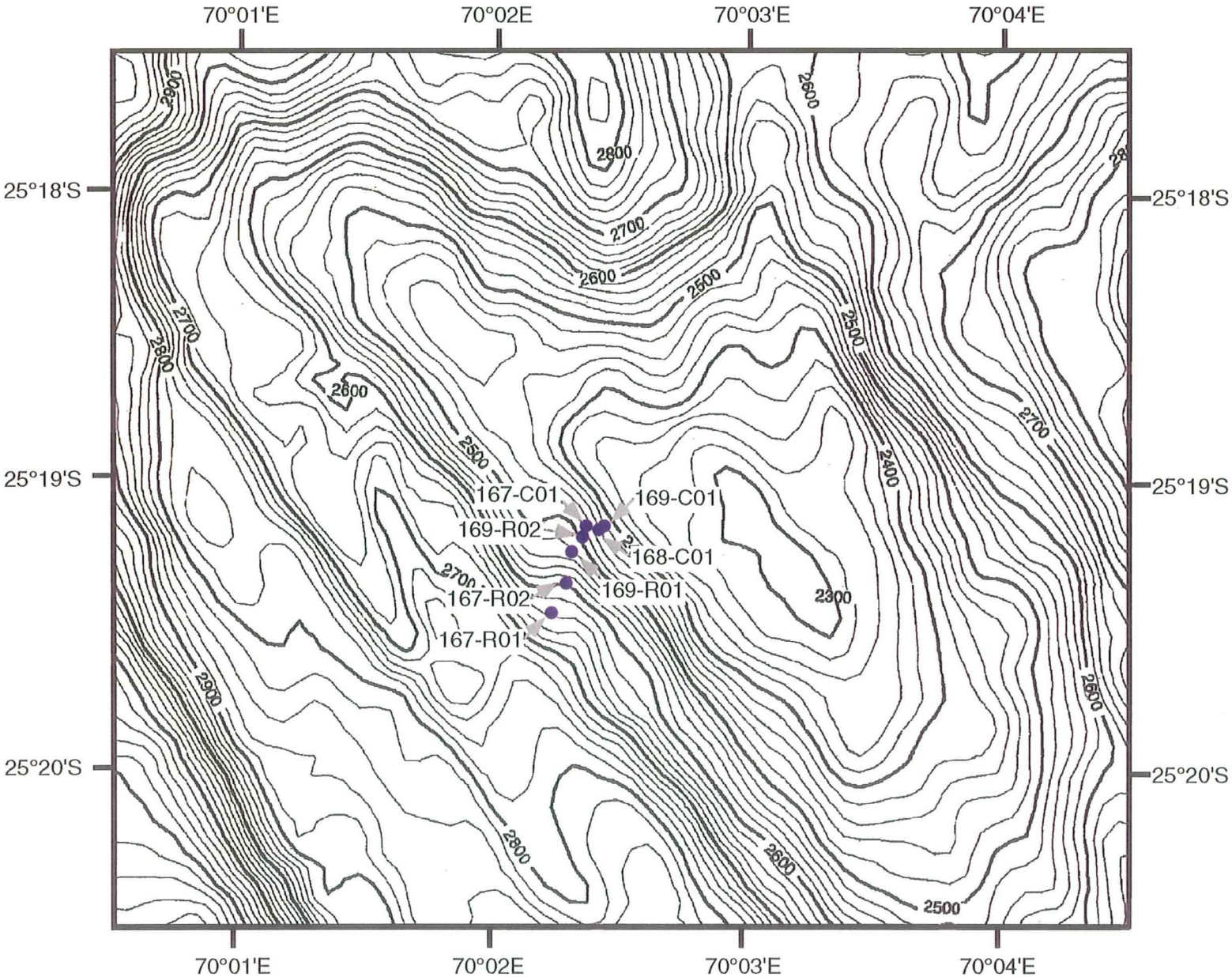

Fig. 4.4.1. Localities of the collected rock and chimney samples.

4. 5. Bathymetric survey (SeaBeam)

The Rodriguez triple junction (RTJ), also called the Indian Ocean Triple junction (25°33'S, 70°00'E), is a place where three mid-ocean ridges meet. This kind of triple junction is called Ridge-Ridge-Ridge (RRR) type. RTJ is a stable at regional scale and existed since at least 65 Ma (Patriat and Segoufin, 1988). The Central Indian Ridge (CIR, 5 cm/y), Southwest Indian Ridge (SWIR, 1.6 cm/y) and Southeast Indian Ridge (SEIR, 6 cm/y) meet at the triple junction. The influence of the SWIR on the CIR is still not well understood; the morphology of the CIR is generally similar to a slow spreading center despite an intermediate spreading rate (Briais, 1995). The bathymetric survey KR00-05 of the R/V *Kairei* aimed at understanding the evolution of the RTJ, and the geological structure of the Indian ridges near the RTJ. Our survey revealed tectonic fabric around the Indian Ocean triple junction.

The French R/V *Jean Charcot* in 1984 and the Japanese R/V *Hakuho-Maru* in 1993 (Honsho *et al*, 1996) surveyed the RTJ. Bathymetric data (Fig. 4.5.1.) obtained during these two cruises expose the topographic feature of RTJ in spite of lack of precision in GPS positioning system. The navigation system of the R/V *Kairei* is a differential GPS (DGPS) system so that better positing data are expected. The main purpose of KR00-05 cruise was the investigation of hydrothermal vents in approximately point 25°19'S - 70°02'E. It appeared that it might be rather to know more precisely the topography around the target site. The Seabeam survey was done around this point during the first night in order to facilitate future tow-yo and deep-tow camera surveys. The map obtained is shown in Fig. 4.5.2.

Bathymetric surveys have been almost done in nights, for 12 to 13 hours (roughly from 17 to 2 o'clock in the morning, local time. See Operation log). Swath width was 2.5 to 5 miles (for 2000 to 5000 m depths) and track lines are shown in Fig. 4.5.3. The data were acquired with a ship speed between 7 and 13 knots, depending on sea conditions. As the data quality was greater, the North orientation was preferred to the South. The best direction for taking data was SSE to NNW; the second one was the WSW to ENE. Winds and roughs was usually SW to NE oriented. With these conditions, an approximately 27765 km box (104' x 77') was surveyed around the RTJ (24°57'S-69°00'E, 26°18'S-69°53'E, 25°38'S-71°10'E, 24°05'S-70°25'E).

The data processing took place in following order:

1. Data were edited by "mbedit" program of the MB-system software.
2. Grid file were created with the "mbgrid" program. The mesh interval was 100 m.

The Seabeam survey took place during 15 nights and a surface of 27765 km^2 was covered (Fig. 4.5.4. and Fig. 4.5.5.). With these data, particular structure can be observed.

(1) The SWIR is the deepest ridge (about 5000 m), and the SEIR is the shallowest (about 4000 m) of the three ridges.

(2) Two non-transform discontinuities (NTDs) are observed. The segment 1 and 2 are offset by the 25°10'S discontinuity and segment 2 and 3 by the 24°30'S discontinuity.

