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NATSUSHIMA NT15-E02 CRUISE REPORT

Tairiku Project: Geological and Petrological Research on Nishinoshima Volcano, Ogasawara Arc, Japan, by using Deep Ocean Floor Survey System DEEP TOW

June 11, 2015 -- June 21, 2015

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

1. Cruise Information

● Cruise ID: NT15-E02

● Name of vessel: Natsushima

● Title of the cruise: Tairiku Project: Geological and Petrological Research on Nishinoshima Volcano, Ogasawara Arc, Japan, by using Deep Ocean Floor Survey System DEEP TOW

● Representative of the Science Party [Affiliation] : Yoshihiko Tamura [ODS, JAMSTEC]

○ Title of proposal: Tairiku Project

● Cruise period： From June 11 to June 21, 2015

● Ports of departure: Yokosuka, JAMSTEC/ arrival: Yokosuka, HI Sumitomo

● Research area: Nishinoshima, Ogasawara Arc, Japan

● Research Map

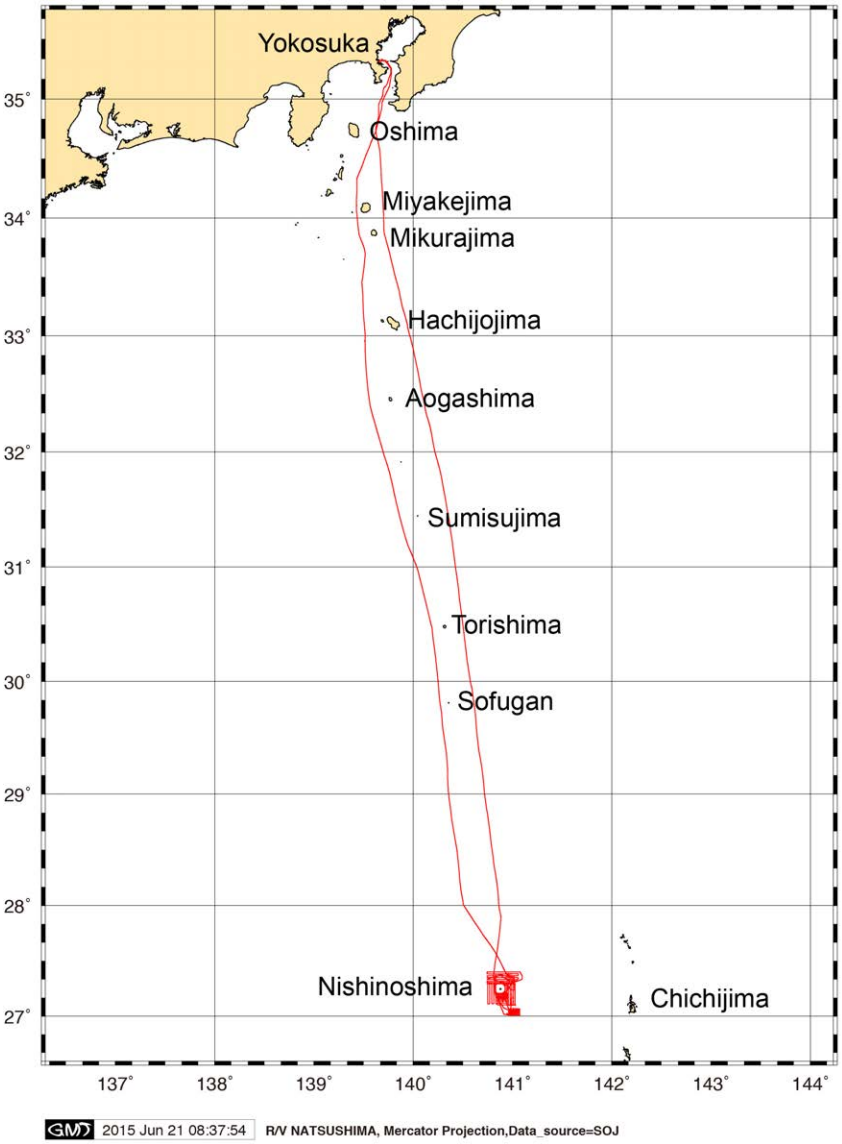

Fig. 1. Round-trip Cruise track between Yokosuka, JAMSTEC and Nishinoshima

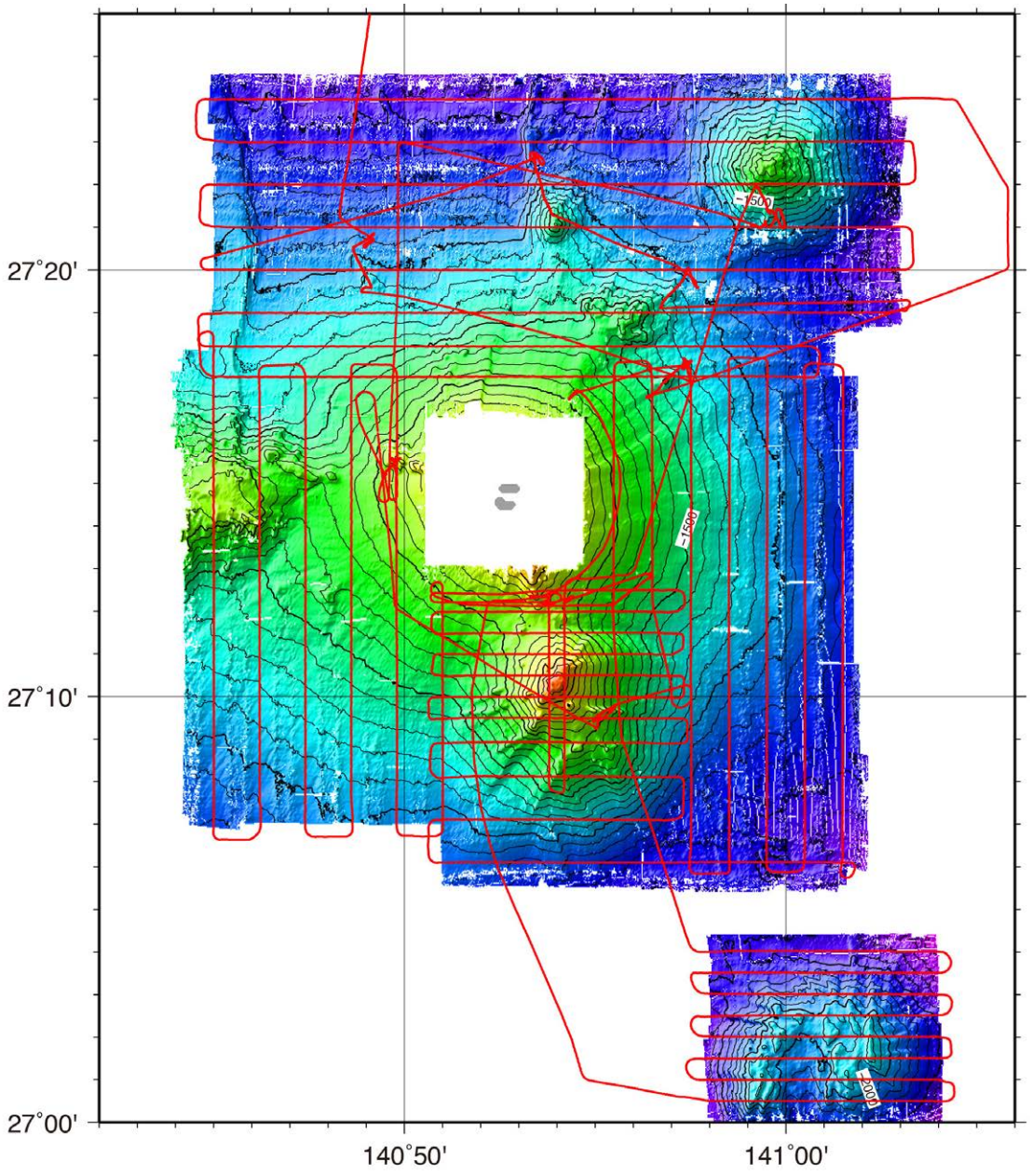

Fig. 2. Cruise track around Nishinoshima Island

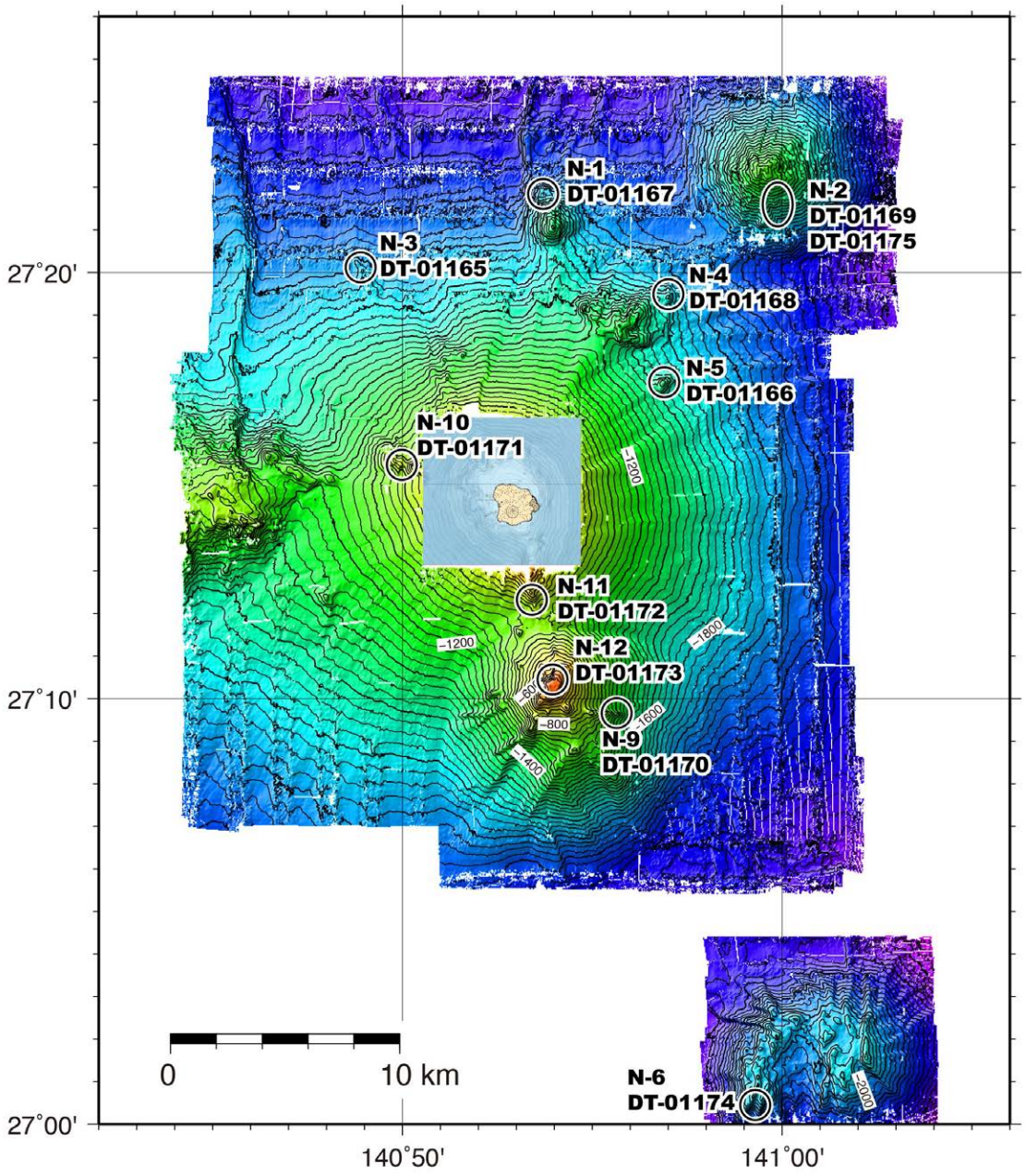

Fig. 3. Areas of 11 DEEP TOW dives (DT-01165~DT-01175), where sampling by using DEEP TOW dredge were conducted.

2. Researchers

● Chief scientist: Yoshihiko Tamura [R & D Center for Ocean Drilling Science (ODS), JAMSTEC]

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3. DEEP TOW Observation

JAMSTEC cruise NT15-E02 on the R/V Natsushima took place from 11 June to 21 June 2015 to Nishinoshima Island in the Ogasawara Arc, Japan (Fig. 1). The R/V Natsushima arrived in the waters around Nishinoshima early in the morning on 13 June 2015 and left in the late afternoon on 18 June 2015. The main objective of the cruise was to conduct surveys of the ocean floor and collect samples on knolls and satellite cones on the lower slope or surrounding the edifice in water depths between 200 and 2000 mbsl using Deep Tow (Figs. 2 and 3). Between dives and around sunset volcanic activity on Nishinoshima Island was observed from the deck of R/V Natsushima at a minimum distance of 4.5 km (the limit of the current exclusion zone).

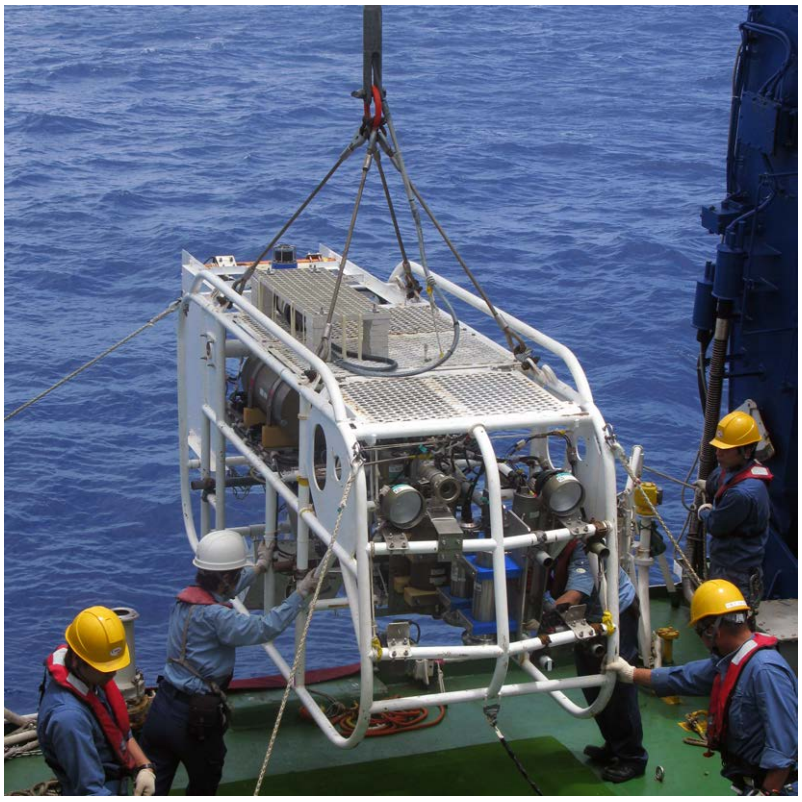


Fig. 4. Deep Ocean Floor Survey System DEEP TOW (photo taken by Alexander Nichols).

DT-01165

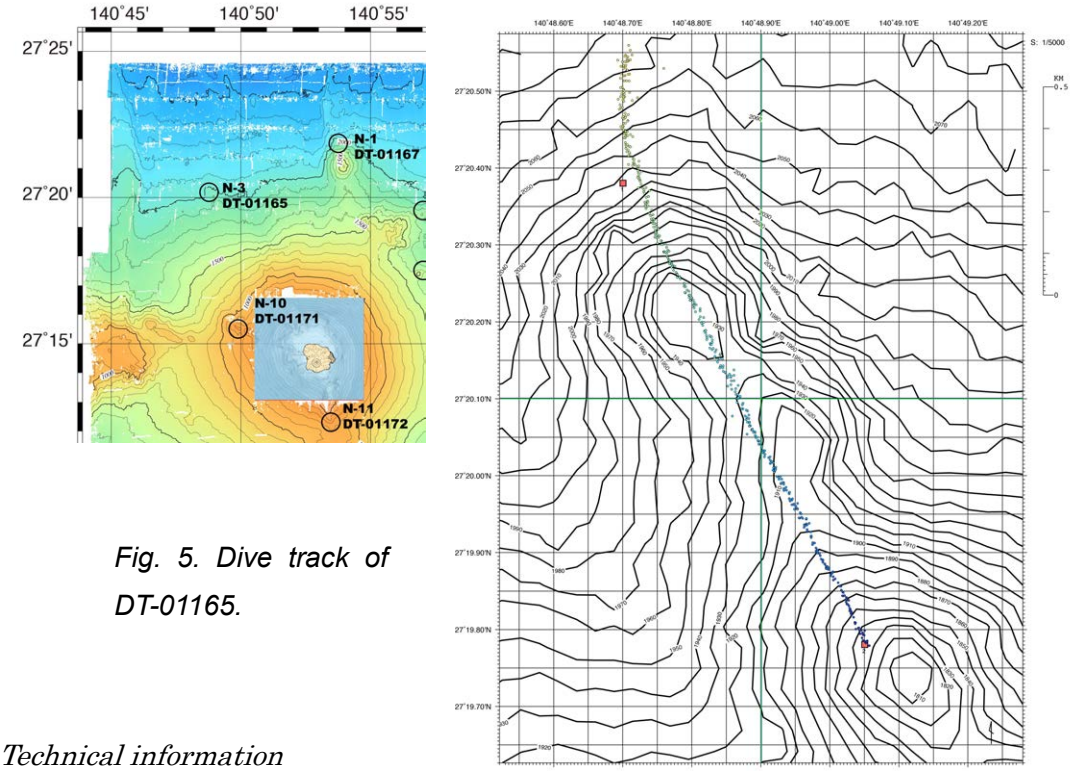


Fig. 5. Dive track of DT-01165.

Technical information

Date: 13 June 2015

Location: Knoll ~10 km NNW of Nishinoshima Island at ~2000 mbsl (site N3).

