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Cruise Report

YK 13-11

SHINKAI6500/ RV YOKOSUKA

North Kermadec Arc and Louisville Seamount Chain

October 24th –November 2nd, 2013

Japan Agency for Marine-Earth Science and Technology

National Institute of Water & Atmospheric Research

GNS

Natural History Museum and Institute, Chiba

Contents

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Operation team of *SHINKAI 6500*

Submersible Op. Manager	Toshiaki Sakurai
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C Captain	Shinya Ryono
Chief Officer	Naoto Kimura
2nd Officer	Tetsuo Shirayama
3rd Officer	Hiroharu Omae
Chief Engineer	Eiji Sakaguchi
1st Engineer	Kazunori Noguchi
2nd Engineer	Kenichi Shirakata
3rd Engineer	Kota Kataoka
Chief Radio officer	Masamoto Takahashi
2nd Electronic Operator	Hiroki Ishiwata
3rd Electronic Operator	Ryosuke Komatsu
Boat Swain	Yoshiaki Kawamura
Quarter Master	Kazumi Ogasawara
Quarter Master	Jiro Hanazawa
Quarter Master	Daizuke Yanagitani
Sailor	Kazuho Ikeda
Sailor	Yoshihiro Ogawa
Sailor	Kenta Nasu
No.1 Oiler	Kazuaki Nakai
Oiler	Shinya Sugi
Oiler	Masayuki Fujiwara
Oiler	Tatsuomi Chino
Oiler	Toshinori Matsui
Chief Steward	Sueto Sasaki
Steward	Shinsuke Tanaka
Steward	Masanao Kunita
Steward	Kazuma Sonoda
Steward	Shiho Shimizu

Cruise Summary

１．Cruise Information

● Cruise ID: YK13-11

● Name of vessel: R/V Yokosuka

● Title of the cruise: YK13-11 SHINKAI6500/RV YOKOSUKA

● Chief scientist [Affiliation]: Shinji Tsuchida [JAMSTEC]

● Representative of the Science Party [Affiliation]: Shinji Tsuchida [JAMSTEC]
Kei Shiomi[JAXA]

○ Title of proposal: ・Comparative studies of biology, geology, and geochemistry on subducting seamounts in the Louisville Seamount and active volcanoes in the Kermadec Arc.
・Global sea surface pCO2 observation: Estiamation of carbon budget between Ocean-Atmosphere by GOSAT data

● Cruise period: 24th October – 2nd November 2013

● Ports of call: Nuku'alofa, Tonga – Auckland, New Zealand

● Research area: Kermadec, South Pacific

２. Overview of the Observation

● Overview of the observation

1. Objectives of the survey of the Kermadec Trench

The oceanic structure around New Zealand, a country in the southern hemisphere, is similar to the one around Japan. There are areas where seamount chains stretch over several thousand kilometers. In this survey, jointly with the National Institute of Water and Atmospheric Research of New Zealand, JAMSTEC has studied organisms living in an area where two large seamount chains meet.

One of the large seamount chains surveyed is the Louisville Seamount Chain - a chain of over 70 seamounts stretching over about 4,300 kilometers from north-east to south-west of New Zealand. Seamounts in this area were formed around the South Pole, and some 70 millions of years later, they will subduct into the Kermadec Trench. Thus, in geological times those seamount will soon disappear. The Tonga-Kermadec Arc is located just across the trench with a series of volcanically active seamounts. There is an area where hot water loaded with sulfur and acids spews out of cracks in the seabed. Although the area is too deep (below 200-meter depth) for most of marine species to survive, those populations of

several species can be found, like around coral reefs. Those organisms rely on bacteria for energy. The bacteria produce energy from hydrogen sulfide and methane contained in the hot water.

In such a very unique environment where the disappearing seamount chain and the volcanically-active seamount chain lie over the trench axis, this survey was conducted to determine if there is any difference in ecosystems between the two seamount chains and, if any, where the difference comes from. For the first time in the world, JAMSTEC observed the seafloor in this area, using the manned research submersible SHINKAI 6500. JAMSTEC tried to collect data as well as samples of deep-sea species, using high-definition cameras and various measuring instruments. Based on the biological distribution data and the genetic information, JAMSTEC plans to unravel the biodiversity patterns of evolution in unique environments.

2. Outline (see the attached map)

(1) The Louisville Seamount Chain at depths of 1,200 – 2,800 meters and the northern Kermadec Arc at depths of 400 – 800 meters

Period: October 26 to 30, 2013

Details:

i) Topographic and geological survey in and around the Louisville Seamount Chain and the northern Kermadec Arc at depths of 300 – 5,000 meters.

- Survey was conducted during dives of SHINKAI 6500.
- Survey was conducted, using the "DEEP TOW" camera system.
- Outcrops were observed and rock samples were obtained, using SHINKAI 6500.
- Data on the submarine topography, gravity, and magnetism were measured, using instruments on the vessel.

ii) Ecosystem and biodiversity monitoring in the Louisville Seamount Chain and the northern Kermadec Arc at depths of 300 – 5,000 meters.

- Visual observation was conducted from SHINKAI 6500 to study depth distribution of fauna.
- During the survey deep-sea animals were collected using a slurp gun (suction sampler), manipulators, and core samplers.
- Environmental variables of habitats were measured, including water depth, water temperature, salinity, dissolved oxygen level, and hydrogen sulfide level.
- Distribution of deep-sea fauna was investigated, using the "DEEP TOW" camera

system.

3. Summary of research achievements

(1) A detailed bathymetric chart of the area around the Osbourne , Canopus, and Hinepuia Seamounts were drawn, as there was little topographic data available. The Osbourn Seamount is located at the west end of the Louisville Seamount Chain, while the Hinepuia Seamount is located in the northern Kermadec Arc.

(2) The seafloor was observed at the Louisville Seamount Chain for the first time in the world. Many animals were found, including sponges, corals, lobsters, crabs, sea cucumbers, sea urchins, starfish, and fish. Some of the species were successfully sampled.

(3) At the Hinepuia Seamount located in the northern Kermadec Arc, a new hydrothermal vent field was discovered for the first time. Vent-associated communities including *Bathymodiolus* mussels, *Symphurus* flat fish, and other species were found there. These observations are important in understanding the continuity and evolution of biological communities in the area.

Geological features were observed and rock samples were obtained. This made it possible to compare volcanic zones between the northern Kermadec Arc and the Louisville Seamount Chain.

Shipboard log

Date	Local Time	Description	Note	Position/Weather/Wind/Sea condition
23-Oct-13		**Scientists onboard.**		10/23 12:00 (UTC+13h)
	14:00	Scientists onboard.		NUKU'ALOFA Vuna Wharf
	15:00	Tonga Immigration.		21-07.8S,175-11.8W
				Cloudy
				ESE-4 (Moderate breeze)
				2 (Sea smooth)
				0 (No swell)
				Visibly: 8'
24-Oct-13		**Left NUKU'ALOFA for Research area**		10/24 12:00 (UTC+13h)
	08:30-09:00	Carried out Shipboard education & traning for scientist.		OFF WEST TONGA
	10:00	Let go all shore lines & left NUKU'ALOFA for Research area(KERMADEC arc).		20-55.6S,175-21.1W
	10:20	Scientist meeting.		Cloudy
	13:00-14:30	Cruise meeting(Scientist & SHINKAI team & Captain).		ESE-5 (Fresh breeze)
	16:40-17:00	KONPIRA pray.		3 (Sea slight)

Date	Local Time	Description	Note	Position/Weather/Wind/Sea condition
	20:00-20:30	Scientist meeting.		1 (Low swell sea)
				Visibly: 8'
25-Jan-13		**Arrived at Research area(KERMADIC Islamd Arc)**		10/25 12:00 (UTC+13h)
	12:00	Arrived at Research area(KERMADIC Islamd Arc S1).		OFF SOUTH TONGA
	12:04	Released XBT.	25-57.8208S,174-54.8819W	25-55.2S,174-54.4W
	12:36-13:19	Carried out MBES site survey.		Fine but coudy
	13:00-13:30	Scientist meeting.		East-4 (Moderate breeze)
	16:24	Released XBT.	26-31.6973S,174-30.9485W	3 (Sea slight)
	16:57-17:52	Carried out MBES site survey.		1 (Low swell sea)
	18:06	Com'ced MBES mapping survey.		Visibly: 8'
26-Oct-13		**SHINKAI Dive#1372**		10/26 12:00 (UTC+13h)
	05:48	Finished MBES mapping survey.		LOUISVILLE Seamount
		then proceeded to dive point.		20-36.3S,174-33.9W
	06:45	Arrived at dive point.		Cloudy
	10:02	SHINKAI6500 dove & started her operation #1372.		ESE-4 (Moderate breeze)
	11:12	SHINKAI 6500 landed on sea bottom (D=2,244m).		3 (Sea slight)
	15:43	SHINKAI 6500 left sea bottom (D=1,285m).		1 (Low swell sea)

Date	Local Time	Description	Note	Position/Weather/Wind/Sea condition
	16:17	SHINKAI 6500 refloated.		Visibly: 8'
	16:44	Recovered SHINKAI 6500 & finished above operation.		
	17:30	Proceeded to next dive point(S4).		
	19:00-19:40	Scientist meeting.		
27-Oct-13		**SHINKAI Dive#1373**		10/27 12:00 (UTC+13h)
	04:50	Arrived at dive point.		North KERMADIC Island Arc
	04:55	Released XBT.	25-57.8208S,174-54.8819W	26-24.3S,177-15.6W
	05:27-07:46	Carried out MBES site survey.		Overcast
	10:01	SHINKAI6500 dove & started her operation #1372.		NE-5 (Fresh breeze)
	10:34	SHINKAI 6500 landed on sea bottom (D=2,244m).		4 (Sea moderate)
	13:08	SHINKAI 6500 left sea bottom (D=1,285m).		3 (Moderate short)
	13:15	SHINKAI 6500 refloated.		Visibly: 8'
	13:43	Recovered SHINKAI 6500 & finished above operation.		
	14:38	Com’ced towing proton magnetometer.		
	15:25	Com'ced MBES mapping survey.		
	18:00-18:30	Com'ced MBES mapping survey.		

