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NT08-07 Cruise

Dynamics of submarine eruption of felsic magmas at Myojinsho caldera

Natsushima

Cruise Report

April 3 to April 11, 2008

NT08-07 Leg 1

Research Leader

Taketo Shimano

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

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Cruise Information
Cruise number: NT-08-07
Ship name: Natsushima
Title: Dynamics of submarine eruption of felsic magmas at Myojinsho caldera
Proposal number: S08-56
Title: Dynamics of submarine eruption of felsic magmas at Myojinsho caldera
Period: April 3 to April 10, 2008
Port: Yokosuka (JAMSTEC; April 3, 2008) – Yokosuka (April 10, 2008)
Area: Myojinsho Caldera (Bayonnaise rocks): 31-53N, 139-57E
Dive list: see Chapter 3 for detail
Track line chart: see Chapter 4 for detail

SUMMARY

Submarine volcanic eruption can be highly destructive generating characteristic jets (called “cock’s tail jets”) and base surges in addition to pyroclastic gravity currents. Although some models have been proposed for these phenomena (ex. FCI theory for water-magma interaction), the mechanisms of magma-water interaction and mode of pyroclast deposition on the sea floor are still unclear. We surveyed Myojinsho caldera, 32° N, 140° E, for the second time after the cruise we made in December 2006. The caldera is one of the calderas along Izu-Bonin island arc with an active post-caldera volcano called Myojinsho reef.

We confirmed similar facts as NT06-21 cruise; (1) Myojinsho is a conical edifice whose surface of the slope consists of deposits by gravity currents of pumices at distant farther than 500 m from the vent, and dense angular lava blocks probably as a consequence by cock’s tail jets that accompanied with phreatomagmatic eruptions. (2) The edifice of Myojinsho caldera consists of the alternation of altered lava and pyroclastic layers at deeper part than ca. 500 m bsl, and thick pumice fall and flow deposit that would have been generated by caldera eruption. We also obtained new observation; (1) Deposits outside the caldera also consist of pumiceous materials. (2) The N-S aligned ridge is a chain of pyroclastic cones consisting of scoria, spatter and possibly lavas with some morphological variety.

Samples for petrological and geochemical analyses in the laboratory are obtained, more than 50 rock samples and some sediment samples. Most samples are relatively fresh for whole rock measurement.

要旨

海底火山における噴火活動については，その実態，メカニズムともまだ不明な点が多い．特に海底噴火活動ではマグマと海水との接触によって爆発が起こり，きわめて破壊的な現象が発生することが危惧されるが，この爆発メカニズムや噴出物の堆積過程などについてはあまり調べられていない．本調査航海では，明神礁カルデラにおける２度目の潜航調査である．明神礁カルデラは伊豆小笠原弧にいくつか存在する海底カルデラの一つであり，現在もきわめて活発な活動を続ける後カルデラ火山である明神礁を有する．

本調査の結果，我々は次の点について，前回調査（NT06-21 航海）を裏付ける証拠を得た．（１）明神礁の山体斜面は山頂火口から 500ｍ以内の地域では角張った溶岩片からなる堆積物，500ｍ以遠では軽石からなる重力流堆積物からなり，それぞれ 1952－53 年噴火で確認されたマグマ水蒸気爆発による cock’s tail jet およびベースサージの到達範囲に対応する．（２）明神礁カルデラを有する火山体は水深約 500ｍ以深が変質した溶岩･火砕物の互層，これ以浅がカルデラ噴火によって堆積したと考えられる軽石堆積物からなる．また，次の新たな事実を確認した．（１）カルデラ外側にも軽石からなる堆積物が存在する．（２）カルデラの西方に存在する南北に連なる凸状地形は，数多くの火砕丘ないし割れ目火口列である．

本調査では，本火山のマグマ進化過程を考察するため，岩石学的，地球化学的分析に用いる試料を各潜航地点において採取した（岩石試料 50 試料以上，堆積物試料数試料）．これらは分析に十分な新鮮さであると考えられる．

1. INTRODUCTION

Understanding the mechanism of explosive eruption has been one of the major subjects in volcanology. This topic is now fairly understood for those that occurred on land; for example, degassing of magma during ascent in a conduit controls the eruption style. However, the fundamental processes that control degassing and how deep they work during the course of an eruption is still not clear. In addition, how effusive eruptions and explosive eruptions could result from similar magma is not well understood. Explosive eruptions have also resulted from the sudden large volume expansion of seawater due to magma-water interactions. These processes can be highly destructive and can generate jets (called "cock's tail jets") and base surges. Some models have been proposed for these phenomena (ex. FCI theory for water-magma interaction). However, the mechanisms of magma-water interaction and mode of pyroclast deposition on the sea floor are still not well understood.

In addition, the mechanisms associated with caldera-forming eruption in the sea are much less understood. These types of eruptions occur rarely (There have been almost no direct observations), but they are known as some of the most violent and destructive and can generate large scale pumice falls, pyroclastic flows and surges, and tsunamis. Although the deposits on land associated with caldera-forming eruptions (including subaqueous) are documented in detail due to their well-preserved and accessible exposures, the counterparts in the deep sea have not been well investigated.

The evolution of the edifices and magmatic systems for these caldera forming-volcanoes is one of the topics that should be investigated to better understand how magma ascends from depth and resides at shallow level in the crust. Recent topographical mapping by Sea beam scanning in the Izu-Bonin arc revealed many submarine calderas which consist of several topographical peaks around each caldera in this area. So the investigation of stratigraphy with its petrological evolution and the correlation among these calderas should give constraints on the evolution of submarine calderas in this island arc.

In this research project of Myojinsho caldera and related volcanic features, three main subjects to be investigated; (1) the dynamics of recent eruptions, (2) the dynamics of its caldera forming eruption, and (3) the evolution of both the Myojinsho volcanic edifice and the magma whose eruption caused the caldera to form. In the following sections, the objectives of each of these topics are described.

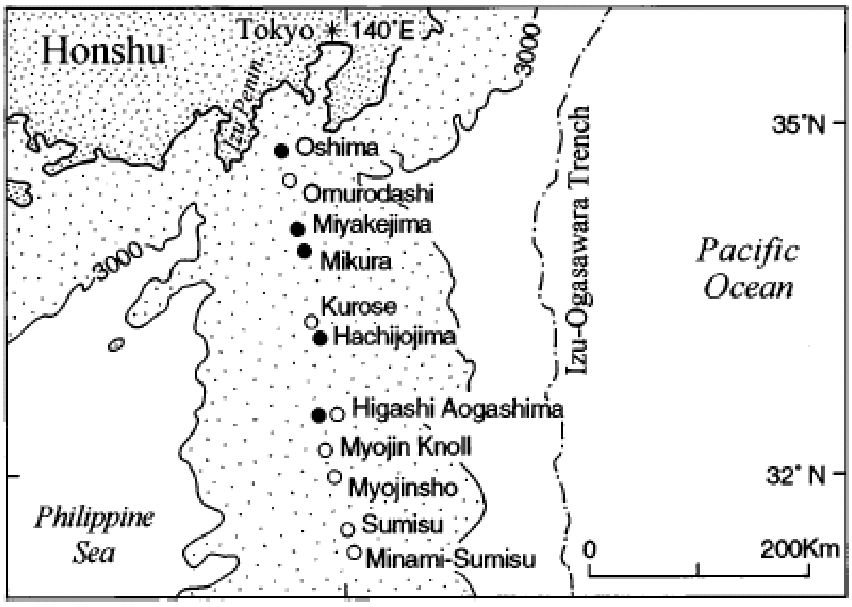


Fig. 1-1 Locality map of the Izu-Bonin arc front showing islands and submarine calderas near Myojinsho caldera (after Fiske et al., 1998)

Myojinsho, or Myojin reef, is situated ca. 600 km south of Tokyo (Fig. 1-1), and is one of the several submarine peaks surrounding Myojinsho caldera. Myojinsho is at the eastern rim of the caldera. The topography of Myojinsho edifice is highly symmetrical cone whose slope angle is almost identical for all directions (Fiske *et al.*, 1998). The shape of the caldera is elongated to E-W direction with diameter of ca. 12 km and ca. 8 km, for longitudinal and latitudinal direction, respectively (Fig. 1-2). Another famous peak, Beyonnaise rocks, is above sea level and located at the western rim of the caldera. At the center of the caldera, there is a hill or central edifice on the flat caldera floor at depth of ca. 1100 m bsl (below sea level). The central hill has a flat top surface which declines eastwards.

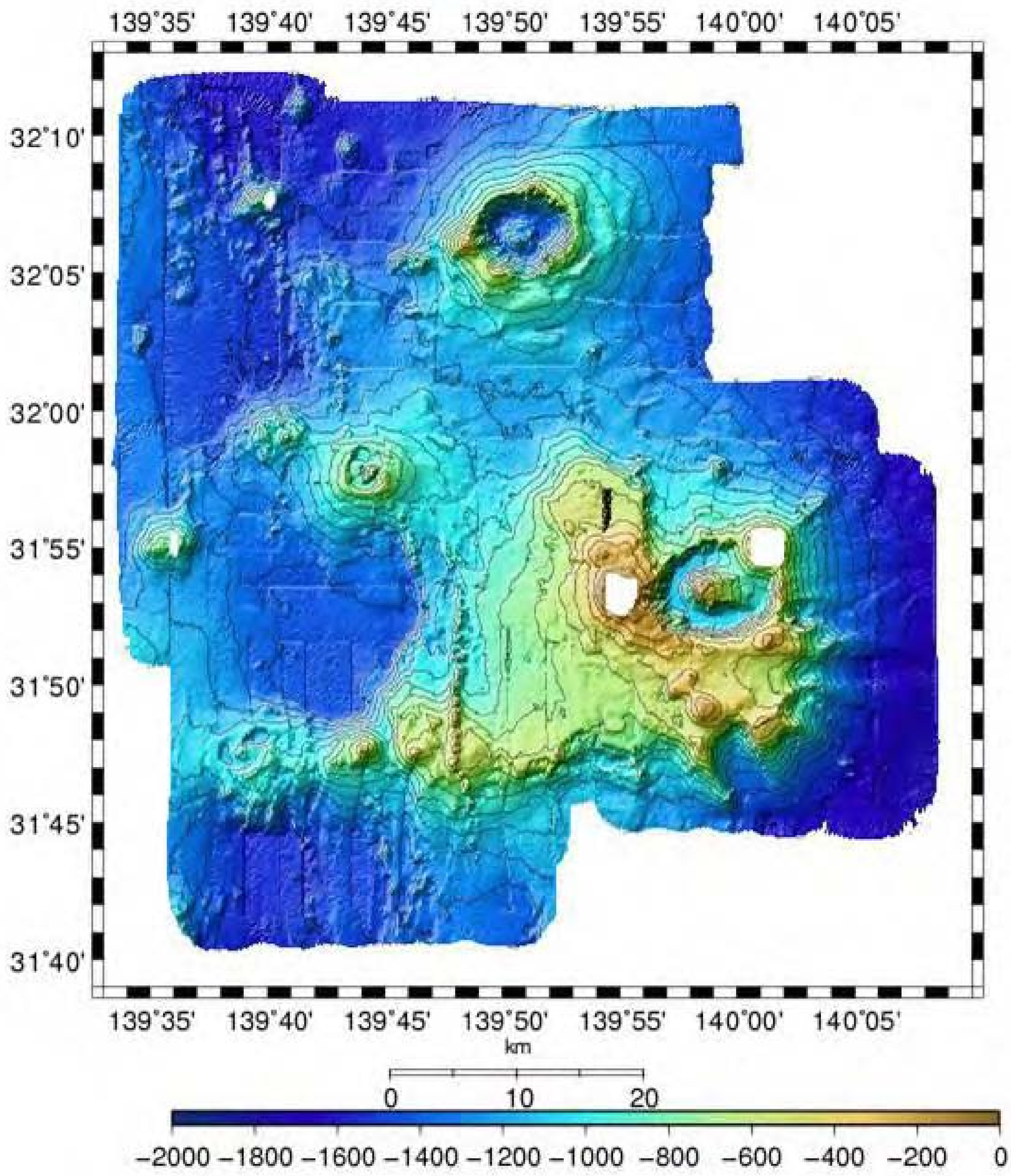


Fig. 1-2 Topographical map near Myojinsho caldera (Tamaki et al., unpublished data). Myojinsho caldera is at 31-53N, 139-57E (WGS84). The 10-km diameter submarine caldera at Myojin Knoll at 32-07N, 139-52E.

Year	Reported location	Comments
1869	?	Submarine eruption
1870	?	Submarine eruption, new island
1871	?	Submarine eruption
1896	Approximately 8 nautical miles north of Bayonnaisse Rocks	New island forms and then disappears
1906	9 nautical miles northeast of Bayonnaise Rocks	Eruption columns, floating pumice
1915	Approximately 6 nautical miles east of Bayonnaise Rocks	Submarine eruption, eruption columns, discolored water
1934	Approximately 5.5 nautical miles east of Bayonnaise Rocks	Submarine eruption, discolored water, smell of sulfur
1946	31°57′N, 140°01′E	Dome eruption builds new island, which then disappears
1952–1953	Myojinsho	Many explosive eruptions; three cycles of island growth and destruction
1954	Myojinsho	Submarine eruption
1955	Myojinsho	Submarine eruption
1957	Myojinsho	No known eruption, but dead fish found floating nearby
1960	Myojinsho	Submarine eruption; subaerial eruption column rises to 2000–3000 m
1970	Myojinsho	Submarine eruption, discolored water, floating pumice
1971	Myojinsho	Discolored water
1979	Myojinsho	Discolored water
1980	Miyojinsho	Discolored water
1982	Myojinsho	Discolored water
1986	Myojinsho	Discolored water
1987	Myojinsho	Discolored water
1988	Myojinsho	Discolored water

Table 1-1 Representative recent eruptions at Myojinsho volcano (after Fiske *et al.*, 1998)

1-1. Dynamics of recent eruptions at Myojinsho

The Myojinsho volcano is one of the most active submarine volcanoes in Japan. Some eruptions had been witnessed by fishermen since 19th century, and it became famous when many crews of a ship of Japan Coast Guard were killed by explosions during the 1952-53 eruption. The eruption is characterized by the alternation of dome formation and its collapse accompanied by energetic phreatomagmatic eruptions. The lava dome morphology changed from rubbly lava in early 1952 to spine-like features from October 1952 to October 1953. Some explosion events are investigated during eruption and the pressure sources of the explosions were estimated by using this information. Fiske *et al.* (1998), using bathymetric data, proposed a model of the mode of emplacement for the products of the eruption; Large dense blocks and pumices ejected into water traveled down the slope in density currents. In contrast, pumices ejected in the air floated and were dispersed widely, or descended as vertical density currents as a consequence of hyperconcentrations when large volumes of tephra fell to the sea surface. There are some reports on discolored seawater and floating pumices in 1970-80's. As the locality of this area is far from the mainland of Japan, however, many small-scale eruptions might have occurred more recently.

In this cruise, we are planning to study the slopes of Myojinsho. In addition, detailed bathymetric data have been obtained recently around this area (Fig. 1-1). From direct observation of the topography and internal structures of the deposits, we will discuss the mode of emplacement of pyroclastics on the slopes of submarine volcano, accessing the model of Fiske *et al.* (1998). We are also planning to survey the summit area and to investigate present-day activity that might be taking place.

We will also collect samples from recent eruptions. Shimano and Nakada (2006) investigated vesicular texture of submarine scoria from the submarine fissure formed during the 2000 eruption at Miyakejima volcano in Izu-Bonin arc. These scorias have identical composition (basalt), but have different densities

Stage I (most observations made during this stage)	
16 Sept 1952	Eruption (and explosions) begin; tsunamis recorded at Hachijo Island (130 km away); SOFAR signals received in California
17 Sept	Eruption first observed by crew of fishing boat "No. 11 Myojin-maru," whose name was given to the volcano. Numerous small explosions; island emerges from sea
18–23 Sept	Numerous explosions, island persists
24 Sept	Large explosion at 0540 JST; island destroyed. Survey ship No. 5 Kaiyo-maru cruises above submerged volcano summit and is destroyed by large explosion at approximately 12:20 JST
Stage II (intermittent observations only)	
25 Sept–10 Oct	Numerous explosions from submerged volcano summit; eruption columns repeatedly rise into the air
11 Oct	New dome growth builds island
12 Oct– 10 March 1953	Numerous explosions; island persists
11 March	Perhaps the largest explosion of the eruption; island is destroyed
Stage III (intermittent observations only)	
12 March–3 April	Numerous submarine eruptions; many subaerial eruption columns noticed
5 April	New island observed
14 April–17 Aug	No explosions observed; island perists
18 Aug–1 Sept	Numerous large explosions; subaerial eruption columns noted; island persists
3 Sept	Continuing explosions; island destroyed; breakers on sea surface mark position of former island
16 Sept–5 Oct	No island visible; minor steaming and discolored water

Table 1-2 The sequence of the 1952-53 eruption (after Fiske *et al*., 1998).

(vesicularity) and groundmass water contents with certain systematics (less vesicular scoria contains more water). The results of these textural analyses show that vesiculation proceeds by nucleation dominantly with minor growth of bubbles, and when vesicularity exceeds ~ 0.5, vesiculation mode changes to growth dominant. Detailed textural investigation shows that bubble coalescence occurred significantly at vesiculariy ~ 0.5. This is the first observation that the mode changes with vesiculation for basaltic magma, and shows that vesicle coalescence is an essential process to promote degassing of magma. As in this example, pyroclasts that quenched at different times provide snapshots of vesiculation so that we can discuss vesiculation processes, and we are expecting low density pumices collected on this cruise to early-stage vesiculation to reveal insights about silicic magmas.

1-2. Dynamics of caldera forming eruption at Myojinsho Caldera

There are many submarine calderas in the Izu-Bonin island arc. Among them, Fiske *et al.* (2000) proposed, for Myojin Knoll caldera, that most pumices ejected from the caldera sank and formed caldera-fill deposit because the volcano is deep in the sea and large volumes of pumices ingested seawater rather than air as magmatic steam condensed. Manned submersible observations showed that much pumice was deposited along the caldera rim.

In contrast, Tani *et al.* (2007) investigated the deposits of Sumisu Caldera. There, the eruption column rose high into the air. Magmatic steam filling the vesicles thus quenched in the air, causing air (rather than seawater) to be ingested; these pumices floated when they fell back to the sea surface. These workers interpreted that much pumice floated for long periods of time and was deposited far from the volcano. They also showed that only minor amounts were deposited along the caldera rim. They concluded that this is because the caldera rim was near sea level and this had an important influence on pumice dispersal patterns.

Myojinsho Caldera is at relatively shallow depth (<1000 m) but it is deeper than Sumisu calderas. Thus, some of the pumices produced during the Myojinsho's caldera forming eruption may have floated but probably not as extensively as those of Sumisu caldera. In this research cruise, we will search for the essential pumices of Myojinsho's caldera-forming eruption. We will then correlate the pumices at several localities and attempt to define their areal distribution.

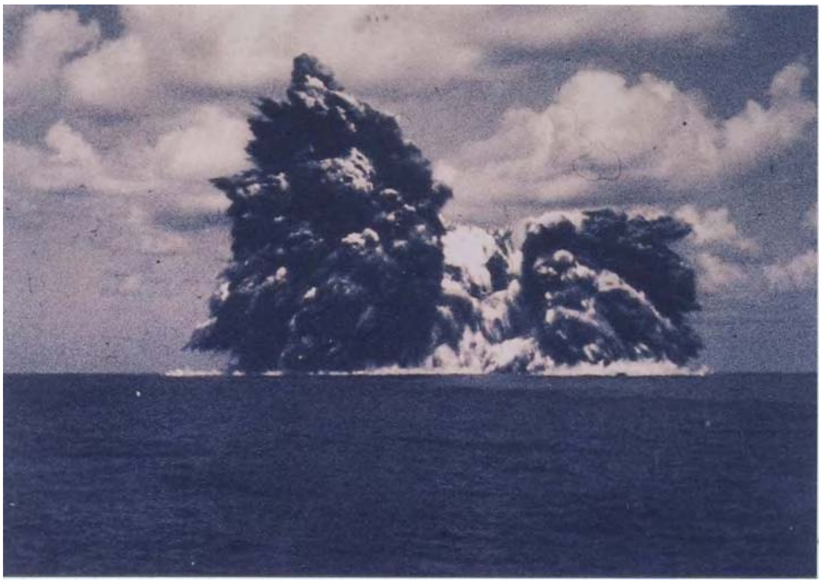


Fig. 1-3 The phreatomagmatic explosion on September 23, 1952 (after Ossaka, 1991).

1-3. Evolution of volcanic edifice and magma at Myojinsho Caldera

Myojinsho caldera volcano consists of several older edifices whose summits lie below sea level; one of these, however, is above sea level and is called Beyonnaise rocks. There are many caldera volcanoes in Izu-Bonin island arc, and they have some similarity in topography. They consist of several edifices with topographical peaks around the main caldera. The chemistry of the rocks Making up these caldera-forming volcanoes seem to have similar variation, although additional data are needed. As one of the examples, Tani *et al.* (2007) showed the stratigraphical relationship of the edifices of Sumisu caldera and defined three stages of its evolution history; (1) stratovolcano stage, (2) caldera forming stage, and (3) post-caldera stage. They also suggested systematic change in chemistry with the edifice evolution. At the stratovolcano stage, basaltic and dacitic magmas were dominant. At the caldera forming stage, large amount of rhyolitic magma was ejected as pumices. Then, during the post-caldera stage, lava domes grew around the caldera.