(3) Two segments compose the CIR axial domain of the surveyed area. The first one is started from the RTJ to 25°10'S. The trend is about 150°E and it is about 40 km length. The axial valley is about 10 to 20km width. The segment is symmetrical to the axis. The second one is started from 25°10'S to 24°30'S. It has a parallel direction to the first segment (trend 150°E). It is about 45km length. The axial valley is about 20km width. The segment is asymmetrical to the axis. The western side of the axial valley is deeper than the eastern side.

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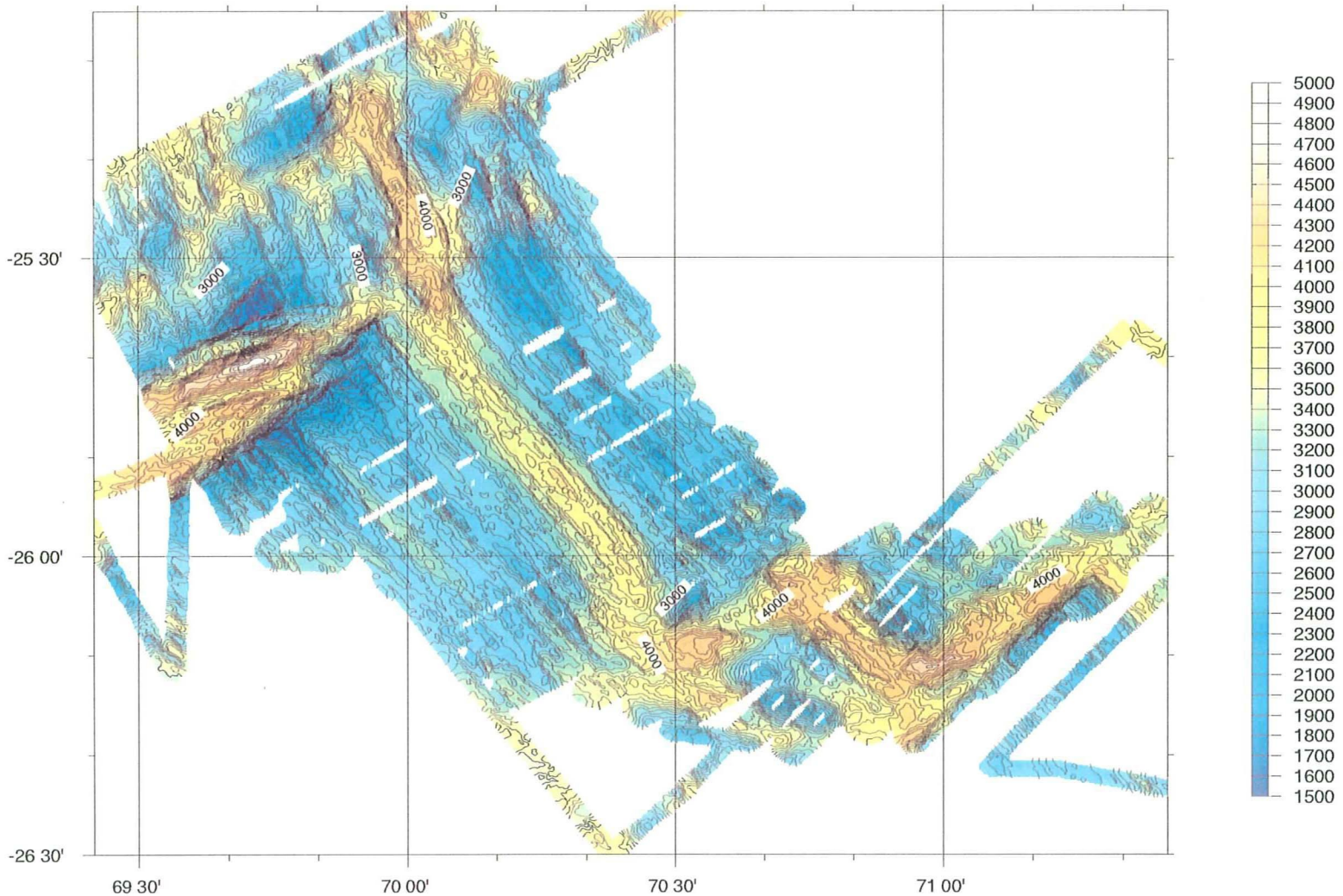

Fig.4.5.1. KH93-3 survey area.