Date	Local Time	Description	Note	Position/Weather/Wind/Sea condition
	20:00	Scientist meeting.		
28-Oct-13		**Suspended to SHINKAI dive**		10/28 12:00 (UTC+13h)
	07:00	Arrived at dive point S1.		LOUISVILLE Seamount
		Suspended to SHINKAI dive,due to rough sea.		25-55.1S,174-58.9W
	09:10	Com'ced MBES mapping survey & Towing Proton magnetometer.		Overcast
				North-6 (Strong breeze)
				5 (Sea rough)
				3 (Moderate average)
				Visibly: 8'
29-Oct-13		**YKDT#158**		10/29 12:00 (UTC+13h)
	06:30	Finished to MBES mapping survey.		LOUISVILLE Seamount
	07:00	Suspended to SHINKAI dive,due to raugh sea.		26-02.5S,174-57.3W
	07:05	Recovered Proton magnetometer.		Cloudy
	10:24	YKDT on the sea		North-5 (Fresh breeze)
	11:36	Com'ced towed YKDT. #158.	D=2728m	4 (Sea moderate)
	16:32	Finished towed YKDT. #158.	D=1934m	3 (Moderate short)

Date	Local Time	Description	Note	Position/Weather/Wind/Sea condition
	17:22	YKDT on deck.		Visibly: 8'
	18:24	Com'ced towing Proton magnetometer.		
	19:00	Proceeded to dive point S4.		
30-Oct-13		**SHINKAI Dive#1374**		10/30 12:00 (UTC+13h)
	05:45	Arrived at dive point(S4).		North KERMADIC Island Arc
	06:34	Recovered Proton magnetometer.		26-23.7S,177-14.8W
	10:01	SHINKAI6500 dove & started her operation #1372.		Fine but coudy
	10:26	SHINKAI 6500 landed on sea bottom (D=494m).		SSE-4 (Moderate breeze)
	15:45	SHINKAI 6500 left sea bottom (D=278m).		3 (Sea slight)
	15:54	SHINKAI 6500 refloated.		3 (Moderate short)
	16:23	Recovered SHINKAI 6500 & finished above operation.		Visibly: 8'
	17:00	Left research area(KERMADIC RIDGE) for AUCKLAND.		
31-Oct-13		**Proceeding to AUCKLAND**		10/31 12:00 (UTC+13h)
	09:00-10:00	Scientist meeting.		OFF NORTH-EAST NEW ZEALAND
				29-41.4S,179-48.5W

Date	Local Time	Description	Note	Position/Weather/Wind/Sea condition
				Fine but coudy
				NE-3 (Gentle Bleeze)
				2 (Sea smooth)
				1 (Low swell sea)
				Visibly: 8'
01-Nov-13		**Proceeding to AUCKLAND**		11/1 12:00 (UTC+13h)
	18:00	Scientist meeting.		OFF NORTH-EAST NEW ZEALAND
				33-54.6S,176-47.2W
				Over cast
				NE-5 (Fresh breeze)
				4 (Sea moderate)
				3 (Moderate short)
				Visibly: 6'
02-Nov-13		**Arrived at AUCKLAND**		AUCKLAND
	09:00	Sent out 1st shore line, arrived at AUCKLAND, completed YK13-11.		

Dive Report 6K#1372

Date: 26th October, 2013

Site: Canopus Seamount, Louisville Seamount Chains **Depth:** 2244-1285m

Landing (Lat., Long., Time, Depth): 26°36.3228'S, 174°33.8796'W, 11:12, 2244m

Leaving (Lat., Long., Time, Depth): 26°37.2360'S, 174°35.0507'W, 15:43, 1285m

Pilot: Hirofumi Ueki, **Co-pilot:** Keigo Suzuki

Observer: Malcolm Clark (NIWA)

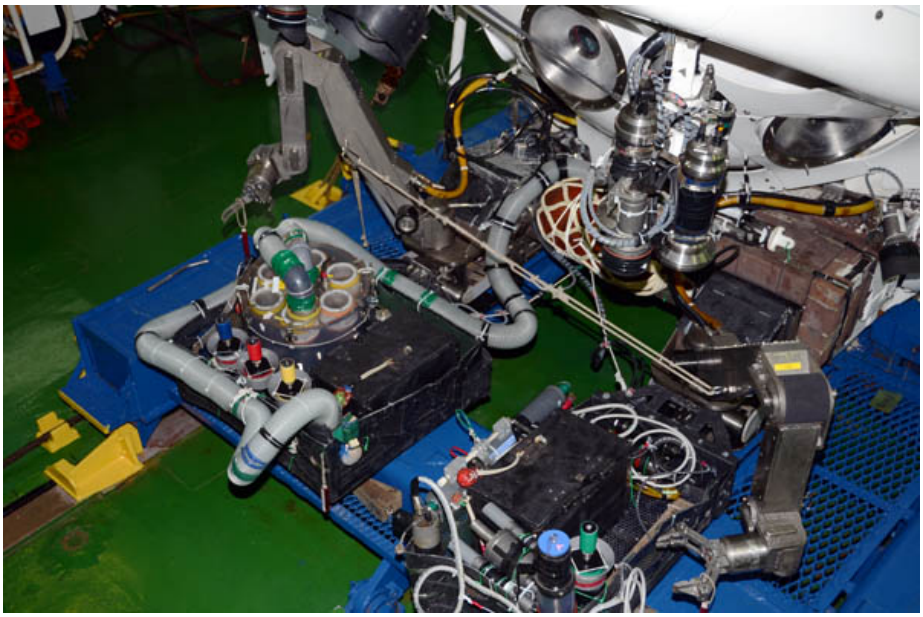
Theme: Comparative studies on the biodiversity between subducting seamounts in Louisville Seamount Chain and active volcanoes in the North Kermadec Arc.

Purpose:

1. Observing and recording of benthic animals on Canopus Seamount.
2. Sampling of animals, rocks, sediment and sea water.

Payload Equipment:

Slurp gun, Sample boxes(x2), seven bottle canister, H-type corer (x4), M-type corer (for scooping), Niskin water sampler (x2), D-port system, Major sampler (Alvin water sampler) Whats sampler, and CTD DO profiler (SBE-19)



Sampling Points and Markers:

Events	*Time*	*Depth (m)*	*Sample*	*Lat./ Long.*
Suction sampling	1118	2244	Urchin	26°36.323'S 174°33.879'W
	1227	2022	Holothurian	26°36.61'S 174°34.09'W
	1328	1645	Holothurian	26°36.88'S 174°34.28'W
Manipulator sampling	1118	2244	Rock (2)	26°36.323'S 174°33.879'W
	1149	2199	Glass sponge, Primnoid coral	26°36.38'S 174°33.93'W
	1242	1950	Rocks (2)	26°36.69'S 174°34.14'W
	1350	1567	Long glass sponge	26°36.92'S 174°34.39'W
	1410	1513	Sponge, Rocks (2)	26°36.97'S 174°34.58'W
	1424	1492	Pink primnoid/gorgonean coral	26°36.98'S 174°34.59'W
	1446	1411	Tulip sponge	26°37.12'S 174°34.82'W
Core sampling	1215	2049	Sediment	26°36.58'S 174°34.08'W
	1353	1567	Sediment	26°36.92'S 174°34.39'W
	1415	1513	Small rubble	26°36.97'S 174°34.58'W
Water samplers	1518	1285	Niskin (2)	26°37.24'S 174°35.05'W
	1520	1285	Majors (2)	26°37.24'S 174°35.05'W
	1530	1285	Whats (2)	26°37.24'S 174°35.05'W

Dive Summary

The dive was on the northeastern flank of Canopus seamount. We landed at a depth of 2244m, exactly on target. After an immediate sample of rocks and an urchin, we started moving upslope. The seafloor was rugged, with large pillow lava flows. There were scattered corals and sponges on the large overhanging rocks, and a couple were sampled. At about 2000 m there were extensive drifts of fine sandy seafloor in amongst the lava flows. This enabled a further sediment core, and a seapen to be sampled. Several attempts were made during the dive to break off pieces of the black basaltic lava, but it was too hard and strong. Pieces were taken from the seafloor, but typically were not hard. Continuing upslope from about 1900 m we encountered steep rock walls and massive blocky flows, with scattered anemones, corals, featherstars and bamboo corals. The substrate changed somewhat as we got shallower, with more crusty material overlain by thin sediment. Samples of a sea cucumber and a long unusual sponge were taken. An extensive drift of soft seafloor yielded another sediment core, and also a scoop of small pebbles and pumice. The crusty rock material was also collected. From 1500 m and up, the substrate was dominated by basaltic lava again, although more large and flat areas of bedrock, overlain by thin sediment. There was, however, a patch of soft sediment that had large crater-like pits. Only a few fish were seen, mainly rattails, apart from a small orange-brown ophidiid-like fish that was well off the bottom. Around 1400 m

pillow flows were evident again, with scattered gorgonian and primnoid corals. At 1500 hrs the submersible's batteries started to run low, and so direct sampling was stopped, and we settled down to fire the Niskins, and test the operation of the Whats and Majors samplers. At 1543hrs we began the ascent from a final depth of 1285 m.

Overall the dive was successful, with good photographic data collected along a transect up the flanks from 2244m to 1285 m. The summit was not reached due to the battery limitations cutting the dive by about an hour, but nevertheless faunal changes with depth were evident, and valuable samples collected for the first time from this area. Thanks Shinkai team!