Regarding the evolution of the Myojinsho volcano, we observed three major facts during the first cruise, NT06-21-leg2-2. (A) The lower part of the caldera wall (ca. 500-1100 mbsl) consists of stratified successions of altered lava and volcaniclastic deposits. (B) The upper part of the wall consists of pumice fall and flow deposits (ca. 500-200 mbsl). (C) At least lower part of the edifice at the center of the caldera consists of very similar sequence to that of caldera wall. (A) and (B) show that the upper pumice deposits are the essential materials produced during the caldera-forming eruption, and that the lower altered rocks make up part of the pre-caldera edifice of the volcano. (C) is inconsistent with the idea that the central edifice is a post-caldera cone, and indicates that the edifice may be a criptdome formed after the caldera-forming eruption.

In addition, we found a very unique chain of conical seamounts during the cruise NT06-21 that has a trend of N-S direction to the west of the caldera, and the formation of such kind of structure may have some relation with the evolution of Myojinsho caldera.

In this cruise, we are planning to survey the caldera wall at some localities, especially northern and outer part of the caldera, to confirm the evolution history of Myojinsho caldera. We will also have dives into the topographic chain with N-S trend to investigate its mode of formation. The SCS survey will also provide constraints on the structure of the deposit near the seafloor. We will collect rock samples to investigate chemical evolution of the magmatic system at Myojinsho caldera.

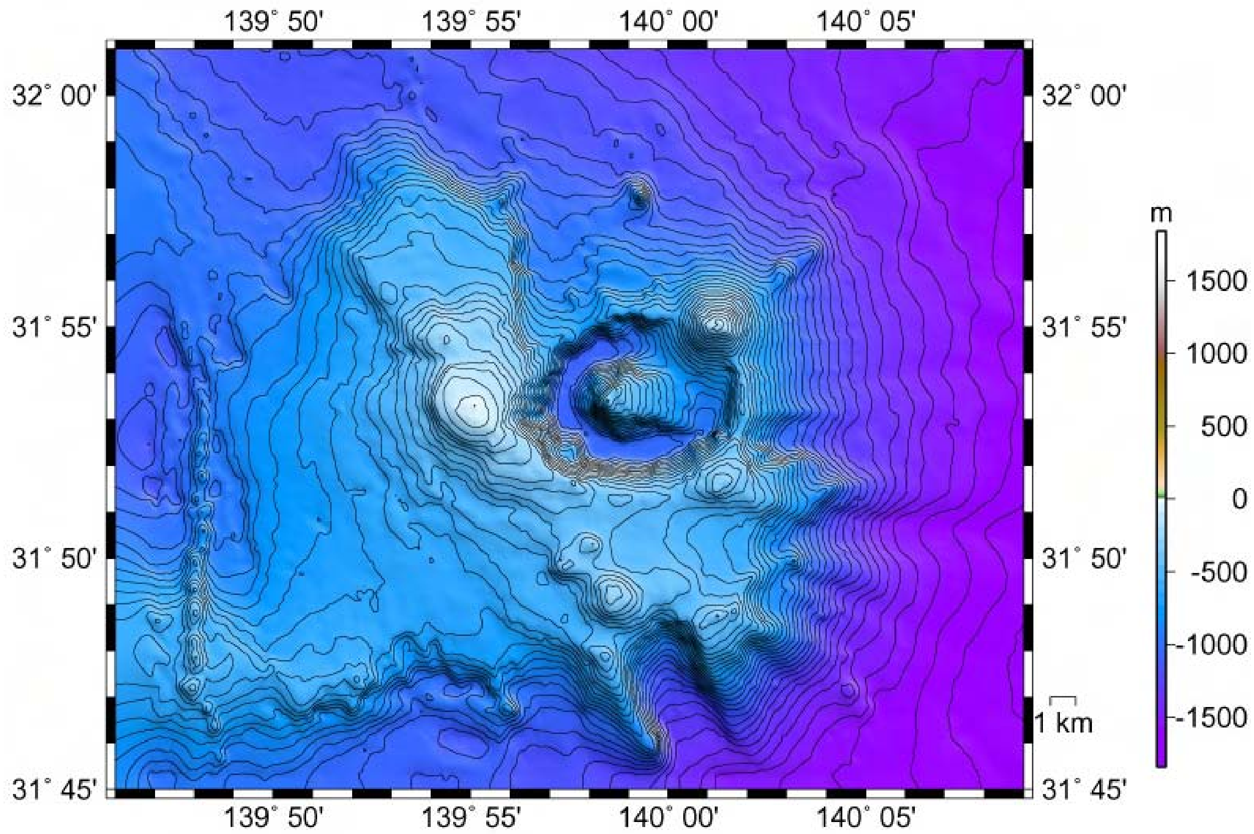


Fig. 1-4 Topographic map of Myojinsho caldera (Japan Coast Guard, 2000).

2. PAYLOADS AND OPERATIONS

2-1. Scoop

Samples of loose pyroclastic materials are collected by manipulator using a steel scoop in Fig. 2-1. To collect a sample, the scoop is held by its handle (yellow), and dragged along the sea floor rotating the wrist of the manipulator. Scooped samples are poured into box or cylinder with cap to prevent lost during ascent to the sea surface.

Fig. 2-1 Scoop

2-2. Stand-Alone Heat Flow meter (SAHF) measurements

The Stand-Alone Heat Flow meter (SAHF; Fig. 2-2) is designed to measure heat flow from manned submersibles or ROVs. Five thermistors are situated within the probe at 11 cm intervals. Since SAHF takes measurements as an “OFF LINE” system, heat flow can be measured while the observer is conducting other tasks at that position or elsewhere. While Hyper-Dolphin (HD) is descending or ascending, SAHF is inserted into a case beside the sample basket. After HD lands on the seafloor, SAHF is grasped by the HD’s left manipulator and takes a reference water temperature for 5 minutes. SAHF is then pushed vertically into the sediment and the temperature gradient is measured for 20 minutes. Thermal conductivity data is necessary to obtain a heat flow value, which is not available on current SAHF. We measured thermal conductivities after the cruise from the sediments sampled simultaneously using push-cores and MBARI-type cores from nearby (<1 m) sites. The following are descriptions of SAHF.

Material	Titanium alloy
Weight	4.0 kg in air, 2.6 kg in seawater
Length of pressure case	294 mm
Diameter of pressure case	85 mm
Length of probe	600 mm
Diameter of probe	13.8 mm (filled by silicon oil inside)
Number of thermistors	5
Intervals of thermistors	110 mm
Accuracy	0.01 °C
Resolution	0.001 °C
External Interface	RS232C (9600bps, 8bit, Non-parity, 2 stop-bit)

Fig. 2-2 Stand-Alone Heat Flow meter (SAHF)

During the NT08-07 Leg 1 cruise, two heat flow measurements were conducted using the SAHF probe. One measurement was made during Dive HD815 on the floor of Myojinsho caldera, and the other during Dive HD817 at the western foot of the N-S seamount chains.

2-3. SEABAT bathymetric survey

Bathymetric data were obtained by a hull-mounted multi-narrow beam mapping system SEABAT 8160 aboard R/V Natsushima. The SEABAT system has hydrophone arrays that synthesize narrow, fan-shaped beams. The width of the sea floor mapping in a single swath is generally ca.0.7 times the local water depth, and the resolution of the depth measurement is generally within 0.25 % of the water depth. The SEABAT system can collect up to 126 soundings on each ping cycle over depths varying from 10 to 3,000 meters, providing swath width coverage up to 150°. The ship speed was kept below 8 knots (against water) during the SEABAT survey. In measurement of bathymetry, one of the important parameters is the sound velocity profile of the local water column. We calculated the sound velocity profile onboard, using a temperature profile based on in-situ XBT (Expendable Bathythermograph) measurements.

2-4. Single-Channel Seismic (SCS) survey

The single channel seismic (SCS) system is comprised of a generator-injector (G.I.) air gun as a seismic source, a streamer cable as a receiver, controllers for firing and data processors. The seismic source consists of two parts, pressurized air supplied from two air compressors (total 1785 psi); the 45 / 105 cu in. generator (G) creates the primary seismic pulse, and the 105 cu in. injector (I) controls bubble oscillation. The GI gun was towed ~30 m aft, port side, at a depth of 2 m. Seismic waves were received by an analog streamer filled with mineral oil. The streamer has a 47 m active section with 48 hydrophones and was towed 135m aft, starboard side, at a depth of 3 m (Fig. 2-3). Received seismic data are monitored with an on-line processing system and recorded digitally in SEG-Y format. The system was operated at a ship speed of 3.2-3.5 knots (against ground), with shot intervals of 10-14 seconds.

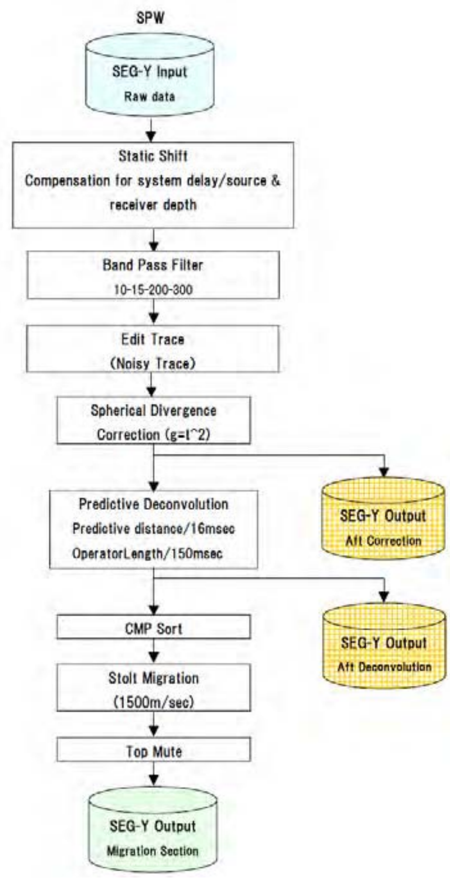


Fig. 2-3 Processing flow of SCS survey

The single channel seismic survey equipment and specification is as follows.

Streamer

Manufacturer S.I.G
Active section length 47m
Hydrophone Interval 1m
Type of Hydrophone S.I.G.16
Hydrophone output -90 dB,re 1V/μbar,±1dB
Frequency flat from 10Hz to 1000Hz
Depth sensor Yes
Preamplifier gain 39
Lead in cable 135m
Receiver depth 4.0m[scs-a-1], 3m[scs-b-1], 3.5m[scs-b-2]

Source

Manufacturer Sercel
Type of airgun GI-Gun
Volume 45(G)+105(I)cu.in
Air pressure 14MPa
Source depth 2m
Depth sensor None
Gun Controller GI-01

Air Compressor

Manufacturer Service Eng.Ltd.
Type of machine 4S30A-150K
Air supply Capacity 2m3/min.

Recording System

Manufacturer TRITON ELICS
Type of system Delph Seismic
Monitor EPC The model GSP-1086 Printer
Recording format SEG-Y Int.
Recording length 7.0sec
Single Channel Seismic Equipment and Survey Specification
Water Delay None
Sample rate 1msec
High cut filter None
Low cut filter None
Recording media HD

GPS System

Manufacturer Fugro
Type of system SkyFix
DGPS Reference Station Okinawa

GPS System

Manufacturer MARIMEX JAPAN
Type of system NAVLOG

Shot Point Geometry

Time mode shooting 10.0sec

Geodetic Parameter

Spheroid WGS84
Semi-major Axis 6,378,137m
Inverse Flattening 298.26
Projection U.T.M
Zone 54

Table 2-1 Line list of single-channel seismic survey

NME SINGLE CHANNEL SEISMIC SURVEY LINE LIST NT08-07

Line No.	Date (UTC)	Time (UTC)	Passing Point	Shot No.	Vessel Position Lat.		Lon.		Length [m]	Direction [deg]	Remarks
scs-a-1	2008/4/5	12:21:50	F.G.S.P	1	31-51.9920	N	140-04.5308	E	42502.5	289.6	
	2008/4/5	19:20:50	L.G.S.P	2503	31-59.5502	N	139-38.8742	E			
scs-b-1	2008/4/6	9:28:00	F.G.S.P	1	31-47.7770	N	139-41.3490	E	33136.8	90.5	
	2008/4/6	15:00:35	L.G.S.P	1987	31-47.7959	N	140-03.1364	E			
scs-b-2	2008/4/6	15:12:40	F.G.S.P	1	31-47.7976	N	140-02.9940	E	51320.6	331.2	Cross point[scs-a-1]:SP705
	2008/4/6	23:03:04	L.G.S.P	2811	32-10.0696	N	139-48.2960	E			

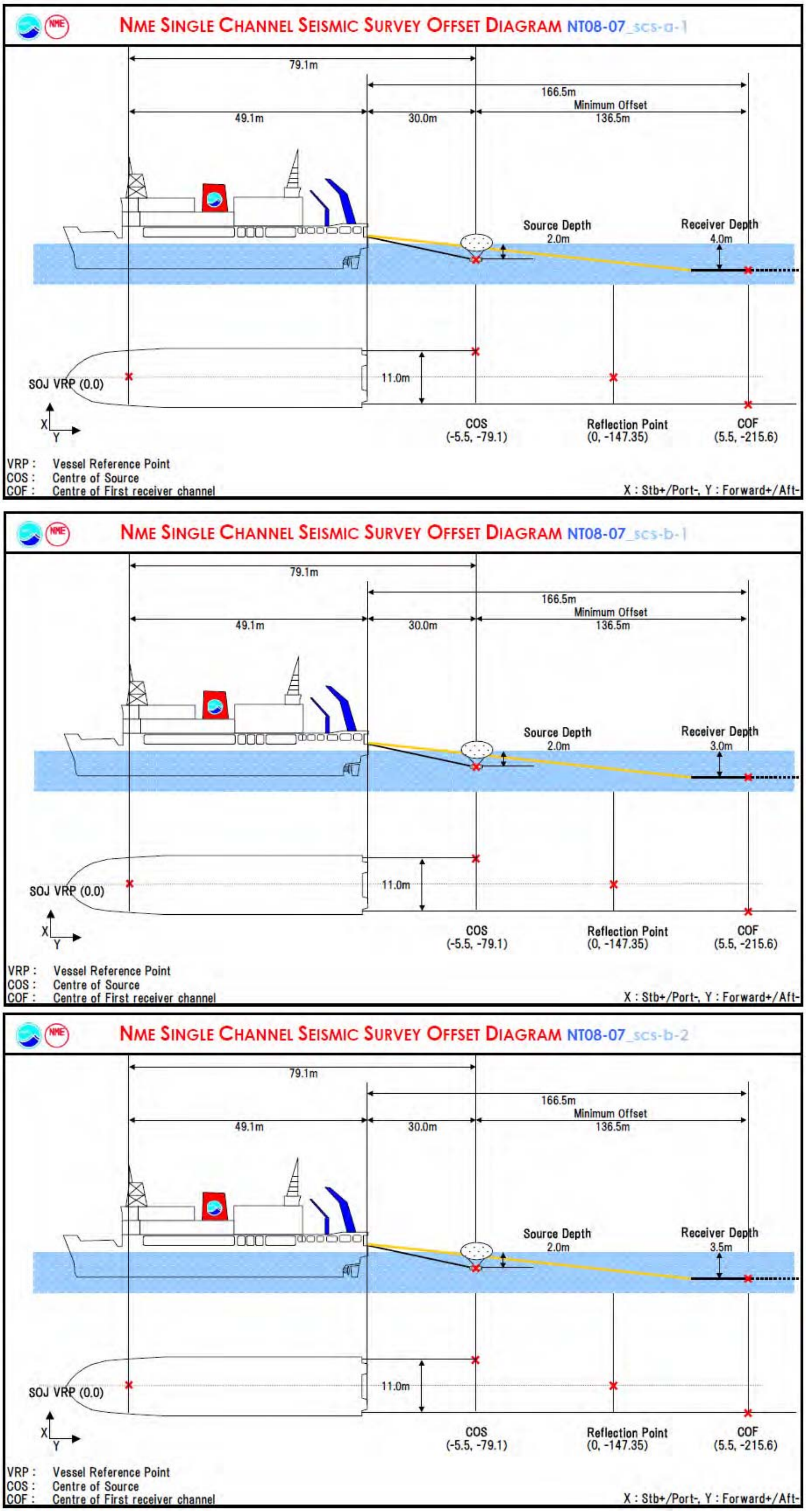


Fig. 2-4 Offset diagrams of SCS survey (JAMSTEC) for lines A, B-1, and B-2.

3. DIVE LOGS

3-1. Ship log: Natsushima (NT08-07 leg 1)

Shipboard Log & Ship Track(NT08-07 Leg.1 08/4/3 - 08/4/10)				Position/Weather/Wind/Sea condition (Noon)
Date	Time	Description	Remark	
03,Apr,08	9:00	embarkation science group		4/3 12:00
	10:00	departure from JAMSTEC		35-00.8N, 139-41.5E
	11:00	on board seminar	for safety NATSUSHIMA life	fine but cloudy
	13:00	on board education & training	for emergency operation	N-3(Gentle breeze)
	19:00	scientific meeting		
04,Apr,08	5:30	arrived at Dive point		4/4 12:00
	5:49	released XBT		31-55.0N, 140-02.5E
	6:08～6:49	carried out MBES survey		fine but cloudy
	8:09	launched HPD		NW-4(Moderate breeze)
	8:25	started HPD Dive#812		
	8:57	arrived at bottom	D=753m	
	11:58	leave the bottom	D=60m	
	12:04	surfaced HPD		
	12:20	recovered HPD		
	13:33	launched HPD		
	13:49	started HPD Dive#813		
	14:28	arrived at bottom	D=1113m	
	16:41	leave the bottom	D=725m	
	17:03	surfaced HPD		
	17:16	recovered HPD		
	17:28	commenced proceeding to MBES area		
	19:43	commenced MBESS mapping survey		
05,Apr,08	3:49	finished MBES mapping survey		4/5 12:00
	6:00	arrived at Dive point		31-46.9N, 140-00.0E
	8:02	launched HPD		fine but cloudy
	8:20	started HPD Dive#814		NNW-4(Moderate breeze)
	9:13	arrived at bottom	D=1287m	
	11:47	leave the bottom	D=709m	
	12:09	surfaced HPD		
	12:25	recovered HPD		
	14:03	launched HPD		
	14:21	started HPD Dive#815		
	15:03	arrived at bottom	D=1107m	
	17:22	leave the bottom	D=822m	
	17:49	surfaced HPD		
	18:04	recovered HPD		
	18:25～19:03	set GI Gun & SCS Streamer cable		
	21:22	commenced SCS survey		
06,Apr,08	4:21	finished SCS survey		4/6 12:00
	7:00	arrived at Dive point		31-51.7N, 139-47.9E
	8:02	launched HPD		cloudy
	8:18	started HPD Dive#816		SE-3(Gentle breeze)
	8:59	arrived at bottom	D=1004m	
	10:47	leave the bottom	D=822m	
	11:11	surfaced HPD		
	11:24	recovered HPD		
	13:01	launched HPD		
	13:16	started HPD Dive#817		
	13:45	arrived at bottom	D=614m	
	17:00	leave the bottom	D=424m	
	17:15	surfaced HPD		
	17:28	recovered HPD		
	18:00～18:12	set GI Gun & SCS Streamer cable		
	18:28	commenced SCS survey		
07,Apr,08	8:04	finished SCS survey		4/7 12:00
	8:25	commenced proceeding to HACHIJO SHIMA		32-48.8N, 139-43.4E

				cloudy
				SE-7(Near gale)
08,Apr,08	19:00～19:30	scientific meeting		4/8 12:00
				33-04.2N, 139-51.1E
				rain
				W-8(Gale)
09,Apr,08				4/9 12:00
				33-02.8N, 139-49.0E
				cloudy
				N-7(Neal gale)
10,Apr,08	13:00	arrived at YOKOSUKA		
	17:00	left the ship and concluded NT0807 Leg-1	Leg-1 scientists	

Table 3-1 Shipboard log of Natsushima (NT08-07 Leg 1)

3-2. Hyper Dolphin Dive # 812: Log Date: 2008/04/04

Objective

Dive to the eastern slope of the conical-shaped Myojinsho seamount. We will traverse its eastern slope from a depth of ca. 750 m to its summit at ca. 50 m. This is a revisit to the Myojinsho summit; we surveyed the western slope to its summit during Hyper-Dolphin Dive #620 in December, 2006. This time we will observe and sample pyroclasitc deposits from a different side of the cone.

Dive Summary

Start: 31° 54.996’ N, 140° 02.408’ E (depth = 753 m)

Finish: 31° 55.087’ N, 140° 01.297’ E (depth = 60 m)

Hyper Dolphin Dive #812 Log (HD and CCD Camera)

Time	Depth	Heading	Descriptions	Samples
8:13	0	266	Enter water	
8:56	752	278	Observe seafloor. Landed on pumiceous gravel. Coarse buff pumice fragments are scattered. Lobes consisting of small pumice fragments are observed every several meters.	
9:01	753	276	Trying to sample small pumice fragments using MBARI core.	
9:02			Cancel sampling with MBARI core. Change to M-type core.	
9:11	754	277	Successful in sampling fine pumice fragments from the lobe using M-type core.	HD812-S01
9:14	742	270	Scattered subrounded pumice blocks.	
9:16	730	270	Landed to sample pumice blocks. Columnar jointed angular pumice blocks.	
9:18	730	270	Sampled two large pumice blocks. One jointed pumice block, another one was a dense, less-vesiculated rock.	HD812-R01, R02
9:24	712	270	Continuous slope of fine light-colored pumice fragments. Occasionally, dark pumice blocks are scattered.	
9:28	688	270	Slope begins to cover with dark blocks. Less amount of fine material.	
9:33	654	281	Slope completely covered with dark equally-sized blocks.	
9:34	650	280	Landed to sample. Collected three dark dense subrounded blocks from the cover. Blocks from fragmented lava dome?	HD812-R03, R04, R05
9:40	650	280	Start to traverse.	
9:44	640	270	Again, slope begins to be covered with light-colored pumicious gravel. Fewer amounts of dark blocks.	
9:53	564	280	Still going up a slope. Fewer amount of dark blocks. In contrast, increasing amount of whitish block, pumice?	
9:56	552	275	Landed to sample. Trying to sample whitish block.	