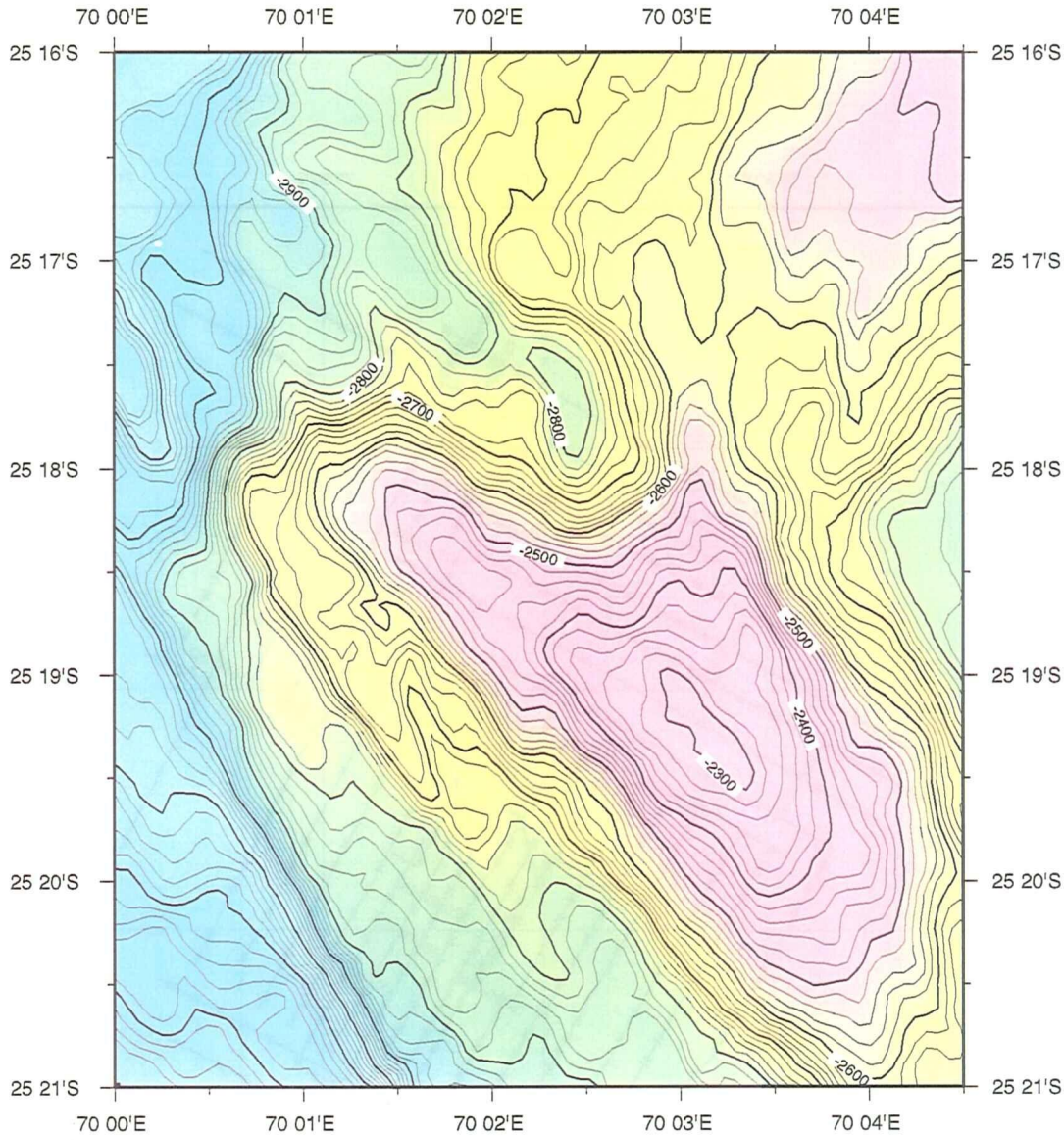

Fig. 4.5.2. Hydrothermal vent site of the KR00-05 cruise.

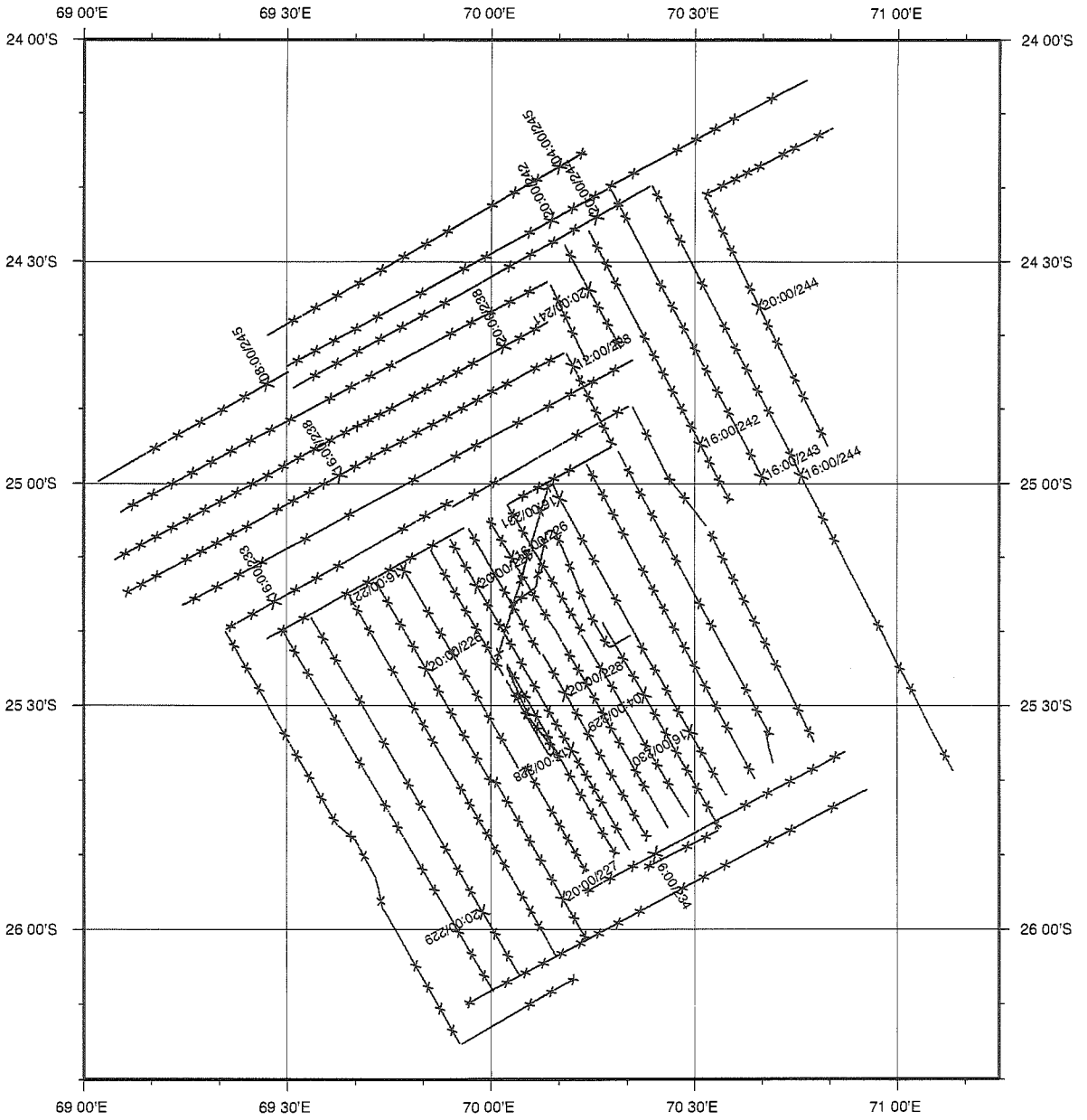

Fig. 4.5.3a. Track lines of the bathymetric survey during the KR00-05 cruise.