Written by Malcolm Clark

Dive Log

Time	Depth	Grid X	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
1000	0							In water, released from tether, begin descent
1011	350							All dark now, nothing pelagic seen shallower. Slurp cannisters checked
1026	1000	1860	1250	160				Too deep, so heading SE upslope tpwards gully
1057	2143	1290	1380	144				Approaching bottom. 80m off, final checks
1110	2244	1260	1370		4			Start of dive. Hard rock, lava flows. Shrimp, urchin, scattered coral.
1117	2244				0	Slurp	No. 1	Urchin, small, ?Dermechinus/Gracellochinus?
1123	2246				0	Rock 1, 2	Port Bio Box	Both samples, not very hard, looked sedimentary.
1126	2240	1230	1350					Massive (to me anyway) lava flows, seapen, glass sponge, crinoids, soft corals scattered.
1135	2209							Black coral on rocks

Time	Depth	Grid X	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
1137	2200							Glass sponge.
1138	2199			216				Continue upslope. Blocky lava flows, black basalt.
1149	2199	1140	1280	205	0	Biol 1 and 2	Front BioBox	Glass sponge, vase (1). ?Primnoid coral, white, slender (2)
1155	2181			205				Continue upslope. Very rugged lava flows, scattered corals
1202	2136	960	1160					Overhanging rock walls, shrimps, anemones, bamboo corals, rattail fishes
1204	2130							Occasional shrimps, small mesopelagic fishes, a bit pelagic cod like.
1209	2091	850	1080					Blocky massive flows and boulders. Corals and sponges on overhangs. Halosaur.
1215	2049	780	1040			Core	No 1 blue	Sandy-looking sediment. Good depth, 65% full.
1220	2030			211				Blocky lava flow structures, large primnoid corals, some brittle stars on soft sediment.
1223	2026	750	1028.1	210	2			coral (isidiid?) on steep boulder face,
1224	2022			197	1			Mostly sediment cover, some holothurians
1227	2022	710	1010			Slurp	No. 2	Holothurian.
1234	1987	634	926	212	2			Soft sediments, bioturbation (holothurians, brittle stars?
1237	1986			211				Swimming holothurian, large shrimp to port. Blocky basalt flows.
1242	1950					Rock 3, 4	Port	Soft rock, take anyway. Smaller bit on

Time	Depth	Grid X	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
							BioBox	seafloor, larger piece broken off end of thin lava block.
1249	1926	580	920	197	3			Moving up slope again. Need to stretch legs!
1256	1884			214	4			Massive boulders and lava blocks/flows overlain with thin sediment.
1300	1836	480	850	230	20			Steep, almost sheer wall, murky conditions, rock wall on RHS, gully on LHS.
1305	1806			201	7			Blocky massive flows, small sedimentfilled interspaces, nice anemone below us.
1309	1754			209	15			Coming up steep slope. Check stalked crinoid?
1312	1718	356	802	211	11			Top of vertical rock face, edge of face crust-like then moves on to sediment overlay (thick? -some signs of bioturbation)
1313	1715	370	810	212	11			Scattered anemones, corals, featherstars, bamboo coral.
1315	1699			212				Transition from lava blocks into more a crust-type region. Halosaur.
1319	1678							Blocky outcrops still occur. Mainly crusty looking substrate.
1323	1662	260	700	200	2			Crust substrate, thin sediment layer.
1328	1645	220	690			Slurp	No. 3	Holothurian. End of slurp nozzle broken.
1337	1610			240	2			Crusty slab substrate, thin sediment. Nice swimming holothurian directly

Time	Depth	Grid X	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
								below us.
1340	1579	150	510		0			Going back to find long ?seapen–turns out to be a sponge
1350	1567	150	510		0	Biol. 3	Port BioBox	Long hexactinellid.
1353	1567	150	510		0	Core No 2	Red tape	Soft sandy sediment. Good core.
1358	1543			250	1			Underway again upslope. Soft sediment, scattered bamboo corals.
1403	1515			245	1			Soft sediment on slope, Scattered corals, seapens, sponges
1405	1513	60	200			Scoop		Scoop of small debris, maybe simply rubbishy pebbles, maybe some scoria, light pummice?
1410	1513	60	200			Rock 5	Aft BioBox	Crusty piece. Soft, broke up on placement in box
1414	1513	60	200			Rock 6	Aft BioBox	Larger piece, still crusty type and broke up.
1418	1513	60	200			Biol 4	Aft BioBox	Very flat sponge. Broke up and most lost from BioBox.
1421	1494			232	2			Lava flow substrate again.
1424	1492					Biol 5	Front BioBox	Pink primnoid coral–networky lace type.
1428	1486	49	217	240	2			Pavement and boulders, thin sediments
1430	1473							Glass sponge to port, scattered small black rattails, shrimps
1432	1456							Large ophidiid below us, hard to see. Small rattail.
1436	1428			237	1			Large holes (still photo). Soft

Time	Depth	Grid X	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
								sediment. Occasional stalked cup sponges (Hyanolema).
1440	1408	−225	−205	174	1			Mounds, bioturbation, sponges
1444	1406							Cool octopus. We are moving quickly upslope to reach the plateau
1446	1411	−220	−200			Biol 6	Front BioBox	Purple holothurian collected by manipulator arm. Broke away while opening box, and lost. Sample instead a large orange stalked sponge
1454	1395							Underway again upslope. Blocky lava flows.
1457	1385							Try sampling lava flow, where exposed ″tips″ but too hard and cannot break.
1500	1376			237	1			Hard lava pavement ″bedrock″. Exposed, little sediment.
1505	1346	−410	−480	243	2			Pillow lava, with scattered corals, Iridigorgia, Metallogorgia, Radicipes. Coral rubble in depressions between pillows. Stop to collect some corals, but there is a battery issue and so decide to carry on upslope to try and reach plateau for last sample.
1509	1330	−392	−447	281	2			Anemone, boulders, stones, bedrock, sediment in between
1511	1322			253	3			Mostly bedrock, some boulders, some sediment in crevices, sponge?
1518	1285	−440	−580			Niskin 1,2		Running low on battery power, and so with remaining samplers to test, have to stop and fire other gear.

Time	Depth	Grid X	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
1524	1285	-440	-580			Major 1,2		Fire OK, although access difficult to lower one.
1525	1285	-440	-580			Whats 1,2		Fire OK, takes about 15 minutes for both.
1543	1285	-440	-580					End of dive, begin ascent.
1620	0							
								Thanks Ueki-san and Suzuki-san for an excellent dive.
								SUMMARY of samples:
								Push cores: 2
								Scoop (type M core): 1
								Slurp-gun biology: 3
								Manipulator Biology: 5 (and a bit of sponge)
								Rock samples: 6
								Niskin: 2
								Major test: 2
								Whats sampler test: 2

Dive Report 6K#1373

Date: 27th October, 2013

Site: Hinepuia Seamount, North Kermdec Arc **Depth:** 367-774m

Landing (Lat., Long., Time, Depth): 26°24.4752'S, 177°15.5064'W, 10:34, 774m

Leaving (Lat., Long., Time, Depth): 26°23.8942'S, 177°15.1680'W, 13:05, 367m

Pilot: Kazuhiro Chiba, **Co-pilot:** Hitomi Ikeda

Observer: Shinji Tsuchida (JAMSTEC)

Theme: Comparative studies on the biodiversity between subducting seamounts in Louisville Seamount Chain and active volcanoes in the North Kermadec Arc.

Purpose:

1. Observing and recording of benthic animals on Hinepui Seamount.
2. Sampling of animals, rocks, sediment and sea water.
3. Identifying the locality of hydrothermal vent and associated animals.

Payload Equipment:

Slurp gun, Sample boxes(x2), seven bottle canister, H-type corer (x4), M-type corer (for scooping), Niskin water sampler (x2), D-port system, Major sampler (Alvin water sampler) Whats sampler, and CTD DO profiler (SBE-19)

Sampling Points and Markers:

Events	*Time*	*Depth (m)*	*Sample*	*Lat./ Long.*
Rock sampling	10:52	740	Rock	26°24.4116'S 177°15.5505'W
Animal sampling	12:16	437	Squat lobster	26°24.0820'S 177°15.3777'W
Water sampling	13:05	367	Sea water	26°23.8942'S 177°15.1680'W
Rock sampling	13:05	367	Rock	26°23.8942'S 177°15.1680'W

Dive Summary

Shinkai6500#1373 dive started to descend to a point of around 800m depth on the south slope of Hinepuia Seamount. At the landing point 774m depth, we observed lots of myctophid fish near the sea bottom and a kind of squad lobster with the hairy chelae. On the steep slope around 740m depth, we landed at the rocky bed and sampled a rock by the manipulator. A pair of geryonid crabs that a male guarded a pre-molt female was observed at rocky bottom, 723 m depth. Climbing the slope to the top of the mountain, we found a lots of fishes, small coral, gorgonians, bivalves, and also huge outcrops and rocks. At the depth of 437m, we collected a squat lobster, *Babamunida callista* by the slurp gun. Also, we tried to get a sediment sample by H-type corer on the sandy bottom, it resulted in failure for so much soft sediment. Near the top of the seamount, we saw high density of marine snow and probably whitish plume. Beyond the peak of the seamount we landed at muddy bottom and some altered sediments were observed. Around the top of the seamount, many kinds of fishes were found in high density. On the way of this dive, rough sea condition did not allow to continue the dive, so we had to cease looking for the hydrothermal area. Just before leaving the bottom, one rock sample was collected by its manipulator.

Written by Shinji Tsuchida

Dive Log

Time	Depth	Lat	Long	Hdg	Alt(m)	Samp_type	Location	Comment/observation
10:33	774	-868.7	-827.6	83	1			Landing
1034	774	-865.9	-843.6	84	5			watching weights, sandy slope with rocks
1036	776	-869	-840.8	94	4			squat lobster, water temp: 6 degree, current 240 deg, 10 cm/s
1040	777	-877.1	-834.4	94	28?			back to galatheid (different one) after

Time	Depth	Lat	Long	Hdg	Alt(m)	Samp_type	Location	Comment/observation
								small tour in the water
1040	same	same	same					start moving North, fish, lots of stones
1042	776	-884.8	-850.6	58	1			shrimp school, octocoral (Primnoid?)
1044	764	-919.2	-782.5	18	4			rubbly slope
1047	758	-831.7	-888.7	348	1			light colored rocks, rubbly slope with big boulders
1050	747	-798	-902.4	17	1			sulphur staining on rocks?
1052	740	-751.5	-907.2	43	1	rock		sampling rock (in front of canister, 1 piece)
1056	720	-713.2	-907.7	33	1			Filmed crab Chaceon having sex or simply hugging
1100	723	-721.6	-921.9	57	1			Alfonsino
1104	700	-682.3	-898.6	10	1			rubbly slope
1106	682	-675.2	-894.2	3	1			Actiniaria
1108	670	-644.8	-888.4	2	1			rubbly slope (still yellowishy stones)
1110	652	-628.4	-871.6	4	1			hard substrate
1113	631	-613.8	-871.4	9	1			scorpaenid fish
1117	598	-540	-861	9	1			rubbly slope
1122	548	-476	-853	7	1			rubbly slope
1124	532	-407	-857	6	1			hard sustrate, bottom of a sulphurish cliff
1126	520	-431	-858	6	1			fish? Shrimps
1129								Blank screen, as angle of signal reduces with shallower depth
1131	471	-385	-859	28				Massive bouldery substrate
1136	458	-390	-859	59				Blocky substrate, more rubbly, possible old chimney
1138	439	-371	-829	40				Rubble substrate, cobble size. Maybe Chaunax fish.
1145		-360	-802					Hardly moving with bottom current. Losing picture…
1150	438	-332	-788	20				No picture still, slow movement