Objective: The area of Nishinoshima exposed above sea level has been greatly enlarged by an eruption that has been ongoing since November 2013. We will observe the lower slopes of Nishinoshima volcano and are hoping to recover Nishinoshima primary magmas from a satellite cone on the older part of the Nishinoshima edifice. This strategy has proved successful in recovering primary basalts from the Mariana Islands.

	On bottom	Off bottom
Time (local):	08:53	10:34
Latitude:	27° 20.399' N	27° 19.670' N
Longitude:	140° 48.690' E	140° 49.102' E
Depth (mbsl):	2063	1804.2

Observations

The dive started on a seafloor covered in unconsolidated sediment, mud to gravel in size. Three knolls were climbed during the dive, but throughout these sediments dominated.

The dredge was deployed towards the top of the second knoll at 1911 mbsl. The dredge remained in contact with the seafloor as Deep Tow dropped down the back side of the knoll to 1925 mbsl. As Deep Tow climbed the third knoll the dredge was lifted off the seafloor. On observing some larger boulder-sized material in the sediment at 1883 mbsl the dredge was dropped down again. As Deep Tow climbed the third knoll boulders and larger blocks were observed intermittently in the sediment; these were attempted to be sampled. On reaching the top of the third knoll and encountering more unconsolidated mud and gravels the dive ended at 1804 mbsl.

Samples

0.5 kg of pebbles and gravel were recovered. These included larger subangular cobbles of basalt, and pebbles of hydrothermal precipitates, possibly iron hydroxide, and semi-consolidated siltstone.

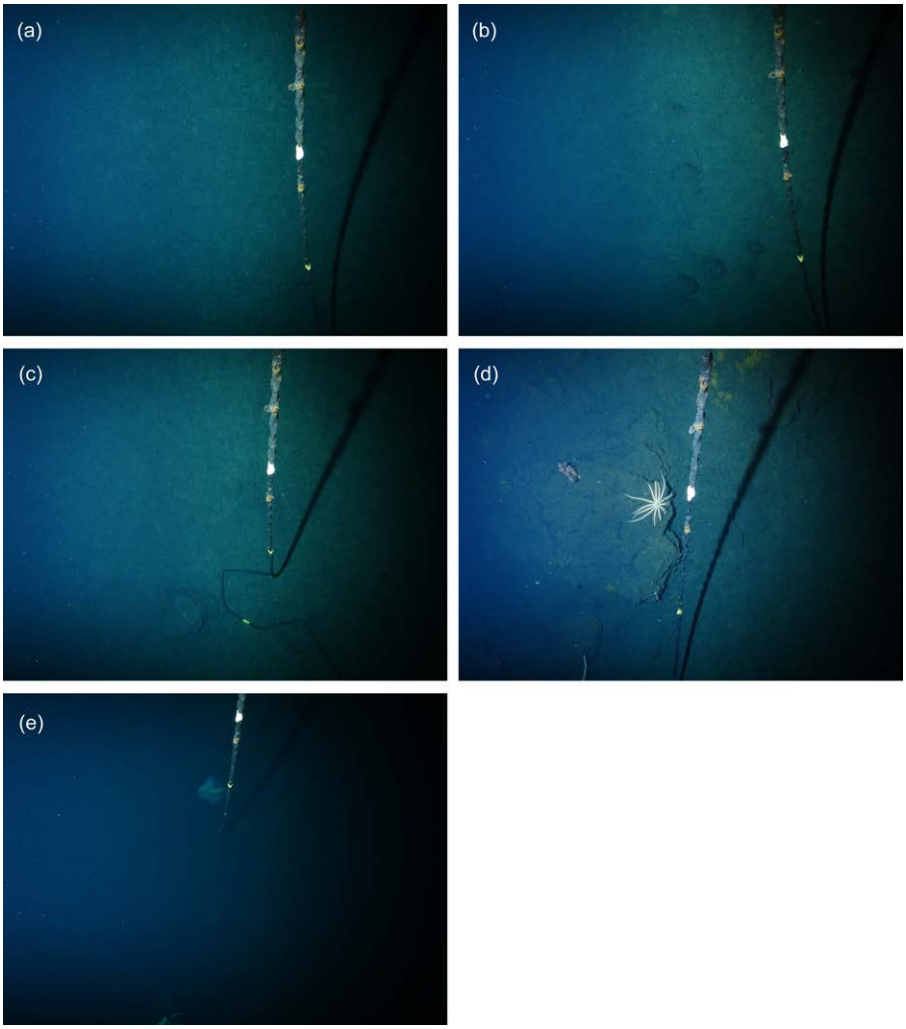


Fig. 6. Still images taken from Deep Tow during dive DT-01165. (a) Seafloor of unconsolidated sediment at beginning of dive (DSC05412.jpg, 08:53). (b) Larger

cobble-sized sediment seen on first knoll (DSC05416.jpg, 08:58). (c) Unconsolidated sediment at top of second knoll (DSC05446.jpg, 09:37). (d) Boulder-sized sediment near the top of the third knoll (DSC05497, 10:23). (e) Ray seen on seafloor at top of third knoll (DSC05501.jpg, 10:26).

Dive log

Logger: Nichols

Time (Local)	Depth (mbsl)	Heading	Notes	Sample descriptions (on deck)
07:30			Deep Tow operations begin.	
07:52			Deep Tow in water.	
08:53	2063.0	226.1	Unconsolidated muddy to gravelly sea floor.	
09:00	2055.7	206.1	More of the same, some larger boulders. One fish, static on the bottom, and some crinoids and sea pens.	
09:07	2042.7	206.1	Still the same.	
09:09	2034.8	216.9	Pink jelly fish.	
09:15	2013.1	206.1	No change.	
09:22	1980.0	203.6	Muddy to gravelly sediments.	
09:27	1941.6	237.1	Near the top of the first knoll. Still the same. Scoria cone?	
09:32	1919.4	219.8	Start climbing second knoll, more mud through to gravel. Decision taken to start dredge here.	Selected samples (0.25 kg) R01: sparsely phyric pyroxene-olivine basalt R02: sparsely phyric plagioclase basalt R03: hydrothermal iron hydroxide R04: semi-consolidated siltstone and various fragments (0.25 kg) Total dive haul: 0.5 kg
09:36	1911.0	211.3	Top of second knoll, still dredging, still the same.	
09:39	1911.1	206.1	Still dredging.	
09:44	1924.7	184.6	Still dredging. Unconsolidated muds to gravels.	
09:49	1923.9	166.1	Close view of the bottom.	
09:50	1921.0	163.7	Stop dredging. Continue observations.	
09:52	1912.5	166.1	Muddy to gravelly sea floor.	

			Dredge stirs up a lot of mud as it bounces along the sea floor.	
09:54	1906.2	000.0	Begin to climb third knoll.	
10:00	1896.9	175.4	Still unconsolidated muds to gravels.	
10:05	1882.6	175.4	Outcrop looms into view	
10:07	1888.0	175.4	Some larger boulders. Drop down to attempt to dredge some of these larger rocks.	
10:10	1888.4	173.1	Still trying. Seem to be stirring up fine sediment and destroying the odd sea pen.	
10:15	1880.0	177.7	Returned to mostly unconsolidated muds and gravels, but some occassional larger blocks. Still dredging.	
10:18	1865.0	173.1	Still dredging.	
10:20	1853.8	173.1	Slope of coarser looking material within muds and gravel.	
10:22	1845.6	153.9	Trying to dredge some of this coarser material.	
10:25	1831.6	166.1	Reached top of third knoll.	
10:26	1826.5	000.0	Ray on seabed.	
10:29	1817.9	161.3	Still dredging, seems to have returned to unconsolidated muds to gravels.	
10:33	1806.4	166.1	Still dredging, unconsolidated muds to gravels with occassional larger blocks	
10:34	1804.2	161.3	End dredging and leave the floor.	

DT-01166

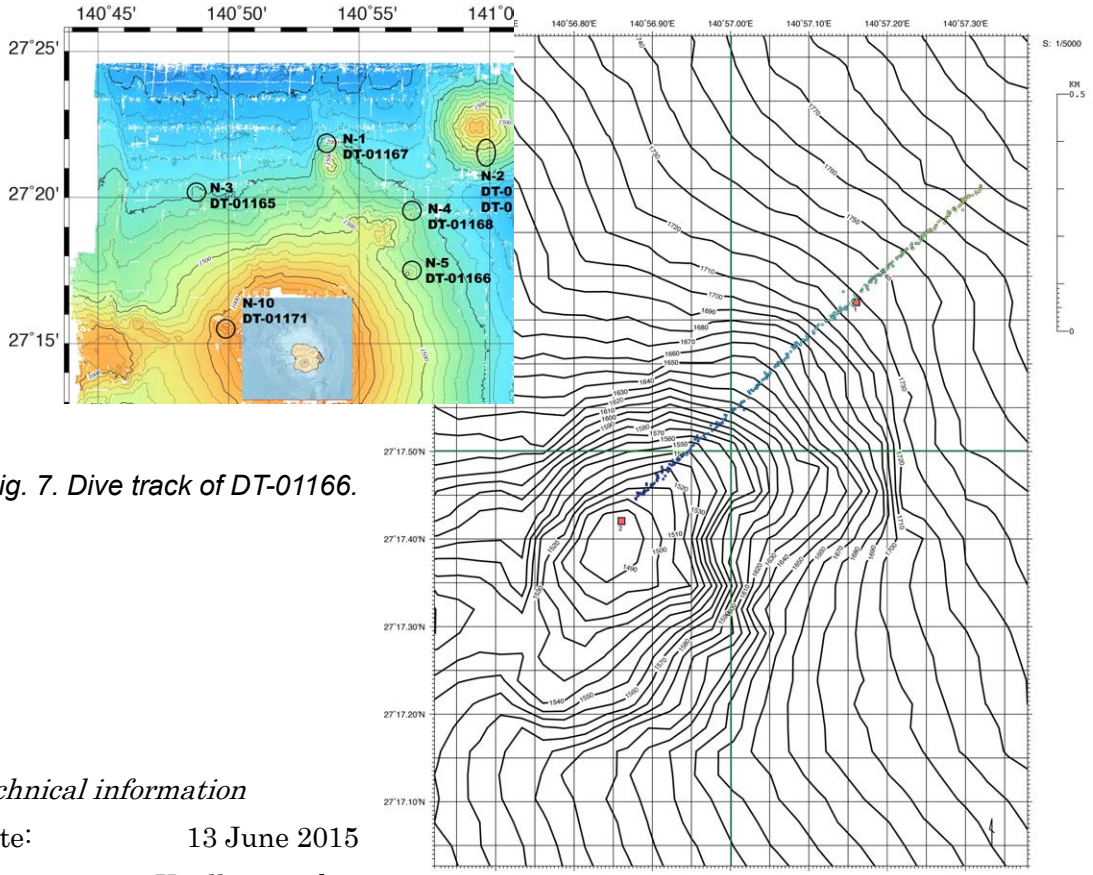


Fig. 7. Dive track of DT-01166.

Technical information

Date: 13 June 2015

Location: Knoll ~9 km ENE of Nishinoshima Island at ~1700 mbsl (site N5).

Objective: We will observe the lower slopes of Nishinoshima volcano and hope to recover Nishinoshima primary magmas from a satellite cone on the older part of the Nishinoshima edifice.

	On bottom	Off bottom
Time (local):	15:28	16:33
Latitude:	27° 17.724' N	27° 17.339' N
Longitude:	140° 57.227' E	140° 56.763' E
Depth (mbsl):	1774.3	1474.8

Observations

Deep Tow reached a seafloor of unconsolidated mud and gravel sediments at 1774 mbsl. Well-defined ripple marks perpendicular to the direction of travel could be observed in the sediment. This continued until 1718 mbsl where the overall grain size of the sediment slightly increased and the ripple marks disappeared. Unconsolidated gravel sediments continued until 1665 mbsl where the slope became very steep and consisted

of an outcrop of jointed lava flows. The dredge was released at 1658 mbsl after the slope became a bit gentler. Many benthic organisms were rooted to the rock face. At 1624 mbsl the slope leveled off more and became covered with unconsolidated mud through to boulder-sized sediments. At 1594 mbsl the slope steepened once again with outcrops of rubbly material. There was an overhang of weakly jointed outcrop at 1545 mbsl and then, at 1534 mbsl, the morphology of the outcropping rocks became more bulbous. Once more many benthic organisms were rooted to these steep rocky outcrops. At the top of the knoll at 1493 mbsl the seafloor became covered in unconsolidated sediment again. The dive and dredging ended at 1475 mbsl.

Samples

The recovered samples were divided into 5 groups on the basis of lithology and representative samples of each were selected. Group (Gr) 01 (0.15 kg) consisted of scoria, Gr02 (0.4 kg) dense phyric to sparsely phyric andesites, Gr03 (0.7 kg) aphyric pumice, Gr04 (1.2 kg) volcanic sandstone with manganese cement, and Gr05 (0.01 kg) two clasts of altered porphyritic plagioclase-andesite and one clast of rhyo-dacite. In total 17 kg of gravel and sand were recovered during the dive.

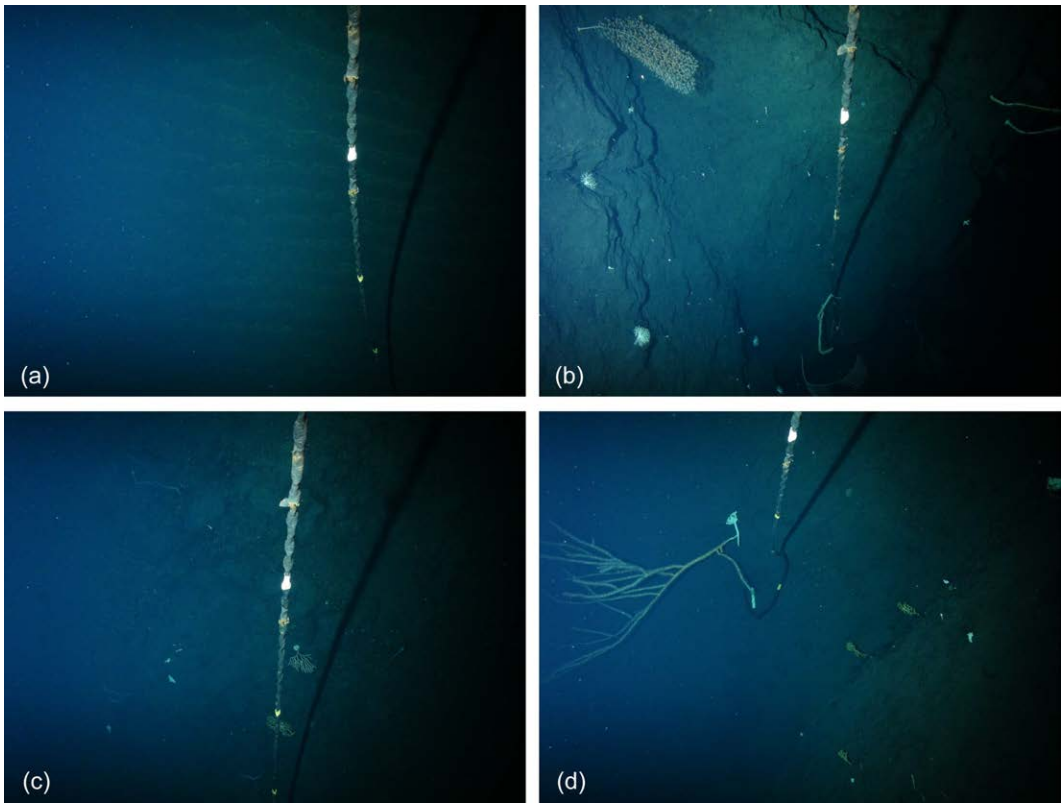


Fig. 8. Still images taken from Deep Tow during dive DT-01166. A) Ripple marks in the sediment near start of the dive (DSC05550.jpg, 15:50). B) Steep slope of rubbly outcrop (DSC05599.jpg, 16:19). C) Steep slope of rubbly outcrop (DSC05606.jpg, 16:23). D)

Benthic organisms rooted to outcrop (DSC05611, 16:25). (Flash was not operating through much of the dive and thus many photos were too dark to be useful.)

Dive log

Logger: Nichols

Time (Local)	Depth (mbsl)	Heading	Notes	Sample descriptions (on deck)
13:00			Deep Tow operations begin	
13:20			Deep Tow in water	
13:55			Dive aborted, release mechanism on dredge not working.	
14:24			Back on deck.	
14:35			Back in the water.	
15:28	1774.3	270.0	Can see bottom. Muddy and gravelly unconsolidated sediment. Some ripple marks.	
15:32	1768.3	253.7	Unconsolidated sediment continues.	
15:35	1761.3	253.7	Continues.	
15:41	1743.5	253.7	Unconsolidated sediment continues. Disturb blunt-headed eely fish.	
15:45	1730.1	270.0	Well-developed ripple marks.	
15:49	1722.7	253.7	More of the same.	
15:50	1720.7	253.7	Ripple marks.	
15:51	1718.4	253.7	Slight increase in sediment's overall grain size. Ripple marks have disappeared.	
15:55	1706.4	253.7	Gravelly unconsolidated sediment.	
15:58	1694.9	253.7	Gravelly unconsolidated sediment. Some white material, coral?	
16:01	1665.0	253.7	Reach very steep slope, jointed outcrop. Possibly lava flows. Pull up and then drop down	

16:02	1664.6	253.7	Ask dredge to be deployed, but not released on steep slope.	
16:04	1657.5	241.6	Dredge still not released	
16:06	1640.3	241.6	Dredge released.	Selected samples (2.46 kg) grouped according to lithology: Gr01: scoria (numerous) Gr02: dense phyric to sparsely phyric plag-andesite (numerous) Gr03: aphyric pumice (numerous) Gr04: volcanic sandstone cemented by manganese (numerous) Gr05: altered porphyritic plag-andsite (two) aphyric rhyo-dacite (one) various pebbles, gravel and sand (14.54 kg) Total dive haul: 17 kg
16:07	1629.6	233.1	Still appears to be a steep slope with many benthic organisms attached.	
16:09	1623.9	226.1	Gentler slope made of mud- through to boulder-size material.	
16:13	1612.5	229.5	Unconsolidated mud- to boulder-size material.	
16:17	1594.0	229.5	Steep rubbly slope, possibly outcrop.	
16:19	1545.6	246.9	Overhang, weakly jointed outcrop	
16:20	1534.0	246.9	A more bulbous rock morphology on steep outcrop.	
16:22	1525.4	237.1	Field of crinoids.	
16:23	1522.0	226.1	Steep slope.	
16:24	1508.6	237.1	Field of crinoids on another terrace of steep outcrop.	
16:25	1505.6	222.8	Dredge picks up and drags along a crinoid.	
16:27	1492.9	229.5	Gentler slope covered with unconsolidated sediment.	
16:33	1474.8	226.1	Reached top of knoll, unconsolidated sediment. End dredge and dive.	