Time	Depth	Heading	Descriptions	Samples
			Fragmented when grabbed with a manipulator. Pumice.	
9:58	552	275	Collected two rounded white pumice.	HD812-R06, R07
10:03	526	276	Dominated by fine pumiceous gravel. Ripple marks.	
10:08	477	276	Slope covered with white subrounded pumice blocks. Landed to sample.	
10:11	474	272	Collected two fresh subangluar pumice blocks.	HD812-R08, R09
10:18	452	275	Landed to sample. Collected one dark subrounded block.	HD812-R10
10:21	452	274	Moved a short distance. Collected one large pumice blocks. Broken into pieces.	HD812-R11
10:29	434	269	Observed a large pumice block. Ascending a slope of pumiceous gravel with pumice rubbles.	
10:37	366	270	Continuous slope of pumiceous gravel. Zzzzz…	
10:39	350	270	Landed to sample gravel using MBARI core.	
10:48	350	270	Finished sampling gravel.	HD812-S02
10:50	348	271	Start to traverse again.	
10:56	295	270	Slope covered with dark and white subangular rubbles. Smaller amount of fine materials.	
11:02	228	268	Amount of large blocks increased. Angular to subangular pumice blocks.	
11:08	201	268	Landed to sample rubbles. Collected two (lava?) blocks. Put into black box.	HD812-R12, R13
11:23	149	263	The bottom is now completely covered with dark angular blocks. It seems that all the blocks are monolithologic. Fragmented lava dome?	
11:27	125	270	Huge pumice block ~size of the Hyper-Dolphin is observed.	
11:30	105	266	Approaching the summit; Slope becomes more gentle. The surface is covered with monolithologic dark blocks.	
11:35	80	268	Landed on a summit surface. Reddened dense lava blocks. Collected two blocks.	HD812-R14, R15
11:48	48	268	Arrive at the crater rim. Surface is partly covered with whitish unidentified material.	
11:58	60	255.4	End of dive; leave the bottom.	

3-3. Hyper Dolphin Dive # 813: Log **Date: 2008/04/04**

Objective

Dive to the western wall of Myojinsho caldera. We will traverse from the caldera floor at 1100 m to the caldera rim at 250 m below sea level. This is a revisit to the Myojinsho caldera wall following our survey of the SW and SE walls during Hyper-Dolphin Dives #618 and #621 in December, 2006. This time we will observe and sample the pyroclastic deposits from a different side of the caldera.

Dive Summary

Start: 31° 53.797’ N, 139° 57.301’ E (depth = 1113 m)

Finish: 31° 53.899’ N, 139° 56.926’ E (depth = 725 m)

Hyper Dolphin Dive #813 Log (HD and CCD Camera)

Time	Depth	Heading	Descriptions	Samples
13:38	0	266	Enter water	
14:28	1114	289	Observe seafloor. Landed on flat surface of fine	

Time	Depth	Heading	Descriptions	Samples
			white sand. Very few coarse pumice or rock fragments are found.	
14:31			~~Core pushed but left it there.~~ Set marker chain.	
14:35	1112	279.6	Flat caldera floor covered with fine white material	
14:35	1108	277	Caldera wall lava-like rock covered thickly with fine pelagic snow. The rock (light color inside with black cover; Mn) was sampled but may be altered.	HD813-R01(attached backside basket)
14:42			Altered rock with white to light yellow color and brown stains.	HD813-R02 (attached backside basket)
14:45	1105	269	Thick snowy deposit on the wall.	
14:48	1080	266	Alternation of nearly vertical walls and talus slopes covered with fine pelagic snow.	
14:50	1079	226	Altered lava-like rock from near the talus on the caldera wall.	HD813-R03 (backside space)
14:54	1075	244	Ascending the wall	
			Big rock several meters high	
15:00	1038	243	Talus consists of slightly coarser sand.	
15:01	1039	245	Sampled; huge altered rock gradually broken to pieces	HD813-R04 (backside space)
15:05	1036	280	Take off	
15:06	1025	287	Landing and sampling >>>abandoned	
15:11	1012	234	Sampled an altered block with red surface.	HD813-R05 (right basket)
15:16	1005	289	Take off	
15:18	990	297	Wall rock with rough surface; breccia?	
15:22	960	290	Sampled altered rock with black surface	HD813-R06 (right basket)
15:30			Continued	
15:38	920	300	Talus of fine material covers almost entire the wall	
15:40	900	300	Vertical wall with horizontal laminae	
15:44	867	300	Stratified wall with alternation of cm scale layers	
15:46	848	323	Breccia with round blocks	
15:56			Tried sampling….and at last obtained black dense block	HD813-R07 (front space)
15:58	845	329	Take off	
16:02	833	310	Thick snow-like talus deposit	
16:05	830	378	A block with some creatures sampled	HD813-R08 (front space)
16:07			Take off	
16:08	821	293	Massive breccia, but flat blocks are near-horizontal. The deposit looks unconsolidated and has loose matrix. Sampled black subrounded block (inside not known)	HD813-R09 (left basket)
16:17	808	315	Alternation of breccia and laminated layers; faults? Tried sampling but gave up.	
16:20	795	315	Stratified dense rock covered by white pelagic snow.	
16:22	779	320	Less steeper talus and some meters high slightly stratified ~ massive breccia (consisting of white	

Time	Depth	Heading	Descriptions	Samples
			pumice? <<scratched).	
16:28	745	337	Wall of breccia with rugged surface	
16:33	727	338	Rounded large blocks (pumice or altered rock) sampled.	HD813-R10 (left basket)
	725		Black block ca. 10cm sampled	HD813-R11 (left basket)
16:39	725	337	Black block	HD813-R12 (left basket)
16:40			End of dive; Leave bottom	

3-4. Hyper Dolphin Dive # 814: Log Date: 2008/04/05

Objective

Dive up the west wall of a large bathymetric re-entrant on the south side of the edifice of Myojinsho caldera. We will traverse from a depth at 1280 m to the caldera rim at 450 m bsl. This is the first visit to the outer edifice of the Myojinsho caldera. This time we will try to investigate the evolution of the volcano in the steep cliffs where outcrops of the pre-caldera rocks are expected.

Dive Summary

Start: 31° 46.899’ N, 140° 00.010’ E (depth = 1287 m)

Finish: 31° 47.485’ N, 139° 58.941’ E (depth = 709 m)

Hyper Dolphin Dive #814 Log (HD and CCD Camera)

Time	Depth	Heading	Descriptions	Samples
X:XX	0	0	Enter water	
9:13	1283	304	Observe seafloor. Landed on white pumiceous sand. Ripples are observed.	
9:15	1283	304	Start to traverse towards the northwestern cliff. Continuous rippled sand floor.	
9:25	1274	304	Still rippled sand floor…	
9:29	1272	305	Observed a large pumice block on a rippled floor. Sunken pumice raft?	
9:35	1261	304	Still rippled sand floor…	
9:38	1251	305	Observed a large block about a similar in size to the Hyper-Dolphin.	
9:42	1240	304	Still rippled sand floor…	
9:57	1198	308	Still rippled sand floor……	
10:13	1134	300	Still rippled sand floor……Zzzzzzz…	
10:18	1100	312	Small debris of subangular dark blocks. Landed to collect sample.	
10:23	1101	315	Sampled three dark blocks. It fragmented when the manipulator tried to grab it, and it turned out to be a large pumice block.	HD814-R01, R02, R03
10:32	1098	309	Start to traverse. Again, gentle slope of rippled sand.	
10:36	1075	309	Outcrop of ~1 m thick sub-horizontal bedded breccia. Contained dark lithics.	
10:52	954	323	Still no outcrop. Gentle slope of fine sand.	
11:01	891	314	Surface becomes rough with thin sediment cover. The rough surface consists of pumice blocks.	
11:07	888	291	Landed and led to collect pumice clasts.	
11:10	876	308	Canceled sampling. Start to traverse.	
11:17	812	314	Lobes of finer grained pumice appeared.	
11:24	774	316	Lobes of fine grained pumice. Occasionally, some scattered pumice blocks.	
11:30	713	320	Still continuous slope of fine pumice.	

Time	Depth	Heading	Descriptions	Samples
11:44	709	281	Collected one pumice block using MBARI core. Collected pumiceous sand using M-type core.	HD814-S01, M01
11:45	710	282	End of dive; Leave bottom.	

3-5. Hyper Dolphin Dive # 815: Log **Date: 2008/04/05**

Objective

Investigate the north wall of Myojinsho caldera. We will traverse from the caldera floor at 1100 m to the caldera rim of 820 m bsl. This is the first visit to the north wall of the caldera. This time we will observe pyroclasitc deposits from a different side of the caldera wall.

Dive Summary

Start: 31° 54.598' N, 139° 58.502' E (depth = 1107 m)

Finish: 31° 54.953' N, 139° 58.597' E (depth = 822 m)

Hyper Dolphin Dive #815 Log (HD and CCD Camera)

Time	Depth	Heading	Descriptions	Samples
14:08	0	XX	Enter water	
15:03	1108	360	Observe seafloor. Landed on sand. Mainly fines, and lava blocks are sometimes scattered.	
15:06	1108	360	Try to set SAHF.	
15:12	1108	358	Successful in setting SAHF on seafloor, and start of heat-flow measurement.	
15:13	1108	357	Sampled sandy materials composed of seafloor, using a 2K-type sampler.	HD815-S01
15:20	1108	348	Sampled a subrounded rock (lava?).	HD815-R01
15:24	1108	357	Sampled a subangular pumice block (whitish-colored).	HD815-R02
15:33	1108	357	Finish of heat-flow measurement with SAHF, and leaving the first event mark.	
			Flat sandy seafloor continuing…	
15:51	1098	4.5	Coarse blocks appeared on sandy seafloor.	
15:53	1100	1.7	Trying to sample a part of a large block.	
15:57	1100	4.0	Successful in sampling the large rock fragment.	HD815-R03
15:58	1100	4.0	Leaving the sampling point.	
16:00	1090	4.0	Massive lava appeared. Continuing the massive-lava and coarse lava blocks, which are partially covered by sand.	
16:04	1080	25.0	Lobes of small submarine debris flows or talus (?), composed of coarse rounded to subrounded clasts (lava or pumice).	
16:05	1080	26.1	Sampling a subrounded rock.	HD815-R04
16:10	1080	26	Trying to sample another one, but end to be fault. Again, sandy seafloor, and large blocks.	
16:18	1057	31.7	Landing to sample. Trying to sample a fragment of massive rock.	
16:20	1057	32.2	Successful in sampling angular-shaped rock block. Set a chain marker.	HD815-R05
16:23	1037	10.3	Observe massive dark-colored rock (near-vertical wall) with fractures. Massive rock continuing.	
16:30	1005	6.4	Stratified facies (fractures or joints) are recognized on the massive rock.	
16:37	960	18.3	Massive rock and its fragments continuing.	
16:40	940	10.9	Decrease of massive rock with increase sandy	

Time	Depth	Heading	Descriptions	Samples
			materials. Sand covers the rocks.	
16:42	935.5	11.1	Observe only sand.	
16:43	930.2	10.8	Again, massive dark-colored rock (m-sized) and its fragments appear.	
16:46	919.2	37.7	Landing on seafloor near a massive rock.	
16:47	920.0	34.8	Try to sample the fragments of massive rock, but end to be fault. Change the sampling location.	
16:52	918.1	20.3	Again, try to sample the fragment of a rock and successful in sample it. Leaving the sampling point.	HD815-R06
16:57	900	15.1	A few amount of rocks. Mainly sandy materials.	
17:02	869	20.6	Slope is mostly covered by whitish sand.	
17:03	857	20.9	Again, massive dark-colored rock and its fragments appear.	
17:06	832	20.5	Slope is mostly covered by whitish sandy materials. Coarse rocks are sometimes scattered.	
17:11	820.6	39.0	Landing on seafloor near a scattered rock fragments.	
17:17	822.7	64.8	Sampled a fragment of fragile rock (pumice?)	HD815-R07
17:21	822.7	64.8	Second time, sampled whitish sandy materials using a M-type sampler.	HD815-M01
17:23	821.1	65.3	End of dive; Leave bottom.	

3-6. Hyper Dolphin Dive # 816: Log — Date: 2008/04/06

Objective

Dive to the ridge ca. 20 km to the west of Myojinsho caldera where a chain of small cones is aligned N-S. We will traverse deepest part of the ridge from its bottom ca. 1000 m bsl to its top at ca. 800 m bsl. This is the first-time visit to this ridge. We will attempt to survey the structure and deposits of the cones.

Dive Summary

Start: 31° 51.708’ N, 139° 47.902’ E (depth = 1004 m)

Finish: 31° 51.768’ N, 139° 48.164’ E (depth = 822 m)

Hyper Dolphin Dive #816 Log (HD and CCD Camera)

Time	Depth	Heading	Descriptions	Samples
8:07	0	250	Enter water	
8:59	1005.1	70	Landed on breccia composed of grayish coarse (a few to 10 cm size) grains. Unknown species.	
9:02	1004.8	69.3	Try to set SAHF, but ended up to fault. It is difficult to put SAHF on hard seafloor.	
9:09	1005.2	68.7	Retry to set SAHF several times, but again ended up to fault.	
9:16	1005.4	67.4	Try to sample a platy subrounded block (> 30 cm in diameter).	
9:18	1005.4	68.4	Successful in sampling the platy block, but it broke into pieces when placed into the box.	HD816-R01
9:24	1005.3	69.3	Collected relatively coarse (lapilli size) grains using M-type sampler.	HD816-M01
9:27	1002.4	69.2	Leaving the first sampling point.	
9:30	991.3	68.9	Seafloor is mainly composed of lapilli or block sized grains. Fines-poor.	
9:32	990.4	68.9	SAHF was moved to a cylinder in right-hand side.	
9:33	990.4	69.5	Try to sample a subangular block (> 30 cm in diameter).	
9:34	990.2	69.1	Successful in sampling it, and departed this site.	HD816-R02
9:38	966.0	74.0	Grain size increased with distance.	

Time	Depth	Heading	Descriptions	Samples
9:40	963.8	73.9	Observe and landed on breccia.	
9:41	963.7	75.1	Sampled a subrounded black clast composed of breccia.	HD816-R03
9:43	963.8	74.2	Sampled another subrounded black clast (> 30 cm size in diameter) at the same point.	HD816-R04
9:45	960.7	74.2	Leaving the sampling point.	
9:50	927.0	75.0	Breccia continuing.	
9:52	917	74.4	Sand to lapilli-sized grains increased. Not large blocks.	
9:54	908.8	78.1	Landing on sandy seafloor.	
9:55	908.8	78.6	Sampled a grayish subangular block (> 30 cm in diameter). It was broken during setting in the box.	HD816-R05
10:05	908.6	78.4	Try to collect sand to lapilli-sized clasts using 2K-type core. After a few times challenges, it ended up being successful.	HD816-S01
10:10	906.9	74.0	Leave the sampling point.	
10:13	890.0	73.9	A lot of strange corals…	
10:14	884	79.1	Narrow flat and breccia.	
10:16	879.5	79.5	Observation of the breccia	
10:18	879.3	79.4	Sampled a subangular block, and departed this site.	HD816-R06
10:25	846	29.9	Almost the top of slope?	
10:28	843.8	62.5	Landing on brecciated seafloor. Loose and looks like a basalt fragments (clinker-like?).	
10:30	843.8	73.6	Sampled a subrounded block.	HD816-R07
10:33	843.7	74.0	Sampled another subangular block (> 30 cm in long axis) at the same point.	HD816-R08
10:35	842.9	92.2	Leave the sampling point.	
10:39	830	111.6	Still gentle slope.	
10:43	822.6	111.0	Landing on brecciated seafloor, and sampled a subangular block with some leaves.	HD816-R09
10:47	822	111	End of dive; Leave bottom.	

3-7. Hyper Dolphin Dive # 817: Log — Date: 2008/04/06

Objective

Dive again to the ridge ca. 20 km to the west of Myojinsho caldera where a chain of small cones is aligned along an N-S direction. We will traverse along the axis of the ridge from the foot of the cone ca. 600 m bsl to the top of ca. 500 m bsl. We will survey the structure and deposits of the cones, and compare with the results of Dive HD816.

Dive Summary

Start: 31° 48.790’ N, 139° 47.591’ E (depth = 614 m)

Finish: 31° 48.172’ N, 139° 48.016’ E (depth = 424 m)

Hyper Dolphin Dive #817 Log (HD and CCD Camera)

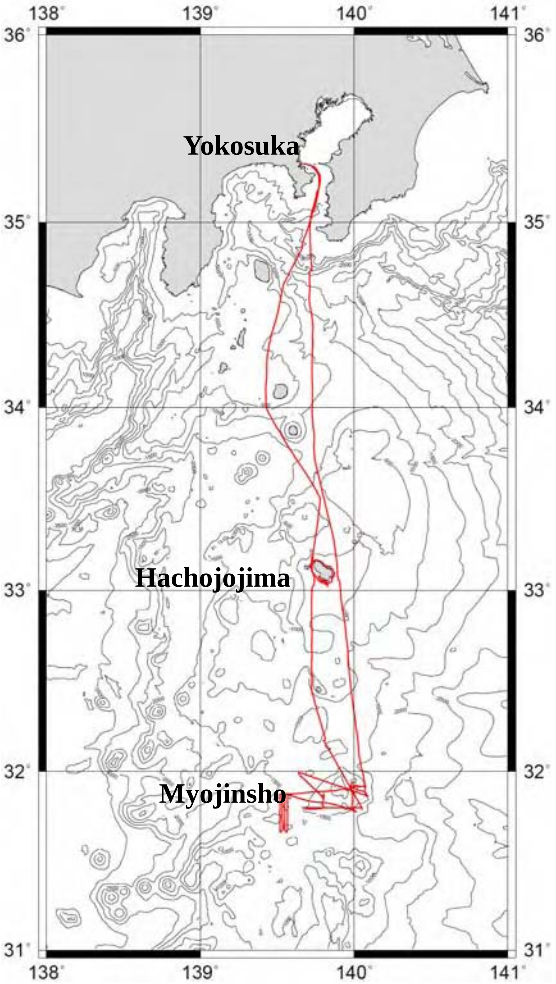
Time	Depth	Heading	Descriptions	Samples
13:05	0	137	Enter water	
13:45	614	79.4	Landed on seafloor. Sand to gravel-sized clasts are dominant; some scattered angular blocks are present.	
13:47	614.1	78.2	Try to set SAHF, but failed to do so. It is difficult to push the SAHF into the hard seafloor.	
13:55	614.7	79.7	Sampled an angular-shaped lava block.	HD817-R01
13:57	614.7	79.2	Retry to set SAHF. Incompletely set.	
14:00	615	78.7	Start to measure heat flow, using only a lower half of the sensor.	
14:05	615.2	79.4	Try to sample sand to gravel-sized materials on	HD817-M01

Time	Depth	Heading	Descriptions	Samples
			seafloor using M-type core sampler. Successful.	
14:10	615.1	48.4	Try to sample another angular lava block. Successful.	HD817-R02
14:13			Waiting for completion of heat-flow measurement.	
14:20			Finish of heat-flow measurement with SAHF.	
14:21			Leaving the sampling point.	
14:26	614.1	68.5	Seafloor is flat, and covered by sand to gravel-sized materials. Some subangular blocks are scattered.	
14:30	602.3	57.4	Continuation of sand to gravel-sized materials.	
14:35	575.0	65.1	Still continuing of sand to gravel-sized materials, but grain-size seems to increase.	
14:37	566.5	69.6	Breccia is dominant around here. Landing on the breccia, and try to sample an angular lava block. Successful.	HD817-R03
14:42	566.5	67.4	Try to sample another lava block at the same point as R03, but fail to do so.	
14:43	566.5	108.5	Again try to sample a fragment composed of breccia (probably basaltic lava). Leave the point.	HD817-R04
14:47	547.4	73.2	Still continuing of sand to gravel-sized materials with breccia.	
14:53	497.5	74.4	Try to sample a platy angular-shaped lava fragment. Successful.	HD817-R05
14:54	497.5	74.4	Try to sample another angular-shaped lava fragment. Successful. Leaving the sampling point.	HD817-R06
14:58	467.0	79.6	Again, sand to gravel-sized materials.	
15:00	459.2	78.2	Landing on seafloor to sample a lava block. Successful in sampling a platy subangular lava block. It was broken to some pieces in a box.	HD817-R07
15:04	459.2	78	Leaving the sampling point.	
15:07	440	179	Change vehicle direction from east to south. (event mark 3)	
15:10	426.7	163.6	Basically, gravel to block-sized lava is dominant. Large irregular-shaped lava blocks sometimes appear.	
15:13	425.7	168.4	Flat bottom continues.	
15:17	467.1	147.0	Landing on seafloor to observe and sample. Successful in sampling angular-shaped lava clast.	HD817-R08
15:19	467	173.2	Leave the seafloor. Almost flat and continues of small to medium-sized lava fragments (the surface of lava flow?).	
15:28	491.3	154.6	Landing on seafloor to sample.	
15:31	491.3	154.2	Successful in sampling of a subangular lava block.	HD817-R09
15:35	482.5	179.2	Almost flat, and continues of small to medium-sized lava fragments or lava surface.	
15:43	479.6	168.9	Seafloor is covered with fragments of lava, but large blocks cannot be observed.	
15:46	479.6	197.3	Massive lava appeared (Main body?). Try to sample a fragment of massive lava. Successful in sampling a subangular block.	HD817-R10
15:51	479.3	195.9	Successful in sampling another subangular block. Leave this point.	HD817-R11
15:56	506.7	168.3	Continue of irregular-shaped small to medium-sized lava blocks or lava surface.	
16:00	517.6	174.2	Massive lava field, covered with irregular-shaped lava fragments.	
16:03	509.2	148.1	Landing on seafloor, composed of massive and	

Time	Depth	Heading	Descriptions	Samples
			fragmented lava. Try to sample, but resulted in fault.	
16:10	500.2	169.2	Landing on seafloor. Retry to sample, and successful in sampling a subangular lava block (> 30cm).	HD817-R12
16:16			Leave the point.	
16:21	477.7	179.5	Continue of irregular-shaped small to medium-sized lava blocks or lava surface.	
16:22	470	179.7	Fissure-like structure. (Vent?)	
16:24	468.8	179.2	Landing on seafloor, and try to sample.	
			Successful in sampling a subrounded lava block.	HD817-R13
16:27	469.2	179.3	Successful in sampling another angular-shaped lava	HD817-R14
16:29			block. Leave the point.	
16:36	439.6	179.4	Almost flat, and continues of small to medium-sized lava fragments or lava surface, but sometimes, fissures are developed and welded spatter deposits (?) are recognized.	
16:42	422.2	252.5	Try to sample a fragment of the spatter.	
16:46	422.2	251.3	Successful in sampling a block of it.	HD817-R15
16:50	416	189.9	Large fragments (> m size) of agglutinate (?).	
16:56	424.8	208.8	Try to sample a massive lava-like rock.	
16:58	424.9	213.4	Successful in sampling a fragment of the rock.	HD817-R16
17:00	424.4	216	End of dive; leave bottom.	