Time	Depth	Lat	Long	Hdg	Alt(m)	Samp_type	Location	Comment/observation
1156	461	-284	-740	37	4			Blocky cobbles and boulders, no alteration.
1200	439	-271	-688	26	5			Rubbly boulder and cobble bottom. Pretty barren.
1206	424	-179	-634					Blank screen, as angle of signal reduces with shallower depth
1210	437	-155	-621	342	1			little image back, merky… rocks… lost image again soon
1214	437	-154	-628	330	1			squat lobster (munidid?)
1218	436	-149	-620	326	1			red core but lost, gave up with core
1222	434	-152	-628	325	1			yellow boulder on sandy slope
1226	423	-55	-627	16	1			moving over large boulders
1229	417	22	-605	27	1			moving along the top
1237	468	102	-454	42	1			moving along the top (in between summits)
1242	430	137	-388	34	6			moving around
1246	424?	148	-341					Blank screen, as angle of signal reduces with shallower depth
1250	395	152	-340	55				Blank screen, as angle of signal reduces with shallower depth
1253	360	152	-295	57				colored water
1258	429	139	-337	53				Blank screen, as angle of signal reduces with shallower depth
1301	377	182	-298	54				Landing and observe, still blank screen
1307	291	214	-294	61				on the way up, before leaving taking niskin (1 or 2) and rock

Dive Report YKDT#158

Date: 29th October 2013

Site: Osborne Seamount, Louisville Seamount Chains **Depth:** 1930-2737m

Landing (Lat., Long., Time, Depth): 26°02.8223'S, 174°57.3888'W, 11:36, 2737 m

Leaving (Lat., Long., Time, Depth): 26°00.4216'S, 174°46.1062'W, 16:32, 1930 m

Observer: Tomoyuki Komai (Natural History Museum and Institute, CHIBA)

Theme: Comparative studies on the biodiversity between subducting seamounts in Louisville Seamount Chain and active volcanoes in the North Kermadec Arc.

Purpose:

1. Observing and recording of benthic animals on Osbourne Seamount.
2. Sampling of rocks and sediments by the dredger.

Dive Summary

At 11:36, the deep-tow, YKDT landed on rock bottom at a depth of 2737 m, and then operation was started with the direction to north-north east. At 16:30, towing was finished (depth 1930 m), and the deep-tow was retracted on the ship at 17:22. The survey line was almost the same as that originally planned for "Shinkai 6500" diving, though the actual starting point was deeper than planned. Video and photography records were made throughout the operation. During the tow, we have encountered hexactinellid sponges, octocorals, aristeid shrimps, holothurians, and variety of fishes. The substratum was rather variable, sandy mud, mud, and sometimes rocks were seen during the operation.
Dredge operation was made just before leaving the bottom for 20 minutes. The collected samples contain pumice rocks, supposed to come from volcanoes of the Kermadec Ridge. No biological specimens were obtained.

noyuki Komai

Dive Log

Time	Note
29/10/2013 10:32:45 a.m.	[-81] IN THE WATER
29/10/2013 10:42:28 a.m.	[-2]
29/10/2013 10:54:14 a.m.	[701] Corallium spp
29/10/2013 11:12:51 a.m.	[-1] delete
29/10/2013 11:37:29 a.m.	[-82] AT THE BOTTOM
29/10/2013 11:37:50 a.m.	[6] Sand
29/10/2013 11:38:34 a.m.	[2] Boulders
29/10/2013 11:38:57 a.m.	[503] Gorgonacea
29/10/2013 11:39:06 a.m.	[6] Sand
29/10/2013 11:39:22 a.m.	[5] Gravel
29/10/2013 11:39:26 a.m.	[6] Sand
29/10/2013 11:39:58 a.m.	[-2] Stationary while ship catches up.
29/10/2013 11:40:08 a.m.	[-2] Towing not yet started
29/10/2013 11:41:12 a.m.	[-2] 2090, -840
29/10/2013 11:43:16 a.m.	[6] Sand
29/10/2013 11:43:35 a.m.	[6] Sand
29/10/2013 11:43:40 a.m.	[15] ripples
29/10/2013 11:43:42 a.m.	[6] Sand
29/10/2013 11:46:25 a.m.	[6] Sand
29/10/2013 11:47:02 a.m.	[6] Sand
29/10/2013 11:47:11 a.m.	[2] Boulders
29/10/2013 11:47:13 a.m.	[18] sand overlay
29/10/2013 11:47:45 a.m.	[507] Crinoidea (motile)
29/10/2013 11:47:49 a.m.	[6] Sand
29/10/2013 11:47:55 a.m.	[103] Echinoid
29/10/2013 11:48:42 a.m.	[-2] Start moving 034deg, 1148
29/10/2013 11:48:46 a.m.	[6] Sand
29/10/2013 11:49:17 a.m.	[6] Sand
29/10/2013 11:49:31 a.m.	[401] Bony fish
29/10/2013 11:49:38 a.m.	[6] Sand
29/10/2013 11:50:10 a.m.	[7] Muddy sed.
29/10/2013 11:50:41 a.m.	[-2] position -2090, -840, 2729m
29/10/2013 11:50:47 a.m.	[6] Sand
29/10/2013 11:50:51 a.m.	[7] Muddy sed.
29/10/2013 11:51:49 a.m.	[6] Sand
29/10/2013 11:51:51 a.m.	[7] Muddy sed.
29/10/2013 11:52:06 a.m.	[608] Mound
29/10/2013 11:52:10 a.m.	[6] Sand
29/10/2013 11:52:12 a.m.	[7] Muddy sed.
29/10/2013 11:52:36 a.m.	[6] Sand
29/10/2013 11:52:54 a.m.	[6] Sand
29/10/2013 11:53:02 a.m.	[203] Anemones
29/10/2013 11:53:04 a.m.	[6] Sand
29/10/2013 11:53:20 a.m.	[1] Bedrock
29/10/2013 11:53:27 a.m.	[18] sand overlay
29/10/2013 11:53:34 a.m.	[1] Bedrock
29/10/2013 11:53:51 a.m.	[1] Bedrock
29/10/2013 11:53:57 a.m.	[18] sand overlay
29/10/2013 11:54:18 a.m.	[-2] Depth 2705m
29/10/2013 11:54:34 a.m.	[7] Muddy sed.
29/10/2013 11:54:36 a.m.	[6] Sand
29/10/2013 11:54:59 a.m.	[1] Bedrock
29/10/2013 11:55:02 a.m.	[18] sand overlay
29/10/2013 11:55:09 a.m.	[209] Molluscs (bivalves)
29/10/2013 11:55:10 a.m.	[217] Echiura
29/10/2013 11:55:17 a.m.	[-1] delete
29/10/2013 11:55:18 a.m.	[-1] delete
29/10/2013 11:55:20 a.m.	[217] Echiura
29/10/2013 11:55:30 a.m.	[1] Bedrock
29/10/2013 11:55:32 a.m.	[18] sand overlay
29/10/2013 11:55:44 a.m.	[1] Bedrock
29/10/2013 11:55:48 a.m.	[18] sand overlay
29/10/2013 11:56:15 a.m.	[104] Holothurian
29/10/2013 11:56:18 a.m.	[1] Bedrock
29/10/2013 11:56:21 a.m.	[18] sand overlay
29/10/2013 11:56:42 a.m.	[1] Bedrock
29/10/2013 11:56:45 a.m.	[18] sand overlay
29/10/2013 11:57:08 a.m.	[2] Boulders
29/10/2013 11:57:12 a.m.	[11] outcrop
29/10/2013 11:57:16 a.m.	[691] Primnoidae
29/10/2013 11:57:26 a.m.	[1] Bedrock
29/10/2013 11:57:27 a.m.	[2] Boulders
29/10/2013 11:57:51 a.m.	[-2] Large blocky structures
29/10/2013 11:57:56 a.m.	[6] Sand
29/10/2013 11:58:04 a.m.	[7] Muddy sed.
29/10/2013 11:58:40 a.m.	[6] Sand
29/10/2013 11:59:02 a.m.	[401] Bony fish
29/10/2013 11:59:06 a.m.	[6] Sand
29/10/2013 11:59:11 a.m.	[1751] Lava
29/10/2013 11:59:13 a.m.	[2] Boulders
29/10/2013 11:59:16 a.m.	[2] Boulders
29/10/2013 11:59:31 a.m.	[6] Sand
29/10/2013 11:59:32 a.m.	[2] Boulders
29/10/2013 11:59:36 a.m.	[11] outcrop
29/10/2013 11:59:40 a.m.	[6] Sand
29/10/2013 11:59:54 a.m.	[1] Bedrock
29/10/2013 11:59:57 a.m.	[18] sand overlay
29/10/2013 12:00:03 p.m.	[29] OBSCURED