DT-01167

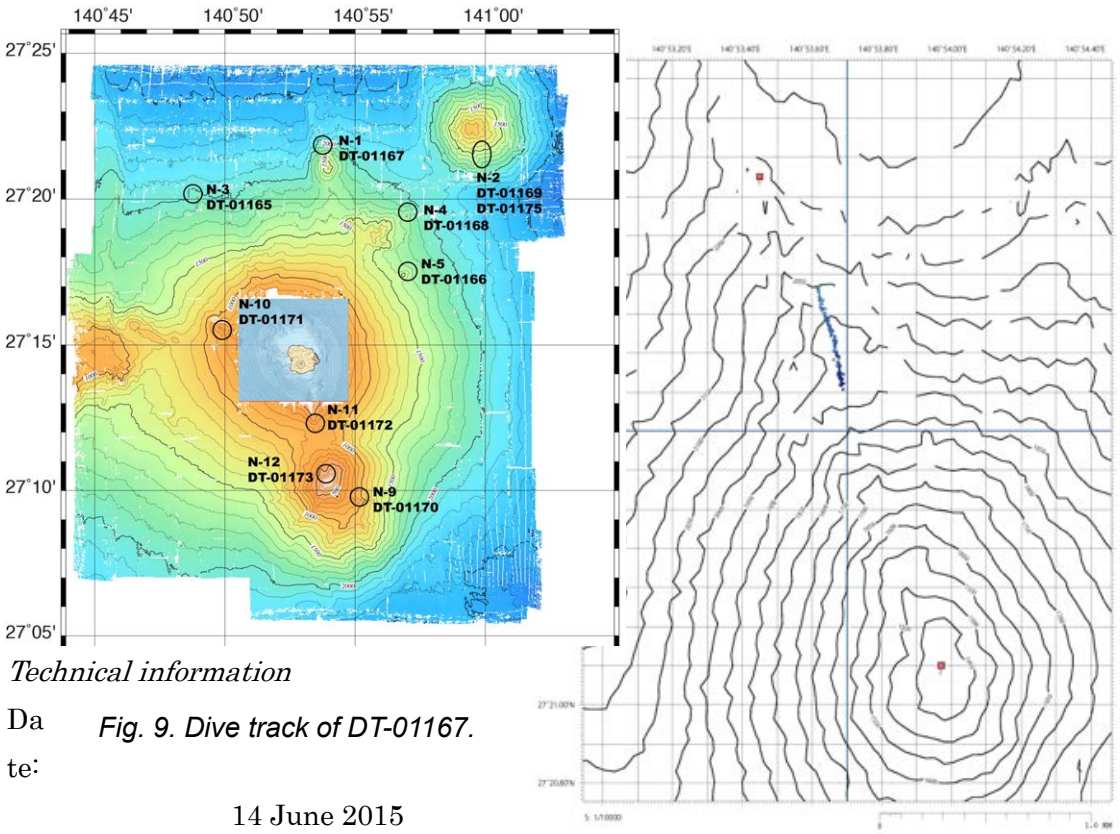


Fig. 9. Dive track of DT-01167.

Technical information

Date: 14 June 2015

Location: Knoll ~12 km NNE of Nishinoshima at ~2000 mbsl (site N1).

Objective: To observe seafloor on the lower flank of Nishinoshima and to collect lava samples derived from primitive magma at a satellite cone on the northern flank of Nishinoshima.

	On bottom	Off bottom
Time (local):	09:35	10:05
Latitude:	27° 21.887' N	27° 21.634' N
Longitude:	140° 53.614' E	140° 53.693' E
Depth (mbsl):	2019.2	1910.9

Observations

This dive started on a steep rocky slope at 2019 mbsl, and climbed up the NNW flank of the knoll. The steep slope continued until 1910 mbsl. The rocky surface eventually became dominated by sand and gravel, and then massive rocks with rough surfaces, probably lavas, appeared at around 1900 mbsl. The dive ended half-way up the flank of the knoll at 1900 mbsl where sand and gravel covered the massive rocks again.

Dredging by Deep Tow started soon after reaching the seafloor and continued throughout the dive. At ~1905 mbsl the dredge box became stuck on a rough surface but fortunately it could escape. During this dive some pieces of lava blocks were dredged from massive rocks.

Samples

One large piece of highly phyric olivine-plagioclase-pyroxene basalt (px 10%, pl 10%, ol 2%) was recovered. Small pieces of lava and scoria were also recovered. They have similar lithological characteristics to the large piece.

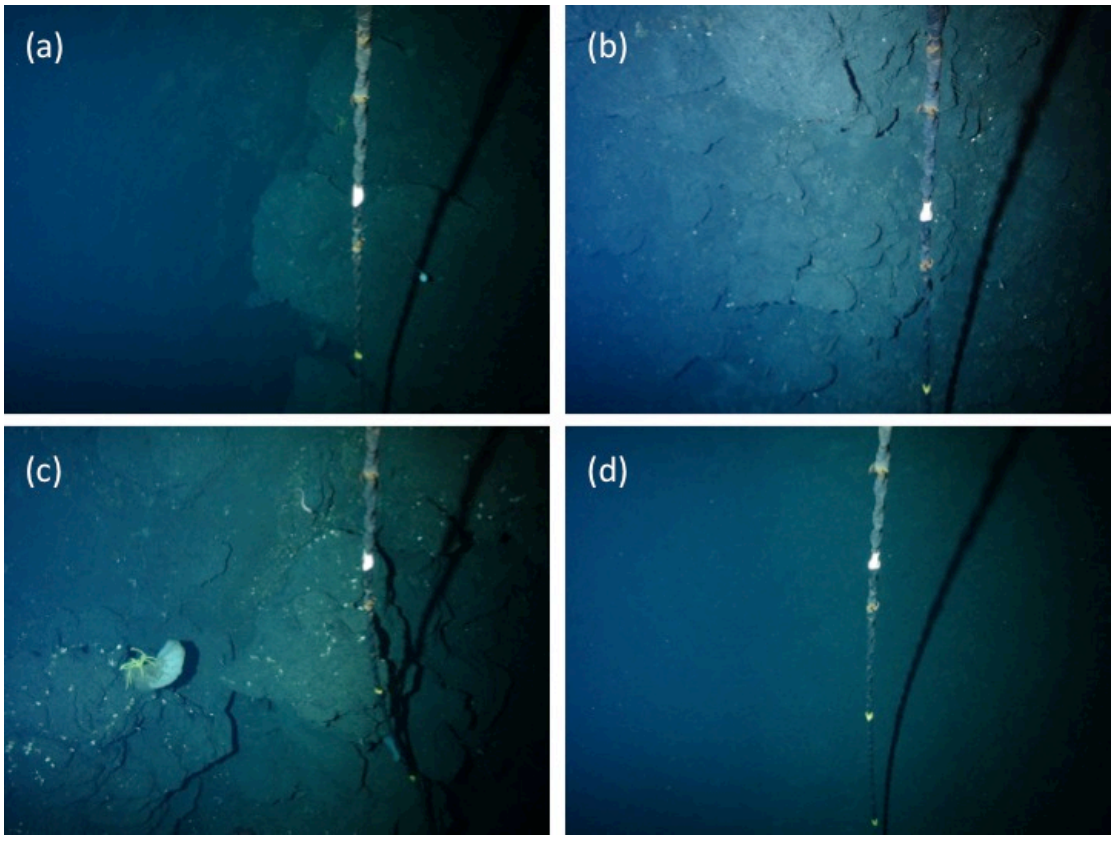


Fig. 10. Still images taken from Deep Tow during dive DT-01167. (a) Rocky cliff with large boulders near the start of dive (DSC05655.jpg, 9:35:58). (b) Steep slope of rocky outcrop where dredging started (DSC05665.jpg, 9:41:17). (c) Subangular blocks of lavas partially covered by sand and gravel (DSC05670.jpg, 9:43:39). (d) Sandy and gravelly seafloor (DSC05691.jpg, 9:54:37). The dive ended near this location.

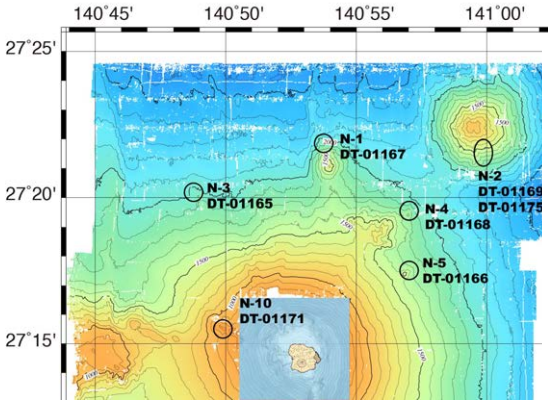
Dive log

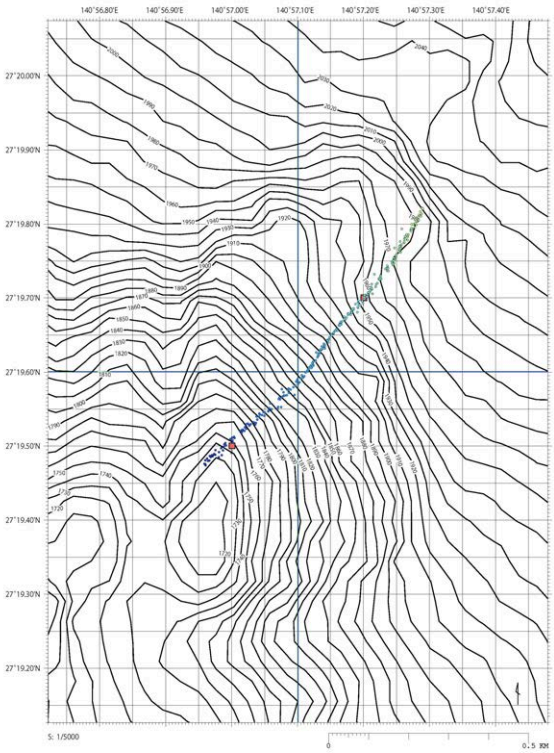
Logger: Maeno

Time (Local)	Depth (mbsl)	Heading	Notes	Sample descriptions (on deck)
07:30			Deep Tow operations begin.	
07:43			Deep Tow in water.	
09:35	2019.2	208.7	Outcrop looms into view. Rocky cliff with large boulders. The subangular boulders seem to be lavas. Partially covered by sandy and gravelly materials.	
09:38	1998.2	208.7	Rocky steep slope is continuing.	
09:39	1984.3	211.3	Decision taken to start dredge here.	
09:40	1972.8	196.3	Dredging the rocky slope surface.	
09:42	1956.2	191.5	Sandy seafloor with sparse lava blocks.	
09:43	1946.0	196.3	Subangular lava blocks again.	selected samples (2.65 kg):
09:45	1932.4	193.9	Still same rocky cliff. Blocks in sampler.	R01-06: highly phyric olivine-plagioclase-pyroxene basalt
09:48	1905.2	182.3	Rocky surface with sandy matrix is continuing.	Gr01: numerous scoria
09:49	1895.9	198.7	Many blocks are larger than the size of sampler. Still dredging.	various pebbles and gravel (2 kg)
09:51	1891.0	191.5	Sandy materials are increasing. Slope is relatively gentle. Still sparse large lava blocks.	Total dive haul: 4.65 kg
09:54	1893.0	189.2	Sandy and gravelly seafloor is continuing. Still dredging.	
09:55	1874.5	206.1	Sandy seafloor. Finish dredge and leave seafloor.	
09:59	1895.4	206.1	Outcrop looms into view	
10:01	1905.4	186.9	Soon after restart dredging, sampler was stuck on rough massive rocky surface.	

10:02	1904.3	182.3	Sampler was luckily released from rough surface, and dredging could resume.	
10:04	1919.3	186.9	Sandy and gravelly seafloor is continuing.	
10:05	1910.9	193.9	End of dredging and leave the seafloor.	
10:55			Out of water	
10:59			On deck	

DT-01168





Technical information

Date: 14 June 2015

Location: Knoll ~10 km NE of Nishinoshima at ~2000 mbsl (site N4).

Objective: To observe seafloor of the lower flank of Nishinoshima and to collect lava samples derived from primitive magma at a satellite cone on the NE flank of Nishinoshima.

	On bottom	Off bottom
Time (local):	13:34	14:36
Latitude:	27° 19.735' N	27° 19.360' N
Longitude:	140° 57.276' E	140° 56.878' E
Depth (mbsl):	2009.6	1710.3

Observations

This dive started on unconsolidated sandy to gravelly seafloor at ~2000 mbsl, and climbed up the NE slope of the knoll. Sandy seafloor with ripple marks extended until 1870 mbsl, and then a massive rocky slope appeared. The surface of the massive rocks was rough, fractured and some parts were slab-like and looked like consolidated sediment layers. They were also partially covered by sand and gravels. These features of seafloor continued until the end of the dive at ~1700 mbsl. Dredging by Deep Tow

commenced on the sandy to gravelly seafloor at ~1880 mbsl and ended on the outcrop of massive rocks at ~1700 mbsl. Most of samples were dredged from the outcrop of massive rocks in the second half of the dive.

Samples

Various sizes of volcanic breccia cemented with Mn-oxide. Fragments of hydrothermal Mn crust and volcanic breccia were also included. These hydrothermal products probably represent the slab-like features or consolidated sediment layers that were observed on the seafloor during the dive.

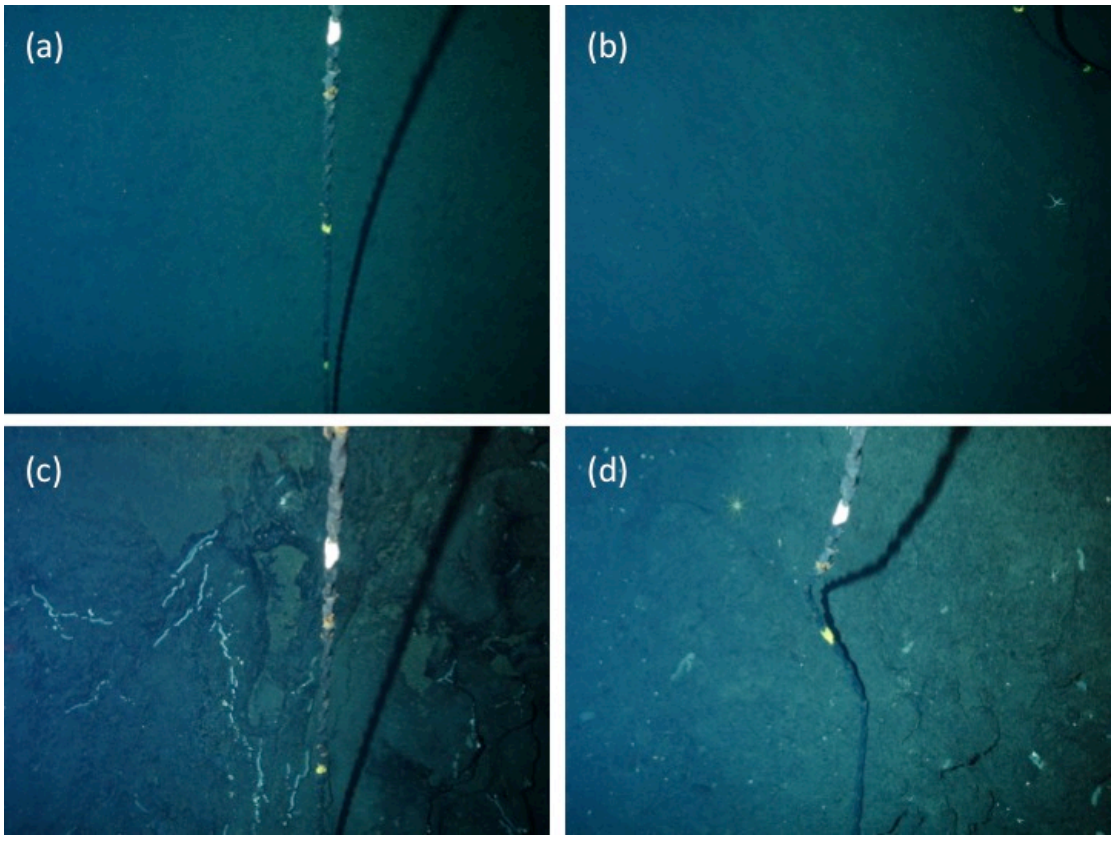


Fig. 12. Still images taken from Deep Tow during dive DT-01168. (a) Sandy seafloor near the start of dive (DSC05716.jpg, 13:38:41). (b) Dredging started on sandy floor with weak ripple marks (DSC05725.jpg, 14:02:44). (c) Outcrop consisting of blocks and massive rocks partially covered by sand (DSC05744.jpg, 14:18:36). (d) Massive rocks with rough surface near the end of dive (DSC05772.jpg, 14:33:36).