4. RESULTS

4-1. Track lines of Natsushima



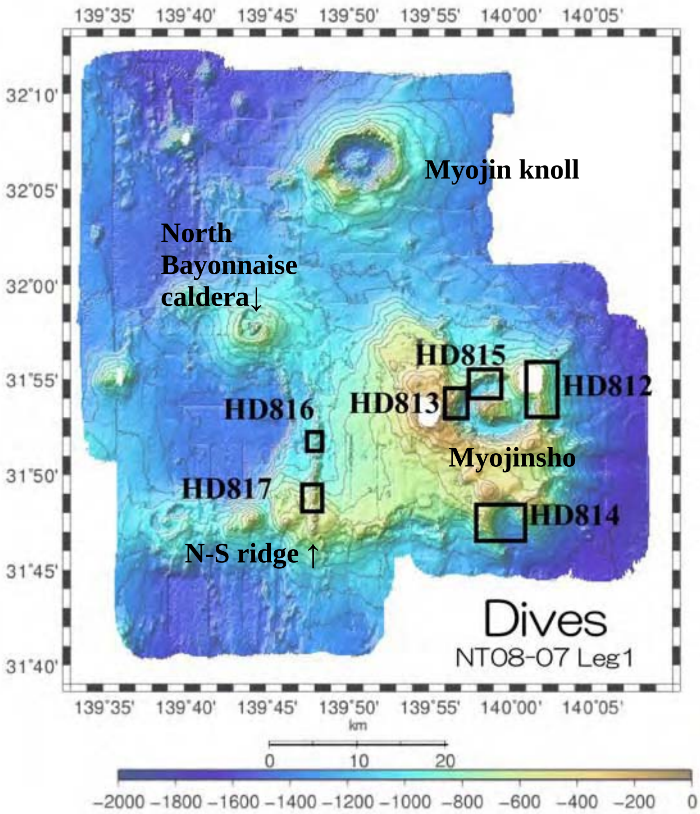


Fig. 4-1 Track line of Ship Natsushima (left) and index map of the dive tracks of Hyper-Dolphin of the NT08-07 leg 1 cruise.

4-2. Dive schedule

Dive 1 (#812) Apr. 4, 2008

Eastern slope of Myojinsho
7:45 to 12:00
From (31° 54.996' N, 140° 02.408' E; depth = 753 m) to (31° 55.087' N, 140° 01.297' E; depth = 60 m)
Payloads: Scoop, square box, M-type sampler, MBARI core (2), baskets

Dive 2 (#813) Apr. 4, 2008

Western wall of Myojinsho caldera
13:00 to 17:00
From (31°53.797'N, 139°57.301'E; depth = 1113 m) to (31°53.899'N, 139°56.926'E; depth = 725 m)
Payloads: Scoop, square box, M-type sampler, MBARI core (2), baskets

Dive 3 (#814) Apr. 5, 2008

Southern edifice of Myojinsho caldera
7:45 to 12:00
From (31°46.899'N, 140°00.010'E; depth = 1287 m) to (31°47.485'N, 139°58.941'E; depth = 709 m)
Payloads: Scoop, square box, M-type sampler, MBARI core (2), baskets

Dive 4 (#815) Apr. 5, 2008

Northern wall of Myojinsho caldera
13:00 to 17:00
From (31° 54.598’N, 139° 58.502’E; depth = 1107 m) to (31°54.953’N, 139° 58.597’E; depth = 822 m)
Payloads: Scoop, square box, M-type sampler, MBARI core (2), baskets, SAHF

Dive 5 (#816) Apr. 6, 2008

Deeper part of the N-S ridge, west of Myojinsho caldera
7:45 to 12:00
From (31°51.708’N, 139°47.902’E; depth = 1004 m) to (31° 51.768’N, 139°48.164’E; depth = 822 m)
Payloads: Scoop, square box, M-type sampler, MBARI core (2), baskets, SAHF

Dive 6 (#817) Apr. 6, 2008

Deeper part of the N-S ridge, west of Myojinsho caldera
13:00 to 17:00
From (31°48.790’N, 139°47.591’E; depth = 614 m) to (31°48.172’N, 139°48.016’E; depth = 424 m)
Payloads: Scoop, square box, M-type sampler, MBARI core (2), baskets, SAHF

4-3. Dive tracks

Dive 1 (#812)

From (31°46.899’N, 140°00.010’E; depth = 1287 m) to (31°47.485’N, 139°58.941’E; depth = 709 m)

Samples: HD812-R01-R15, M01, S01

1: 08:57 on floor

09:11 D = 754 m, sediment (M-type) sampled

2: 09:20 D = 731 m, 2 rocks sampled

3: 09:42 D = 650 m, 3 rocks sampled

4: 10:00 D = 552 m, 2 rocks sampled

5: 10:15 D = 475 m, 2 rocks sampled

6: 10:27 D = 454 m, rocks sampled

7: 10:47 D = 350 m, pumice (MBARI) sampled

8: 11:12 D = 202 m, 2 rocks sampled

9: 11:40 D = 80 m, 2 rocks sampled

10: 11:58 D = 60 m, off the floor

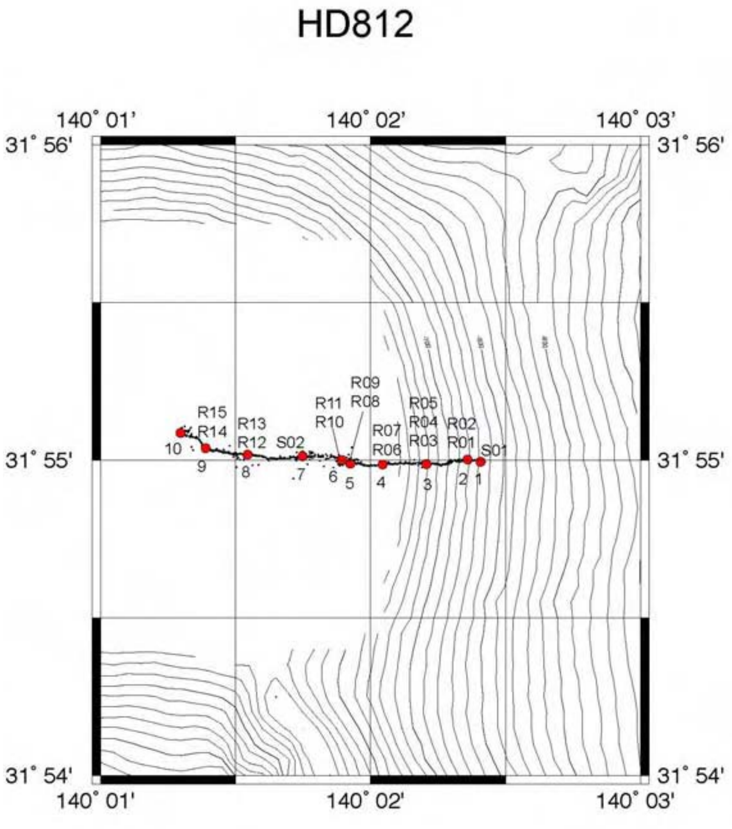


Fig. 4-2 Dive track of HD#812

Dive 2 (#813)

From (31°53.797’N, 139°57.301’E; depth = 1113 m) to (31°53.899’N, 139°56.926’E; depth = 725 m)

Samples: HD813-R01-R12

1: 14:28 D = 1113 m, on floor

2: 14:43 D = 1109 m, 2 rocks sampled

3: 14:54 D = 1079 m, rock sampled

4: 15:04 D = 1039 m, rock sampled

5: 15:15 D = 1012 m, rock sampled

6: 15:31 D = 961 m, rock sampled

7: 15:56 D = 850 m, rock sampled

8: 16:06 D = 831 m, rock sampled

9: 16:15 D = 819 m, rock sampled

10: 16:39 D = 726 m, 3 rocks sampled

16:41 D = 725 m, off the floor

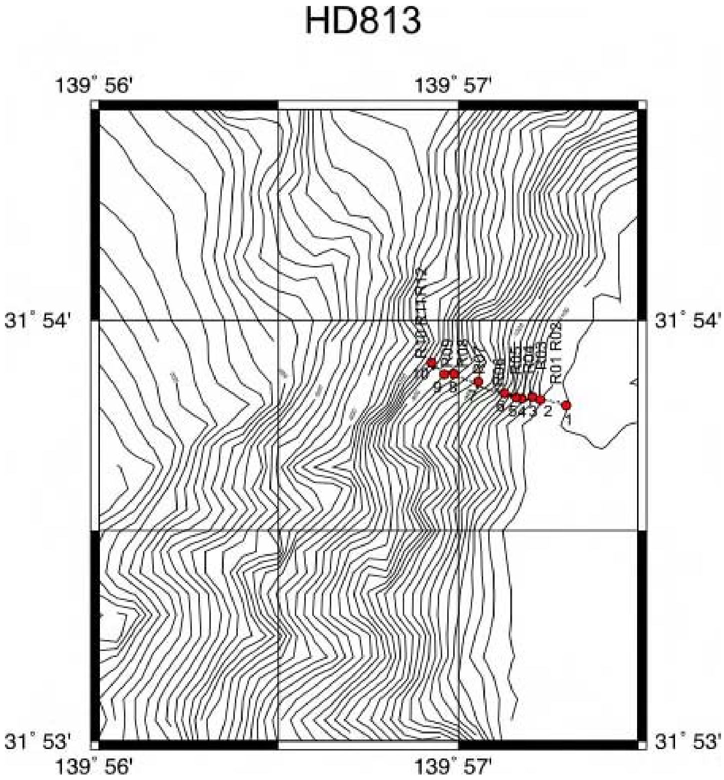


Fig. 4-3 Dive track of HD#813

Dive 3 (#814)

From (31°46.899'N, 140°00.010'E; depth = 1287 m) to (31°47.485'N, 139°58.941'E; depth = 709 m)

Samples: HD814-R01-R03, M01, S01

1: 09:13 D = 1287 m, on floor

2: 09:48 D = 1222 m, observation

3: 10:14 D = 1122 m, observation

4: 10:32 D = 1101 m, rocks sampled

5: 10:57 D = 925 m, observation

6: 11:10 D = 888 m, rocks sampled

7: 11:35 D = 709 m, rock sampled

11:41 sediments sampled (MBARI)

11:44 sediments sampled (M-type)

11:47 off the floor

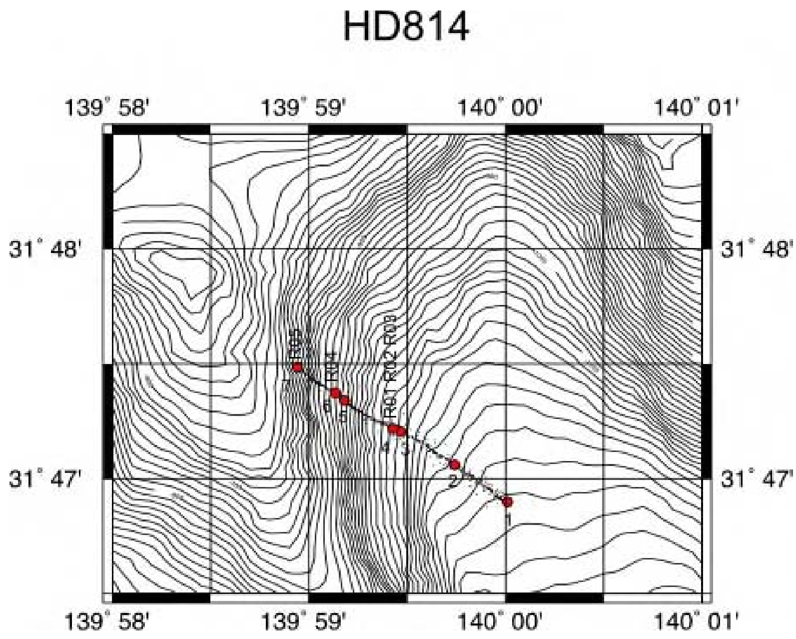


Fig. 4-4 Dive track of HD#814

Dive 4 (#815)

From (31° 54.598'N, 139° 58.502'E; depth = 1107 m) to (31°54.953'N, 139° 58.597'E; depth = 822 m)

Samples: HD815-R01-R07, M01, S01

1: 15:03 D = 1107 m, on floor

15:12 D = 1108 m, SAHF measurement started

15:15 sediment sampled (MBARI)

15:20 rock sampled

15:24 rock sampled

15:32 SAHF measurement ended

2: 15:57 D = 1100 m, rock sampled

3: 16:08 D = 1081 m, rock sampled

4: 16:19 D = 1058 m, rock sampled

5: 16:53 D = 918 m, rocks sampled

6: 17:17 D = 823 m, rock sampled

7: 17:21 sediment sampled (M-type)

17:22 D = 822 m

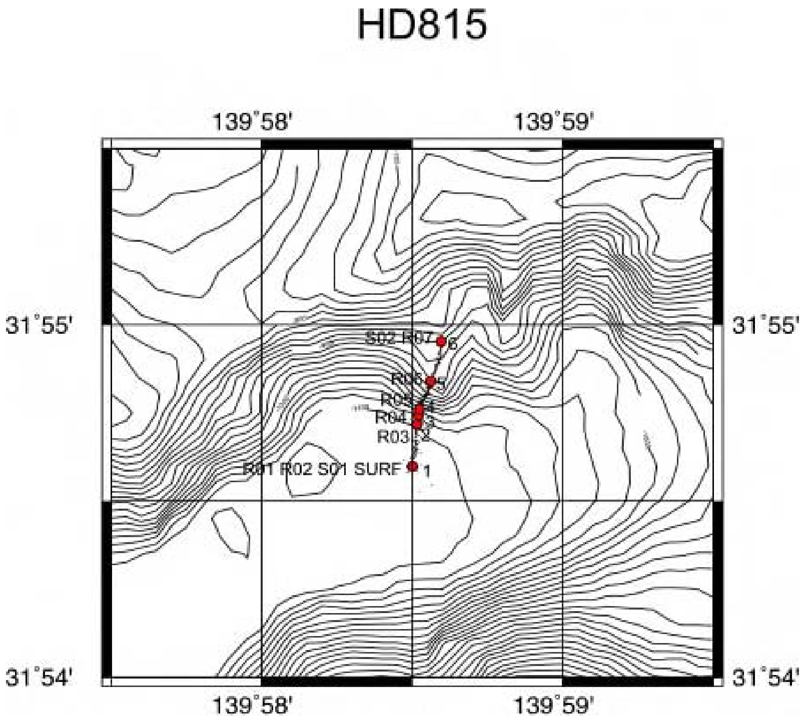


Fig. 4-5 Dive track of HD#815

Dive 5 (#816)

From (31°51.708’N, 139°47.902’E; depth = 1004 m) to (31° 51.768’N, 139°48.164’E; depth = 822 m)

Samples: HD816-R01-R09, M01, S01

1: 8:59 D = 1004 m, on floor

9:20 D = 1005 m, rocks sampled

9:25 sediment sampled (M-type)

2: 9:34 D = 990 m, rock sampled

3: 9:44 D = 964 m, 2 rocks sampled

4: 9:58 D = 909 m, rock sampled

10:09 sediment (MBARI) sampled

5: 10:18 D = 879 m, rock sampled

6: 10:34 D = 844 m, 2 rocks sampled

7: 10:44 D = 823 m, rocks sampled

10:47 D = 822 m, off the floor

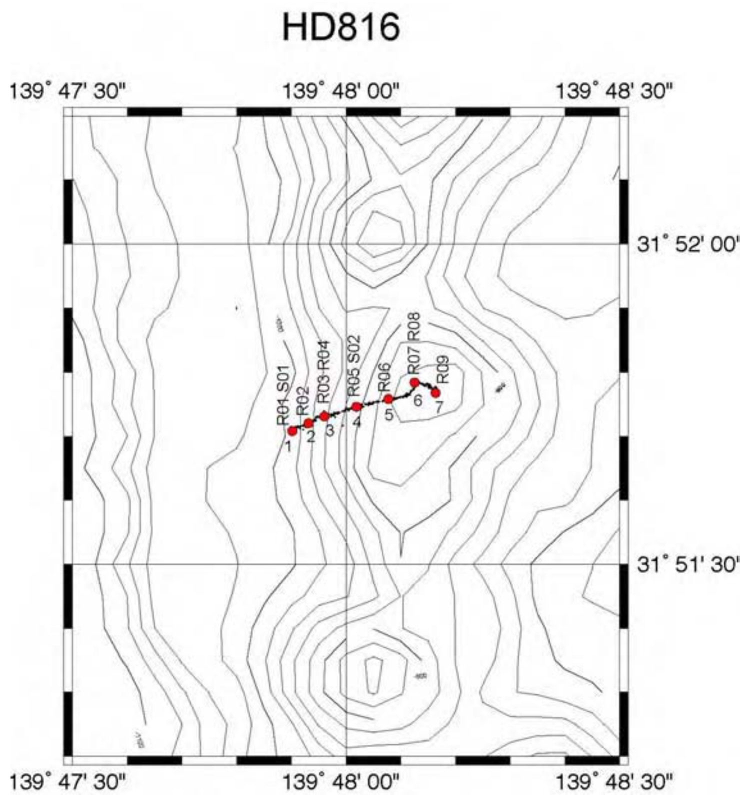


Fig. 4-6 Dive track of HD#816

Dive 6 (#817)

From (31°48.790’N, 139°47.591’E; depth = 614 m) to (31°48.172’N, 139°48.016’E; depth = 424 m)

Samples: HD817-R01-R16, M01

1: 13:45 D = 614 m, on floor

13:56 rock sampled

13:59 SAHF measurement started

14:05 sediment (M-type) sampled

14:11 rock sampled

14:20 SAHF measurement finished

2: 14:38 D = 567 m, rock sampled

14:43 rock sampled

3: 14:54 D = 498 m, 2 rocks sampled

4: 15:03 D = 459 m, rock sampled

5: 15:19 D = 468 m, rock sampled

6: 15:30 D = 491 m, rocks sampled

7: 15:47 D = 479 m, rock sampled

15:51 rock sampled

8: 16:15 D = 502 m, rock sampled

9: 16:28 D = 469 m, 2 rocks sampled

10: 16:46 D = 422 m, rock sampled

11: 16:58 D = 425 m, rock sampled

17:00 D = 424 m, off the floor

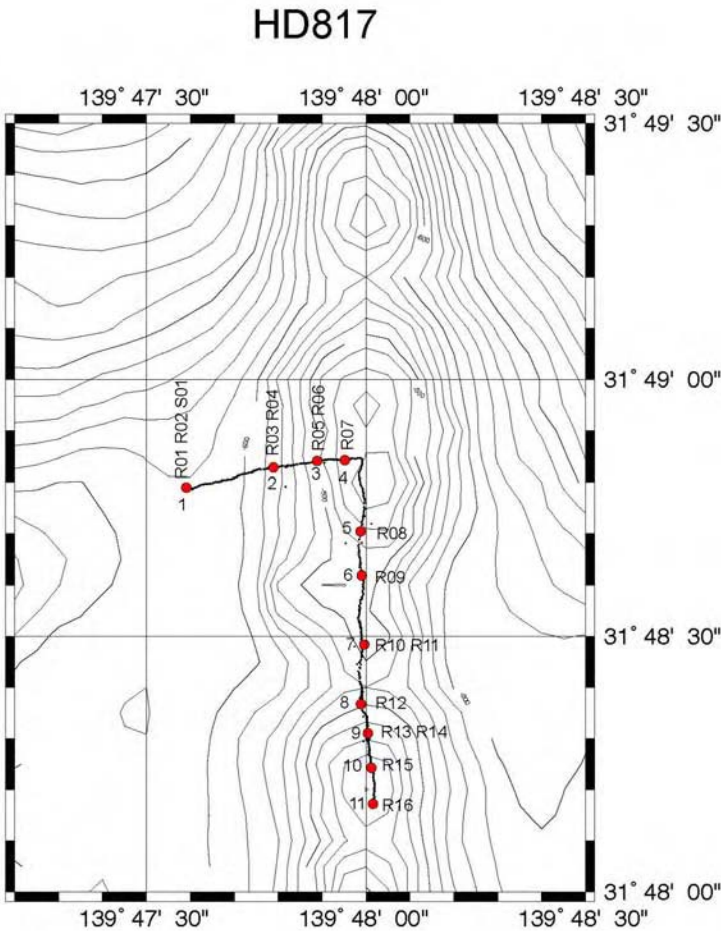


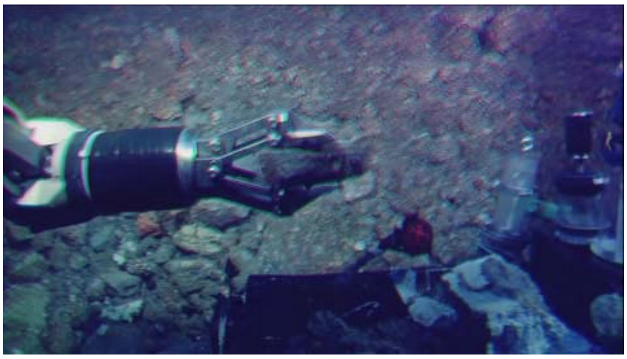
Fig. 4-7 Dive track of HD#817

4-4. Dive points

Dive 1 (#812): Dive at the E slope of Myojinsho (Apr. 4, 2008)

Objective: Comparison of surface deposit and geomorphology of the E slope of Myojinsho with N side (Dive HD 620, December 2006).