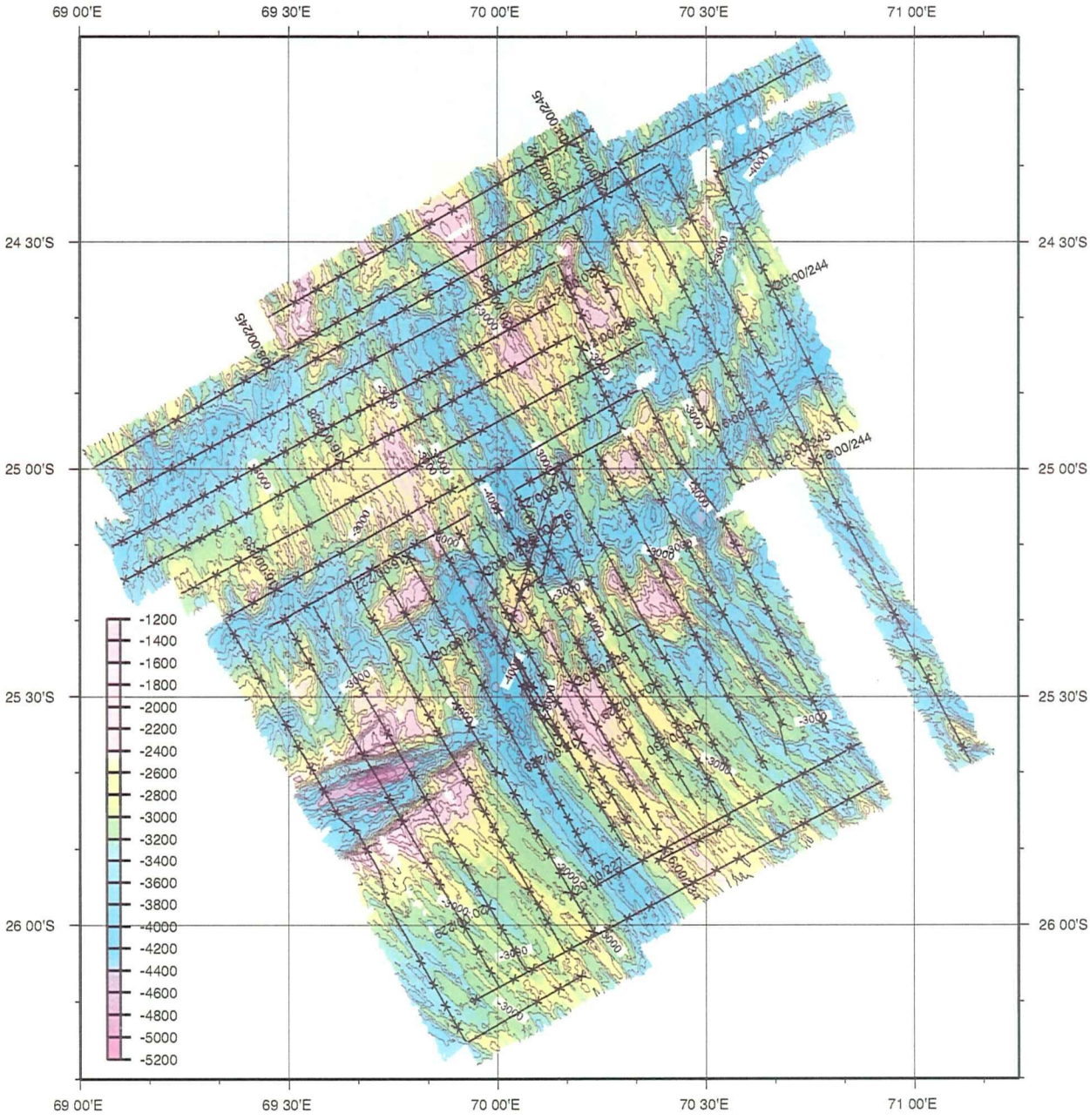

Fig. 4.5.3b. KR00-05 survey area with track lines.

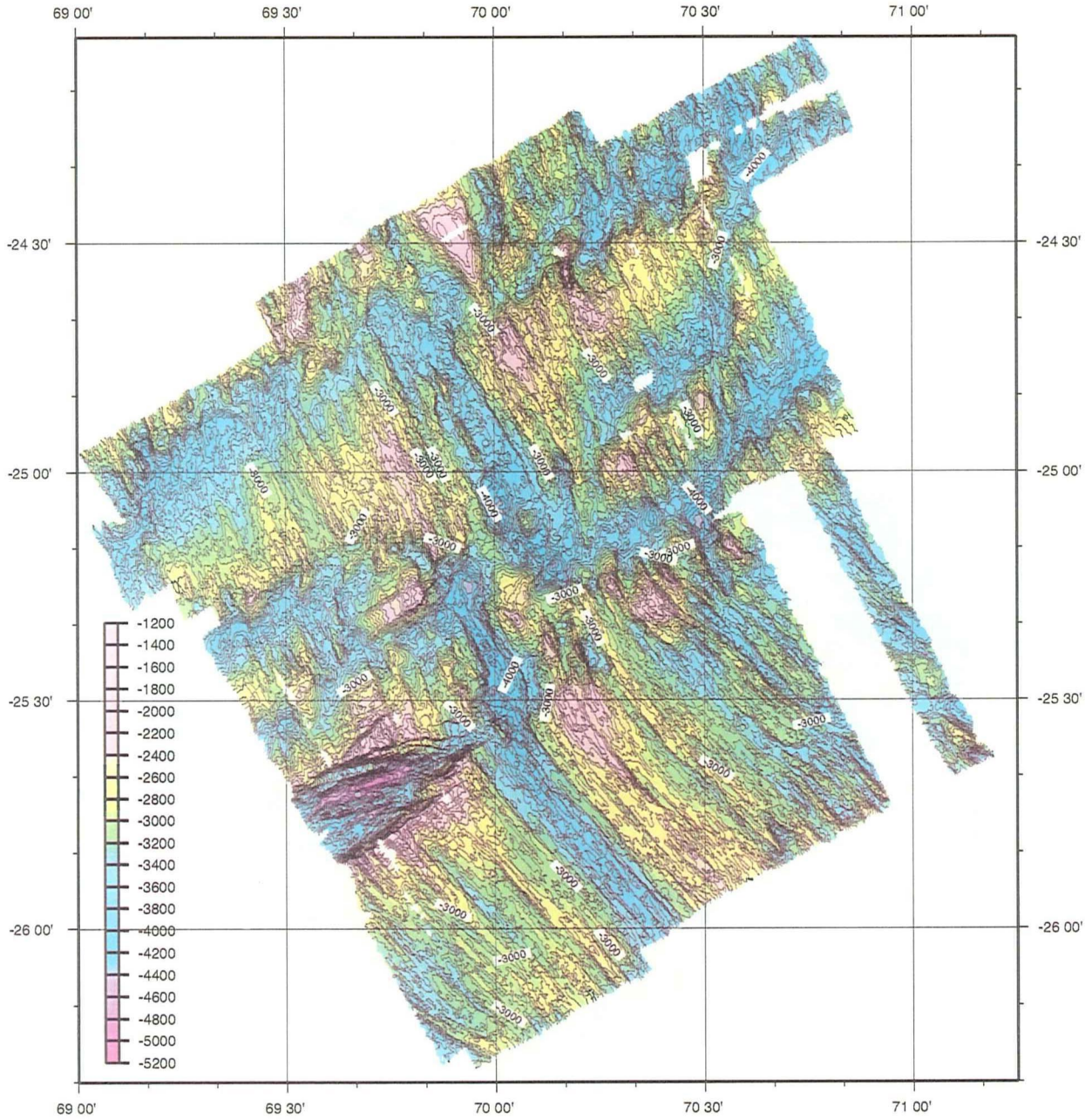

Fig. 4.5.4. KR00-05 survey area.