Dive log

Logger: Maeno

Time (Local)	Depth (mbsl)	Heading	Notes	Sample descriptions (on deck)
12:30			Deep Tow operations begin.	
12:37			Deep Tow in water.	
13:34	2009.6	211.3	Seafloor looms into view. Unconsolidated sandy to gravelly seafloor.	
13:37	1999.3	222.8	Sandy to gravelly seafloor continuing.	
13:38	1995.8	229.5	Ripple marks.	
13:43	1981.8	216.9	Sandy seafloor.	
13:44	1977.5	216.9	Shrimp.	
13:45	1974.1	216.9	Shrimp.	
13:48	1966.0	226.1	Still sandy seafloor.	
13:52	1953.2	241.6	Still sandy seafloor.	
13:53	1947.2	241.6	Sandy to gravelly seafloor. Grain size seems to have increased.	
13:56	1938.8	302.9	Ripple marks on sandy seafloor.	
13:59	1923.8	293.1	Sandy seafloor with weak ripple marks.	
14:02	1907.9	320.2	Still same sandy seafloor.	
14:06	1888.3	310.5	Decision taken to start dredge. Sandy to gravelly seafloor.	
14:09	1870.7	222.8	Still dredging sandy floor.	Selected samples (4.4 kg): R01: volcanic breccia cemented with Mn-oxide R02-04: hydrothermal Mn crust R05: lapillistone others (2 kg): fragments of hydrothermal Mn crust and volcanic breccia Total dive haul: 6.4 kg
14:10	1862.1	226.1	Consolidated seafloor, sandstone?	
14:12	1852.2	229.5	Outcrop of massive rocks on one side, not dredged.	
14:13	1845.7	229.5	Outcrop of massive rock with platy surface, partially covered by sand.	
14:14	1839.2	229.5	Still massive, partially fractured rock, covered by sand to gravel.	

14:16	1830.4	229.5	Still outcrop of massive rocks covered by sand.	
14:18	1809.5	233.1	Outcrop of lava(?) blocks constituting cliff. Partially covered by sand.	
14:19	1801.1	237.1	Massive, partially fractured rock cliff.	
14:21	1789.2	233.1	Dredging the same massive outcrop.	
14:24	1773.4	237.1	Sandy seafloor. Massive part is not visible here. Still dredging.	
14:26	1755.1	237.1	Sandy seafloor. Platy sediment rocks(?) are scattered on seafloor.	
14:28	1738.6	237.1	Rough surface of massive rock and sand. Most part of massive rock is covered by sand but sometimes exposed on seafloor.	
14:30	1727.9	233.1	Same rough seafloor. Massive rocks sometimes consist of step-like features.	
14:32	1711.3	237.1	Rough massive rock with steps and fractures, partially covered by sandy materials.	
14:33	1708.0	233.1	Still dredging the same massive rock.	
14:35	1704.6	226.1	Top of knoll. Massive rock and blocks with many sea creatures. Stop dredging.	
14:36	1710.3	226.1	End dredging and leave the floor.	
15:24			Out of water	
15:28			On deck	

DT-01169

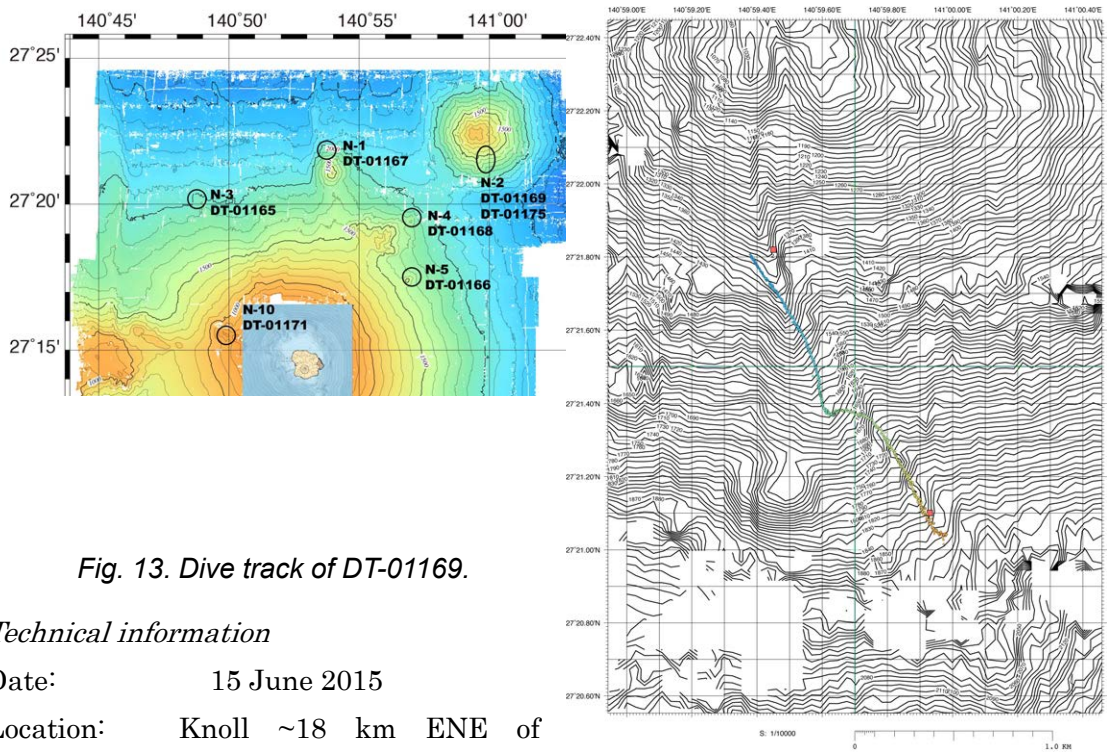


Fig. 13. Dive track of DT-01169.

Technical information

Date: 15 June 2015

Location: Knoll ~18 km ENE of Nishinoshima Island at ~1900 mbsl (site N-2).

Objective: To observe seafloor of a small seamount NE of Nishinoshima and to collect lava samples derived from primitive magma at the satellite cone on the NE flank of Nishinoshima.

	On bottom	Off bottom
Time (local):	8:31	10:35
Latitude:	27° 21.0491' N	27° 21.7940' N
Longitude:	140° 59.9828' E	140° 59.3890' E
Depth (mbsl):	1890.6	1352.7

Observations

Deep Tow reached a seafloor covered with Mn-oxides crust at 1889 mbsl. Sandy sediment covered the crust, but since the morphology of Mn-oxides crust could be recognized, the sediment cover seemed to be relatively thin. The dredge was deployed at 8:36 at 1889.6 mbsl on the Mn-oxides encrusted seafloor. It was difficult to know what the material was beneath the crust. Since no rocks were found on the slope, the dredge was lifted from the seafloor at 8:43 (1878.9 mbsl). At 8:48 (1857 mbsl), abundant white-colored blocks appeared, and the dredge sampler was lowered to seafloor. At 8:50

(1853 mbsl), the seafloor became sandy again, and the dredge was lifted from the seafloor. At 8:58 (1817 mbsl), even though the seafloor was still sandy, the dredge was lowered again to the seafloor. Until 9:10, Mn-oxides encrusted outcrop with occasional mud/sand cover continued. At 9:10 (1777.2 mbsl), an outcrop of blocky rocks was encountered and the dredge was lowered. The outcrops continued upslope forming a steep cliff. The morphology of the outcrop is variable, from platy, irregularly fractured to massive. At 9:18 (1747 mbsl), the outcrop has became blocky, and looked like lava. Continuously lava-like outcrop was observed until 9:23 (1724 mbsl). At 9:23, the operation team noticed that the dredge had been lost. Even though it was announced that the survey was cancelled, after further discussion it was decided to continue observing the seafloor.

At 9:51, Deep Tow reached the seafloor at 1604.1 mbsl, which was relatively rugged and encrusted with Mn-oxides. At 10:00 (1580.0 mbsl), sediments with a platy surface, probably coated with Mn-oxides appeared. After 10:06 (1536.6 mbsl), blocky outcrops were frequently observed. Many floating blocks coated with Mn-oxides crust were observed on a terrace within the steep slope. This area appeared to be suitable for dredge sampling. Similar outcrop continued to around 1400 mbsl. Blocky or highly-fractured outcrop reappeared at 1393 mbsl, and continued to around 1364 mbsl, where seafloor became sandy with ripple marks. The survey ended at 10:35 (1352.7 mbsl) on a sandy seafloor.

There are many good exposures of possible volcaniclastics and lavas along the NNW-SSE scarp (possibly fault scarp), and these could be future targets for sampling. Development of Mn-oxides crust is pervasive, and this implies that this volcano is not very young.

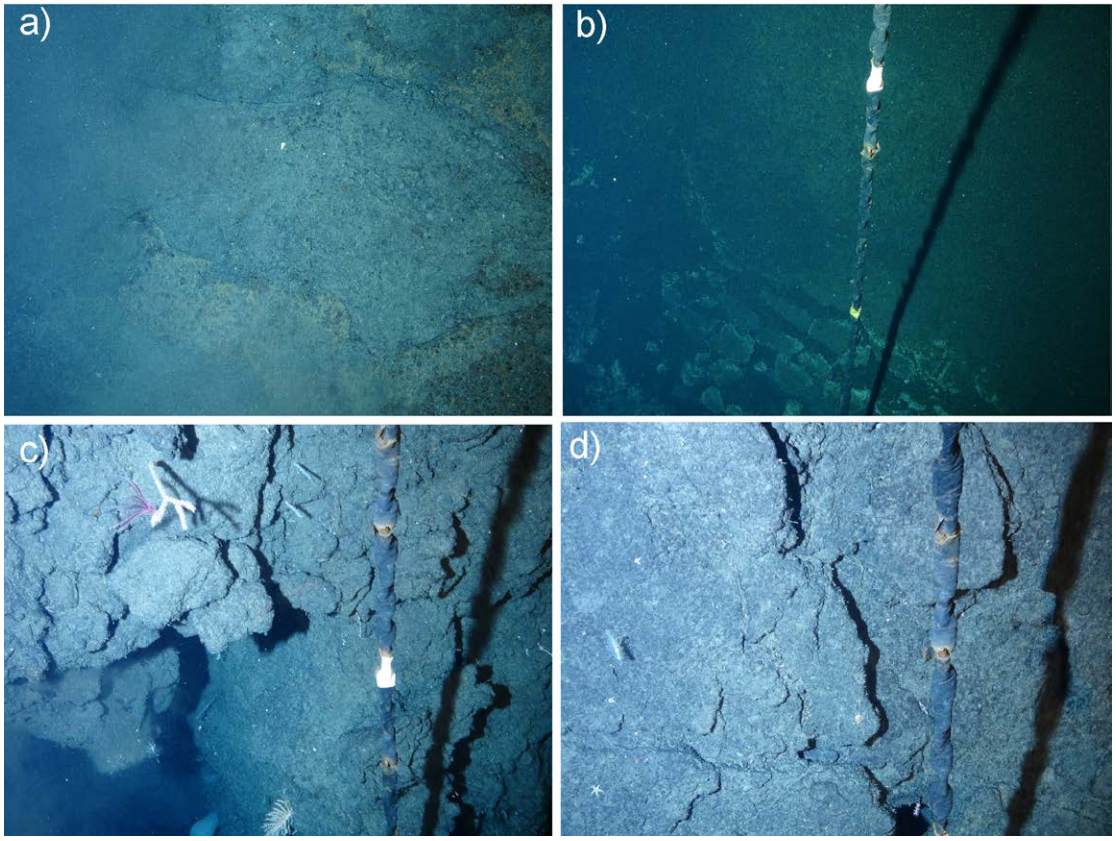


Fig. 14. Still images taken from Deep Tow during dive DT-01169. (a) Mn-oxides encrusted slope (DSC05818.jpg, 08:36). (b) Blocky outcrop, possibly consisting of Mn-oxides cemented sediment (DSC05877.jpg, 09:02). (c) Steep cliff of Mn-oxides encrusted blocky outcrop (DSC05964.jpg, 9:15). (d) Very steep cliff of Mn-oxides crust-covered massive outcrop (lava or volcaniclastics?) (DSC05978, 9:20). This is near the location where the dredge was lost.

Dive log

Logger: Ishizuka

Time (Local)	Depth (mbsl)	Heading	Notes
07:37			Deep Tow operations begin.
07:40			Deep Tow in water.
08:31	1890.6	246.9	Seafloor looms into view. Platy surface covered with sandy sediment.
08:32	1888.6	253.7	Survey started.
08:34	1890.0	241.6	Mn-encrusted rubbly surface.
08:36	1889.6	214.1	Dredge deployed on Mn-encrusted floor.
08:40	1883.7	302.9	Still Mn-encrusted floor with thin sediment
08:42	1882.2	306.9	Became slightly steeper.
08:43	1878.9	310.5	Changed altitude to 5 m to lift dredger off bottom
08:46	1864.8	325.9	White-colored rugged outcrop.
08:48	1857.0	328.7	White outcrop with many blocks, dredger on bottom.
08:50	1853.0	325.9	Sandy floor. Dredger off bottom.
08:55	1831.8	338.9	Still sandy seafloor with occasional white block.
08:58	1817.0	353.1	Lowered dredge to bottom. Still sandy floor.
09:01	1811.0	331.3	Some blocks on the sandy floor.
09:02	1809.6	333.9	Mn-encrusted fractured outcrop. White fractured stuff(probably sampled).
09:08	1777.7	000.0	Slightly rubbly surface covered with mud.
09:10	1777.2	343.7	Blocky outcrop. Lowered dredger.
09:12	1757.6	302.9	Steep cliff. Massive outcrop.
09:14	1753.0	293.0	Continue. Irregularly, but partially platy fractured outcrop. Partially brecciated?
09:18	1747.1	336.4	Lava-like outcrop. Blocky.
09:23	1724.0	348.5	Dredge lost? Keep altitude high to check.
09:24	1721.0	350.8	Yes, dredge lost. Off bottom. Stop survey.
			Stop hauling in the wire. Decide to continue observations.
09:51	1604.1	310.5	Seafloor looms into view. Mn-encrusted rugged seafloor. Survey resumed.
09:57	1590.6	333.9	Still Mn-encrusted floor with thin sediment.
10:00	1580.0	343.7	Mn-encrusted platy surface.

10:06	1536.6	346.1	Steeper slope covered with Mn, occasional blocky part.
10:08	1522.9	333.9	Blocky outcrop.
10:10	1505.7	328.7	Many floating blocks. Mark location.
10:12	1486.0	338.9	Steep cliff. Many sponges.
10:15	1467.9	333.9	Mn-crusted massive, smooth-surfaced outcrop.
10:16	1456.2	331.3	Highly fractured outcrop with abundant blocks.
10:20	1440.8	331.3	Mn-encrusted rugged outcrop.
10:22	1426.9	333.9	Blocky lava-like outcrop.
10:27	1399.5	348.5	Continuous ourcrop ended. Smooth surface. Ripple mark appeared.
10:28	1393.0	355.4	Again blocky outcrop.
10:30	1383.0	355.4	Highly fractured outcrop.
10:33	1364.0	11.5	Covered with Mn-crust and sediments.
10:35	1352.7	21.1	Sandy floor with Mn-crust. Survey finished.
10:36	1343.0	26.1	Sandy ripple marks.

DT-01170

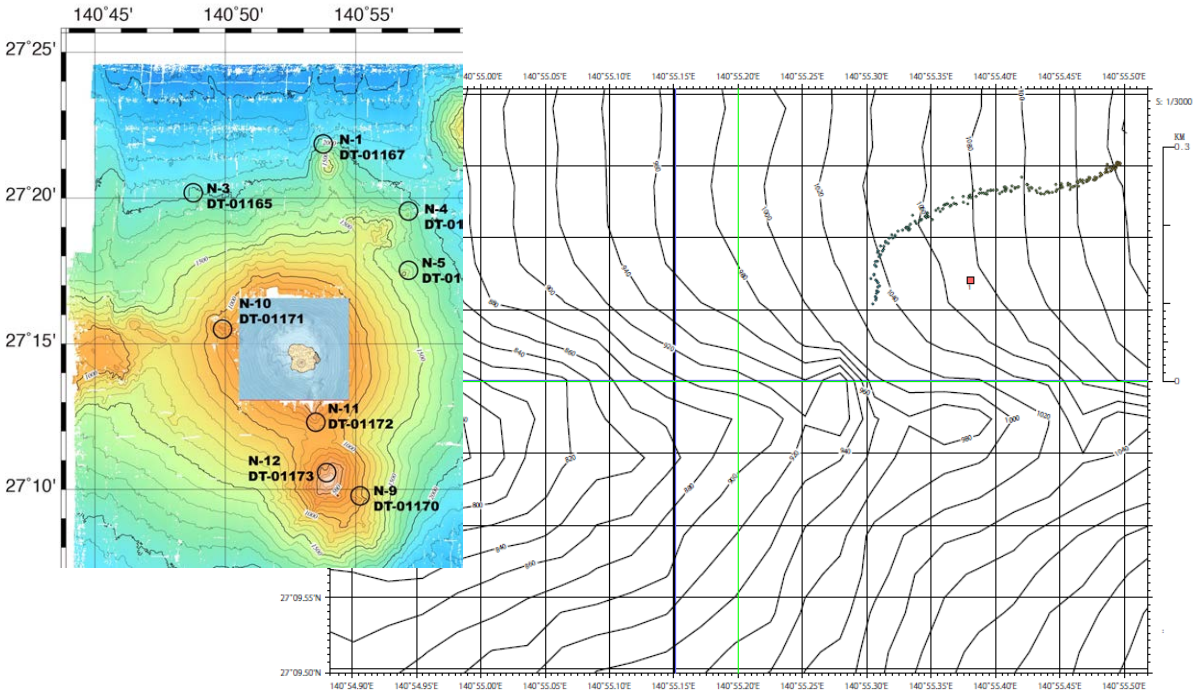


Fig. 15. Dive track of DT-01170.