Time	Note
29/10/2013 12:00:09 p.m.	[2] Boulders
29/10/2013 12:00:15 p.m.	[1] Bedrock
29/10/2013 12:00:17 p.m.	[1751] Lava
29/10/2013 12:00:22 p.m.	[18] sand overlay
29/10/2013 12:00:25 p.m.	[691] Primnoidae
29/10/2013 12:00:31 p.m.	[699] Radicipes spp
29/10/2013 12:00:49 p.m.	[1] Bedrock
29/10/2013 12:01:05 p.m.	[204] Sponge (demospongiae)
29/10/2013 12:01:14 p.m.	[-1] delete
29/10/2013 12:01:15 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:01:20 p.m.	[6] Sand
29/10/2013 12:01:55 p.m.	[104] Holothurian
29/10/2013 12:02:03 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:02:17 p.m.	[1751] Lava
29/10/2013 12:02:59 p.m.	[1] Bedrock
29/10/2013 12:03:04 p.m.	[18] sand overlay
29/10/2013 12:03:20 p.m.	[-2] large lava boulders
29/10/2013 12:04:28 p.m.	[2] Boulders
29/10/2013 12:04:32 p.m.	[104] Holothurian
29/10/2013 12:04:40 p.m.	[-2] purple HTH
29/10/2013 12:05:06 p.m.	[203] Anemones
29/10/2013 12:05:32 p.m.	[1751] Lava
29/10/2013 12:05:34 p.m.	[2] Boulders
29/10/2013 12:05:35 p.m.	[1] Bedrock
29/10/2013 12:05:37 p.m.	[18] sand overlay
29/10/2013 12:05:41 p.m.	[2] Boulders
29/10/2013 12:06:36 p.m.	[1] Bedrock
29/10/2013 12:06:43 p.m.	[104] Holothurian
29/10/2013 12:06:48 p.m.	[18] sand overlay
29/10/2013 12:06:57 p.m.	[2] Boulders
29/10/2013 12:06:59 p.m.	[1751] Lava
29/10/2013 12:07:09 p.m.	[-2] 2655m
29/10/2013 12:07:43 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:08:21 p.m.	[2] Boulders
29/10/2013 12:08:22 p.m.	[1751] Lava
29/10/2013 12:08:25 p.m.	[18] sand overlay
29/10/2013 12:09:13 p.m.	[103] Echinoid
29/10/2013 12:09:27 p.m.	[1] Bedrock
29/10/2013 12:09:36 p.m.	[1751] Lava
29/10/2013 12:09:40 p.m.	[18] sand overlay
29/10/2013 12:09:48 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:09:55 p.m.	[104] Holothurian
29/10/2013 12:10:03 p.m.	[1] Bedrock
29/10/2013 12:10:39 p.m.	[1751] Lava
29/10/2013 12:11:33 p.m.	[-2] Phymorhynchus
29/10/2013 12:11:36 p.m.	[113] Mollusc (gastropod)
29/10/2013 12:11:44 p.m.	[1] Bedrock
29/10/2013 12:11:45 p.m.	[1751] Lava
29/10/2013 12:11:46 p.m.	[2] Boulders
29/10/2013 12:11:48 p.m.	[18] sand overlay
29/10/2013 12:13:07 p.m.	[1] Bedrock
29/10/2013 12:13:08 p.m.	[2] Boulders
29/10/2013 12:13:09 p.m.	[1751] Lava
29/10/2013 12:13:11 p.m.	[18] sand overlay
29/10/2013 12:13:24 p.m.	[-2] 2602m
29/10/2013 12:14:39 p.m.	[1] Bedrock
29/10/2013 12:14:41 p.m.	[2] Boulders
29/10/2013 12:14:42 p.m.	[1751] Lava
29/10/2013 12:14:44 p.m.	[18] sand overlay
29/10/2013 12:15:59 p.m.	[1] Bedrock
29/10/2013 12:16:00 p.m.	[18] sand overlay
29/10/2013 12:16:45 p.m.	[1] Bedrock
29/10/2013 12:16:53 p.m.	[18] sand overlay
29/10/2013 12:17:06 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:17:24 p.m.	[-2] stalked GLS
29/10/2013 12:18:40 p.m.	[-2] large outcrops, vertical walls of a
29/10/2013 12:18:46 p.m.	[1751] Lava
29/10/2013 12:18:49 p.m.	[18] sand overlay
29/10/2013 12:19:16 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:19:23 p.m.	[-2] Euplectellids
29/10/2013 12:19:52 p.m.	[109] Crustacean (shrimp)
29/10/2013 12:20:02 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:20:28 p.m.	[109] Crustacean (shrimp)
29/10/2013 12:20:32 p.m.	[18] sand overlay
29/10/2013 12:20:35 p.m.	[1] Bedrock
29/10/2013 12:20:36 p.m.	[2] Boulders
29/10/2013 12:20:56 p.m.	[-2] big blocky structures
29/10/2013 12:21:16 p.m.	[-2] 2516m
29/10/2013 12:21:57 p.m.	[103] Echinoid
29/10/2013 12:21:59 p.m.	[-1] delete
29/10/2013 12:22:00 p.m.	[104] Holothurian
29/10/2013 12:22:09 p.m.	[204] Sponge (demospongiae)
29/10/2013 12:22:10 p.m.	[-1] delete
29/10/2013 12:22:11 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:22:18 p.m.	[1] Bedrock
29/10/2013 12:22:20 p.m.	[18] sand overlay
29/10/2013 12:22:43 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:22:54 p.m.	[2] Boulders
29/10/2013 12:23:10 p.m.	[1] Bedrock
29/10/2013 12:23:16 p.m.	[18] sand overlay

Time	Note
29/10/2013 12:24:05 p.m.	[401] Bony fish
29/10/2013 12:24:29 p.m.	[-2] stalk?
29/10/2013 12:24:36 p.m.	[29] OBSCURED
29/10/2013 12:24:43 p.m.	[2] Boulders
29/10/2013 12:24:47 p.m.	[18] sand overlay
29/10/2013 12:24:48 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:24:53 p.m.	[1] Bedrock
29/10/2013 12:25:17 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:25:26 p.m.	[1] Bedrock
29/10/2013 12:26:15 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:26:33 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:26:44 p.m.	[2] Boulders
29/10/2013 12:26:49 p.m.	[18] sand overlay
29/10/2013 12:27:09 p.m.	[-2] 2460m
29/10/2013 12:27:19 p.m.	[2] Boulders
29/10/2013 12:27:21 p.m.	[1] Bedrock
29/10/2013 12:27:23 p.m.	[18] sand overlay
29/10/2013 12:27:25 p.m.	[1751] Lava
29/10/2013 12:27:28 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:28:00 p.m.	[18] sand overlay
29/10/2013 12:28:06 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:28:10 p.m.	[2] Boulders
29/10/2013 12:28:51 p.m.	[507] Crinoidea (motile)
29/10/2013 12:29:01 p.m.	[503] Gorgonacea
29/10/2013 12:29:03 p.m.	[-2] stalk
29/10/2013 12:29:10 p.m.	[2] Boulders
29/10/2013 12:29:37 p.m.	[1] Bedrock
29/10/2013 12:29:40 p.m.	[2] Boulders
29/10/2013 12:30:02 p.m.	[-2] Temp:2.0912
29/10/2013 12:30:13 p.m.	[-2] Cond: 3.1612
29/10/2013 12:30:20 p.m.	[-2] Sal: 34.6411
29/10/2013 12:30:26 p.m.	[1] Bedrock
29/10/2013 12:30:28 p.m.	[18] sand overlay
29/10/2013 12:30:39 p.m.	[1751] Lava
29/10/2013 12:30:50 p.m.	[2] Boulders
29/10/2013 12:31:02 p.m.	[18] sand overlay
29/10/2013 12:31:48 p.m.	[2] Boulders
29/10/2013 12:31:58 p.m.	[18] sand overlay
29/10/2013 12:32:01 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:32:20 p.m.	[1] Bedrock
29/10/2013 12:32:22 p.m.	[104] Holothurian
29/10/2013 12:32:22 p.m.	[507] Crinoidea (motile)
29/10/2013 12:32:35 p.m.	[2] Boulders
29/10/2013 12:32:40 p.m.	[1751] Lava
29/10/2013 12:32:43 p.m.	[1] Bedrock

Time	Note
29/10/2013 12:32:46 p.m.	[18] sand overlay
29/10/2013 12:32:57 p.m.	[2] Boulders
29/10/2013 12:33:05 p.m.	[-2] rubble
29/10/2013 12:33:17 p.m.	[2] Boulders
29/10/2013 12:33:18 p.m.	[3] Cobbles
29/10/2013 12:33:27 p.m.	[-2] 2384 m
29/10/2013 12:33:33 p.m.	[2] Boulders
29/10/2013 12:33:38 p.m.	[3] Cobbles
29/10/2013 12:34:23 p.m.	[1] Bedrock
29/10/2013 12:34:26 p.m.	[18] sand overlay
29/10/2013 12:34:33 p.m.	[-2] cobble field
29/10/2013 12:34:49 p.m.	[104] Holothurian
29/10/2013 12:35:07 p.m.	[2] Boulders
29/10/2013 12:35:09 p.m.	[1] Bedrock
29/10/2013 12:35:53 p.m.	[2] Boulders
29/10/2013 12:36:25 p.m.	[109] Crustacean (shrimp)
29/10/2013 12:36:43 p.m.	[2] Boulders
29/10/2013 12:36:55 p.m.	[18] sand overlay
29/10/2013 12:37:03 p.m.	[1] Bedrock
29/10/2013 12:37:06 p.m.	[2] Boulders
29/10/2013 12:37:09 p.m.	[1751] Lava
29/10/2013 12:37:13 p.m.	[11] outcrop
29/10/2013 12:37:20 p.m.	[1] Bedrock
29/10/2013 12:37:27 p.m.	[29] OBSCURED
29/10/2013 12:37:59 p.m.	[1] Bedrock
29/10/2013 12:38:10 p.m.	[1] Bedrock
29/10/2013 12:38:12 p.m.	[18] sand overlay
29/10/2013 12:38:39 p.m.	[1] Bedrock
29/10/2013 12:38:46 p.m.	[18] sand overlay
29/10/2013 12:38:50 p.m.	[1751] Lava
29/10/2013 12:38:59 p.m.	[-2] back to steep outcrops
29/10/2013 12:39:05 p.m.	[1751] Lava
29/10/2013 12:39:12 p.m.	[-2] steep wall
29/10/2013 12:39:58 p.m.	[-2] vertical for ~40m
29/10/2013 12:40:12 p.m.	[-2] 2210m
29/10/2013 12:40:27 p.m.	[-2]
29/10/2013 12:40:55 p.m.	[-2] top of cliff at 2169m
29/10/2013 12:40:57 p.m.	[29] OBSCURED
29/10/2013 12:41:23 p.m.	[1] Bedrock
29/10/2013 12:41:25 p.m.	[1751] Lava
29/10/2013 12:41:33 p.m.	[1] Bedrock
29/10/2013 12:41:35 p.m.	[18] sand overlay
29/10/2013 12:42:06 p.m.	[15] ripples
29/10/2013 12:42:11 p.m.	[1] Bedrock
29/10/2013 12:42:13 p.m.	[18] sand overlay