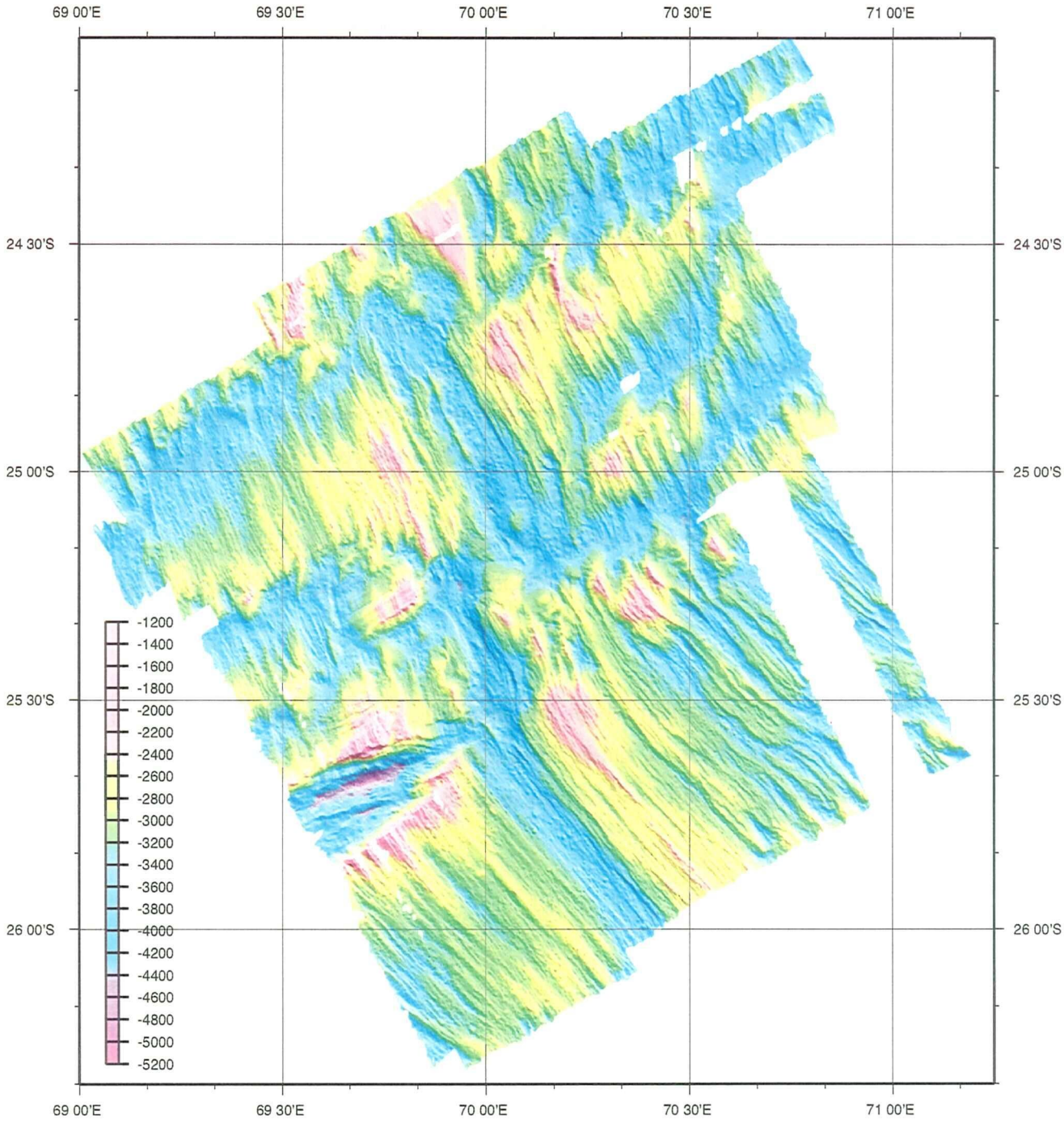

Fig. 4.5.5. Map of KR00-05 survey area with an illumination of 30 deg from the North.

Confidential and Publication Policy

Data and samples obtained during this cruise, most of which are described in this preliminary report, should be treated as carefully as possible, in order to protect the priority of the cruise participants.

Confidential and publication policies are as follows:

(1) No one other than the cruise participants can submit papers, give oral or poster presentation using any data and/or samples of this cruise within 24 months after the completion of the cruise (2 September, 2000).

(2) Although all data and samples of this cruise are common to the cruise participants, primary investigator of each study item has higher priority to use them.

(3) Before submitting papers and/or giving oral or poster presentation using the data and samples, the first author or speaker must send in a notice of the publication to the chief scientist (JAMSTEC) without delay.

(4) No diffusion of data to the press without the permission of JAMSTEC.

(5) Any questions or problems on the publication policy should be forwarded to the chief scientist.

There may be some misprints or mistakes to be corrected later in this report. If any misprint or mistake is found, kindly inform the chief scientist, who is responsible for distributing the cruise report to all the cruise participants.

Future Works

I – General description (immediately after the cruise)

Hashimoto, J. *et al.*

First hydrothermal vent communities from the Indian Ocean discovered (provisional title).

Gamo, T. *et al.*

Chemical characteristics of newly located black-smoker hydrothermal activity and its effluent dispersion at the Rodriguez Triple Junction, Indian Ridge.

Ohta *et al.*,

Kairei hydrothermal vent field and its characteristics.

II – Biology

Hashimoto, J. *et al.*

Deep-Sea mussels collected from hydrothermal vent in the Indian Ocean (provisional title).

Machida, Y. *et al.*

Zoarcid fishs collected from hydrothermal vent site in the Indian Ocean (provisional title).

Miura, T. *et al.*

Scale-worm collected from the Kairei vent site, Indian Ocean (provisional title).

A new scale-worm in mantle cavity of deep-sea mussels in the Indian Ocean (provisional title).

Ohta, S. *et al.*

Nutrition and swarming of the vent-associated rimicarid shrimp (provisional title)

Ohta, S. *et al.*,

Description of the vent -specific rimicarid shrimp collected on he Central Indian Ridge (provisional title)

Okutani, T. *et al.*

A new gastropod belonging to the genus *Alviniconcha* collected from active

vent site of Indian Ocean (provisional title).

Tsuchida, S. *et al.*

First record of Bythograeidae (Decapoda, Brachyura) from Indian Ocean inhabit near hydrothermal vent (provisional title).

Yamaguchi, T. *et al.*

Neolepas sp. nov. (Cirripedia, Pedunculata) from the deep-sea hydrothermal vent of the Indian Ocean (provisional title).

Watabe, H. *et al.*

Rimicaris (Decapoda: Bresiliidae) on the Kairei Hydrothermal Field, Central Indian Ridge: First record of bresiliid shrimp from Indian Ocean (provisional title)

III – Geochemistry

Yamanaka, T. *et al.*

Organic geochamical study of hydrothermal vent sediments from Indian Ocean (provisional title).

Multi stable isotope and biomarker studies of deep-sea mussels collected from hydrothermal vent in the Indian Ocean (provisional title).

Chiba, H. *et al.*

Mineralogy and stable isotopic study of the active hydrothermal chimney at the Kairei hydrothermal field in Central Indian Ridge (provisional title).

IV – Geology

Okudaira, T. *et al.*

Petrologocal characterization of the basalts near the hydrothermal field of Indian Ocean (provisional title).