Technical information

Date: 16 June 2015

Location: Knoll ~10 km SSE of Nishinoshima at ~1100 mbsl (site N9), Nisinoshima-minami knoll.

Objective: To observe seafloor of the lower flank of Nishinoshima and to collect lava samples derived from primitive magma at a satellite cone on the SE flank of Nishinoshima-minami knoll.

	On bottom	Off bottom
Time (local):	8:19	8:58
Latitude:	27° 9.721' N	27° 9.554' N
Longitude:	140° 55.419' E	140° 55.092' E
Depth (mbsl):	1127	1015

Observations

This dive started on a sandy seafloor with ripple marks at ~1127 mbsl, and climbed up the SE slope of the Nishinoshima-minami knoll. Isolated rocks on a sandy seafloor appeared at ~1125 mbsl and increased until ~1050 mbsl. Then a breccia field appeared. This was possibly outcrop covered with thin sediments. At ~1030 mbsl, a steep massive

outcrop was encountered. After ~6 m of climbing, a sandy seafloor with sparse blocks appeared again. In a short trip, a steep slope loomed into view, and the dive ended at ~1015 mbsl.

Samples

Andesite lava blocks were collected in this dive. They are relatively fresh and include olivine, clinopyroxene and plagioclase phenocrysts. Various sand to pebble size sample were also collected.

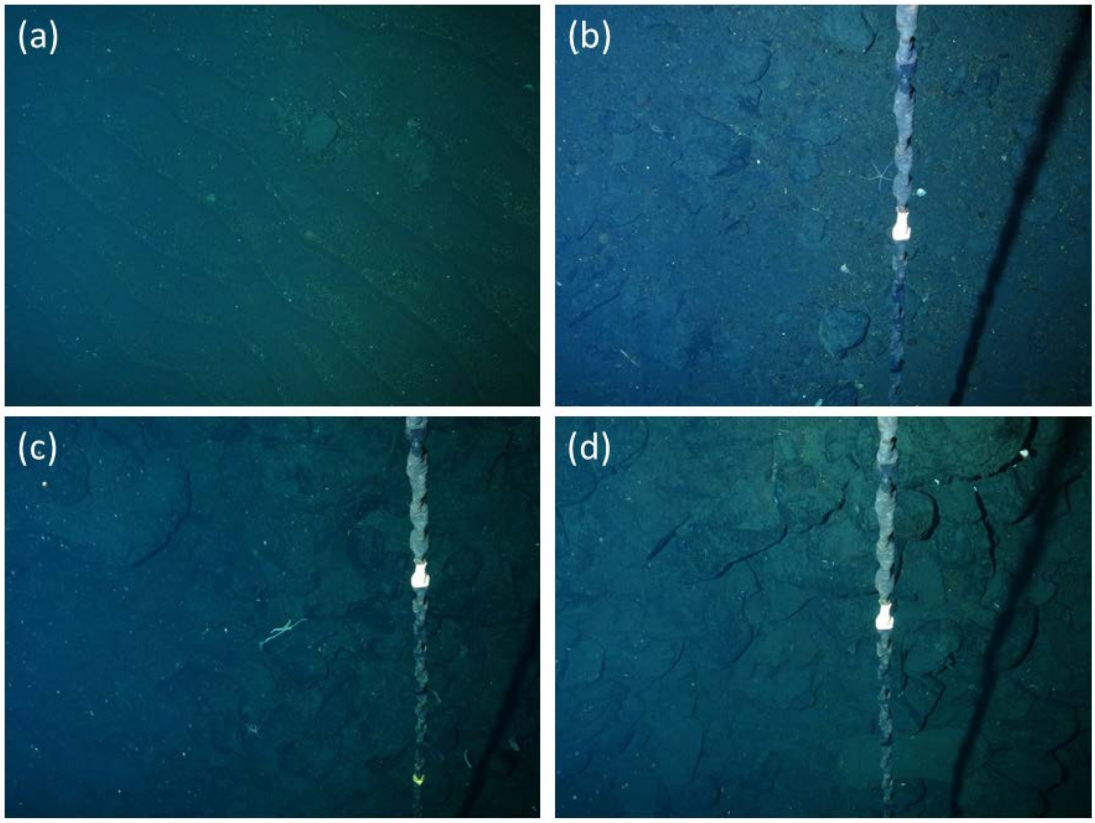


Fig. 16. Still images taken from Deep Tow during dive DT-01170. (a) Sandy seafloor with ripple marks and isolated blocks (DSC06097.jpg, 8:33). (b) Breccia field or outcrop covered with thin sediments (DSC06133.jpg, 8:51). (c) Steep massive outcrop (DSC06151.jpg, 8:55). (d) Steep massive rocks near the end of dive (DSC06162.jpg, 8:58).

Dive log

Logger: Tomoki Sato

Time (Local)	Depth (mbsl)	Heading	Notes	Sample descriptions (on deck)
07:30			Deep Tow operations begin.	
07:44			Deep Tow in water.	
08:19	1126.0	173.1	Seafloor looms into view.	
08:19	1127.0	173.1	Sandy seafloor with well-developed ripple marks. Deep Tow pulled strong current?	
08:23	1125.0	000.0	Sandy seafloor with sparsely isolated lava blocks.	
08:28	1117.8	140.2	Still sandy seafloor with blocks.	
08:32	1108.1	156.4	Isolated rocks on sand are increasing.	
08:40	1083.4	126.9	Sandy seafloor with blocks still continue.	
08:45	1065.8	148.7	Still sandy floor.	
08:47	1062.0	153.9	Deep Tow travelling direction becomes normal. Dredge released.	R01-07: mod phyric ol-cpx-pl andesite R08: mod phyric ol-pl-cpx andesite R09: mod phyric (ol)-cpx-pl andesite R10: mod phyric (ol)-cpx-pl andesite others1: various pebbles others2: various sand and gravel
08:50	1050.7	241.6	Breccia field or outcrop covered with thin sediments.	
08:54	1030.0	219.8	Steep massive outcrop.	
08:56	1023.7	203.6	Sandy seafloor with sparse blocks.	
08:58	1015.0	222.8	Steep slope. End of dredging and leave the seafloor.	
09:38			On deck.	

DT-01171

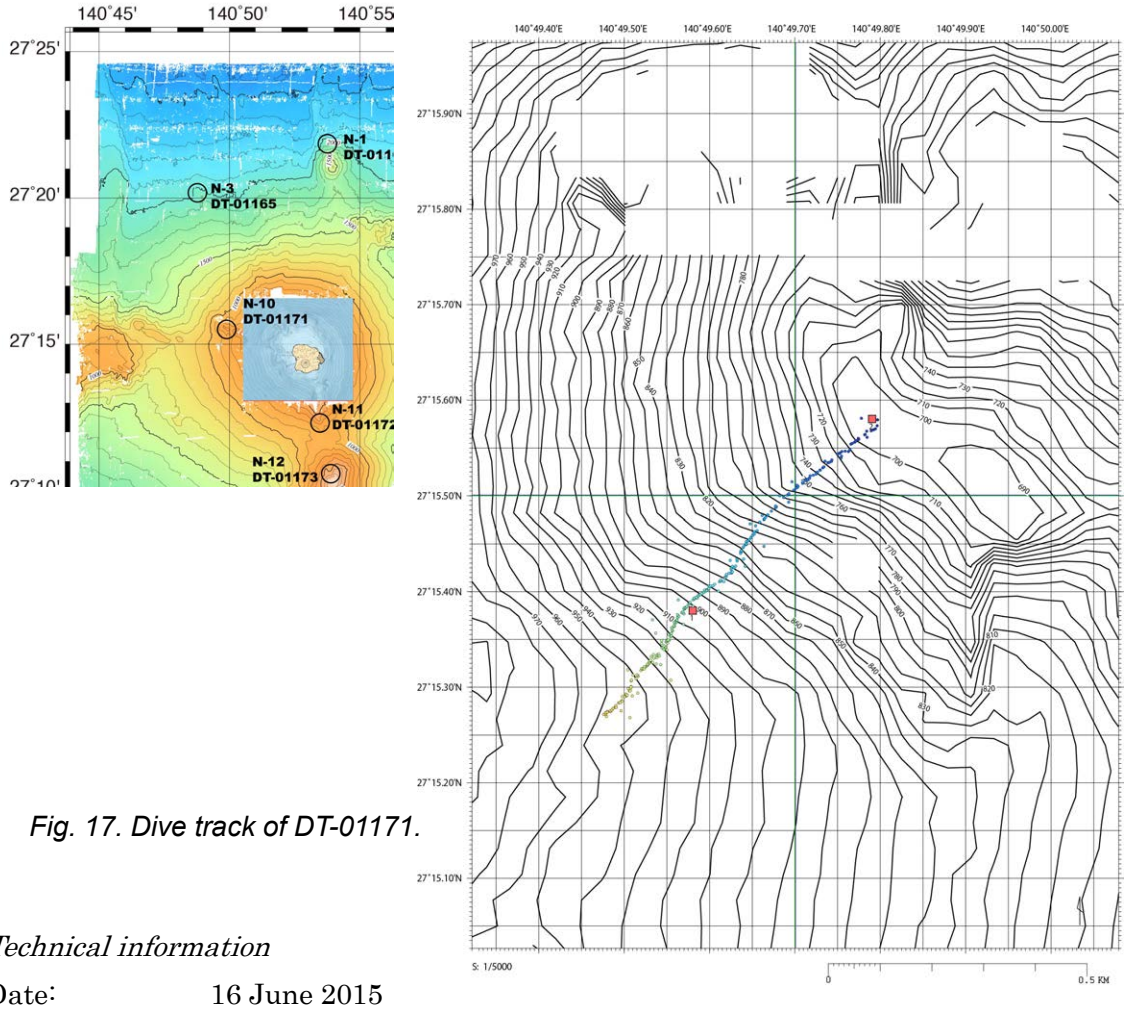


Fig. 17. Dive track of DT-01171.

Technical information

Date: 16 June 2015

Location: Knoll ~4.5 km WNW of Nishinoshima at ~900 mbsl (site N10).

Objective: To observe seafloor of the lower flank of Nishinoshima and to collect lava samples derived from primitive magma at a satellite cone on the WNW flank of Nishinoshima.

	On bottom	Off bottom
Time (local):	11:42	12:38
Latitude:	27° 15.260' N	27° 15.588' N
Longitude:	140° 49.511' E	140° 49.879' E
Depth (mbsl):	952.7	686.4

Observations

This dive started on a sandy seafloor with ripple marks at ~953 mbsl, and climbed up the SW slope of the WNW knoll. A lot of creatures (e.g. shrimp, eely fish) were seen on

the early part of the dive. The sandy seafloor continued until 845 mbsl as the abundance of creatures were gradually decreased. Then massive rocky outcrop covered with sand appeared and dredging by Deep Tow commenced. At ~836 mbsl, a steep outcrop consisting of fresh lava with overhangs and thin sediments started. The surface of the outcrop became smooth. The massive lava outcrop remained steep until ~676 mbsl, and then became gentle. Deep Tow reached the top of the knoll at ~686 mbsl, and began to drop down the slope. The dive ended at this point.

Samples

Various samples were collected in this dive. Most of them are pebble-sized scoria (R04, R06 and others1). In addition, one basalt (R02) was collected. The other samples are sedimentary rocks, including a calcareous rock (R05).

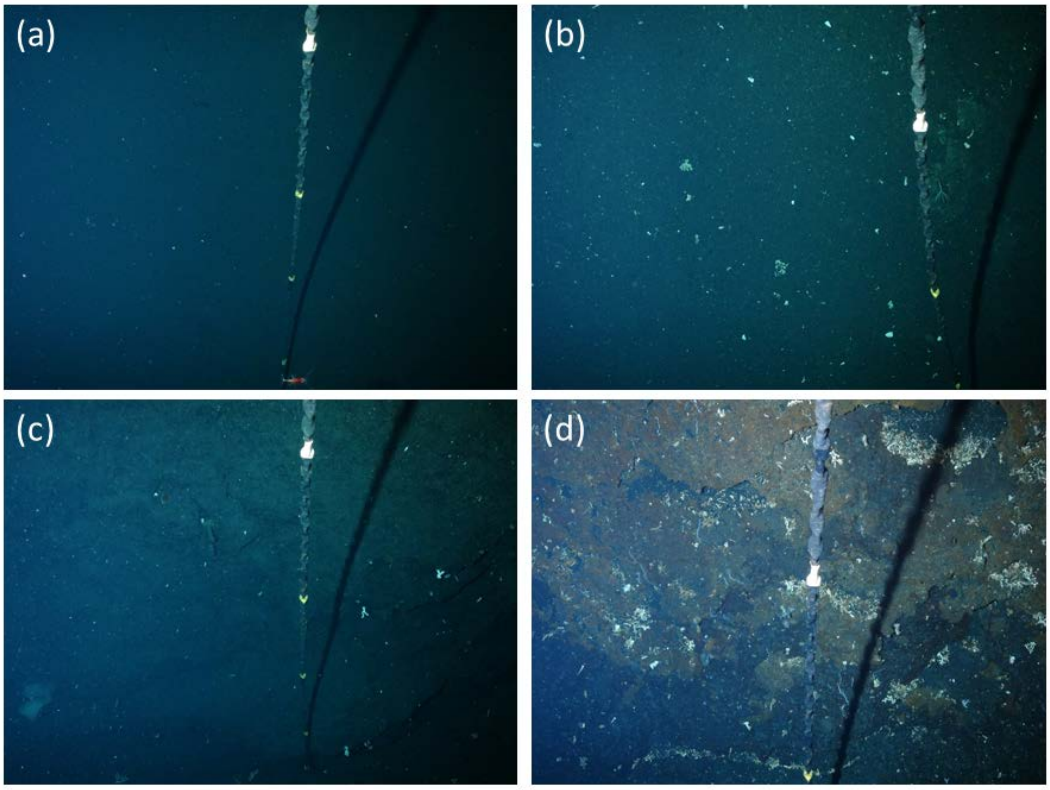


Fig. 18. Still images taken from Deep Tow during dive DT-01171. (a) Sandy seafloor and shrimp near the start of dive (DSC06181.jpg, 11:44). (b) Possibly massive rocky outcrop covered with sand (DSC06206.jpg, 12:14). (c) Steep massive outcrop (DSC06228.jpg, 12:19). (d) Steep smooth outcrop near the end of dive (DSC06281.jpg, 12:30).

Dive log

Logger: Tomoki Sato

Time (Local)	Depth (mbsl)	Heading	Notes	Sample descriptions (on deck)
11:00			Deep Tow operations begin	
11:11			Deep Tow in water	
11:42	952.7	013.9	Sandy seafloor. Many shrimp, eely fish.	
11:45	947.8	034.1	Ripple marks.	
11:51	933.2	000.0	Still sandy seafloor.	
12:00	904.0	018.7	Still sandy seafloor. Creatures are decreasing.	
12:05	886.2	090.0	Still sandy seafloor.	
12:10	858.6	090.0	Still sandy seafloor.	
12:14	845.0	028.7	Massive rocky outcrop covered with sand.	
12:14	845.0	028.7	Dredge released.	R01: volcanic mud-lapillistone R02: mod phyric ol-cpx-pl basalt R03: lapillistone R04: mod phyric (px)-pl andesitic scoria R05: calcareous rock? R06: sparse phyric pl andesitic scoria R07: sandstone R08: conglomerate with andesite pebble others1: various pebbles (scoria) others2: various sedimentary rocks
12:16	836.1	042.8	Steep outcrop. Fresh lava covered with thin sediments.	
12:19	804.2	253.7	Overhang, steep outcrop still continues.	
12:24	756.9	049.5	Still steep outcrop. Smooth surface.	
12:30	717.2	066.9	Still steep outcrop.	
12:36	676.0	066.9	Gentle slope. Massive lava outcrop.	
12:38	686.4	090.0	Reached top of knoll and becomes a downward slope. End of dredging and leave the seafloor.	
13:01			On deck.	

DT-01172

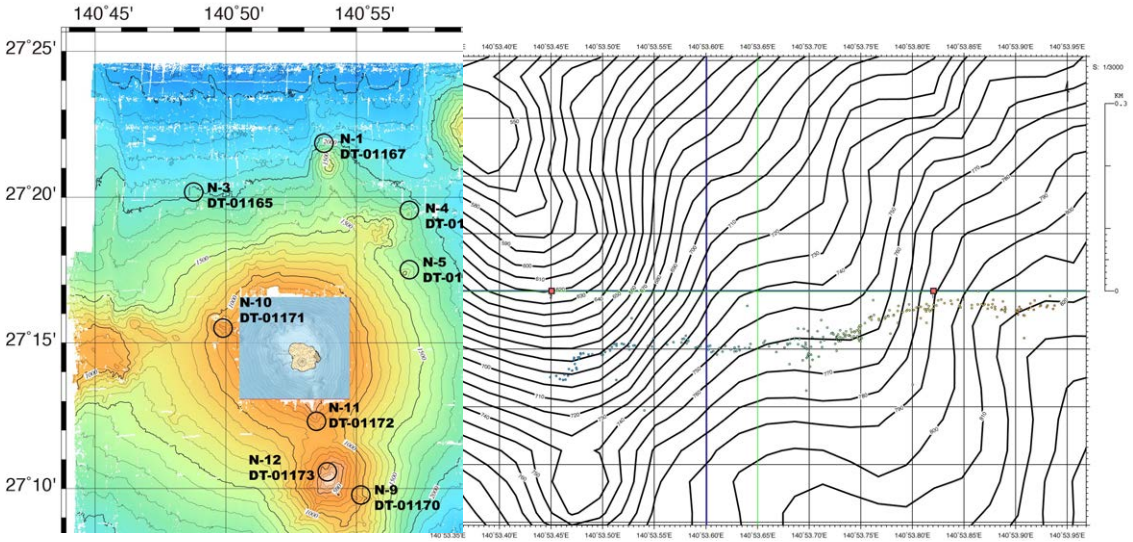


Fig. 19. Dive track of DT-01172

Technical information

Date: 17 June 2015

Location: Knoll on main edifice ~4 km S of Nishinoshima Island at ~800 mbsl (site N11), just above saddle between main Nishinoshima edifice and south Nishinoshima edifice that will be dived on in DT-01173.