	9:11 HD812-1 (754 m bsl) Coarse buff pumice fragments are scattered. Lobes consist of small pumice fragments are observed every several meters. Pumice fragments were sampled with M-type sampler (S01).
	9:16 HD812-2 (730 m bsl) Coarse buff pumice fragments are scattered. Lobes consist of small pumice fragments are observed every several meters. Two large pumice blocks are sampled. One jointed pumice block and the other is a dense less vesicular rock (R01 and R02).
	9:34 HD812-3 (650 m bsl) Slope completely covered with equally sized blocks. Sampled three dark dense subrounded blocks from the cover. Blocks from fragmented lava dome (R03-05)?
	9:56 HD812-4 (552 m bsl) Fewer amount of dark blocks. In contrast, increasing amount of whitish block or pumice. Collected two rounded white pumice (R06, R07).

	10:08 HD812-5 (477 m bsl) Slope covered with white subrounded pumice blocks. Collected two fresh subangular pumice blocks (R08 and R09).
	10:18 HD812-6 (452 m bsl) Collected one dark subrounded block (R10) and one large pumice block (R11) which was broken to pieces.
	10:39 HD812-7 (350 m bsl) Continuous slope of pumiceous gravel. Sampling the gravel with MBARI core (S01).
	11:08 HD812-8 (201 m bsl) Amount of large blocks increased. Angular to subangular pumice blocks. Collected two (lava?) blocks (R12, R13).
	11:35 HD812-9 (80 m bsl) Mostly on the summit of Myojinsho. Slope became gentle. The surface is covered with monolithologic dark blocks. Two reddened dense lava blocks were sampled (R14, R15).

Dive 2 (#813): Dive on the W wall of Myojinsho caldera (Apr. 4, 2008)

Objective: Comparison of stratigraphical sequence with other sides of the caldera wall

<table>
<tr><td></td><td>14:35 HD813-1 (1108 m bsl)
Alternation of nearly vertical wall and talus of fine sand. Caldera wall lava-like rock covered thickly with fine white sand material.
An altered lava-like rock on the wall was sampled (R01). Another altered rock with white to light yellow color and brown stains was also sampled (R02).</td></tr>
<tr><td></td><td>14:48 HD813-2 (1079 m bsl)
The alternation of nearly vertical wall and talus of fine sand.
An altered lava-like rock on the wall was sampled (R03).</td></tr>
<tr><td></td><td>15:01 HD813-3 (1039 m bsl)
A huge altered rock gradually broken to pieces was sampled (R04).</td></tr>
<tr><td></td><td>15:11 HD813-4 (1012 m bsl)
An altered block with red surface sampled (R05).</td></tr>
</table>

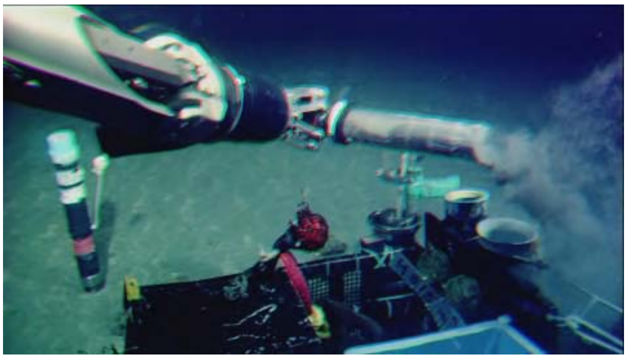
	15:22 HD813-5 (960 m bsl) Wall rock has characteristic rough surface feature of the outcrop (breccia?). An altered rock with black surface was sampled (R06).
	15:56 HD813-6 (848 m bsl) Breccia with rounded blocks which overlies stratified layers of cm scale thick for each. Collected black dense block (R07).
	16:05 HD813-7 (830 m bsl) The alternation of lava-like rocks and talus continues. A block with some creatures was sampled (R08).
	16:08 HD813-8 (821 m bsl) Massive breccia, but flat blocks are oriented horizontally. The deposit looks unconsolidated and has loose matrix. Sampled black subrounded block (R09).
	16:33 HD813-9 (727 m bsl) Wall of breccia with rugged surface. Rounded large blocks (pumice or altered rock) were sampled (R10-R12).

Dive 3 (#814): Dive on the SSE slope of Myojinsho caldera edifice up to the summit (Apr. 5, 2008) Objectives: Understanding the evolution of pre-caldera volcanic edifice. Sampling rocks of the old edifice from the bottom to the top of the cliff is also one of the objectives.

	10:23 HD814-1 (1101 m bsl) Rippled sand floor continues from depth of 1283 m bsl. Small debris of subangular dark blocks. Three dark blocks were sampled (R01-R03). They were turned out to be fragments of a large pumice block.
	11:01 HD814-2 (891 m bsl) Surface becomes rough with thin sediment cover. The blocks on the surface consist of pumice. Tried to sample a piece of white pumice block but cancelled.
	11:32 HD814-3 (709 m bsl) Still continues slope of fine pumice. One pumice block was sampled using MBARI (S01). Collected pumiceous sand using M-type core (M01)

Dive 4 (#815): Dive on the N caldera wall from 1100 m bsl up to ca. 500 m bsl (Apr. 5, 2008)

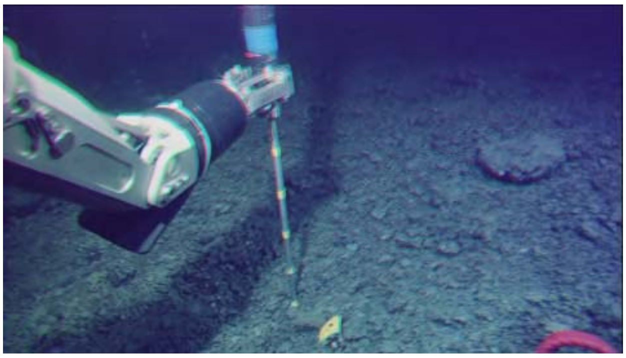
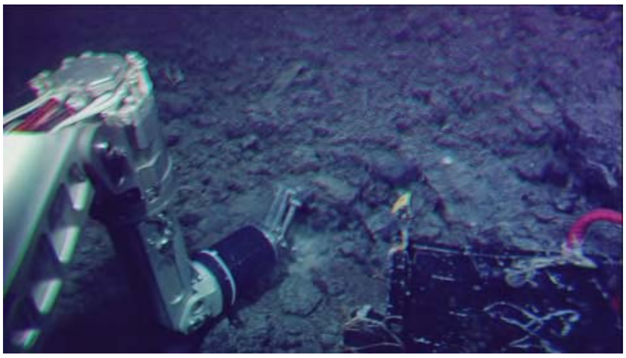
Objectives: Collecting sequential samples, reconstructing the evolution history of the edifice and correlating the deposit with those at other locality, looking for syn-eruptive products of caldera formation.

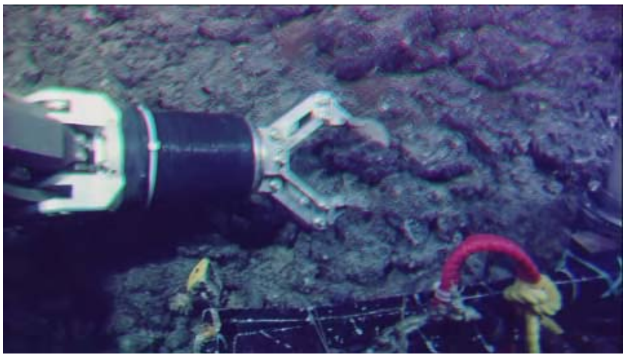
	15:03 HD815-1 (1108 m bsl) Flat sandy seafloor with some lava blocks scattering sometimes. Heat flow measurement was carried out (SAHF). Sandy materials were sampled (MBARI; S01). Also sampled subrounded rock (lava?; R01) and subangular whitish pumice block. (R02).
	15:51 HD815-2 (1100 m bsl) Flat sandy seafloor continued, and coarse blocks appeared on the floor. Massive lava appeared soon after the ROV left here. A part of a large block was sampled (R03).
	16:04 HD815-3 (1080 m bsl) Lobes of small submarine debris flows or talus (?) with finger-like morphology appeared. The lobes consist of coarse rounded to subrounded grains. A subrounded rock was sampled (R04). Tried to sample another one but in vain.
	16:20 HD815-4 (1057 m bsl) Massive lava-like rock crops out on the sub-vertical wall with “snow-like” sediments. An angular dense lava was sampled directly from the outcrop (R05). ROV climbed up nearly vertical wall of dark-colored rock (with many cracks or faults). At depth of ca. 1000 m bsl stratified facies appeared with many fractures and joints.

	16:52 HD815-5 (918 m bsl) Massive lava-like rock crops out on the sub-vertical wall with “snow-like” sediments. A fragment of massive rock was sampled from near the outcrop (R06) after some unsuccessful tries.
	17:17 HD815-6 (823 m bsl) Alternation of massive lava-like rocks and fine whitish sandy materials continued. Sampled one of the fragments of fragile rock (pumice?; R07) and whitish sandy material (M01).

Dive 5 (#816): Dive on the N-S aligned ridge to the west of Myojinsho caldera from the foot up to the summit of the ridge (Apr. 6, 2008)

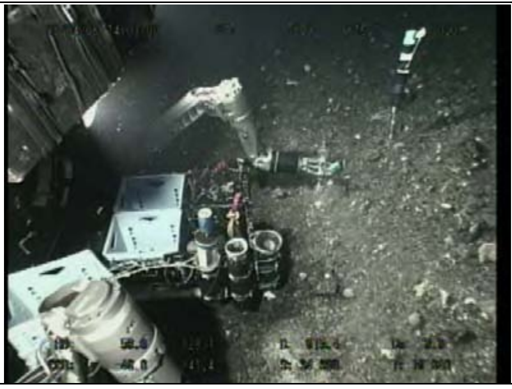
Objectives: Understanding the evolution of the ridge. This topography is thought to be volcanic origin which is related with rifting of oceanic plate. Sampling rocks of the edifice is also one of the objectives.

	9:00 HD816-1 (1005 m bsl) Breccia composed of grayish coarse (a few to 10 cm size) grains. Unknown species. Try to set SAHF, but ended up to fault. Sampled a platy subrounded block, but broken to some pieces in a box (R01). Collected relatively coarse (lapilli size) grains using M-type sampler (M01).
	9:33 HD816-2 (990 m bsl) The surface is covered with lapilli size pyroclastic grains. Fine materials seems to be poor.. A subangular block was sampled (R02).

	9:40 HD816-3 (964 m bsl) Grain size increases with distance from the start point. A subrounded block was sampled from breccia (R03). Another one of >30 cm in size was sampled (R04).
	9:54 HD816-4 (909 m bsl) The seafloor consists of sand to lapilli size grains which increased in amount. Some larger bombs or blocks are scattered every several meters. Sampled a grayish subangular block (>30 cm in diameter), broken to pieces during sampling into the box (R05). Lapilli-size grains are also sampled (MBARI; S01).
	10:16 HD816-5 (879 m bsl) A lot of strange leaves on the floor consisting of breccia. A subangular block was sampled (R06) from the surface of lava(?) or breccia. Around here a lot of leaves setteled.
	10:27 HD816-6 (843 m bsl) On the top of the hill, but there may be some peaks. The floor seems to consist of loose basaltic fragments. A subrounded block (R07) and a subangular block (>30 cm in diameter; R08) were sampled.
	10:42 HD816-7 (822 m bsl) The seafloor composed of breccia with gentle slope. A subangular block with some leaves was sampled (R09).

Dive 6 (#817): Dive on the N-S aligned ridge to the west of Myojinsho caldera from the foot up to the summit of the ridge. The point of this dive is shallower than that of Dive HD816, and thus the thickness of the crust would be thicker (Apr. 6, 2008).

Objectives: Understanding the evolution of the ridge. This topography is thought to be volcanic origin which is related with rifting of oceanic plate. Sampling rocks of the edifice is also one of the objectives.

	13:45 HD817-1 (614 m bsl) Sand to gravel size grain is dominant with some scattering angular blocks. SAHF measurement was also executed. Two angular lava fragments were sampled (R01-R02). Sand to gravel size materials are sampled (M01).
	14:37 HD817-2 (566 m bsl) Although sand to gravel size materials still scatter around, breccia is dominant here. An angular lava block was sampled (R03). After some tries, another sample, a fragment of a breccia, was sampled (R04).
	14:53 HD817-3 (497.5 m bsl) Sand to gravel size materials cover the surface with breccia. Two angular lava fragments were sampled (R05, R06).
	15:00 HD817-4 (460 m bsl) Almost at the top of the hill or cone. Many cracks, gullies and depressions appeared. They seem to be aligned N-S direction. A platy subangular lava block was sampled, but broken to pieces in the box (R07).

	15:17 HD817-5 (468 m bsl) Along the top of the ridge. Gravel to block size lava is dominant. Large irregular shape lava blocks sometimes appear. An angular lava was sampled (R08).
	15:28 HD817-6 (491 m bsl) Going down the slope then climb another peak again. Small to medium size lava fragments scatter on the flat surface (surface of a lava flow?) with many corals. A subangular lava block was sampled (R09).
	15:46 HD817-7 (479 m bsl) Seafloor is covered with fragments of lava, but large blocks are few. Then, reached another peak or lava flow. The number of coral decreased. Massive subangular lava blocks were sampled (R10, R11).
	16:10 HD817-8 (500 m bsl) Massive lava field covered with irregular shape small to medium size lava blocks (Row of agglutinate blocks?). Tried sampling some times, but one subangular lava block was sampled (R12; >30 cm).
	16:24 HD817-9 (469 m bsl) Still irregular shape small to medium size lava blocks cover the surface. Fissure-like structure appears. A subrounded lava block and a subangular block of lava were sampled (R13, R14).

	16:46 HD817-10 (422 m bsl) Section of agglutinate appears in between segmented aggulutinate blocks. A fragment of aggulutinate was sampled (R15).
	16:58 HD817-11 (425 m bsl) Massive agglutinate blocks scattered (>m size). A part of agglutinate was sampled from a flat surface block (R16).

4-5. Representative columnar sections

Dive 1 (#812): E slope of Myojinsho

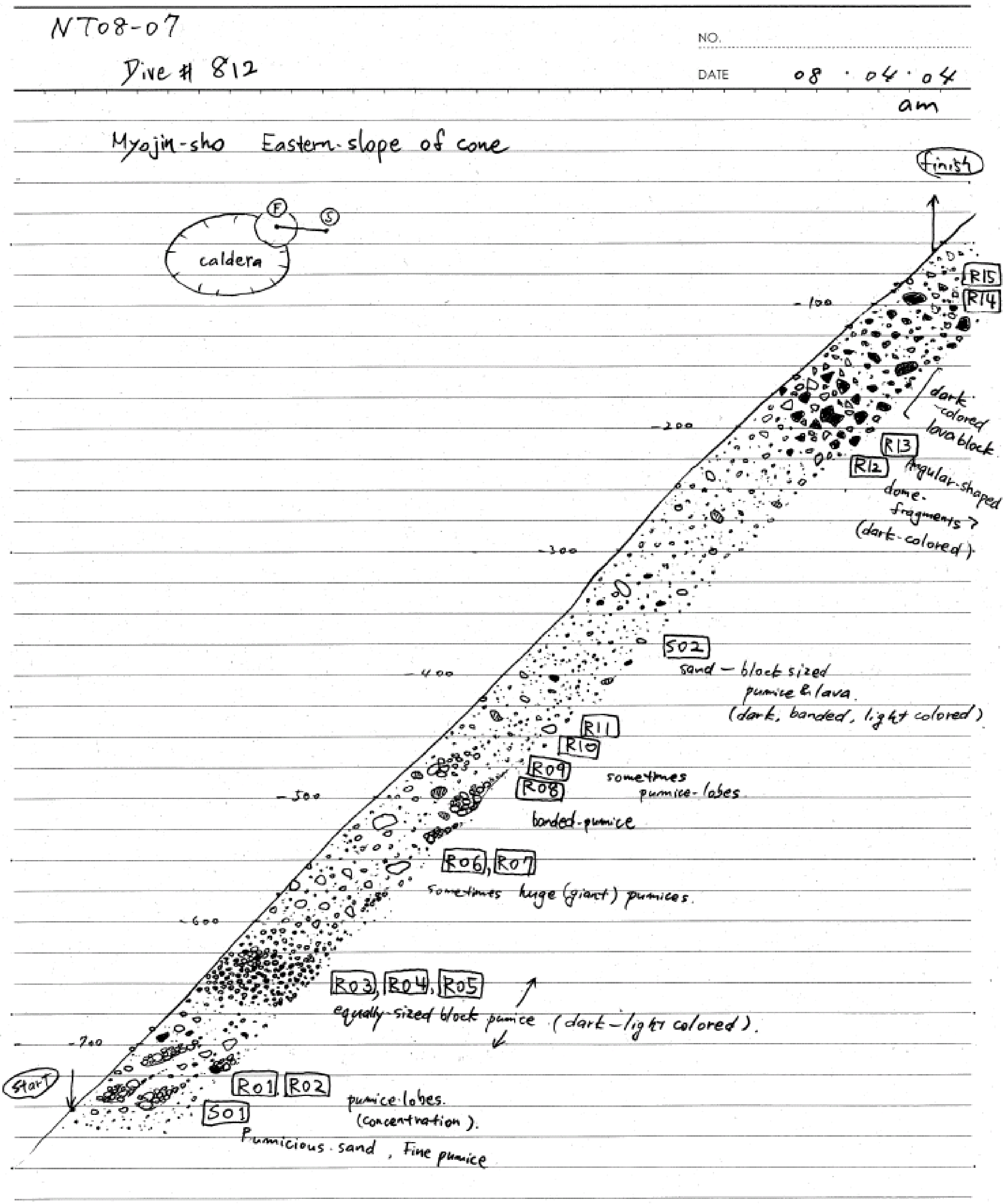


Fig. 4-8 **Representative columner section of HD#812**

Dive 2 (#813): W wall of Myojinsho caldera

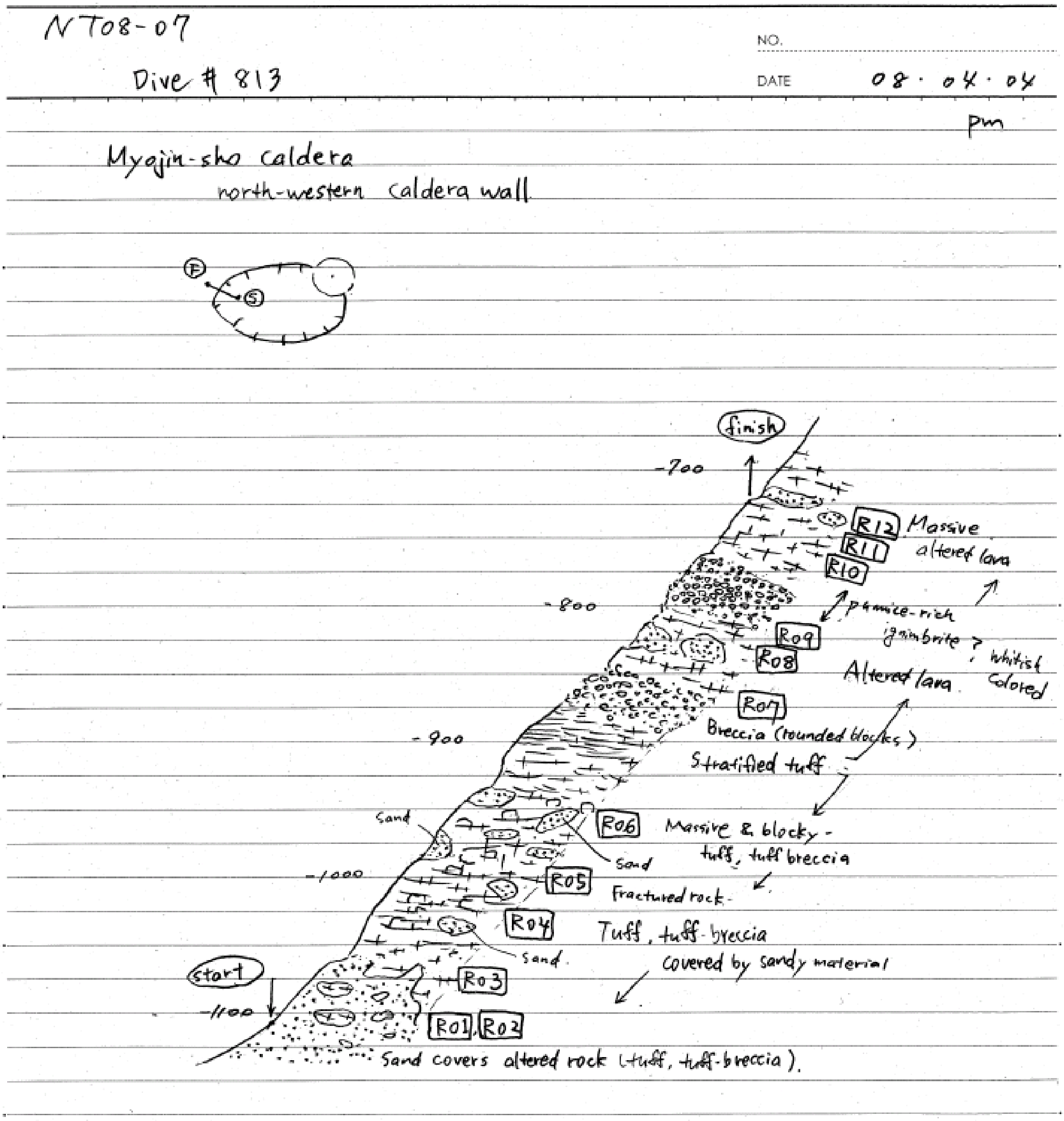


Fig. 4-9 **Representative columner section of HD#813**

Dive 3 (#814): W cliff of the re-entrant on the south side of the edifice of Myojinsho caldera