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Appendix

Survey tracks of the tow-yo and the deep-tow camera

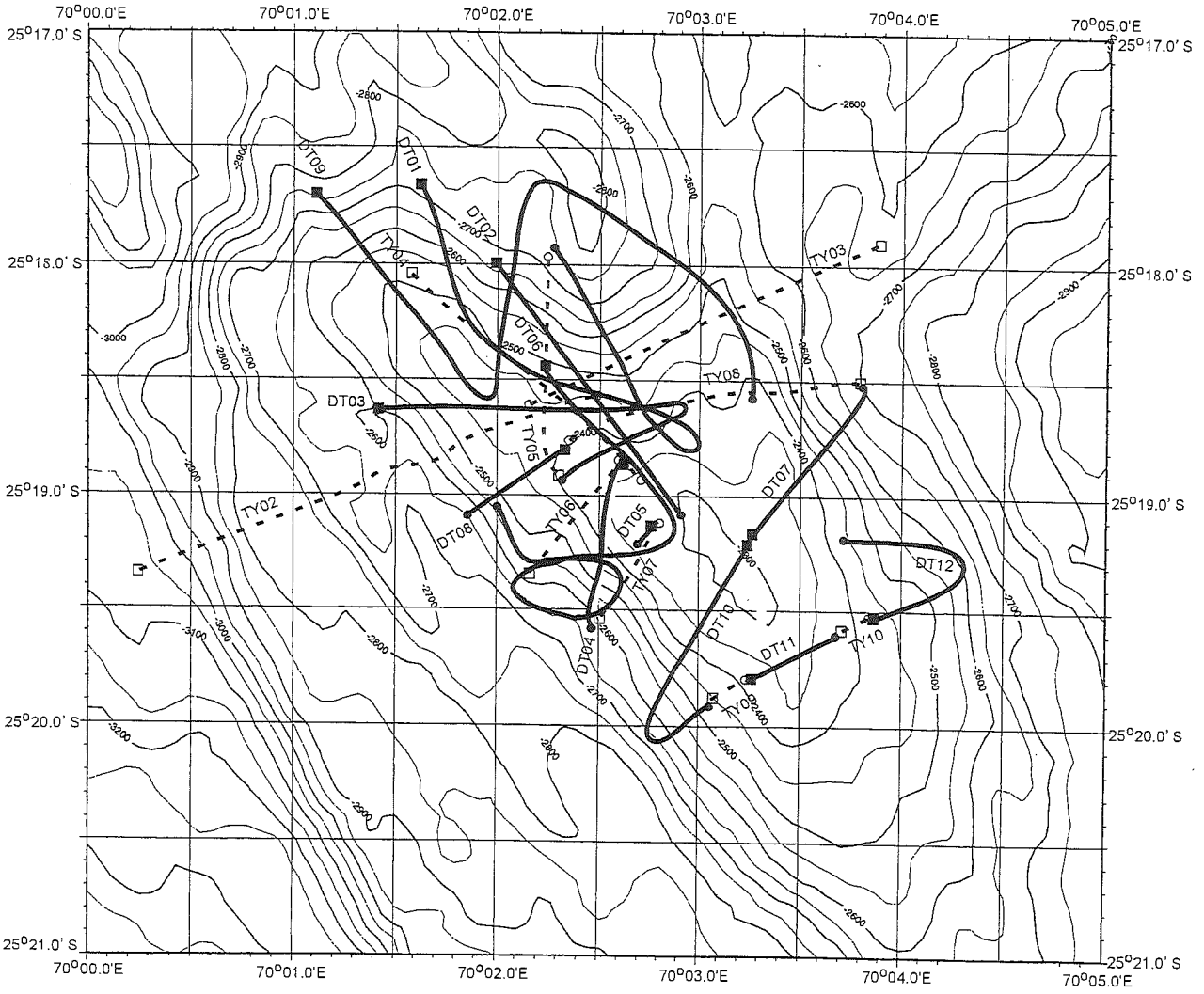


Figure Survey tracks of the tow-yo (broken lines) and the deep-tow camera (solid lines) at the Hakuho Knoll.

Survey tracks of the *Kaiko*

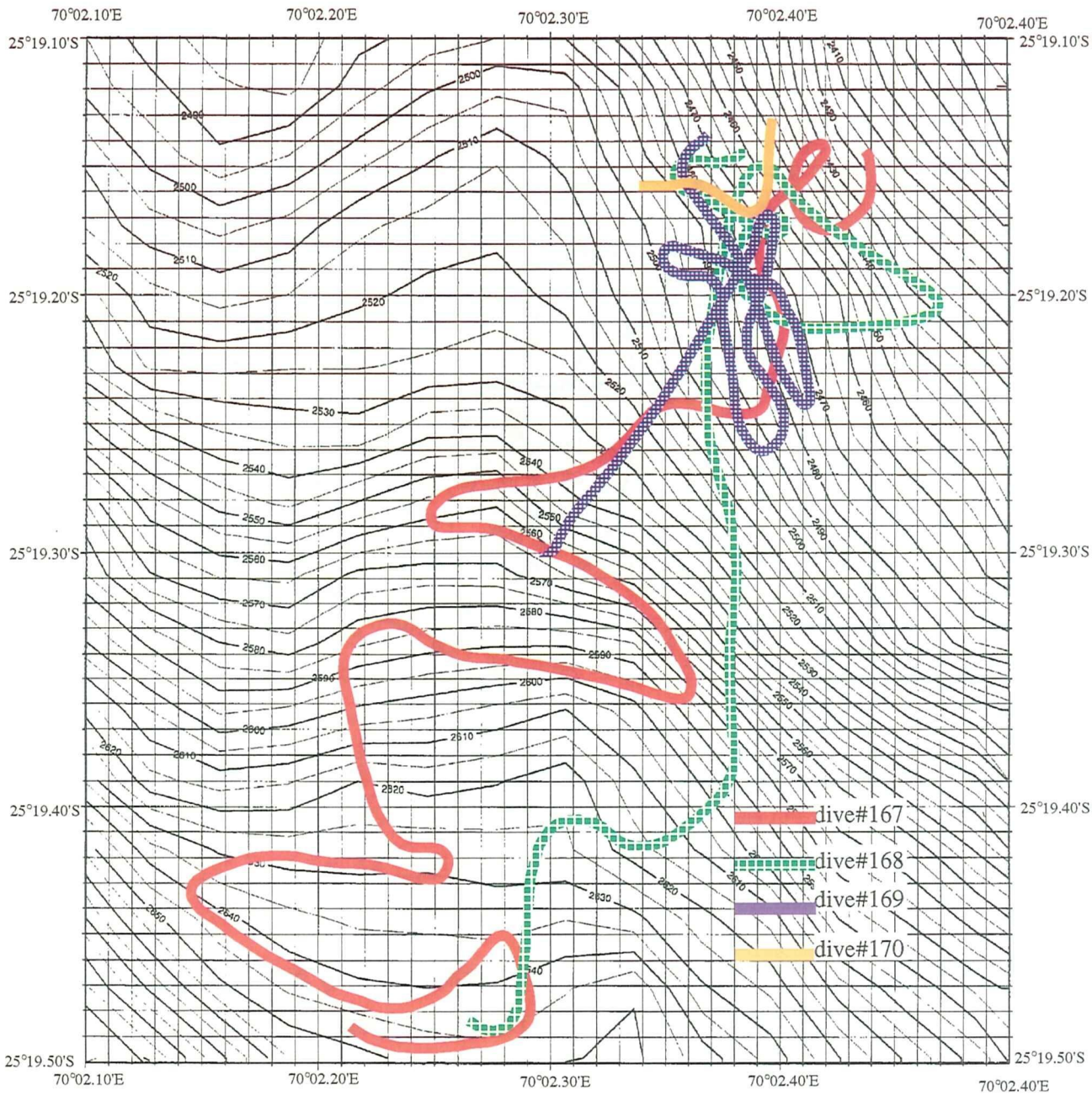


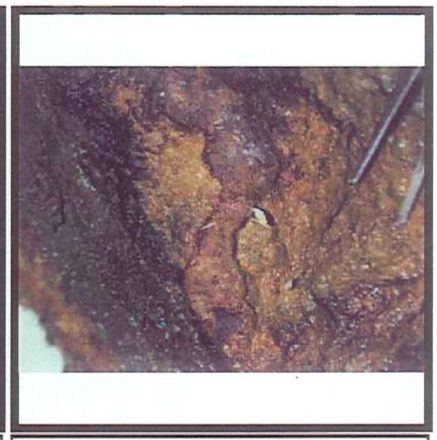
Figure Suevey tracks of the Kaiko near the Kairei Field.