Objective: To observe the seafloor of part of the southern slope of Nishinoshima Island and to collect primitive lava samples derived from Nishinoshima volcano.

	On bottom	Off bottom
Time (local):	08:08	09:10
Latitude:	27° 12.334' N	27° 12.531' N
Longitude:	140° 53.804' E	140° 53.194' E
Depth (mbsl):	815.9	683.9

Observations

Owing to issues with the release mechanism, the dredge was deployed throughout this dive. Deep Tow reached the seafloor at 816 mbsl. Initially the seafloor appeared steep and rocky, however, this soon disappeared from view to be replaced by gravel- to boulder-sized unconsolidated material. The dredge was dragged across the loose sediment in an effort to capture some of the larger material. At 804 mbsl the seafloor steepened to a rocky outcrop with a pitted morphology. The dredge was dragged across

the outcrop to try to break some pieces off. At 748 mbsl (08:32) the slope became gentler and covered in unconsolidated sand to boulder-sized material, possibly spatter. For the next 24 minutes Deep Tow remained at this depth as it followed the contour around the slope; the lithology remained the same. Briefly the dredge was lifted off the seafloor for about 5 minutes, but mostly attempts were made to capture unconsolidated cobble-sized material. At 08:56, 744 mbsl, Deep Tow started to climb again and by 09:01 had reached 704 mbsl. The seafloor lithology remained the same, unconsolidated sand to boulders. At 670 mbsl the material became finer-grained, only reaching cobble size. Deep Tow then began to drop down the slope to 684 mbsl, where the material became finer still (up to gravel size). It was decided to end the dive here.

Samples

The dredge recovered a total of 27.44 kg of sand, gravels and pebbles. Ten pebbles were selected as samples R01 to R10. Of the ten samples, nine are moderately phyric olivine-plagioclase andesite, the other (R06) did not contain any olivine visible to the naked eye, but was otherwise the same petrology. R02, R04 and R08 are notable for containing large plagioclase phenocrysts up to 10 mm in size, and R07 has a clot of olivines in which crystals reach 3 mm in size.

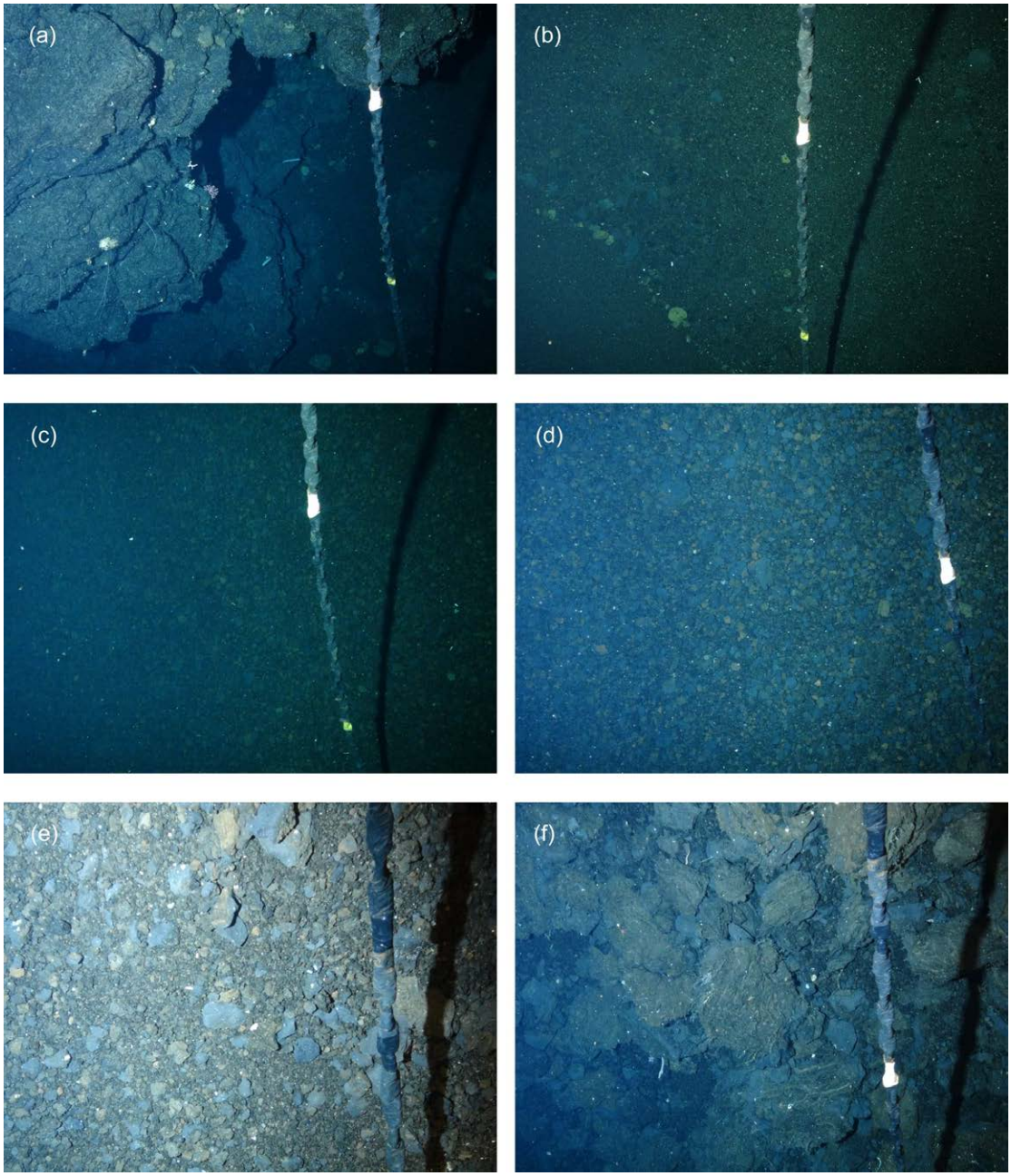


Fig. 20. Still images taken from Deep Tow during dive DT-01172. (a) Rocky steep floor observed when Deep Tow first reached the seafloor (DSC06348, 08:09). (b) Unconsolidated sediment seen near beginning of dive (DSC06359, 08:19). (c) Unconsolidated sediment, possibly spatter (DSC06388, 08:35). (d) Sand-, gravel- and pebble-sized unconsolidated material (DSC06399, 08:43). (e) Cobble-ized loose scoria (DSC06409, 08:52). (f) Cobble- to pebble-sized unconsolidated material observed towards the end of the dive (DSC06453, 09:05).

Dive log

Logger: Nichols

Time (Local)	Depth (mbsl)	Heading	Notes	Sample descriptions (on deck)
07:30			Deep Tow operations begin.	
			Problem with dredge release mechanism. Dredge deployed before entering the water.	
08:08	815.9	018.7	Rocky steep seafloor in view.	
08:13	812.1	336.4	Gravel-sized sediments. Rocky outcrops have gone for now.	
08:14	815.2	333.9	Large stream-lined fish swims past swiftly.	
08:17	815.7	302.9	Boulders strewn over seafloor. Loose float.	
08:18	809.9	286.3	Dragging dredge across loose sediment. Trying to capture the larger material.	
08:20	803.9	286.3	Steeper rocky outcrop appears. Pitted morphology.	
08:25	770.6	302.9	Still rocky outcrop. Looks Mn-encrusted.	
08:28	753.3	286.3	Steep rough rocky outcrop continues.	
08:29	745.5	355.4	Organism forming what looks like a white frilly apron on the rocks.	
08:31	749.2	302.3	Outcrop continues. Trying to get some of the outcrop	
08:32	748.5	317.2	Slopes shallows and seafloor becomes covered in sediment.	
08:33	750.3	336.4	Sand and gravels.	
08:34	752.6	286.3	Pebbles and boulders.	
08:36	748.8	246.9	Dredging through unconsoildated sediment, spatter?	

08:41	755.4	310.5	Still dredging across sand-, gravel- and pebble-sized material.	
08:44	754.4	253.7	Lift dredge off the seafloor.	
08:49	756.8	270.0	Dredge back down. Dredging through unconsolidated sediments up to cobble-size.	Selected samples (1.04 kg): R01-R05, R07-R10: moderately phyric olivine-plagioclase andesite R06: moderately phyric plagioclase andesite others 1: various pebbles (1.4 kg) others 2: various sand, gravel and pebbles (25 kg) Total dive haul: 27.44 kg
08:50	754.9	246.9	Capturing some cobble sized material.	
08:53	755.5	270.0	Up to cobble-sized loose scoria.	
08:55	749.1	270.0	Octopus?	
08:56	743.9	293.1	Still the same. Some quite coarse (cobble-boulder) unconsolidated material.	
09:01	703.8	286.3	Steep slope of unconsolidated material up to boulder-size, could be spatter.	
09:05	670.4	270.0	Cobble to pebble-size unconsolidated material	
09:09	683.9	286.3	Material slightly finer-grained (sand and gravels). Water becomes a little turbid.	
09:10	683.9	286.3	Leave the floor.	

DT-01173

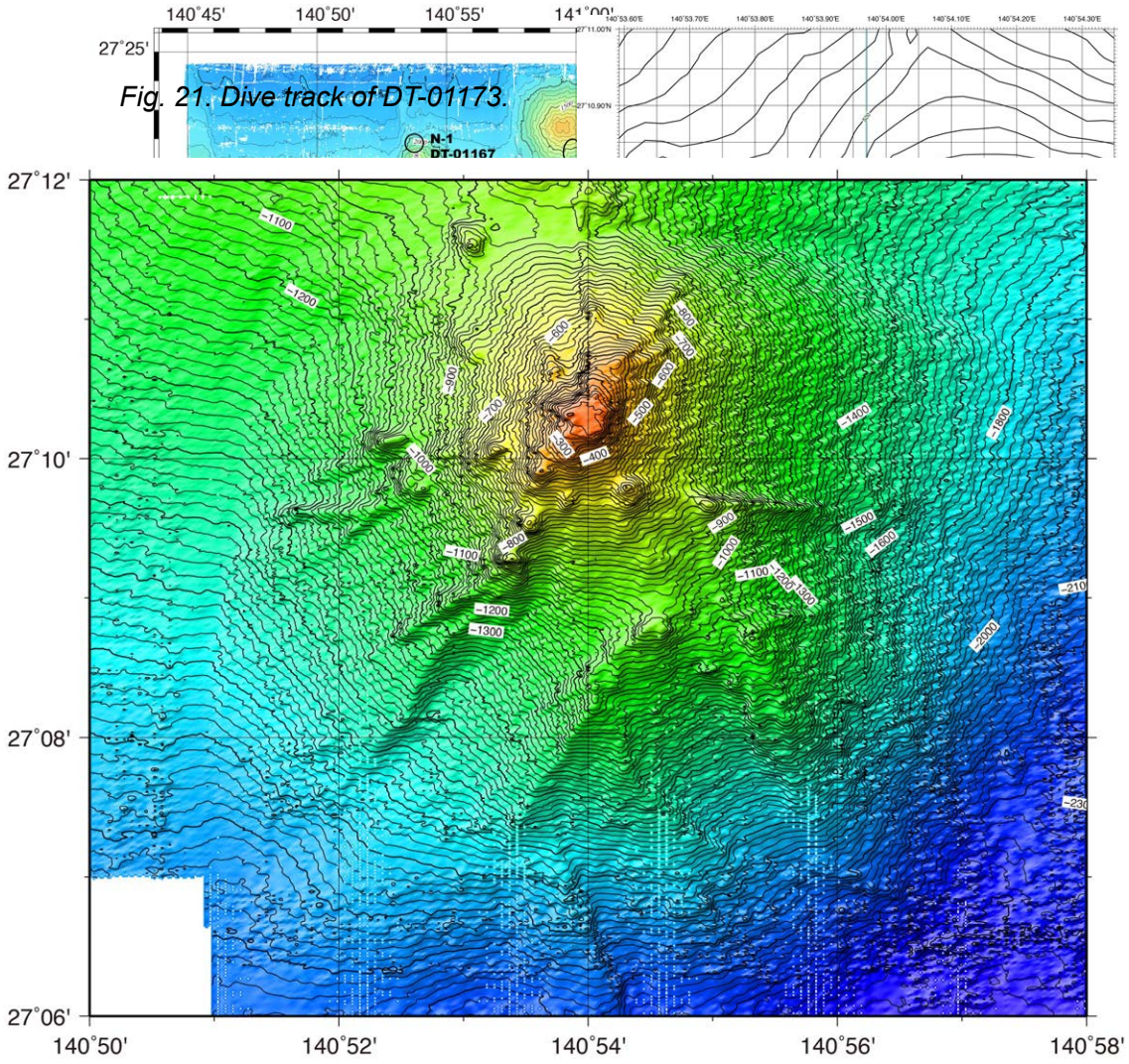


Fig. 21. Dive track of DT-01173.

Technical information

Date: 17 June 2015

Location: Northern flank of seamount ~8 km south of main Nishinoshima edifice in water depth ~530 mbsl (site N12).

Objective: To observe and sample the upper northern flank of the seamount to the south of Nishinoshima Island. Hope to collect primitive magmas.

	On bottom	Off bottom
Time (local):	11:26	12:28
Latitude:	27° 10.776' N	27° 10.368' N
Longitude:	140° 53.822' E	140° 53.996' E
Depth (mbsl):	538.9	202.6

Observations

The seafloor was reached at 539 mbsl and consisted of sand and gravel; once again the dredge was deployed throughout this dive. Initially the dredge was kept off the bottom, but when larger boulder-sized blocks were observed at 516 mbsl the dredge was lowered onto the seafloor. A few minutes later the dredge was lifted again as the blocks were no longer visible. At 497 mbsl outcrops of massive lava and breccia were seen and the dredge was lowered to the seafloor again. At 490 mbsl the seafloor became covered in sand and gravel and the dredge was lifted off the seafloor. At 474 mbsl the slope became much steeper and unconsolidated angular boulders were strewn across the slope; the dredge was lowered to the seafloor once more. At 446 mbsl the abundance of boulders decreased, although dredging continued. The morphology of the seafloor changed suddenly at 381 mbsl to a vertical face of stratified outcrop. The dredge was kept away from the cliff to avoid it snagging in the numerous overhangs. At 363 mbsl the outcrop became less coherent and appeared to consist of unconsolidated boulders. Dredging was briefly attempted at 353 mbsl to try and collect some of these boulders. At 314 mbsl the slope appeared to be made up of rubbly outcrop that showed more organized jointing at 295 mbsl, possibly suggesting an outcrop of lava. Sediment cover returned at 285 mbsl, with boulders strewn across the seafloor, and dredging resumed. The slope became steep at 270 mbsl, possibly as Deep Tow went over an individual huge boulder; the dredge was lifted off the seafloor once more. As the slope became gentler towards the top of the seamount at 220 mbsl the seafloor became covered in benthic organisms and numerous fish were swimming around. At 203 mbsl Deep Tow left the seafloor.

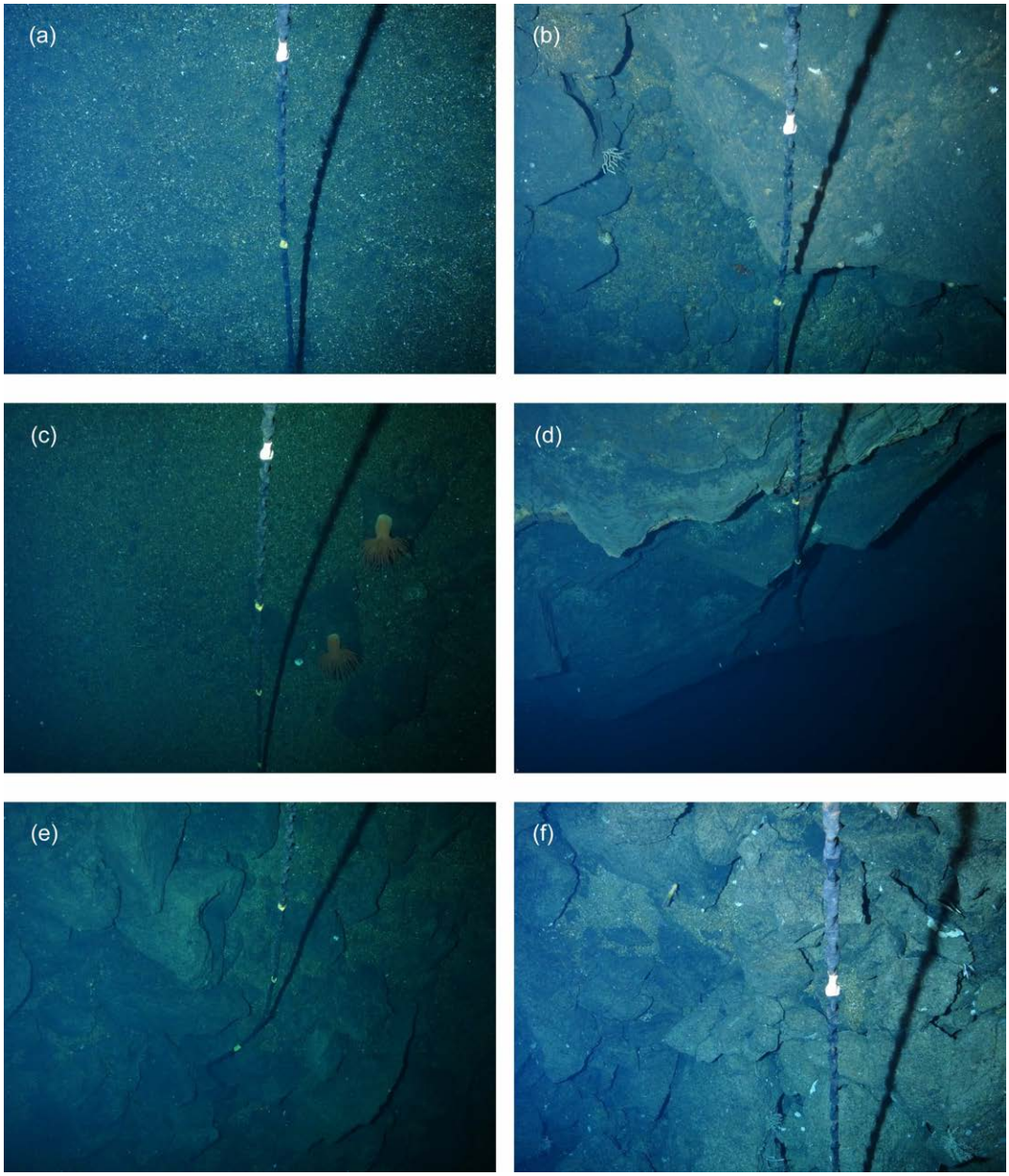


Fig. 22. Still images taken from Deep Tow during dive DT-01173. (a) Unconsolidated sand and gravel where dredge was first lowered to seafloor (DSC06494, 11:40). (b) Boulders strewn across sandy-pebbly sediment (DSC06517, 11:55). (c) Pink sea anemones living on cobbles lying in gravel (DSC06523, 11:57). (d) Vertical cliff of stratified outcrop (DSC06544, 12:05). (e) and (f) Steep slope of rubbly material (DSC06558, 12:12 and DSC06575, 12:20).