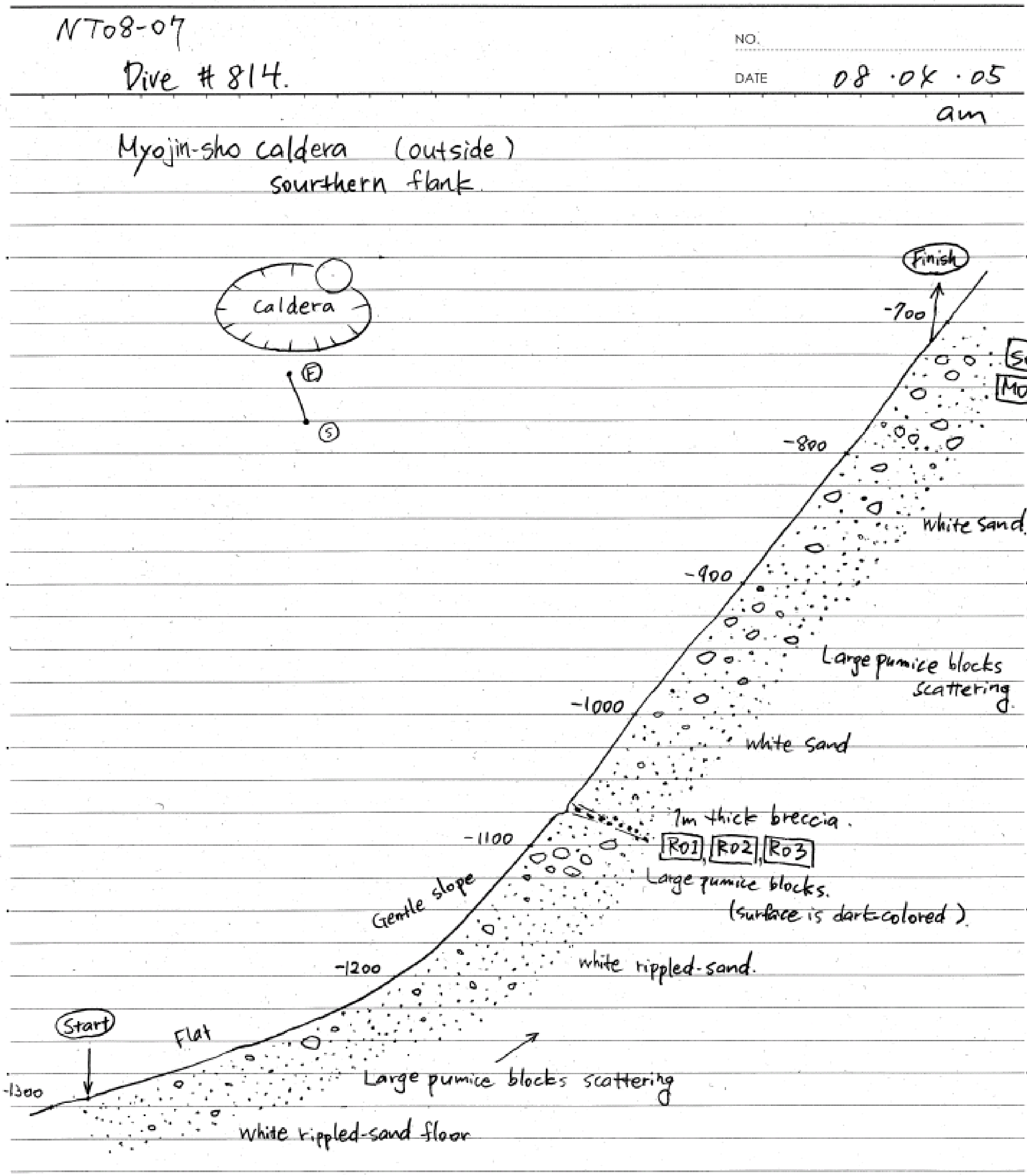


Fig. 4-10 **Representative columner section of HD#814**

Dive 4 (#815): N wall of Myojinsho caldera

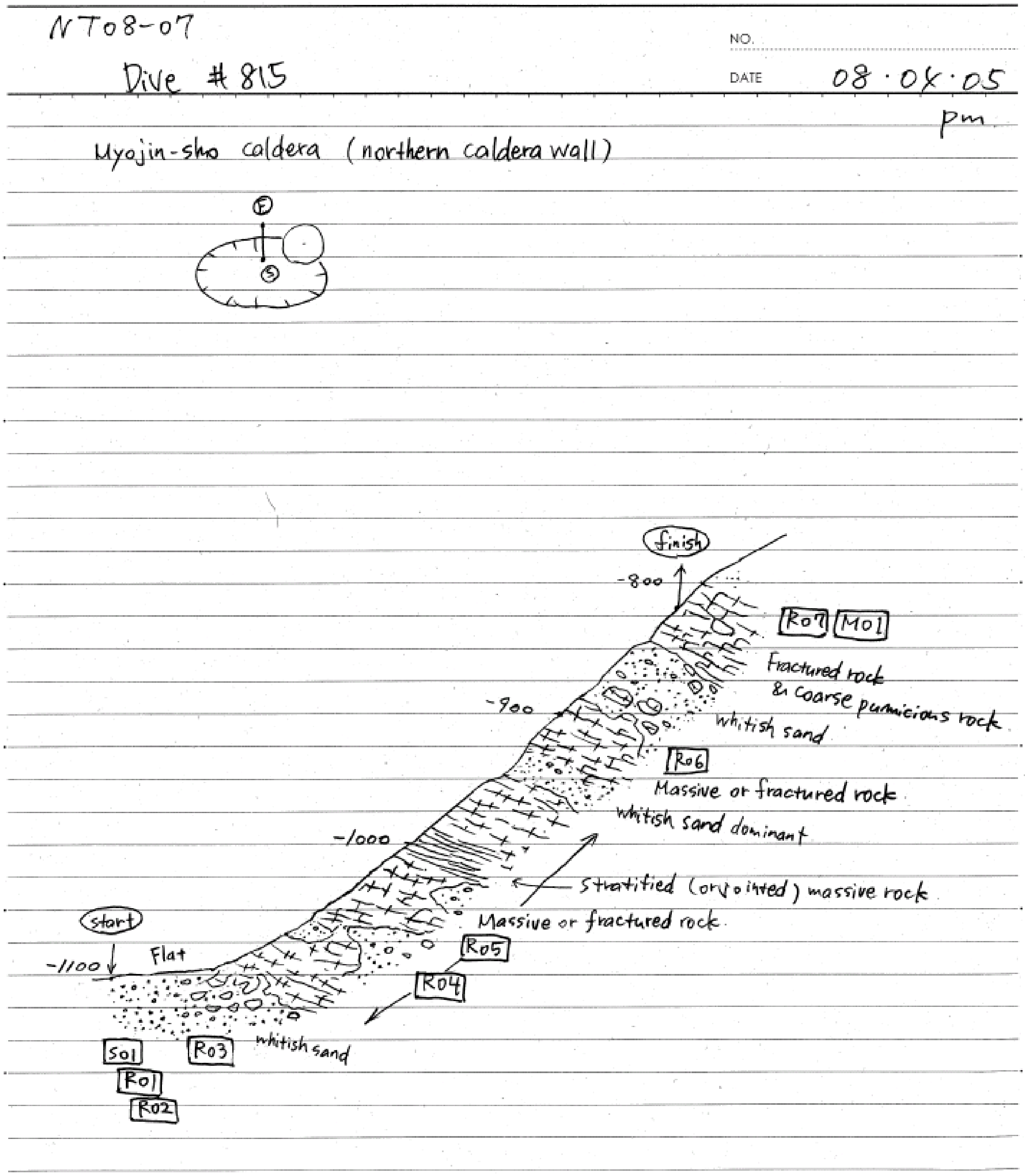


Fig. 4-11 **Representative columner section of HD#815**

Dive 5 (#816): N-S ridge to the west of Myojinsho caldera (across the ridge)

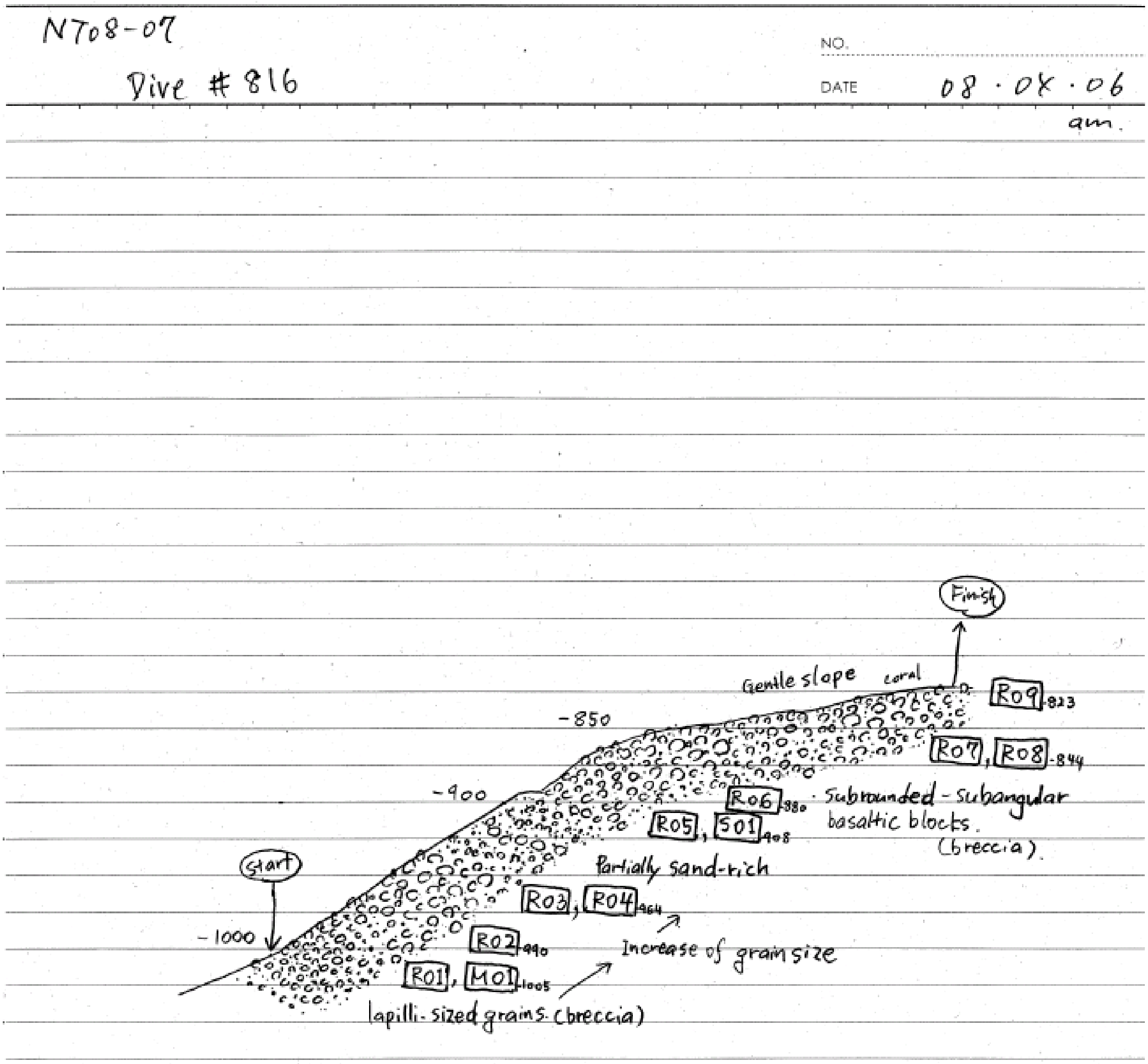


Fig. 4-12 **Representative columner section of HD#816**

Dive 6 (#817): N-S ridge to the west of Myojinsho caldera (along the axis)

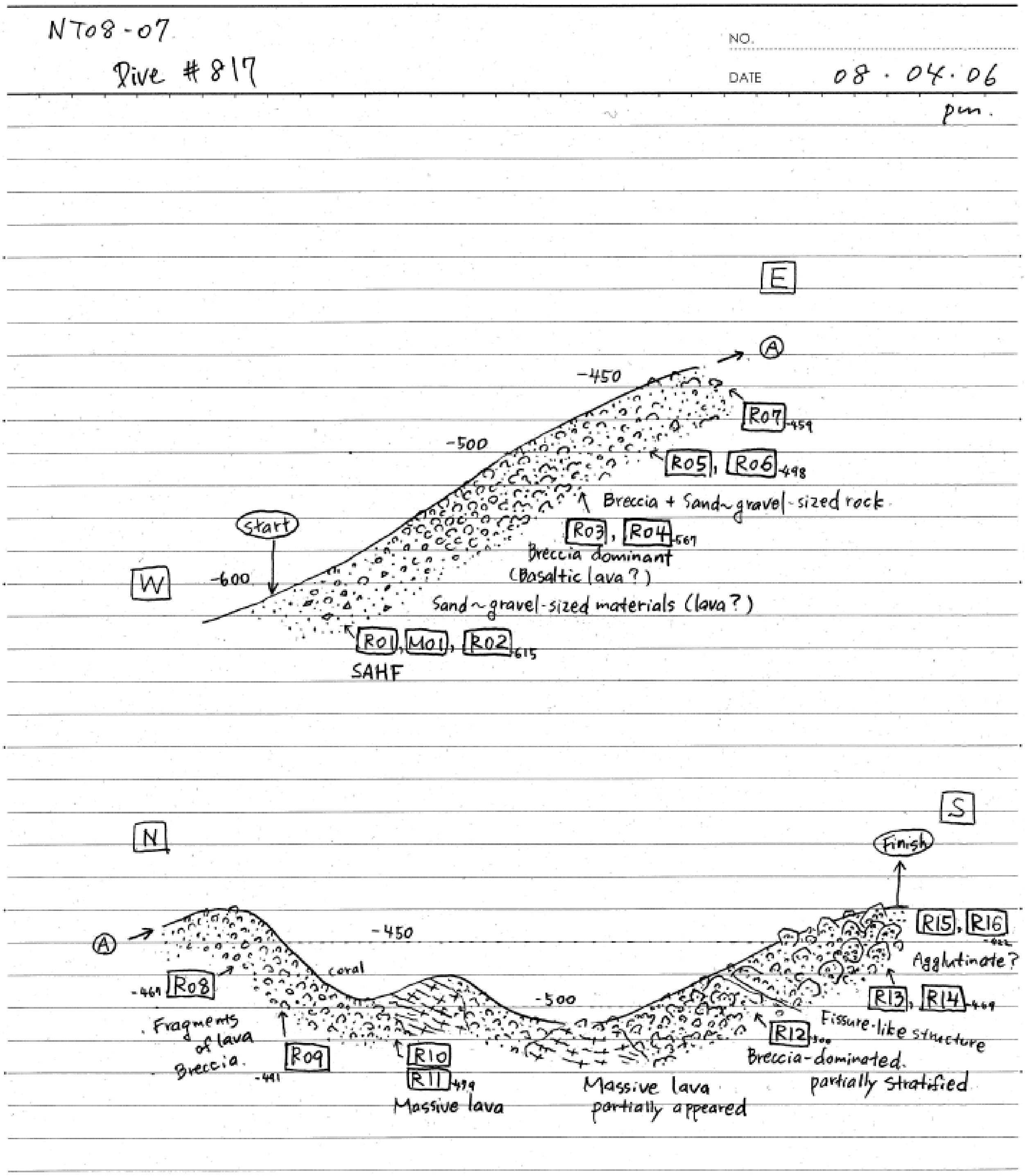


Fig. 4-13 **Representative columner section of HD#817**

4-6. New topographic map

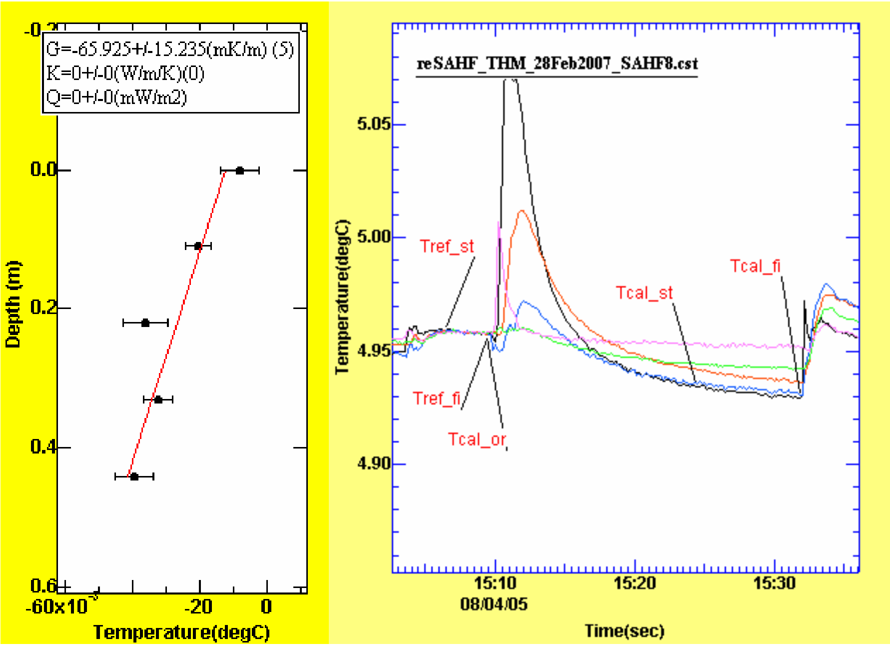
West of Myojinsho Caldera

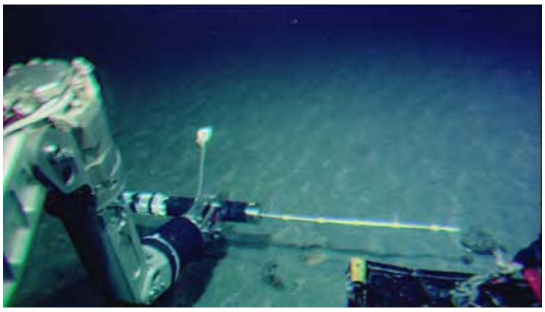
Most of the survey area had been covered by recent Seabat operation. In this cruise, only a small portion of the scheduled area was surveyed.