Time	Note
29/10/2013 12:42:16 p.m.	[2] Boulders
29/10/2013 12:42:21 p.m.	[1] Bedrock
29/10/2013 12:42:34 p.m.	[18] sand overlay
29/10/2013 12:42:37 p.m.	[1] Bedrock
29/10/2013 12:43:02 p.m.	[-2] horizontal layers in bedrock, not
29/10/2013 12:43:21 p.m.	[-2] stalk
29/10/2013 12:43:23 p.m.	[1] Bedrock
29/10/2013 12:43:25 p.m.	[18] sand overlay
29/10/2013 12:43:41 p.m.	[4] Pebbles
29/10/2013 12:43:43 p.m.	[1] Bedrock
29/10/2013 12:43:45 p.m.	[18] sand overlay
29/10/2013 12:43:54 p.m.	[638] Zoanthidea
29/10/2013 12:43:55 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:44:01 p.m.	[-2] zoanthids on sponge stalk
29/10/2013 12:44:08 p.m.	[104] Holothurian
29/10/2013 12:44:13 p.m.	[4] Pebbles
29/10/2013 12:44:14 p.m.	[1] Bedrock
29/10/2013 12:44:17 p.m.	[18] sand overlay
29/10/2013 12:44:27 p.m.	[1] Bedrock
29/10/2013 12:44:37 p.m.	[104] Holothurian
29/10/2013 12:44:43 p.m.	[4] Pebbles
29/10/2013 12:44:48 p.m.	[1] Bedrock
29/10/2013 12:45:05 p.m.	[18] sand overlay
29/10/2013 12:45:13 p.m.	[1] Bedrock
29/10/2013 12:45:15 p.m.	[205] Sponge (hexactinellidae)
29/10/2013 12:45:45 p.m.	[-2] 2129m
29/10/2013 12:45:52 p.m.	[638] Zoanthidea
29/10/2013 12:46:00 p.m.	[-2] sponge stalk with zoanthids
29/10/2013 12:46:15 p.m.	[4] Pebbles
29/10/2013 12:46:18 p.m.	[18] sand overlay
29/10/2013 12:46:25 p.m.	[1] Bedrock
29/10/2013 12:46:32 p.m.	[4] Pebbles
29/10/2013 12:46:40 p.m.	[607] Track
29/10/2013 12:46:48 p.m.	[-2] stalk, zoanthids
29/10/2013 12:47:17 p.m.	[18] sand overlay
29/10/2013 12:47:25 p.m.	[103] Echinoid
29/10/2013 12:48:01 p.m.	[-2] rocky substrate not visible
29/10/2013 12:48:04 p.m.	[4] Pebbles
29/10/2013 12:48:23 p.m.	[6] Sand
29/10/2013 12:48:35 p.m.	[606] Burrow
29/10/2013 12:48:53 p.m.	[-2] 2119m
29/10/2013 12:49:20 p.m.	[607] Track
29/10/2013 12:49:38 p.m.	[4] Pebbles
29/10/2013 12:49:41 p.m.	[6] Sand
29/10/2013 12:49:45 p.m.	[1] Bedrock
29/10/2013 12:49:48 p.m.	[4] Pebbles
29/10/2013 12:50:13 p.m.	[6] Sand
29/10/2013 12:50:21 p.m.	[606] Burrow
29/10/2013 12:50:33 p.m.	[1] Bedrock
29/10/2013 12:50:35 p.m.	[18] sand overlay
29/10/2013 12:50:56 p.m.	[-2] stalk
29/10/2013 12:51:01 p.m.	[4] Pebbles
29/10/2013 12:51:04 p.m.	[1] Bedrock
29/10/2013 12:51:10 p.m.	[18] sand overlay
29/10/2013 12:51:28 p.m.	[606] Burrow
29/10/2013 12:51:49 p.m.	[217] Echiura
29/10/2013 12:51:59 p.m.	[1] Bedrock
29/10/2013 12:52:02 p.m.	[18] sand overlay
29/10/2013 12:52:19 p.m.	[4] Pebbles
29/10/2013 12:52:19 p.m.	[1] Bedrock
29/10/2013 12:52:21 p.m.	[18] sand overlay
29/10/2013 12:52:49 p.m.	[3] Cobbles
29/10/2013 12:52:52 p.m.	[1] Bedrock
29/10/2013 12:53:04 p.m.	[18] sand overlay
29/10/2013 12:53:06 p.m.	[1] Bedrock
29/10/2013 12:53:11 p.m.	[4] Pebbles
29/10/2013 12:53:26 p.m.	[-2] 2119m
29/10/2013 12:53:32 p.m.	[4] Pebbles
29/10/2013 12:53:35 p.m.	[2] Boulders
29/10/2013 12:53:36 p.m.	[1] Bedrock
29/10/2013 12:53:38 p.m.	[18] sand overlay
29/10/2013 12:53:53 p.m.	[708] Ceriantharia spp
29/10/2013 12:54:01 p.m.	[4] Pebbles
29/10/2013 12:54:03 p.m.	[3] Cobbles
29/10/2013 12:54:17 p.m.	[2] Boulders
29/10/2013 12:54:23 p.m.	[18] sand overlay
29/10/2013 12:54:32 p.m.	[1] Bedrock
29/10/2013 12:54:34 p.m.	[3] Cobbles
29/10/2013 12:54:35 p.m.	[4] Pebbles
29/10/2013 12:54:54 p.m.	[1] Bedrock
29/10/2013 12:54:56 p.m.	[4] Pebbles
29/10/2013 12:54:59 p.m.	[3] Cobbles
29/10/2013 12:55:22 p.m.	[607] Track
29/10/2013 12:55:33 p.m.	[638] Zoanthidea
29/10/2013 12:55:39 p.m.	[-2] stalk with zoanthids
29/10/2013 12:55:43 p.m.	[1] Bedrock
29/10/2013 12:55:51 p.m.	[18] sand overlay
29/10/2013 12:55:54 p.m.	[4] Pebbles
29/10/2013 12:56:07 p.m.	[1] Bedrock
29/10/2013 12:56:15 p.m.	[607] Track

Time	Note
29/10/2013 12:56:47 p.m.	[6] Sand
29/10/2013 12:56:48 p.m.	[4] Pebbles
29/10/2013 12:57:02 p.m.	[3] Cobbles
29/10/2013 12:57:03 p.m.	[4] Pebbles
29/10/2013 12:57:20 p.m.	[6] Sand
29/10/2013 12:57:27 p.m.	[4] Pebbles
29/10/2013 12:57:33 p.m.	[3] Cobbles
29/10/2013 12:57:52 p.m.	[502] Pennatulacea
29/10/2013 12:58:03 p.m.	[18] sand overlay
29/10/2013 12:58:09 p.m.	[4] Pebbles
29/10/2013 12:58:33 p.m.	[6] Sand
29/10/2013 12:58:36 p.m.	[4] Pebbles
29/10/2013 12:59:11 p.m.	[1] Bedrock
29/10/2013 12:59:18 p.m.	[4] Pebbles
29/10/2013 12:59:23 p.m.	[3] Cobbles
29/10/2013 12:59:28 p.m.	[6] Sand
29/10/2013 1:01:43 p.m.	[3] Cobbles
29/10/2013 1:01:45 p.m.	[4] Pebbles
29/10/2013 1:01:47 p.m.	[6] Sand
29/10/2013 1:01:57 p.m.	[2] Boulders
29/10/2013 1:02:03 p.m.	[3] Cobbles
29/10/2013 1:02:04 p.m.	[6] Sand
29/10/2013 1:02:09 p.m.	[2] Boulders
29/10/2013 1:02:14 p.m.	[3] Cobbles
29/10/2013 1:02:22 p.m.	[6] Sand
29/10/2013 1:02:28 p.m.	[4] Pebbles
29/10/2013 1:02:43 p.m.	[3] Cobbles
29/10/2013 1:02:52 p.m.	[4] Pebbles
29/10/2013 1:03:11 p.m.	[3] Cobbles
29/10/2013 1:03:15 p.m.	[4] Pebbles
29/10/2013 1:03:18 p.m.	[6] Sand
29/10/2013 1:03:26 p.m.	[3] Cobbles
29/10/2013 1:03:32 p.m.	[4] Pebbles
29/10/2013 1:03:36 p.m.	[217] Echiura
29/10/2013 1:03:47 p.m.	[3] Cobbles
29/10/2013 1:03:55 p.m.	[4] Pebbles
29/10/2013 1:04:06 p.m.	[6] Sand
29/10/2013 1:04:20 p.m.	[2] Boulders
29/10/2013 1:04:30 p.m.	[3] Cobbles
29/10/2013 1:04:35 p.m.	[4] Pebbles
29/10/2013 1:04:40 p.m.	[6] Sand
29/10/2013 1:04:47 p.m.	[3] Cobbles
29/10/2013 1:04:56 p.m.	[4] Pebbles
29/10/2013 1:05:02 p.m.	[6] Sand
29/10/2013 1:05:11 p.m.	[2] Boulders
29/10/2013 1:05:15 p.m.	[3] Cobbles
29/10/2013 1:05:20 p.m.	[4] Pebbles
29/10/2013 1:05:28 p.m.	[6] Sand
29/10/2013 1:05:35 p.m.	[4] Pebbles
29/10/2013 1:05:45 p.m.	[6] Sand
29/10/2013 1:05:53 p.m.	[4] Pebbles
29/10/2013 1:06:01 p.m.	[6] Sand
29/10/2013 1:06:10 p.m.	[4] Pebbles
29/10/2013 1:06:13 p.m.	[2] Boulders
29/10/2013 1:06:24 p.m.	[4] Pebbles
29/10/2013 1:06:27 p.m.	[3] Cobbles
29/10/2013 1:06:29 p.m.	[6] Sand
29/10/2013 1:06:31 p.m.	[4] Pebbles
29/10/2013 1:06:38 p.m.	[6] Sand
29/10/2013 1:06:44 p.m.	[4] Pebbles
29/10/2013 1:06:54 p.m.	[6] Sand
29/10/2013 1:07:04 p.m.	[2] Boulders
29/10/2013 1:07:07 p.m.	[4] Pebbles
29/10/2013 1:07:10 p.m.	[6] Sand
29/10/2013 1:07:15 p.m.	[102] Ophiuroid
29/10/2013 1:07:25 p.m.	[4] Pebbles
29/10/2013 1:07:32 p.m.	[6] Sand
29/10/2013 1:07:37 p.m.	[109] Crustacean (shrimp)
29/10/2013 1:07:45 p.m.	[4] Pebbles
29/10/2013 1:07:49 p.m.	[6] Sand
29/10/2013 1:07:57 p.m.	[4] Pebbles
29/10/2013 1:08:02 p.m.	[6] Sand
29/10/2013 1:08:09 p.m.	[4] Pebbles
29/10/2013 1:08:16 p.m.	[6] Sand
29/10/2013 1:08:21 p.m.	[217] Echiura
29/10/2013 1:08:27 p.m.	[4] Pebbles
29/10/2013 1:08:28 p.m.	[3] Cobbles
29/10/2013 1:08:29 p.m.	[6] Sand
29/10/2013 1:08:32 p.m.	[4] Pebbles
29/10/2013 1:08:37 p.m.	[6] Sand
29/10/2013 1:08:41 p.m.	[4] Pebbles
29/10/2013 1:08:45 p.m.	[6] Sand
29/10/2013 1:08:50 p.m.	[4] Pebbles
29/10/2013 1:08:56 p.m.	[104] Holothurian
29/10/2013 1:08:59 p.m.	[4] Pebbles
29/10/2013 1:09:03 p.m.	[6] Sand
29/10/2013 1:09:11 p.m.	[4] Pebbles
29/10/2013 1:09:17 p.m.	[6] Sand
29/10/2013 1:09:21 p.m.	[3] Cobbles
29/10/2013 1:09:47 p.m.	[4] Pebbles