Samples

Dredging recovered 32.39 kg of sand, gravel and pebble sized material. Ten pebbles were selected (R01-R10) and are largely moderately phyric pyroxene-plagioclase dacite (R01-R05, R07, R09), with R04 and R05 notable for additionally containing hornblende,

and R09 being only sparsely plagioclase phyric. The other samples are moderately phyric pyroxene-plagioclase andesites, with R06 additionally containing olivine.

Dive log

Logger: Nichols

Time (Local)	Depth (mbsl)	Heading	Notes	Sample descriptions (on deck)
10:53			Deep Tow operations begin	
			Dredge deployed before entering the water.	
11:00			Deep Tow in water	
11:23	483.3	156.4	Lots of small fish.	
11:26	538.9	000.0	Bottom in view. Seafloor of sand and gravel. Surrounded by lots of small fish.	
11:27	531.6	203.6	Dredge off bottom.	
11:31	530.7	148.7	Sand and gravel.	
11:35	527.2	148.7	Lots of shrimp and fish fry.	
11:37	523.2	182.3	A block of rock on sandy sea bottom.	
11:40	516.1	182.3	Blocks on bottom. Dredge lowered and set on sandy sea bottom with some blocks.	
11:42	516.2	170.8	Dredge lifted because blocks no longer visible.	
11:44	503.1	184.6	Sand and gravel.	
11:45	497.2	189.2	Outcrop of lava? Breccia. Massive lava and blocks. Lower dredge again.	
11:47	489.9	002.3	Sand and gravel.	
11:48	486.7	000.0	Dredge lifted off bottom.	
11:50	480.4	189.2	Murky, cannot see the seafloor.	
11:50	477.2	002.3	Steep slopes, drop to dredge.	selected samples (1.39 kg):
11:52	474.4	000.0	Angular boulders, unconsolidated. Some much too	R01-R03, R07: moderately phyric pyroxene-plagioclase

			big to fit into dredge box.	dacite R04-R05: moderately phyric pyroxene-hornblende-plagioclase dacite R09: sparsely phyric plagioclase dacite R06, R08, R10: moderately phyric (olivine)-pyroxene-plagioclase andesite others 1: various pebbles (1 kg) others 2: various sand, gravel and pebbles (9 kg) total dredge haul: 32.39 kg
11:53	468.8	000.0	Some huge boulders strewn across slope sitting in sandy sediment.	
11:56	446.2	357.7	Overall decrease in grain size. More gravel sized material. Still boulders strewn about though.	
11:58	441.0	175.4	Pink sea anemones.	
11:59	437.1	173.1	More sand and gravel, occasional boulder sized blocks.	
12:00	431.3	158.9	Still dredging unconsolidated material.	
12:01	425.4	153.9	More larger material again.	
12:03	417.8	151.3	Several close encounters with seafloor.	
12:05	408.0	148.7	Boulder slightly too big for box	
12:05	381.2	168.5	Impressive vertical cliff of stratified outcrop.	
12:05	381.2	168.5	No dredging.	
12:06	362.8	168.5	Keep dredge away from cliff and overhangs. Cliff less coherent now, made up of boulders.	
12:09	354.0	175.4	Still keeping away from cliff and overhangs.	
12:11	353.4	002.3	Steep slope of looser material trying to dredge.	
12:14	314.3	158.9	Steep slope of rubbly material, looks like outcrop.	
12:15	308.0	158.9	Dredge away from cliff.	
12:17	294.5	153.9	Jointed outcrop. Lava? Lots of nooks and crannies.	
12:18	284.6	170.8	Boulder strewn area.	
12:19	284.5	161.3	Dredge back on floor, try and capture boulders or something smaller.	

12:20	270.0	161.3	Steep slope, could be single boulder. Dredge off floor again.	
12:23	220.4	166.1	Slope covered in benthic organisms, sea pens, fish swimming around.	
12:26	220.9	156.3	Dredge briefly on floor. Lots of biology.	
12:28	202.6	168.5	Leave the floor.	

DT-01174

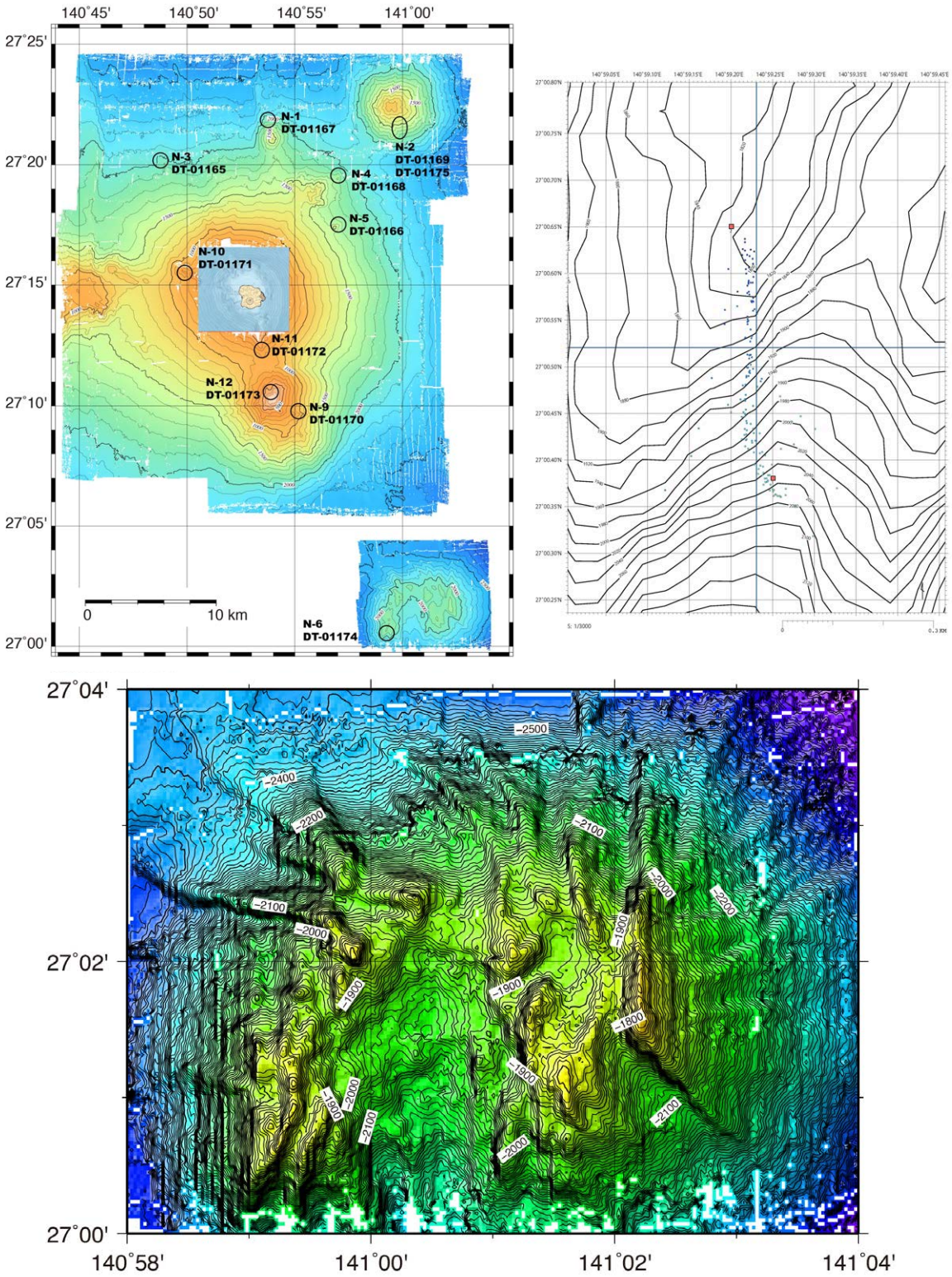


Fig. 23. Dive track of DT-01174.

Technical information

Date: 18 June 2015

Location: Southern flank of seamount ~28 km southeast of Nishinoshima Island at a depth ~2000 mbsl (site N6).

Objective: To observe the southern flank of the seamount to the southeast of Nishinoshima Island and to collect samples derived from primitive magma.

	On bottom	Off bottom
Time (local):	11:09	11:50
Latitude:	27° 00.368' N	27° 00.635' N
Longitude:	140° 59.251' E	140° 59.216' E
Depth (mbsl):	2059.6	1787.3

Observations

This dive climbed up the steep slope inside a depression-like fault scarp on the southern flank of the seamount. Deep Tow reached a rough semi-consolidated seafloor at 2060 mbsl; again the dredge was deployed throughout this dive. The sea bottom around 2060 mbsl consisted of gravel and blocks of lava, partially covered by sand. The dredge was lowered soon after large blocks were observed. The outcrop eventually steepened and became dominated by breccia facies with various sizes of subangular blocks and boulders. The outcrop was almost a vertical cliff from ~1900-1800 mbsl; the dredge was kept away from the cliff in order to avoid becoming caught. At 1800 mbsl the slope became gentler and consisted of breccia and the dredge was lowered again. Sand and gravel partially covered the sea bottom with some scattered isolated lava blocks. Deep Tow reached the top of seamount at 1791 mbsl. For the last ten minutes of the dive the dredge was kept on the relatively flat seafloor, during which time it could be seen that some isolated lava blocks were captured in the dredge. At 1787 mbsl Deep Tow left the seafloor.

Samples

Dredging recovered 28 kg of gravel-, pebble- and block-sized material. Twenty-three blocks were selected (R01-R23). Basically the recovered samples are mostly basalt lavas and breccias with various contents of olivine, pyroxene and plagioclase phenocrysts, except for one hydrothermally altered breccia (R01). Most of the selected samples are olivine-pyroxene basalt (11 samples; R03-07, 09, 17, 18, 20-22). The other samples are

plagioclase-olivine-pyroxene basalt (R08, 10, 11), highly phyric plagioclase-olivine-pyroxene basalt (R02), olivine-pyroxene-plagioclase basalt (R16), pyroxene-bearing plagioclase-phyric basalt (R15), sparsely phyric plagioclase basalt (R19), and olivine-bearing plagioclase-phyric basalt (R23). The breccias (R12-14) consist of olivine-pyroxene basalt clasts.

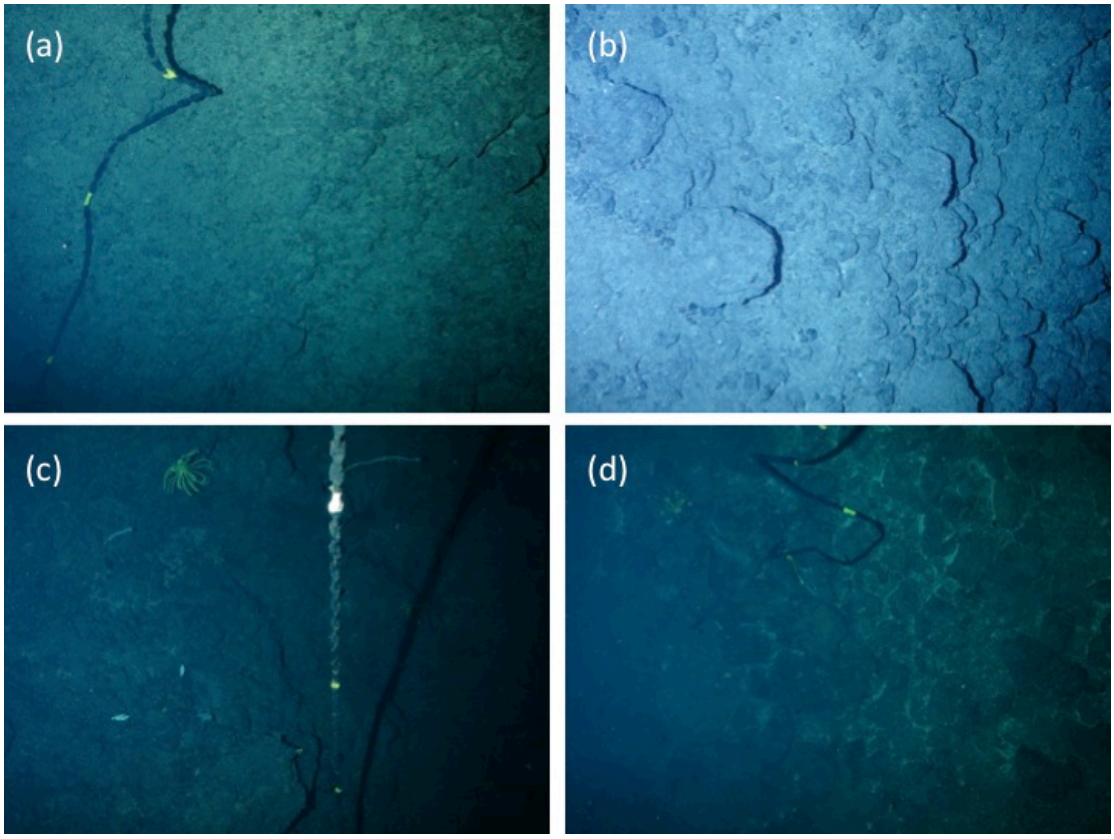


Fig. 24. Still images taken from Deep Tow during dive DT-01174. (a) Outcrop of breccia near the start of dive (DSC06619.jpg, 11:10:57). (b) Cliff of volcanic breccia (DSC06628.jpg, 11:14:54). (c) Almost vertical cliff consisting of breccia with various sizes of blocks (DSC06674.jpg, 11:35:30). (d) Subangular to subrounded lava blocks on gentle slope. The dive ended near this location (DSC06709.jpg, 11:48:27).

Dive log:

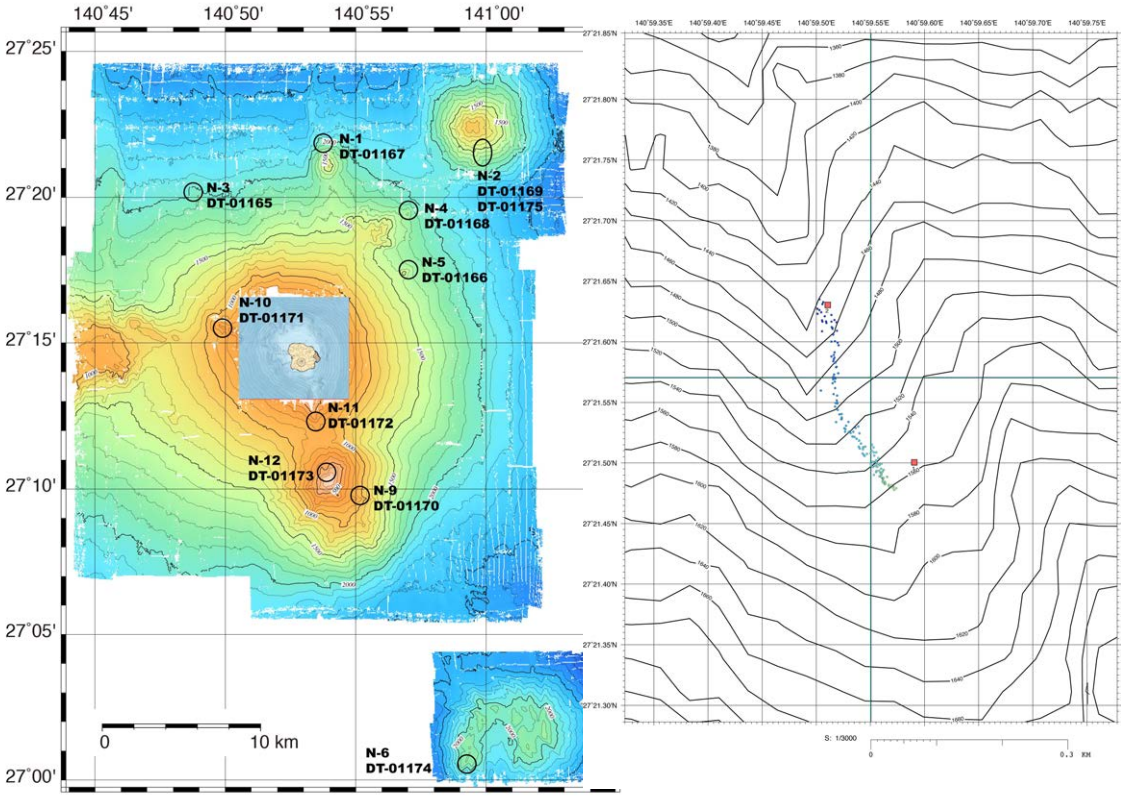
Logger: Maeno

Time (Local)	Depth (mbsl)	Heading	Notes	Sample descriptions (on deck)
09:55			Deep Tow operations begin	
			Dredge deployed before entering the water.	