4-7. Heat flow measurements by SAHF

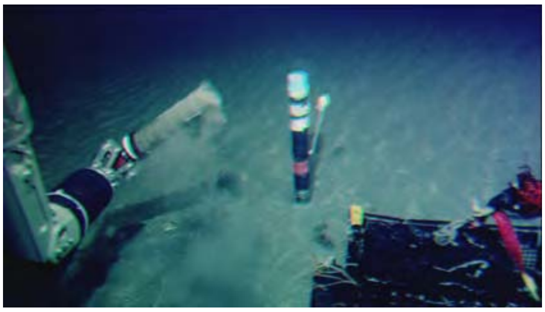
Northern part of the Myojinsho caldera floor (HD815)

Date	2008/4/5
Area	Myojinsho caldera floor
Lat.(N)	31° 54.598'
Lon.(E)	139° 58.502'
Depth (m)	1109
Measurement (W.Temp.)	15:12 - 15:32 (15:05 - 15:10)
Used themistors	#1 - #5
Facies	M.S.
Geotherm (mK/m)	**-65.925 +/- 15.235**





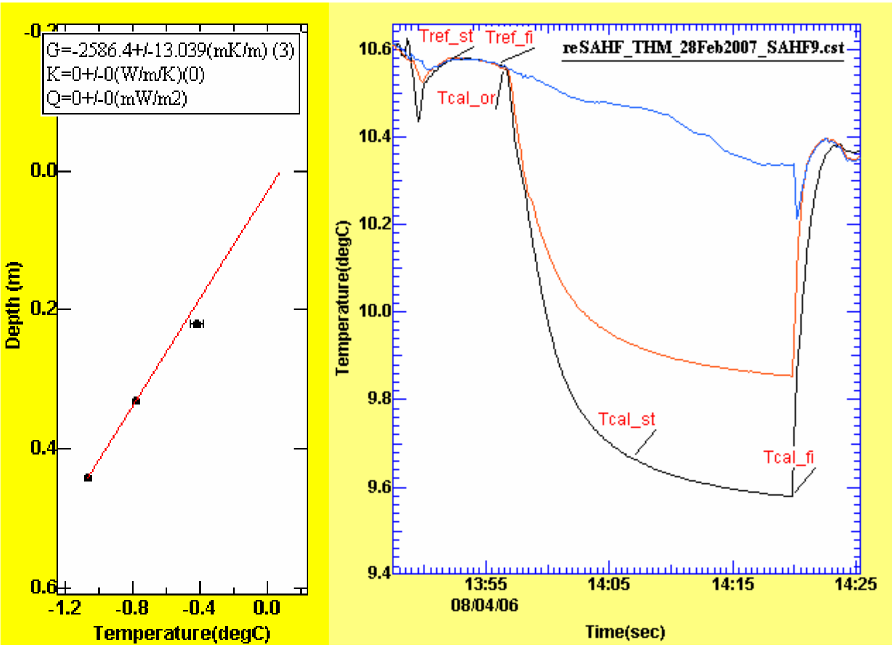
Water temperature measurement

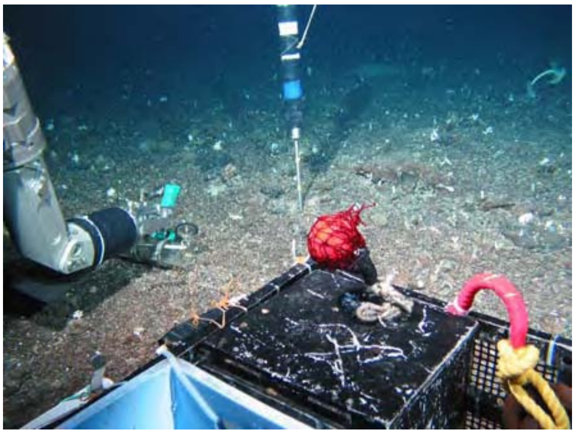


Core sampling and HF measurement

N-S ridge to the west of Myojinsho caldera (HD817)

Date	2008/4/6
Area	Ridge west to the Myojinsho volcano
Lat.(N)	31° 48.790'
Lon.(E)	139° 47.591'
Depth (m)	614
Measurement (W.Temp.)	13:59-14:19 (13:50-13:55)
Used themistors	#1 - #3
Facies	C.S.
Geotherm (mK/m)	**-2586.4 +/- 13.039**





Core sampling and HF measurement

Preliminary interpretation of the results

The two heat flow measurements conducted at Myojinsho caldera floor and at the ridge to the west of Myojinsho volcano both showed negative geotherms. The negative geotherm observed in heat flow measurement at a shallow seafloor is generally attributed to a fluctuation of the water temperature. The temperature gradients in two sites were too small to overcome the effect from the water temperature fluctuation.

4-8. SCS survey

We conducted three lines of SCS surveys (Fig. 4-13). Results are as follows.

Line A

The survey traverses from WNW to ESE of Myojinsho cutting across North Beyonnaise caldera and Myojinsho caldera.

Line B-1

The survey traverses from W to E, crossing across the southern part of the N-S ridge and Myojinsho caldera

Line B-2

The survey traverses from SSE to NNW, crossing across the center of Myojinsho caldera to the center of Myojin knoll from S to N.

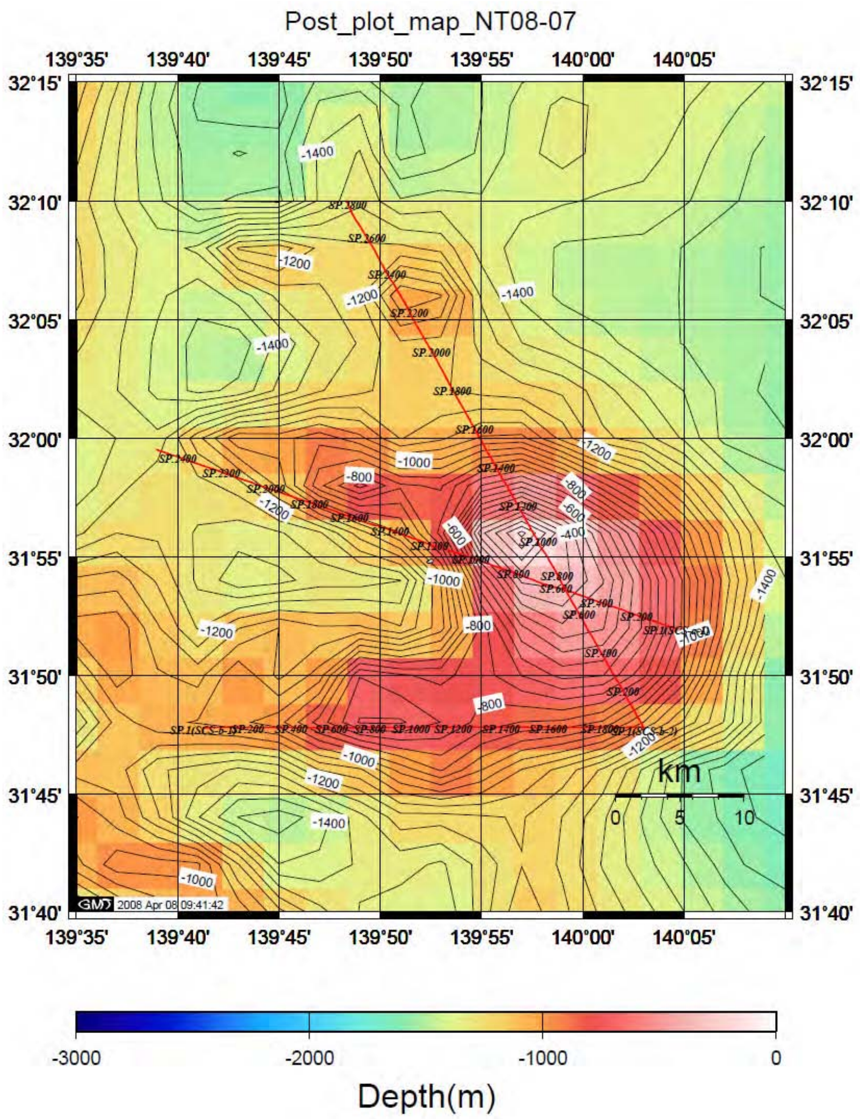
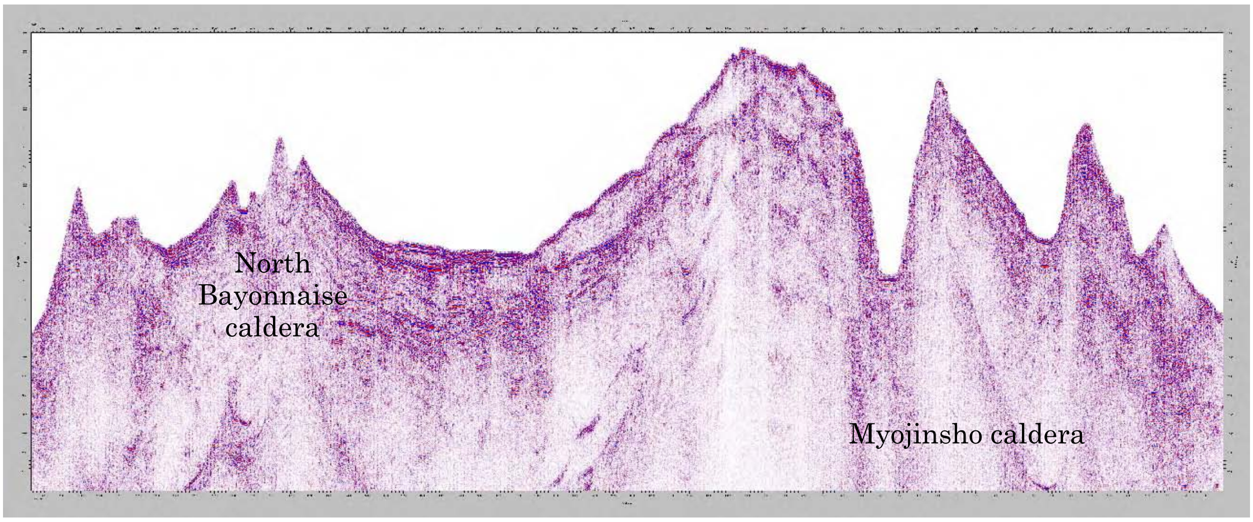
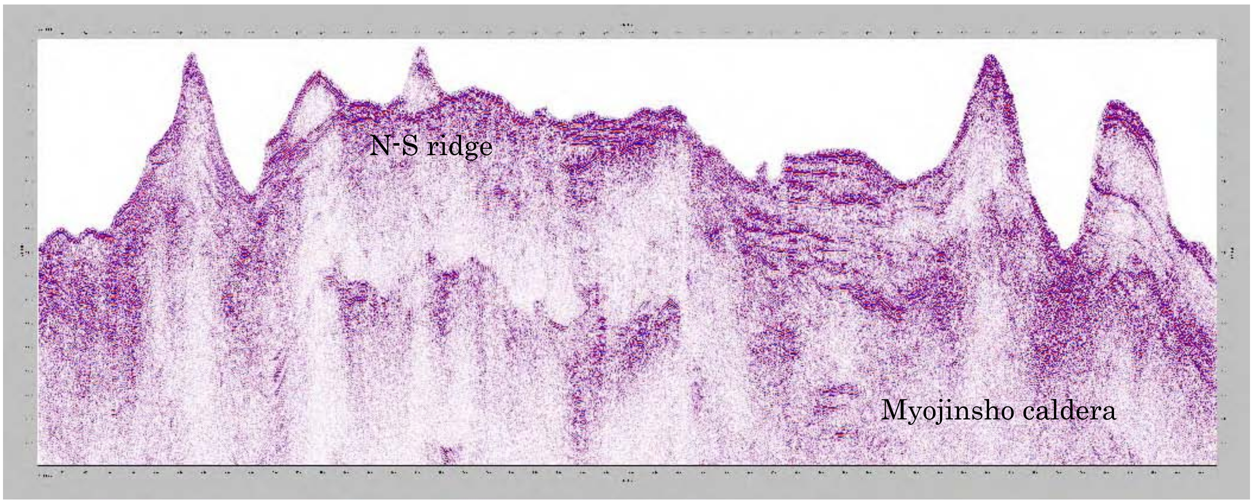


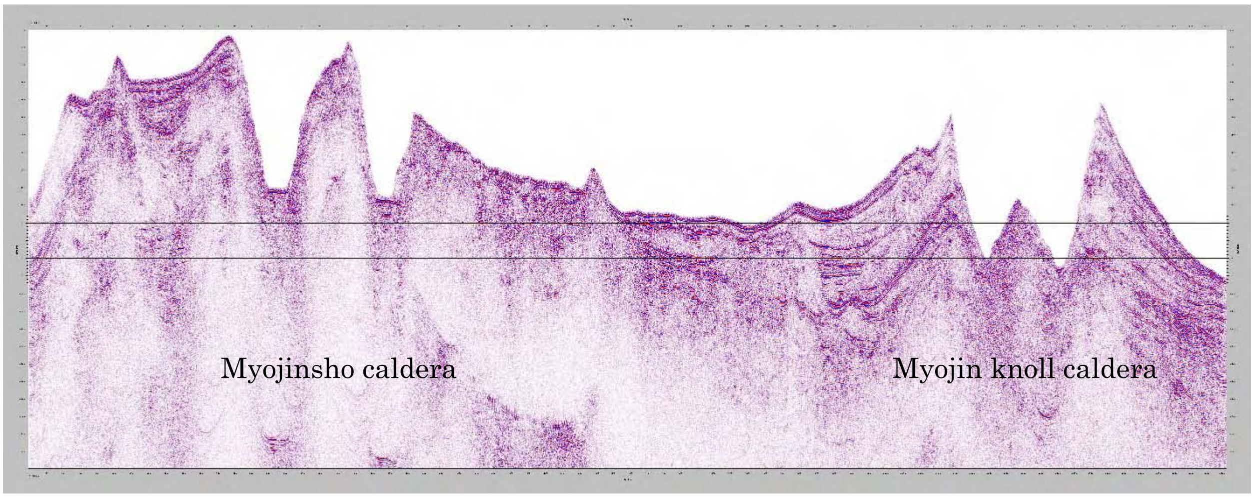
Fig. 4-14 The index map of the SCS sections of Myojinsho caldera area.



Line A The section from NW (left) to SE (right). Right hand side half of the figure is the section of Myojinsho caldera crossing the central edifice.



Line B-1 The section from W (left) to E (right) crossing southern part of the surveyed area. The shallowest peak among the three peaks in the left hand side is the pyroclastic cone along the N-S trending ridge.



Line B-2 The section from SSE (left) to NNW (right) crossing Myojinsho caldera on the left hand and Myojin knoll caldera on the right side.

Fig. 4-15 Results of SCS surveys.

5. FUTURE SCHEDULE

5-1. Recent eruptions of Myojinsho

This is the second submersible operation of Myojinsho volcano. First of all, we had few sign of activity probably because we could not reach active vent at the summit. However, the present state of activity seems not so quiet, although discolored seawater has not been witnessed for years. This is because the echo gram showed some signs of anormaly above the summit during Dive HD620 in December, 2006 (Fig. 5-1) when the ship crossed above the summit of Myojinsho, which we interpret as rising bubbles. We should be watching for the activity in the future.

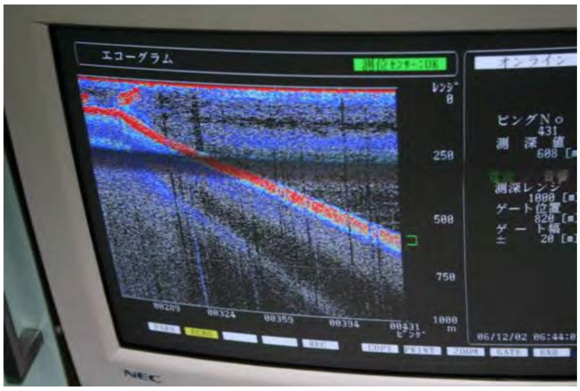


Fig. 5-1 Echogram of the ship Natsushima which shows anormaly above the summit of Myojinsho during the cruise NT06-21 (top left).

As for the topography and the deposit on the eastern slope of Myojinsho, There have been similar characteristic features to those on the northern slope where we observed two years ago. On the slope (farther than ca. 500 m from the summit), there were some lobate topographic structures with a lot of decimeter size pumices covering the surface. They may be a kind of deposits by gravity currents. In addition, the pumices in these deposits changed from white pumice at depth to banded pumice at shallower level. Then near the summit (closer than ca. 500 m to the summit), most lobate deposits consist of angular lava blocks, and some of the blocks are red implying oxidation in the air. These observations may indicate that there are two different modes of deposition, and the travel distance possible for each mode is different. The two depositional facies can be also correlated with two types of phenomena with eye-witness accounts during the 1952-53 eruption; Cock's tail jets and base surges. All the trajectories of the cock's tail jets are confined to within ca. 500 m from the center of the explosion. In contrast, base surges travel farther than 500 m. To constrain more strictly the depositional mechanism that worked, we are going to investigate physical characteristics of pumice samples we collected in this cruise.

We are also planning to carry out chemical analysis to identify the essential products of the recent eruption (ex. the 1952-53 and the 1970 eruption), and textural analysis to investigate vesiculation processes of these eruptions. We are successful in sampling fresh pumice blocks during this cruise for these analyses.

5-2. Caldera forming eruption of Myojinsho caldera

Through the last cruise (NT06-21) we had two dives for caldera wall survey; at SW wall and at SE wall. As a result we have found some candidate pyroclastic fall units at these two sites that might have erupted during caldera formation. In this cruise we observed similar pumice deposits on the top of caldera wall (W and N wall). We correlate them in terms of sequential relation and they all seem to deposit at depth around 500 m to 300 m bsl. To confirm this, we will execute chemical composition analysis, and petrological and morphological characterization of the pyroclasts that we sampled in this cruise.

On the other hand, the mechanism by which central edifice was generated is one of the topics to understand dynamics of caldera formation. In this cruise, we could not have dives for the central edifice. What we found on the western cliff of the edifice in the last cruise was very similar to those found on the caldera wall. The deposit was almost totally altered and stratified from the caldera floor up to ca. 300 m below the top. Some altered rocks have pyrite. This means that this edifice is not a lava dome or post-caldera cone itself, but stratified structure similar to the caldera wall and flat-topped morphology of the edifice indicate that the central edifice is a criptdome or a remnant of pre-caldera edifice of Myojinsho caldera. The alteration of lavas may imply the heat source below the bottom of the caldera, and the existence of criptdome beneath the caldera floor. We have not yet found any essential materials of the lava dome, but the SCS survey crossing the edifice shows stratified reflecting layers only in the very shallow part of the edifice, and this is in favor for the existence of the criptdome. We are now investigating the samples obtained in the last cruise to check if the sequence of the central edifice and the caldera wall can be really correlated in terms of chemical analysis and stratigraphy.

5-3. Evolution of Myojinsho caldera

We had two dives for the walls of Myojinsho caldera and one for the outer side of the edifice during this cruise. At the W wall, vertical section of the edifice of Beyonnaise rocks is expected. At the N wall, vertical section of the edifice without any peak is expected. These two sections on the caldera wall showed similar lithology and sequence as well as those of the SE and NW wall surveyed in the last cruise (NT06-21); alternation of altered lava and pyroclastic rocks. We will correlate the deposits on these walls by chemical and stratigraphical analyses. In addition, the chemical and petrological relationship among the rock samples collected in this cruise will be carried out to reconstruct chemical evolution of magma system in the whole history of Myojinsho caldera in conjunction with caldera formation.