Time	Note
29/10/2013 1:09:51 p.m.	[6] Sand
29/10/2013 1:09:54 p.m.	[109] Crustacean (shrimp)
29/10/2013 1:09:57 p.m.	[4] Pebbles
29/10/2013 1:10:03 p.m.	[6] Sand
29/10/2013 1:10:07 p.m.	[6] Sand
29/10/2013 1:10:13 p.m.	[4] Pebbles
29/10/2013 1:10:36 p.m.	[-2] Large burrow?
29/10/2013 1:10:38 p.m.	[104] Holothurian
29/10/2013 1:10:41 p.m.	[609] Pit
29/10/2013 1:10:48 p.m.	[4] Pebbles
29/10/2013 1:10:50 p.m.	[6] Sand
29/10/2013 1:10:56 p.m.	[3] Cobbles
29/10/2013 1:10:57 p.m.	[4] Pebbles
29/10/2013 1:11:01 p.m.	[6] Sand
29/10/2013 1:11:03 p.m.	[3] Cobbles
29/10/2013 1:11:10 p.m.	[4] Pebbles
29/10/2013 1:11:14 p.m.	[6] Sand
29/10/2013 1:11:17 p.m.	[3] Cobbles
29/10/2013 1:11:22 p.m.	[4] Pebbles
29/10/2013 1:11:27 p.m.	[6] Sand
29/10/2013 1:11:29 p.m.	[3] Cobbles
29/10/2013 1:11:35 p.m.	[4] Pebbles
29/10/2013 1:11:40 p.m.	[6] Sand
29/10/2013 1:12:01 p.m.	[-2] POssible tracks?
29/10/2013 1:12:10 p.m.	[4] Pebbles
29/10/2013 1:12:14 p.m.	[6] Sand
29/10/2013 1:12:18 p.m.	[3] Cobbles
29/10/2013 1:12:22 p.m.	[4] Pebbles
29/10/2013 1:12:28 p.m.	[6] Sand
29/10/2013 1:12:34 p.m.	[3] Cobbles
29/10/2013 1:12:39 p.m.	[4] Pebbles
29/10/2013 1:12:44 p.m.	[6] Sand
29/10/2013 1:12:46 p.m.	[3] Cobbles
29/10/2013 1:12:49 p.m.	[4] Pebbles
29/10/2013 1:12:53 p.m.	[6] Sand
29/10/2013 1:12:58 p.m.	[4] Pebbles
29/10/2013 1:13:02 p.m.	[6] Sand
29/10/2013 1:13:05 p.m.	[4] Pebbles
29/10/2013 1:13:09 p.m.	[6] Sand
29/10/2013 1:13:13 p.m.	[4] Pebbles
29/10/2013 1:13:18 p.m.	[6] Sand
29/10/2013 1:13:22 p.m.	[4] Pebbles
29/10/2013 1:13:26 p.m.	[6] Sand
29/10/2013 1:13:31 p.m.	[4] Pebbles
29/10/2013 1:13:36 p.m.	[6] Sand

Time	Note
29/10/2013 1:13:38 p.m.	[3] Cobbles
29/10/2013 1:13:44 p.m.	[4] Pebbles
29/10/2013 1:13:48 p.m.	[6] Sand
29/10/2013 1:13:55 p.m.	[4] Pebbles
29/10/2013 1:14:00 p.m.	[6] Sand
29/10/2013 1:14:04 p.m.	[4] Pebbles
29/10/2013 1:14:09 p.m.	[6] Sand
29/10/2013 1:14:13 p.m.	[4] Pebbles
29/10/2013 1:14:18 p.m.	[6] Sand
29/10/2013 1:14:27 p.m.	[4] Pebbles
29/10/2013 1:14:33 p.m.	[6] Sand
29/10/2013 1:14:39 p.m.	[4] Pebbles
29/10/2013 1:14:43 p.m.	[102] Ophiuroid
29/10/2013 1:14:46 p.m.	[6] Sand
29/10/2013 1:15:04 p.m.	[102] Ophiuroid
29/10/2013 1:15:13 p.m.	[4] Pebbles
29/10/2013 1:15:19 p.m.	[6] Sand
29/10/2013 1:15:31 p.m.	[502] Pennatulacea
29/10/2013 1:15:36 p.m.	[4] Pebbles
29/10/2013 1:15:40 p.m.	[6] Sand
29/10/2013 1:15:46 p.m.	[4] Pebbles
29/10/2013 1:15:50 p.m.	[6] Sand
29/10/2013 1:16:00 p.m.	[4] Pebbles
29/10/2013 1:16:05 p.m.	[6] Sand
29/10/2013 1:16:08 p.m.	[4] Pebbles
29/10/2013 1:16:12 p.m.	[104] Holothurian
29/10/2013 1:16:15 p.m.	[6] Sand
29/10/2013 1:16:19 p.m.	[4] Pebbles
29/10/2013 1:16:22 p.m.	[6] Sand
29/10/2013 1:16:25 p.m.	[607] Track
29/10/2013 1:16:27 p.m.	[6] Sand
29/10/2013 1:16:31 p.m.	[4] Pebbles
29/10/2013 1:16:34 p.m.	[6] Sand
29/10/2013 1:16:38 p.m.	[4] Pebbles
29/10/2013 1:16:40 p.m.	[6] Sand
29/10/2013 1:16:43 p.m.	[4] Pebbles
29/10/2013 1:16:46 p.m.	[6] Sand
29/10/2013 1:16:53 p.m.	[4] Pebbles
29/10/2013 1:16:58 p.m.	[6] Sand
29/10/2013 1:17:03 p.m.	[4] Pebbles
29/10/2013 1:17:06 p.m.	[6] Sand
29/10/2013 1:17:10 p.m.	[4] Pebbles
29/10/2013 1:17:15 p.m.	[6] Sand
29/10/2013 1:17:19 p.m.	[4] Pebbles
29/10/2013 1:17:22 p.m.	[3] Cobbles

Time	Note
29/10/2013 1:17:23 p.m.	[6] Sand
29/10/2013 1:17:26 p.m.	[4] Pebbles
29/10/2013 1:17:30 p.m.	[6] Sand
29/10/2013 1:17:33 p.m.	[4] Pebbles
29/10/2013 1:17:37 p.m.	[6] Sand
29/10/2013 1:17:40 p.m.	[4] Pebbles
29/10/2013 1:17:44 p.m.	[6] Sand
29/10/2013 1:17:48 p.m.	[4] Pebbles
29/10/2013 1:17:52 p.m.	[6] Sand
29/10/2013 1:17:56 p.m.	[4] Pebbles
29/10/2013 1:18:00 p.m.	[6] Sand
29/10/2013 1:18:01 p.m.	[4] Pebbles
29/10/2013 1:18:04 p.m.	[6] Sand
29/10/2013 1:18:06 p.m.	[4] Pebbles
29/10/2013 1:18:08 p.m.	[607] Track
29/10/2013 1:18:13 p.m.	[4] Pebbles
29/10/2013 1:18:16 p.m.	[6] Sand
29/10/2013 1:18:18 p.m.	[4] Pebbles
29/10/2013 1:18:21 p.m.	[3] Cobbles
29/10/2013 1:18:23 p.m.	[6] Sand
29/10/2013 1:18:28 p.m.	[4] Pebbles
29/10/2013 1:18:32 p.m.	[3] Cobbles
29/10/2013 1:18:34 p.m.	[6] Sand
29/10/2013 1:18:40 p.m.	[4] Pebbles
29/10/2013 1:18:44 p.m.	[6] Sand
29/10/2013 1:18:48 p.m.	[4] Pebbles
29/10/2013 1:18:53 p.m.	[6] Sand
29/10/2013 1:18:56 p.m.	[4] Pebbles
29/10/2013 1:19:01 p.m.	[6] Sand
29/10/2013 1:19:05 p.m.	[4] Pebbles
29/10/2013 1:19:07 p.m.	[6] Sand
29/10/2013 1:19:09 p.m.	[4] Pebbles
29/10/2013 1:19:11 p.m.	[3] Cobbles
29/10/2013 1:19:13 p.m.	[4] Pebbles
29/10/2013 1:19:20 p.m.	[102] Ophiuroid
29/10/2013 1:19:30 p.m.	[5] Gravel
29/10/2013 1:19:32 p.m.	[4] Pebbles
29/10/2013 1:19:34 p.m.	[3] Cobbles
29/10/2013 1:19:35 p.m.	[6] Sand
29/10/2013 1:19:36 p.m.	[5] Gravel
29/10/2013 1:19:38 p.m.	[4] Pebbles
29/10/2013 1:19:41 p.m.	[3] Cobbles
29/10/2013 1:19:42 p.m.	[6] Sand
29/10/2013 1:19:46 p.m.	[5] Gravel
29/10/2013 1:19:49 p.m.	[4] Pebbles
29/10/2013 1:19:50 p.m.	[3] Cobbles
29/10/2013 1:19:51 p.m.	[6] Sand
29/10/2013 1:19:55 p.m.	[607] Track
29/10/2013 1:19:59 p.m.	[5] Gravel
29/10/2013 1:20:00 p.m.	[4] Pebbles
29/10/2013 1:20:02 p.m.	[3] Cobbles
29/10/2013 1:20:03 p.m.	[6] Sand
29/10/2013 1:20:05 p.m.	[5] Gravel
29/10/2013 1:20:08 p.m.	[4] Pebbles
29/10/2013 1:20:09 p.m.	[3] Cobbles
29/10/2013 1:20:10 p.m.	[6] Sand
29/10/2013 1:20:11 p.m.	[5] Gravel
29/10/2013 1:20:13 p.m.	[4] Pebbles
29/10/2013 1:20:15 p.m.	[6] Sand
29/10/2013 1:20:19 p.m.	[5] Gravel
29/10/2013 1:20:22 p.m.	[4] Pebbles
29/10/2013 1:20:24 p.m.	[6] Sand
29/10/2013 1:20:27 p.m.	[4] Pebbles
29/10/2013 1:20:29 p.m.	[6] Sand
29/10/2013 1:20:34 p.m.	[4] Pebbles
29/10/2013 1:20:36 p.m.	[6] Sand
29/10/2013 1:20:40 p.m.	[4] Pebbles
29/10/2013 1:20:43 p.m.	[6] Sand
29/10/2013 1:20:48 p.m.	[4] Pebbles
29/10/2013 1:20:51 p.m.	[6] Sand
29/10/2013 1:20:56 p.m.	[4] Pebbles
29/10/2013 1:20:58 p.m.	[6] Sand
29/10/2013 1:21:05 p.m.	[6] Sand
29/10/2013 1:21:07 p.m.	[4] Pebbles
29/10/2013 1:21:10 p.m.	[6] Sand
29/10/2013 1:21:16 p.m.	[4] Pebbles
29/10/2013 1:21:20 p.m.	[6] Sand
29/10/2013 1:21:27 p.m.	[4] Pebbles
29/10/2013 1:21:30 p.m.	[6] Sand
29/10/2013 1:21:33 p.m.	[4] Pebbles
29/10/2013 1:21:35 p.m.	[6] Sand
29/10/2013 1:21:41 p.m.	[3] Cobbles
29/10/2013 1:21:45 p.m.	[4] Pebbles
29/10/2013 1:21:48 p.m.	[6] Sand
29/10/2013 1:21:53 p.m.	[4] Pebbles
29/10/2013 1:21:56 p.m.	[6] Sand
29/10/2013 1:22:07 p.m.	[4] Pebbles
29/10/2013 1:22:09 p.m.	[6] Sand
29/10/2013 1:22:13 p.m.	[4] Pebbles
29/10/2013 1:22:16 p.m.	[6] Sand