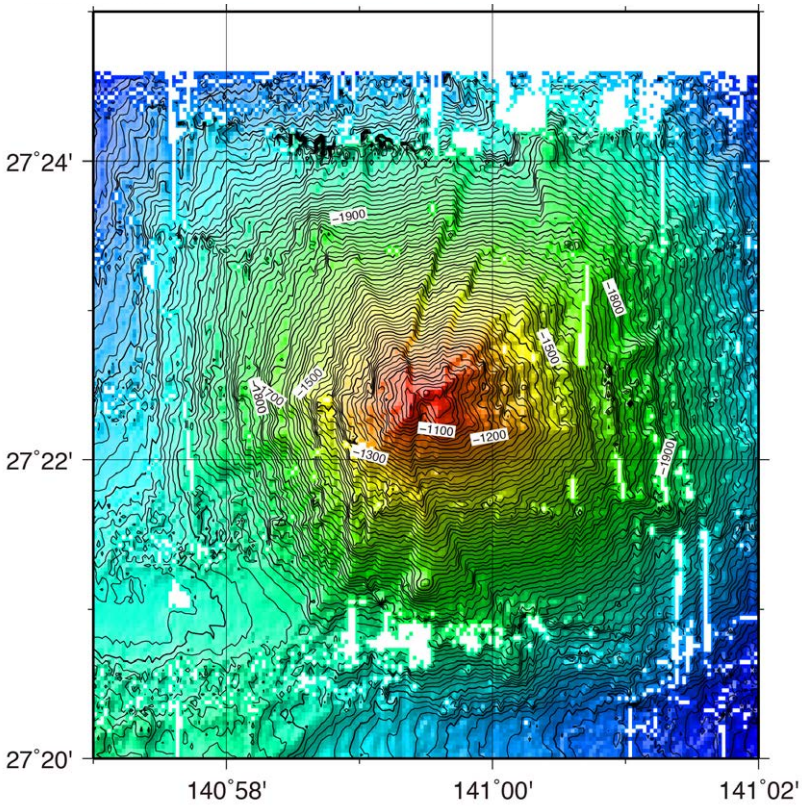
10:04			Deep Tow in water	
11:09	2059.6	253.5	Bottom in view. Outcrop of rough, semiconsolidated materials. Gravel and block sized lava, covered by thin sand layer.	
11:11	2051.3	323.1	Dredge on bottom. Start to dredge.	
11:13	2042.7	034.1	Breccia of subangular lava with matrix sand.	
11:15	2041.8	328.7	Breccia field continues.	
11:17	2020.3	346.1	Still outcrop on cliff of breccia. Breccia consisting of block to boulder sized lava.	
11:19	2008.4	353.1	Same outcrop. Sometimes large boulders.	
11:20	2003.2	346.1	Dredge continues on steep slope.	
11:22	1984.9	350.8	Same outcrop of lava breccia.	
11:25	1939.0	346.1	Still lava breccia with subangular block and boulder.	
11:28	1922.4	006.9	Still same cliff.	
11:30	1910.1	013.9	Lava breccia covered by sand.	
11:33	1881.3	039.8	Still rough breccia surface partially covered by sand.	
11:35	1870.1	021.1	Almost vertical cliff continues.	
11:36	1858.2	350.8	Same cliff. Dredger is not on surface.	
11:38	1824.9	333.9	Same cliff.	
11:40	1796.2	002.3	Cliff continues.	
11:42	1791.1	006.9	Gentle slope of blocks and boulders. Massive parts sometimes appear. Dredge restarts.	selected samples (21 kg): R01: hydrothermally altered breccia R02: highly phyric plagioclase-olivine-pyroxene basalt R03-07, 09, 17, 18, 20-22:
11:44	1790.9	018.7	Same rocky slope. A lot of isolated blocks.	
11:44	1789.1	357.7	Rocks in dredger.	

11:45	1790.4	002.3	Rocks in dredger?	olivine-pyroxene basalt R08, 10, 11: plagioclase-olivine-pyroxene basalt R12-14: breccia consisting of olivine-pyroxene basalt clasts R15: pyroxene-bearing plagioclase-phyric basalt R16: olivine-pyroxene-plagioclase basalt R19: sparsely phyric plagioclase basalt R23: olivine-bearing plagioclase-phyric basalt others: various pebble and gravel (7 kg) total dredge haul: 28 kg
11:47	1791.5	356.7	Subangular to subrounded lava blocks covered by sand.	
11:48	1788.5	357.7	Sand increases.	
11:49	1787.5	000.0	Rocks in dredger.	
11:50	1787.3	355.4	Leave the floor.	

DT-01175



ck of DT-01175.



Technical information

Date: 18 June 2015

Location: Knoll ~18 km ENE of Nishinoshima Island at ~1900 mbsl (site N-2).

Objective: To observe seafloor on a small seamount NE of Nishinoshima and to collect primitive lava samples from this satellite cone of Nishinoshima.

	On bottom	Off bottom
Time (local):	15:45	16:18
Latitude:	27° 21.480' N	27° 21.636' N
Longitude:	140° 59.570' E	140° 59.502' E
Depth (mbsl):	1555.9	1448.0

Observations

Deep Tow reached a seafloor covered with a crust of Mn-oxides at 1555.9 mbsl. The dredge sampler had been deployed from the beginning of the operation. The Mn-oxides crust had a relatively smooth surface, and it looked difficult to collect samples from this type of slope. At 1542 mbsl, the seafloor became rubbly, and the dredge was lowered. From 1501 mbsl, Deep Tow reached Mn-oxides-encrusted steep cliff. This cliff continued up to around 1450 mbsl. Accumulations of blocks with crusts of Mn-oxides was sporadically observed, and in such locations, the dredger seemed to collect samples. The dive ended at 1448 mbsl, soon after Deep Tow passed the planned goal.

Samples

Collected samples were mostly precipitates of hydrothermal Mn-oxides, commonly disseminated in volcanic sandstone. One fresh porphyritic basalt sample with pyroxene, olivine and plagioclase phenocrysts was collected (R01). This basalt has 7 mm-thick Mn-oxides crust, which implies that the activity of this volcano is not very recent.

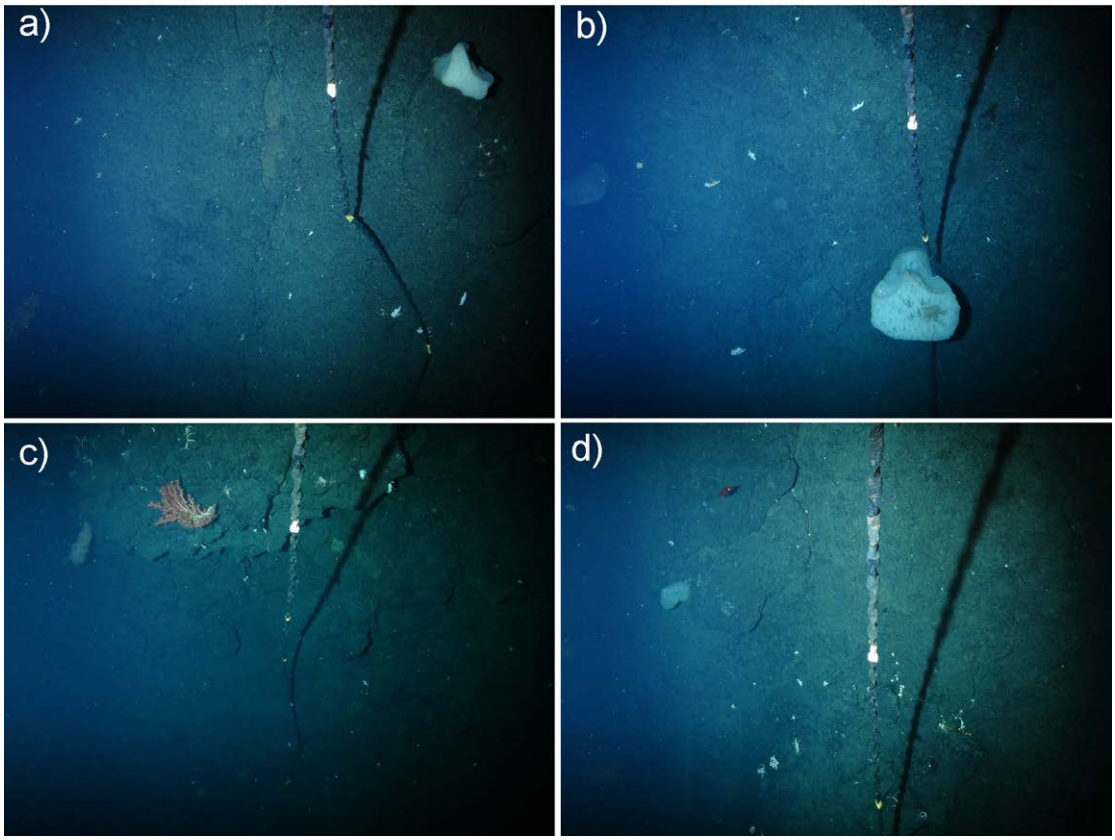


Fig. 26. Still images taken from Deep Tow during dive DT-01175. A) Mn-oxides encrusted slope near the starting point (DSC06740.jpg, 15:46). B) Mn-oxides encrusted slope with rubbly surface (DSC06750.jpg, 15:54). C) Step of Mn-oxides encrusted slope with blocks (DSC06784.jpg, 16:11). D) Blocky outcrop (DSC06800, 16:17). Each block seems to be covered with a crust of Mn-oxides.

Dive log

Logger: Ishizuka

Time (Local)	**Depth (mbsl)**	**Heading**	**Notes**	**Sample descriptions (on deck)**
15:00			Deep Tow operations begin.	
15:03			Deep Tow in water.	
15:45	1555.9	011.5	Seafloor looms into view. Mn-oxides encrusted surface.	
15:49	1550.5	011.5	Still Mn-oxides encrusted relatively smooth surface.	

15:51	1542.0	031.3	Mn-encrusted rubbly surface, dredge lowered.	
16:01	1516.0	336.4	Mn-encrusted rubbly surface with some blocks	
16:02	1506.0	355.4	Dredge was lifted , then lowered.	
16:04	1501.0	357.7	Steep cliff covered with Mn crust	Selected samples (3.7 kg) R01: ol-pl-px basalt R02-R05:hydrothermal Mn-oxides, volcanic sandstone Total dive haul: 6.2 kg
16:10	1474.2	006.9	Mn-oxides encrusted fractured outcrop, with blocks.	
16:13	1451.0	348.5	Fractured steep cliff.	
16:18	1448.0	357.7	Still Mn-encrusted floor with fractures. End of dive.	

4. Observations of volcanic activity on Nishinoshima Island from R/V Natsushima during cruise NT15-E02

The volcano now covers an area of approximately 2.5 km^2 above sea level since emerging in November 2013, joining and overwhelming the old Nishinoshima Island (Fig. 27). Throughout the six days of observations (13 June to 18 June 2015) both explosive and effusive activity were sustained (Fig. 27). Explosive strombolian eruptions occurred from a central summit crater in an approximately 150 m high pyroclastic cone. About halfway down the eastern slope of the cone another smaller steaming cone could be seen (Fig. 28), which is the source of the lava. The lava flowed to the south and reached the sea along the island's south coast where there was continuous steaming as lava entered the sea.

Fig. 27. (Left) Nishinoshima from the south east showing the plume from explosive strombolian eruptions at the summit of the ~150 m high pyroclastic cone and steam from where the lava flow enters the sea along the south coast (12:22 15 June). (Right) Old Nishinoshima Island overwhelmed by lava flows from the latest eruption (ongoing since November 2013) (14:05 15 June). Photos: Fukashi Maeno.

Explosive strombolian eruptions

The explosive strombolian eruptions from a central crater (50-60 m in diameter) at the summit of the approximately 150 m high pyroclastic cone (the highest point of the island) occurred with a frequency of one every 10 seconds to 1 minute and lasted up to between 1 and 2 minutes. Bombs (maximum size 2-3 m) and ash were erupted (Fig. 28). Smaller bombs were thrown to maximum heights of approximately 100 m above the crater; the largest bombs were thrown only several tens of meters high. Many bombs fell back in to the crater but some were seen to fall outside the crater and roll down the flanks of the cone. The shape of some bombs (Fig. 28) suggested they were still molten on leaving the vent. The height of the ash plume depended on the strength of the wind. On the calmest days the plume reached ~500 m above the cone before being sheared by the wind, on windier days it only reached 100 m. Even at a distance of 4.5 km ash could be felt in the air when R/V Natsushima was under the plume, and tephra traps set up at various locations on the forward of the ship successfully collected ash at various distances from the

volcano. At night the bombs could be seen to be incandescent (Fig. 28). Even from 4.5 km, some bombs were large enough to be seen with the naked eye.

Fig. 28. (top left) Beginning of an ash-generating explosive strombolian eruption with steaming lava flow front in foreground. Viewed from the south. Note the smaller cone half way down the left-hand (eastern) flank of the cone from which the lava is flowing (12:26 15 June). (top right) Ash plume sheared off to the right (east) by the strong westerly winds and bombs being thrown against the wind (06:19 17 June). (bottom left) Close up of bombs, showing irregular spatter shapes suggesting they are still molten on being ejected from the crater (14:14 15 June). (bottom right) Incandescent bombs in a strombolian eruption viewed from the south-west (18:58 16 June). Photos: Fukashi Maeno

Effusive lava flow

On the basis of steaming, lava appeared to be being erupted from a smaller cone halfway down the eastern flank of the pyroclastic cone (Fig. 28) and entering the sea along the south coast (Fig. 27). From a distance of 4.5 km no evidence of flowing could be seen and at night there was no visible glow from the smaller cone. However, thermal images (Fig. 29) suggest the flow originated from this area. Steaming from the small cone was not related to the explosive activity at the summit crater and was most vigorous on the first day. The lava flowed in a southerly direction and reached the sea along the south coast

forming a continually steaming ~800 m wide flow front (Fig. 28). At night the front could be seen to be glowing and using binoculars it could be seen that the glow was emanating from point sources along the front. These point sources were assumed to be tongues of lava entering the sea. Between 10 and 20 point sources could be observed at any one time across the front. During the day more intense pulses of steam could be seen being periodically released at the front, presumably due to an advance of one of the lava tongues into the water or a lava bench collapse. While glow could be seen at the lava front at night, no glow was visible with the naked eye on the flow itself. Thermal imaging highlights the active flow as hotter than the surrounding older flows, but that the older flows are still hotter than ambient temperature (Fig. 30). During the day shimmering above the active flow could be observed with high-powered camera lenses indicating its high temperature. Thus based on observations from 4.5 km it is unclear whether the lava has formed one or more tubes that flow down to the sea, or that it is advancing as an a'a flow with glow only visible on the over-steepened and unstable flow front, whereas the flow top is cooler and not incandescent.

Fig. 29 (left) Steaming flow front from the south (13:49 15 June) (right) Steaming flow front with lava flow behind showing flow top of rough a'a type morphology viewed from the south. Cone from which lava flow is believed to originate in the background (12:25 15 June). Photos: Fukashi Maeno

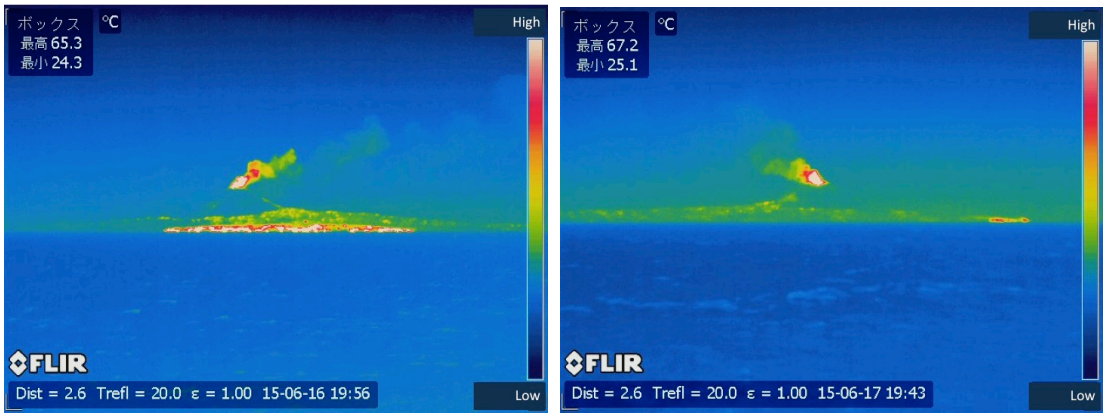


Fig. 30. Thermal images of Nishinoshima Island (red high temperature, blue ambient temperature). (left) View from south-east with the hottest areas being the plume from the explosive eruptions at the summit crater and the lava flow front. Note that the flow behind the front is warmer than the surrounding older flows, but not as hot as the flow front, suggesting that molten material is covered and either flowing in tubes or forms the core of the (a'a) flow. The hotter area extends up to the smaller cone halfway up the eastern flank of the main pyroclastic cone (19:56 16 June). (right) View from the south-west showing the hot explosive eruption plume and hot flow front on the far right (south). The older flows show lower, but still warmer than ambient, temperatures (as this is the western side of the island this is not believed to be the currently active flow) (19:43 17 June). Photos: Fukashi Maeno

5. Notice on Using

Notice on using: Insert the following notice to users regarding the data and samples obtained.

This cruise report is a preliminary documentation as of the end of the cruise.
This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.
Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.