6. SAMPLE LIST

6-1. Rock sample list

Dive# HD812	Date: 2008/4/4						Shape		62.3				
sample No.	latitude (N)	longitude (E)	depth (m)	rock type	shape	X (cm)	Y (cm)	Z (cm)	weight (kg)	colour	alteration	vesiculation	Memo
Dive# HD812-M01	31 ° 54.996 '	140 ° 2.408 '	753	Pumice							fresh	strong	pumice lapilli-sand
Dive# HD812-R01	31 ° 55.003 '	140 ° 2.361 '	731	Pumice	subangular	32	23	18	7.4		fresh	strong	banded pumice
Dive# HD812-R02	31 ° 55.003 '	140 ° 2.361 '	731	Lava	angular	19	14	15	3.8	black	fresh	weak	andesitic block
Dive# HD812-R03	31 ° 54.988 '	140 ° 2.208 '	650	Pumice	subangular	13	9	10	0.9	dark gray	fresh	strong	banded pumice
Dive# HD812-R04	31 ° 54.988 '	140 ° 2.208 '	650	Lava	subangular	11	8	7	0.7	dark gray	weak	weak	dense andesitic rock
Dive# HD812-R05	31 ° 54.988 '	140 ° 2.208 '	650	Lava	subangular	16	14	13	3.2	dark gray	weak	weak	dense andesitic block
Dive# HD812-R06	31 ° 54.987 '	140 ° 2.045 '	552	Pumice	subangular	14	9	5	0.3	brown	fresh	strong	porphyritic pumice
Dive# HD812-R07	31 ° 54.987 '	140 ° 2.045 '	552	Pumice	subangular	15	13	10	1.1	dark gray	fresh	moderate	dark inside, pale inside
Dive# HD812-R08	31 ° 54.99 '	140 ° 1.926 '	475	Pumice	subrounded	16	15	13	1.5	gray	fresh	strong	porphyritic pumice
Dive# HD812-R09	31 ° 54.99 '	140 ° 1.926 '	475	Pumice	subangular	30	30	25	18.5	pale gray	fresh	strong	dacitic pumice
Dive# HD812-R10	31 ° 55.001 '	140 ° 1.895 '	454	Lava	subangular	13	11	10	1.2	gray	weak	weak	dense andesitic block
Dive# HD812-R11	31 ° 55.001 '	140 ° 1.895 '	454	Pumice	angular	35	30	24	15.5	white	fresh	strong	banded pumice
Dive# HD812-SC01	31 ° 55.013 '	140 ° 1.75 '	350	Pumice							fresh		MBARI
Dive# HD812-R12	31 ° 55.018 '	140 ° 1.545 '	202	Lava	angular	16	15	7	1.7	gray	fresh	weak	dense lava
Dive# HD812-R13	31 ° 55.108 '	140 ° 1.545 '	202	Lava	angular	24	15	12	3	gray	fresh	weak	prizmatic joint, uncut
Dive# HD812-R14	31 ° 55.039 '	140 ° 1.389 '	80	Lava	angular	20	13	12	2.2	dark gray	fresh	weak	dacite block, prizmatic joint
Dive# HD812-R15	31 ° 55.039 '	141 ° 1.389 '	80	Lava	angular	15	13	10	1.3	gray	fresh	weak	dacite, prizmatic joint

Dive# HD813	Date: 2008/4/4						Shape		76.2				
sample No.	latitude (N)	longitude (E)	depth (m)	rock type	shape	X (cm)	Y (cm)	Z (cm)	weight (kg)	colour	alteration	vesiculation	Memo
Dive# HD813-R01	31 ° 53.811 '	140 ° 57.229 '	1109	Lava	subangular	12	12	7	0.9	gray	altered	weak	
Dive# HD813-R02	31 ° 53.811 '	140 ° 57.229 '	1109	Breccia	subangular	37	28	13	11	gray	altered	weak	
Dive# HD813-R03	31 ° 53.818 '	140 ° 57.207 '	1079	Breccia	subangular	24	17	16	4.5	pale gray	altered	weak	pale green
Dive# HD813-R04	31 ° 53.814 '	140 ° 57.177 '	1039	Breccia	subrounded	46	20	19	14.5	pale gray	altered	weak	pale green
Dive# HD813-R05	31 ° 53.816 '	140 ° 57.161 '	1012	Breccia	subangular	28	18	8	3.5	brown	altered	weak	brown-green, beachrock?
Dive# HD813-R06	31 ° 53.826 '	140 ° 57.129 '	961	Breccia	subrounded	40	28	19	14	brown	altered	weak	yellowish brown
Dive# HD813-R07	31 ° 53.854 '	140 ° 57.056 '	850	Lava	subangular	16	11	9	1.8	black	weak	weak	dacitic lava
Dive# HD813-R08	31 ° 53.872 '	140 ° 56.988 '	831	Lava	subangular	24	22	18	9.2	dark gray	weak	weak	pre-cut photo wrong label
Dive# HD813-R09	31 ° 53.871 '	140 ° 56.961 '	819	Lava	subrounded	18	17	10	3.1	dark gray	weak	weak	lava block
Dive# HD813-R10	31 ° 53.899 '	140 ° 56.926 '	726	Lava	rounded	24	20	19	11.5	gray	weak	weak	porphyritic lava block
Dive# HD813-R11	31 ° 53.899 '	140 ° 56.926 '	726	Lava	subangular	9	9	4	0.5	black	weak	weak	andesitic lava block
Dive# HD813-R12	31 ° 53.899 '	140 ° 56.926 '	726	Lava	subrounded	15	11	7	1.7	dark gray	weak	weak	dacite lava block

Dive# HD814	Date: 2008/4/5					Shape			0.5				
sample No.	latitude (N)	longitude (E)	depth (m)	rock type	shape	X (cm)	Y (cm)	Z (cm)	weight (kg)	colour	alteration	vesiculation	Memo
Dive# HD814-R01	31 ° 47.217 '	139 ° 59.428 '	1101	Pumice	subangular								lost
Dive# HD814-R02	31 ° 47.217 '	139 ° 59.428 '	1101	Pumice	subangular								lost
Dive# HD814-R03	31 ° 47.217 '	139 ° 59.428 '	1101	Pumice	subangular								lost
Dive# HD814-R04	31 ° 47.374 '	139 ° 59.135 '	888	Pumice	angular	9	8	6	0.3	gray	fresh	strong	several grains
Dive# HD814-R05	31 ° 47.485 '	139 ° 58.941 '	709	Pumice	subrounded	10	6	6	0.2	pale gray	weak	strong	part of a large pumice
Dive# HD814-S01	31 ° 47.485 '	139 ° 58.941 '	709	Pumice	subrounded					pale gray	fresh	strong	same as R05
Dive# HD814-M01	31 ° 47.485 '	139 ° 58.941 '	709	Pumice	subangular					brown	moderate	strong	on the floor

Dive# HD815	Date: 2008/4/5					Shape			28.2				
sample No.	latitude (N)	longitude (E)	depth (m)	rock type	shape	X (cm)	Y (cm)	Z (cm)	weight (kg)	colour	alteration	vesiculation	Memo
Dive# HD815-S01	31 ° 54.598 '	139 ° 58.502 '	1108							gray	weak	strong	gray sand
Dive# HD815-R01	31 ° 54.598 '	139 ° 58.502 '	1108	Pumice	subangular	17	13	7	0.9	gray	weak	strong	porphyritic
Dive# HD815-R02	31 ° 54.598 '	139 ° 58.502 '	1108	Pumice	angular	17	11	10	0.7	white	fresh	weak	dense but vesiculated
Dive# HD815-R03	31 ° 54.719 '	139 ° 58.518 '	1100	Pumice	angular	39	28	19	18.5	ark gra	weak	moderate	concentric structure
Dive# HD815-R04	31 ° 54.744 '	139 ° 58.521 '	1081	Pumice	subrounded	20	15	13	2.8	gray	weak	weak	porphyritic, dense
Dive# HD815-R05	31 ° 54.761 '	139 ° 58.524 '	1058	Lava	angular	16	15	10	3.1	gray	weak	weak	dense block dacite
Dive# HD815-R06	31 ° 54.84 '	139 ° 58.563 '	918	Pumice	subrounded	20	15	13	2	ark gra	fresh	strong	porphyritic
Dive# HD815-R07	31 ° 54.953 '	139 ° 58.597 '	823	Pumice	subangular	9	6	7	0.2	gray	fresh	moderate	banded; grey&white
Dive# HD815-M01	31 ° 54.953 '	139 ° 58.597 '	823							brown	weak	strong	brown fine silt

Dive# HD816	Date: 2008/4/6					Shape			76.6				
sample No.	latitude (N)	longitude (E)	depth (m)	rock type	shape	X (cm)	Y (cm)	Z (cm)	weight (kg)	colour	alteration	vesiculation	Memo
Dive# HD816-R01	31 ° 51.708 '	139 ° 47.902 '	1004	Lava	subangular	39	33	12	11.5	black	weak	weak	lava crust
Dive# HD816-M01	31 ° 51.708 '	139 ° 47.902 '	1004									strong	
Dive# HD816-R02	31 ° 51.72 '	139 ° 47.932 '	990	Lava	subangular	31	28	16	10.2	black	moderate	weak	lava breccia
Dive# HD816-R03	31 ° 51.731 '	139 ° 47.961 '	964	Scoria	subangular	16	14	7	1.7	black	weak	moderate	bomb
Dive# HD816-R04	31 ° 51.731 '	139 ° 47.961 '	964	Lava	subangular	28	25	14	8	black	weak	weak	lava breccia
Dive# HD816-R05	31 ° 51.746 '	139 ° 48.019 '	909	Scoria	subangular	28	27	20	9.9	brown	weak	moderate	bomb
Dive# HD816-S01	31 ° 51.746 '	139 ° 48.019 '	909										
Dive# HD816-R06	31 ° 51.758 '	139 ° 48.078 '	879	Lava	subangular	27	20	15	7	black	weak	weak	lava breccia
Dive# HD816-R07	31 ° 51.784 '	139 ° 48.126 '	844	Lava	subrounded	24	16	16	8.6	black	weak	weak	
Dive# HD816-R08	31 ° 51.784 '	139 ° 48.126 '	844	Lava	subangular	37	25	17	9.7	black	weak	moderate	bomb or lava breccia
Dive# HD816-R09	31 ° 51.768 '	139 ° 48.164 '	823	Scoria	subangular	22	18	17	10	black	weak	weak	bomb basaltic

Dive# HD817 Date: 2008/4/6 Shape 58

sample No.	latitude(N)	longitude(E)	depth (m)	rock type	shape	X (cm)	Y (cm)	Z (cm)	weight (kg)	colour	alteration	vesiculation	Memo
Dive# HD817-R01	31 ° 48.79 '	139 ° 47.591 '	615	Lava	angular	30	18	14	5.2	dark gray	weak	weak	lava fragment
Dive# HD817-M01	31 ° 48.79 '	139 ° 47.591 '	615									strong	gray sand
Dive# HD817-R02	31 ° 48.79 '	139 ° 47.591 '	615	Lava	angular	22	17	11	3.2	dark gray	weak	weak	lava block
Dive# HD817-R03	31 ° 48.829 '	139 ° 47.79 '	567	Lava	subangular	16	15	11	2.2	dark gray	weak	weak	lava block
Dive# HD817-R04	31 ° 48.829 '	139 ° 47.79 '	567	Scoria	subangular	12	11	5	0.5	brown	weak	moderate	bomb? Spatter?
Dive# HD817-R05	31 ° 48.841 '	139 ° 47.889 '	498	Scoria	subangular	14	15	7	1	brown	weak	weak	spatter?
Dive# HD817-R06	31 ° 48.841 '	139 ° 47.889 '	498	Lava	angular	14	12	10	1.7	gray	weak	none	lava
Dive# HD817-R07	31 ° 48.843 '	139 ° 47.952 '	459	Scoria	subangular	28	23	16	6	brown	altered	moderate	spatter?
Dive# HD817-R08	31 ° 48.705 '	139 ° 47.988 '	468	Lava	subangular	21	12	8	1.5	gray	weak	weak	lava block
Dive# HD817-R09	31 ° 48.619 '	139 ° 47.991 '	491	Scoria	subangular	27	24	15	6	brown	altered	weak	spatter
Dive# HD817-R10	31 ° 48.484 '	139 ° 47.996 '	479	Scoria	subrounded	20	16	13	2.5	gray	altered	moderate	bomb?
Dive# HD817-R11	31 ° 48.484 '	139 ° 47.996 '	479	Lava	subrounded	17	16	14	3.1	gray	altered	weak	lava block
Dive# HD817-R12	31 ° 48.367 '	139 ° 47.989 '	502	Scoria	subangular	35	32	19	15.3	dark gray	weak	weak	spatter or lava crust
Dive# HD817-R13	31 ° 48.31 '	139 ° 48.004 '	469	Lava	angular	21	14	13	2.6	dark gray	weak	weak	lava
Dive# HD817-R14	31 ° 48.31 '	139 ° 48.004 '	469	Lava	angular	23	20	18	6	gray	weak	weak	lava block
Dive# HD817-R15	31 ° 48.243 '	139 ° 48.013 '	422	Lava	subangular	13	10	9	1	gray	weak	weak	lava block
Dive# HD817-R16	31 ° 48.172 '	139 ° 48.016 '	425	Scoria	subangular	19	7	5	0.2	brown	altered	moderate	agglutinate?

6-2. Sample photo

HD812 Sample Photos (1/4)

HD812-R01

HD812-R01 cut

HD812-R02

HD812-R02 cut

HD812-R03

HD812-R03 cut

HD812-R04

HD812-R04 cut

HD812 Sample Photos (2/4)

HD812-R05

HD812-R05 cut

HD812-R06

HD812-R06 cut

HD812-R07

HD812-R07 cut

HD812-R08

HD812-R08 cut

HD812 Sample Photos (3/4)

HD812-R09

HD812-R09 cut

HD812-R10

HD812-R10 cut

HD812-R11

HD812-R11 cut

HD812-R12

HD812-R12 cut

HD812 Sample Photos (4/4)

HD812-R13

HD812-R14

HD812-R14 cut

HD812-R15

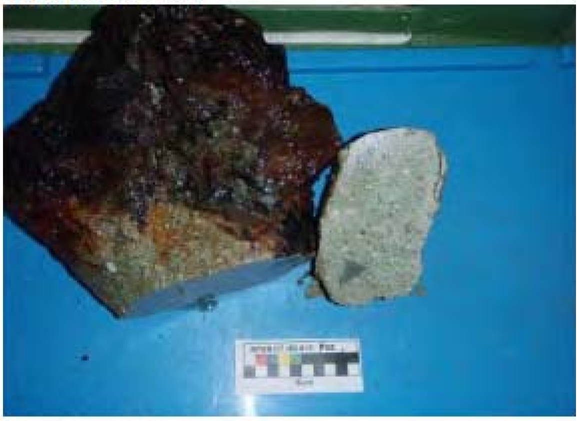
HD812-R15 cut

HD813 Sample Photos (1/3)

HD813-R01

HD813-R01 cut

HD813-R02



HD813-R02 cut

HD813-R03

HD813-R03 cut

HD813-R04

HD813-R04 cut

HD813 Sample Photos (2/3)

HD813-R05

HD813-R05 cut

HD813-R06

HD813-R06 cut

HD813-R07

HD813-R07 cut

HD813-R08

HD813-R08 cut

HD813 Sample Photos (3/3)

HD813-R09

HD813-R09 cut

HD813-R10

HD813-R10 cut

HD813-R11

HD620-R11 cut

HD813-R12

HD813-R12 cut

HD814 Sample Photos (1/1)

HD814-R04

HD814-R05

HD815 Sample Photos (1/2)

HD815-R01

HD815-R01 cut

HD815-R02

HD815-R02 cut

HD815-R03

HD815-R03 cut

HD815-R04

HD815-R04 cut

HD815 Sample Photos (2/2)

HD815-R05

HD815-R05 cut

HD815-R06

HD815-R07

HD816 Sample Photos (1/3)


HD816-R01


HD816-R01 cut


HD816-R02


HD816-R02 cut


HD816-R03


HD816-R03 cut


HD816-R04


HD816-R04 cut

HD816 Sample Photos (1/3)


HD816-R05


HD816-R05 cut


HD816-R06


HD816-R06 cut


HD816-R07


HD816-R07 cut


HD816-R08


HD816-R08 cut

HD816 Sample Photos (3/3)

HD816-R09

HD816-R09 cut

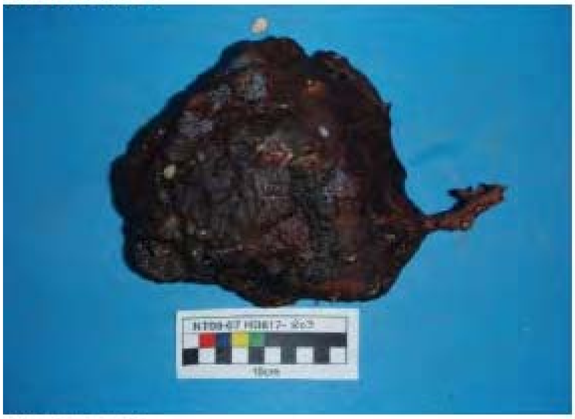
HD817 Sample Photos (1/4)

HD817-R01

HD817-R01 cut

HD817-R02

HD817-R02 cut



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HD817 Sample Photos (2/4)

HD817-R05

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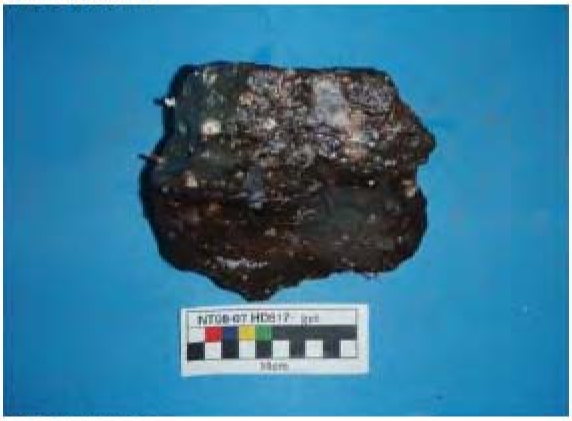

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HD817-R07

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HD817-R08

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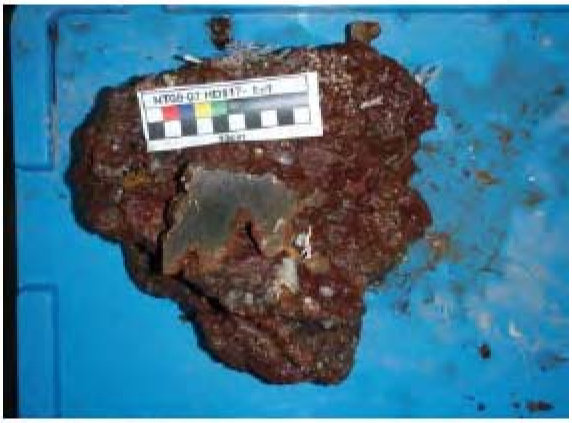
HD817 Sample Photos (3/4)

HD817-R09



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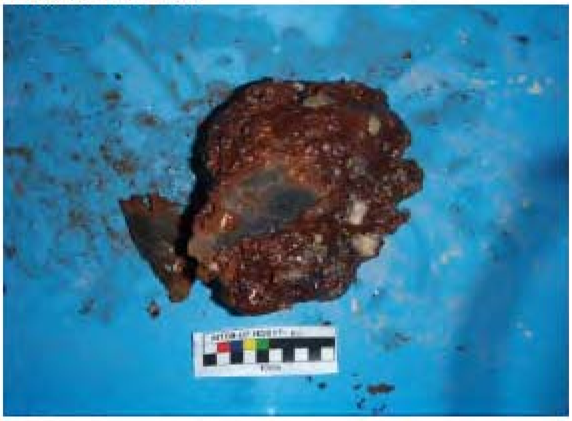

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HD817 Sample Photos (4/4)

HD817-R13

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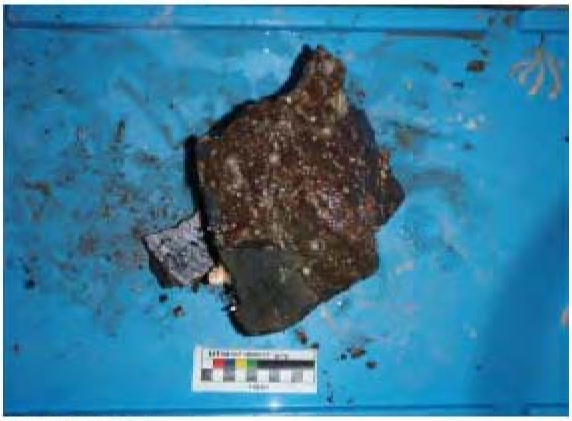
HD817-R14



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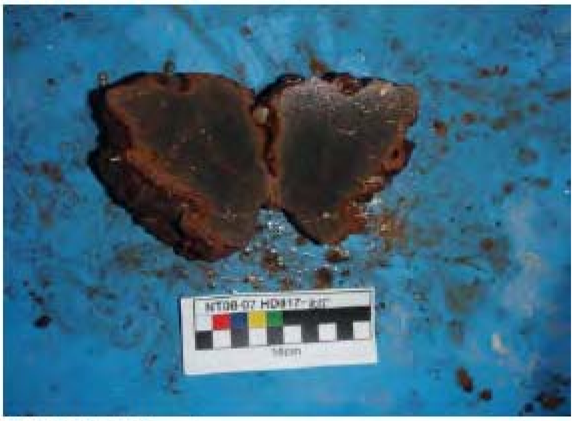

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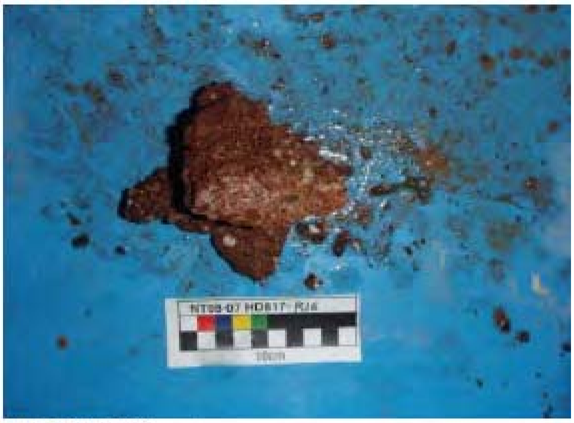

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2nd Officer	Isao Maeda
3rd Officer	Makoto Ohkubo
Chief Engineer	Tatsuo Jidouzono
1st Engineer	Masahiro Kajiwara
2nd Engineer	Yoshinobu Hiratsuka
Junior 2nd Engineer	Kazunori Noguchi
3rd Engineer	Takahiro Mori
Chief Radio Operator	Satoshi Watase
2nd Radio Operator	Hidehiro Itoh
3rd Radio Operator	Yosuke Komaki
Boat Swain	Kazuo Abe
Able Seamen	Tugimi Sasaki
Able Seamen	Kozo Yatogo
Able Seamen	Shuji Takuno
Able Seamen	Kazushiro Ohsako
Sailer	Hiroaki Murase
Sailer	Tomohiro Kimura
No.1 Oiler	Kouzou Miura
Oiler	Takaatsu Inomoto
Oiler	Shinji Maruyama
Oiler	Tatsuomi Chino
Oiler	Keiya Taniguchi
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Steward	Toshiharu Kishita
Steward	Shinsuke Tanaka
Steward	Yoshio Okada

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2ndSubmersible Staff	Shigeru Kikuya
3rd Submersible Staff	Tetsuya Ishizuka
3rd Submersible Staff	Katsushi Chiba
3rd Submersible Staff	Teppei Kido
3rd Submersible Staff	Yuta Sakakibara

Information for secondary use

This cruise report is a preliminary documentation as of the end of the cruise. It may not be corrected even if changes on content (i.e. taxonomic classifications) are found after publication. It may also be changed without notice. Data on the cruise report may be raw or not processed. Please ask the PI for the latest information before using.

Users of data or results of this cruise are requested to submit their results to Data Integration and Analysis Groupe (DIAG), JAMSTEC.

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Tables and figures

Abbreviation

HD: Hyper-Dolphin

JAMSTEC: Japan Agency for Marine-Earth Science and Technology

NT: Natsushima

ROV: Remotely Operated Vehicle

SAHF: Stand-Alone Heat Flow meter

SCS: Single Channel Seismic