Species Name	No. of Inds.	Tentative Sample No.	Dive No.	Preservation Method	Present Location
Bathymodiolus sp.	1	167-01	10k#167	70%Ethanol fixation	JAMSTEC
Rimicaris sp.	1	167-02	10k#167	70%Ethanol fixation	JAMSTEC
Scalpellum sp.	7	167-03	10k#167	70%Ethanol fixation	Chiba Univ.
Bathymodiolus sp.	4	168-01	10k#168	10% Formalin	JAMSTEC
Actinostolidae? gen. sp. 1	1	168-02	10k#168	10% Formalin	JAMSTEC
Rimicaris sp.	197	168-03	10k#168	10% Formalin	JAMSTEC
Rimicaris sp.	150	168-04	10k#168	-80 deg. C freeze	JAMSTEC
Neolepas sp.	80	168-05	10k#168	100%Ethanol	Chiba Univ.
Chorocaris sp.	100	168-06	10k#168	-80 deg. C freeze	JAMSTEC
Chorocaris sp.	116	168-07	10k#168	10% Formalin	JAMSTEC
Austinograea sp.	3	168-08	10k#168	10% Formalin	JAMSTEC
Neolepas sp.	10	168-09	10k#168	-80 deg. C freeze	JAMSTEC
Neolepas sp.	20	168-10	10k#168	-80 deg. C freeze	Chiba Univ.
Phymorhynchus sp.	5	168-11	10k#168	-80 deg. C freeze	JAMSTEC
Alviniconcha sp.	3	168-12	10k#168	-80 deg. C freeze	JAMSTEC
Zoarcidae gen. sp.	2	168-13	10k#168	10% Formalin	JAMSTEC
Phymorhynchus sp.	15	168-14	10k#168	10% Formalin	JAMSTEC
Actinostolidae? gen. sp. 2	24	168-15	10k#168	10% Formalin	JAMSTEC
Unidentified plankton	many	168-16	10k#168	10% Formalin	JAMSTEC
Alviniconcha sp.	7	168-17	10k#168	10% Formalin	JAMSTEC
Neolepas sp.	7	168-18	10k#168	10% Formalin	JAMSTEC
Melanodrymia? sp.	many	168-19	10k#168	10% Formalin	JAMSTEC
Desbruyeresia? sp.	87	168-20	10k#168	10% Formalin	JAMSTEC
Polynoidae gen. sp. 1	1	168-21	10k#168	10% Formalin	JAMSTEC
Polynoidae gen. sp. 2	1	168-22	10k#168	10% Formalin	JAMSTEC
Branchipolynoe sp.	2	168-23	10k#168	10% Formalin	JAMSTEC
Symmetromphalus? sp.	1	168-24	10k#168	10% Formalin	JAMSTEC
Lepetodrilus? sp.	1	168-25	10k#168	10% Formalin	JAMSTEC
Rimicaris sp.	10	168-26	10k#168	-80 deg. C freeze	ORI, Univ. Tokyo

Species Name	No. of Inds.	Tentative Sample No.	Dive No.	Preservation Method	Present Location
Chorocaris sp.	10	168-27	10k#168	-80 deg. C freeze	ORI, Univ. Tokyo
Bathymodiolus sp.	2	168-28	10k#168	-80 deg. C freeze	JAMSTEC
Rimicaris sp.	6	168-29	10k#168	10% Formalin	ORI, Univ.
Chorocaris sp.	6	168-30	10k#168	10% Formalin	ORI, Univ. Tokyo
Bathymodiolus sp.	11	169-01	10k#169	10% Formalin	JAMSTEC
Bathymodiolus sp.	1	169-02	10k#169	10% Formalin	JAMSTEC
Hesionidae? gen. sp.	7	169-03	10k#169	10% Formalin	JAMSTEC
Unidentified plankton	many	169-04	10k#169	10% Formalin	JAMSTEC
Lepetodrilus? sp.	2	169-05	10k#169	10% Formalin	JAMSTEC
Olgasolaris? sp.	1	169-06	10k#169	10% Formalin	JAMSTEC
Phymorhynchus sp.	1	169-07	10k#169	10% Formalin	JAMSTEC
Bathymodiolus sp.	1	169-08	10k#169	10% Formalin	JAMSTEC
Bathymodiolus sp.	13	169-09	10k#169	-80 deg. C freeze	JAMSTEC
Bathymodiolus sp.	2	169-10	10k#169	-80 deg. C freeze	JAMSTEC
Chorocaris sp.	17	169-11	10k#169	10% Formalin	JAMSTEC

167-01

167-02



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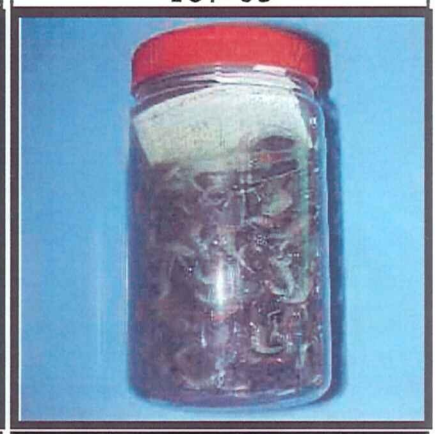

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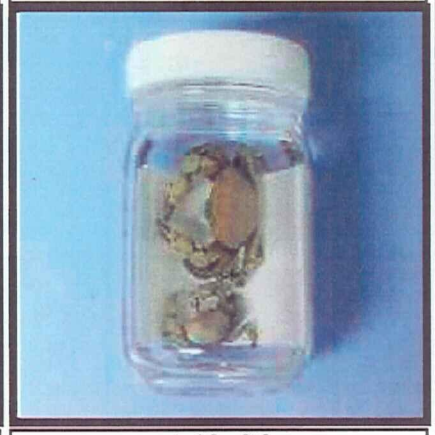

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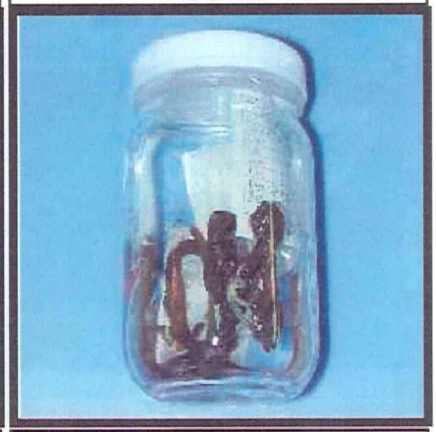

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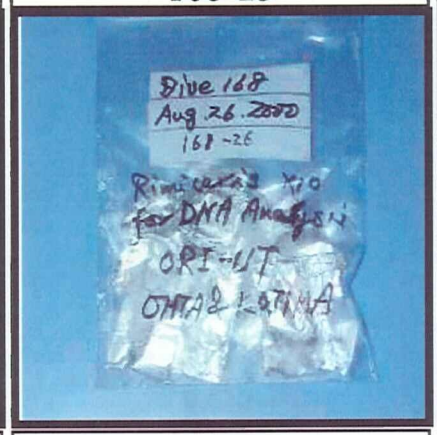

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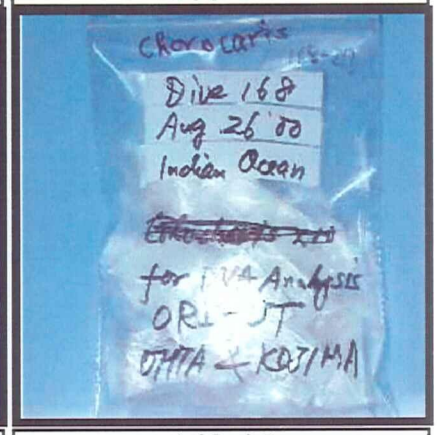

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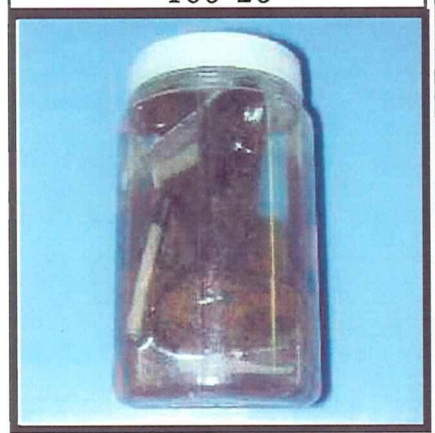

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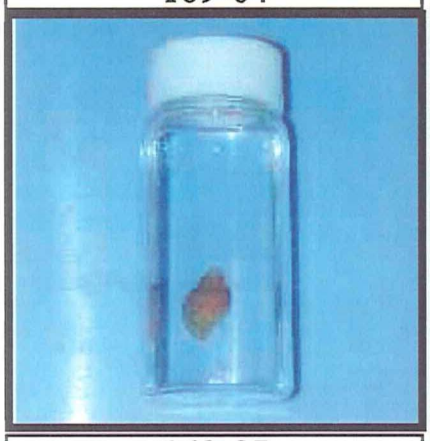

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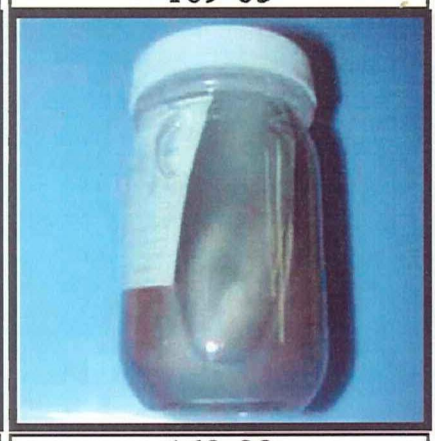

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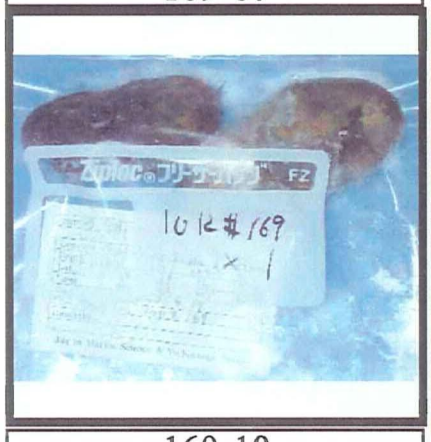

169-10

169-11

List of rock samples

Sample 167-R01

Date: August 25, 2000
Dive no: 10K#167
Location: 25°19.46'S, 70°02.22'E
Depth: 2648 m
Weight: 1.9kg
Dimensions: 15 x 10 x 7 cm
MnO crust: up to 3 mm on top and side surfaces
Lithology: Ol+Pl-phyric basalt
Description: The cut surface shows a up to 3 mm thick altered rim inside the MnO rind. Inside the altered part, fresh gray basalt is recognized. In mantle part of the fresh basalt, some vesicles are developed The fresh basalt contains many olivine and plagioclase microphenocrysts. Any internal structure such as shape preferred orientation of plagioclase are not recognized.

Sample 167-R02

Date: August 25, 2000
Dive no: 10K#167
Location: 25°19.36'S, 70°02.28'E
Depth: 2620 m
Weight: 3.0 kg
Dimensions: 19 x 11 x 10 cm
MnO crust: none
Lithology: altered hyaloclastic or autobrecciated basalt
Description: Many angular clasts (up to 3 mm) of basaltic glasses and white altered basaltic glasses (?) are contained. Greenish mineral (Cu-bearing mineral ?) forms thin (up to 2 mm) layers. These layers are parallel to each others. However, in the hyaloclastic part, any internal structure, such as preferred orientation of the clasts, are not developed.

Sample 169-R01

Date: August 27, 2000
Dive no: 10K#169
Location: 25°19.25'S, 70°02.30'E
Depth: 2528 m
Weight: 2.8 kg
Dimensions: 13 x 12 x 9 cm
MnO crust: None
Lithology: olivine basalt
Description: The cut surface is gray and fresh. There are many olivine phenocrysts and aggregates (up to 10 mm). Subordinate amount of pyroxene and plagioclase phenocrysts are also observed. A faint flow structure formed by preferred alignment of long axis of pyroxene and plagioclase grains.

Sample 169-R02

Date: August 27, 2000
Dive no: 10K#169
Location: 25°19.20'S, 70°02.34'E
Depth: 2482 m
Weight: 14 kg
Dimensions: 37 x 25 x 17 cm
MnO crust: None
Lithology: altered olivine basalt
Description: The cut surface is completely red color. There is no fresh part. Other petrographical features are similar to sample 169-R01.

List of chimney samples

Sample 167-C01

Date: August 25, 2000
Dive no: 10K#167
Location: 25°19.16'S, 70°02.43'E
Depth: 2452 m
Weight: not measured
Dimensions: not measured
Lithology: active chimney clasts
Description: many pieces of active chimney rind

Sample 168-C01

Date: August 26, 2000
Dive no: 10K#168
Location: 25°19.17'S, 70°02.41'E
Depth: 2452 m
Weight: not measured
Dimensions: not measured
Lithology: dead chimney clasts
Description: many pieces of dead chimney rind

Sample 169-C01

Date: August 27, 2000
Dive no: 10K#169
Location: 25°19.16'S, 70°02.36'E
Depth: 2441 m
Weight: 0.9 kg
Dimensions: 14 x 11 x 6 cm
Lithology: active chimney rind
Description: fragment of active chimney rind


KR00-05
祝
インド洋ロドリゲス三重合点海域
The first discovery of the hydrothermal vent at the Rodriguez Triple Junction, the Indian Ocean
熱水噴出孔発見
平成12年8月25日
August 25, 2000
「R/V KAIREI」
「KAIKO」「DEEP·TOW」