Time	Note
29/10/2013 1:22:19 p.m.	[3] Cobbles
29/10/2013 1:22:20 p.m.	[4] Pebbles
29/10/2013 1:22:22 p.m.	[6] Sand
29/10/2013 1:22:24 p.m.	[3] Cobbles
29/10/2013 1:22:52 p.m.	[4] Pebbles
29/10/2013 1:22:54 p.m.	[6] Sand
29/10/2013 1:22:59 p.m.	[4] Pebbles
29/10/2013 1:23:02 p.m.	[6] Sand
29/10/2013 1:23:21 p.m.	[4] Pebbles
29/10/2013 1:23:23 p.m.	[6] Sand
29/10/2013 1:23:26 p.m.	[4] Pebbles
29/10/2013 1:23:29 p.m.	[6] Sand
29/10/2013 1:23:35 p.m.	[4] Pebbles
29/10/2013 1:23:39 p.m.	[6] Sand
29/10/2013 1:23:43 p.m.	[4] Pebbles
29/10/2013 1:23:46 p.m.	[6] Sand
29/10/2013 1:23:51 p.m.	[4] Pebbles
29/10/2013 1:23:57 p.m.	[6] Sand
29/10/2013 1:24:05 p.m.	[607] Track
29/10/2013 1:24:07 p.m.	[4] Pebbles
29/10/2013 1:24:09 p.m.	[6] Sand
29/10/2013 1:24:17 p.m.	[4] Pebbles
29/10/2013 1:24:19 p.m.	[6] Sand
29/10/2013 1:24:24 p.m.	[4] Pebbles
29/10/2013 1:24:27 p.m.	[6] Sand
29/10/2013 1:24:30 p.m.	[4] Pebbles
29/10/2013 1:24:31 p.m.	[6] Sand
29/10/2013 1:24:34 p.m.	[4] Pebbles
29/10/2013 1:24:35 p.m.	[6] Sand
29/10/2013 1:24:39 p.m.	[4] Pebbles
29/10/2013 1:24:44 p.m.	[109] Crustacean (shrimp)
29/10/2013 1:24:46 p.m.	[4] Pebbles
29/10/2013 1:24:50 p.m.	[6] Sand
29/10/2013 1:24:54 p.m.	[607] Track
29/10/2013 1:24:57 p.m.	[4] Pebbles
29/10/2013 1:24:59 p.m.	[6] Sand
29/10/2013 1:25:03 p.m.	[4] Pebbles
29/10/2013 1:25:04 p.m.	[6] Sand
29/10/2013 1:25:08 p.m.	[4] Pebbles
29/10/2013 1:25:09 p.m.	[6] Sand
29/10/2013 1:25:12 p.m.	[4] Pebbles
29/10/2013 1:25:13 p.m.	[6] Sand
29/10/2013 1:25:16 p.m.	[4] Pebbles
29/10/2013 1:25:17 p.m.	[6] Sand
29/10/2013 1:25:23 p.m.	[217] Echiura

Time	Note
29/10/2013 1:25:24 p.m.	[4] Pebbles
29/10/2013 1:25:27 p.m.	[6] Sand
29/10/2013 1:25:31 p.m.	[4] Pebbles
29/10/2013 1:25:32 p.m.	[6] Sand
29/10/2013 1:25:35 p.m.	[607] Track
29/10/2013 1:25:37 p.m.	[4] Pebbles
29/10/2013 1:25:40 p.m.	[6] Sand
29/10/2013 1:25:42 p.m.	[607] Track
29/10/2013 1:25:45 p.m.	[4] Pebbles
29/10/2013 1:25:48 p.m.	[6] Sand
29/10/2013 1:25:51 p.m.	[4] Pebbles
29/10/2013 1:25:55 p.m.	[6] Sand
29/10/2013 1:25:58 p.m.	[4] Pebbles
29/10/2013 1:26:02 p.m.	[6] Sand
29/10/2013 1:26:06 p.m.	[4] Pebbles
29/10/2013 1:26:10 p.m.	[6] Sand
29/10/2013 1:26:14 p.m.	[4] Pebbles
29/10/2013 1:26:16 p.m.	[6] Sand
29/10/2013 1:26:19 p.m.	[4] Pebbles
29/10/2013 1:26:22 p.m.	[6] Sand
29/10/2013 1:26:26 p.m.	[4] Pebbles
29/10/2013 1:26:29 p.m.	[607] Track
29/10/2013 1:26:31 p.m.	[6] Sand
29/10/2013 1:26:34 p.m.	[4] Pebbles
29/10/2013 1:26:37 p.m.	[6] Sand
29/10/2013 1:26:41 p.m.	[4] Pebbles
29/10/2013 1:26:45 p.m.	[607] Track
29/10/2013 1:26:47 p.m.	[102] Ophiuroid
29/10/2013 1:26:48 p.m.	[6] Sand
29/10/2013 1:26:51 p.m.	[4] Pebbles
29/10/2013 1:26:53 p.m.	[6] Sand
29/10/2013 1:26:56 p.m.	[4] Pebbles
29/10/2013 1:27:00 p.m.	[6] Sand
29/10/2013 1:27:04 p.m.	[4] Pebbles
29/10/2013 1:27:06 p.m.	[6] Sand
29/10/2013 1:27:10 p.m.	[4] Pebbles
29/10/2013 1:27:11 p.m.	[6] Sand
29/10/2013 1:27:15 p.m.	[4] Pebbles
29/10/2013 1:27:16 p.m.	[6] Sand
29/10/2013 1:27:19 p.m.	[4] Pebbles
29/10/2013 1:27:21 p.m.	[6] Sand
29/10/2013 1:27:23 p.m.	[4] Pebbles
29/10/2013 1:27:26 p.m.	[6] Sand
29/10/2013 1:27:29 p.m.	[607] Track
29/10/2013 1:27:33 p.m.	[607] Track

Time	Note
29/10/2013 1:27:37 p.m.	[607] Track
29/10/2013 1:27:40 p.m.	[6] Sand
29/10/2013 1:27:43 p.m.	[4] Pebbles
29/10/2013 1:27:45 p.m.	[6] Sand
29/10/2013 1:27:47 p.m.	[607] Track
29/10/2013 1:27:50 p.m.	[4] Pebbles
29/10/2013 1:27:52 p.m.	[6] Sand
29/10/2013 1:27:57 p.m.	[4] Pebbles
29/10/2013 1:28:04 p.m.	[109] Crustacean (shrimp)
29/10/2013 1:28:05 p.m.	[6] Sand
29/10/2013 1:28:07 p.m.	[4] Pebbles
29/10/2013 1:28:10 p.m.	[6] Sand

Time	Note
29/10/2013 1:28:13 p.m.	[4] Pebbles
29/10/2013 1:28:15 p.m.	[6] Sand
29/10/2013 1:28:18 p.m.	[4] Pebbles
29/10/2013 1:28:20 p.m.	[6] Sand
29/10/2013 1:28:25 p.m.	[4] Pebbles
29/10/2013 1:28:26 p.m.	[6] Sand
29/10/2013 1:28:30 p.m.	[4] Pebbles

Dive Report 6K#1374

Date: 30th October, 2013

Site: Hinepuia volcano **Depth:** 494-304 m

Landing: (Lat., Long., Time, Depth): 26° 24.1202' S, 177° 14.6352' W, 10:26, 494 m

Leaving: (Lat., Long., Time, Depth): 26° 23.9567' S, 177° 14.9539' W, 15;45, 278 m

Pilot: Iijima, **Co-pilot:** Katagiri

Observer: Cornel E.J. de Ronde (GNS)

Theme: Comparative studies between the biodiversity of subducting seamounts of the Louisville Seamount Chain and active volcanoes of the northern Kermadec Arc.

Purpose:

1. Observe and video record vent-related animals and hydrothermal vents of Hinepuia volcano,
2. Sample vent-related animals, hydrothermal fluids, rocks and sediments.

Payload Equipment:

Slurp gun, Sample box (divided into 2 compartments), six bottle canister, H-type corer (x2), M-type corer for scooping (x2), Niskin water sampler (x2), D-port system, Major water samplers (x2) WHATS sampler, and CTD DO profiler (SBE-19)

Sampling Points and Markers:

Events	*Time*	*Depth (m)*	*Sample*	*Lat./ Long.*
Core sample (yellow)	10:26	494	Sediment	26°24.1202'S, 177°14.6352' W
Manipulator	10:33	494	Rock	26°24.1202'S, 177°14.6352' W
Suction (jar #1)	10:42	499	Squat lobsters	26°24.1246'S, 177°14.6428' W
Suction (jar #1)	10:46	499	Gastropod	26°24.1246'S, 177°14.6428' W
Suction (jar #2)	10:53	499	Spikey bivalve	26°24.1246'S, 177°14.6428' W
Manipulator	10:55	499	Pencil urchin	26°24.1242'S, 177°14.6456' W
Core sample (blue)	12:31	388	Sediments	26°23.9090'S, 177°15.0377' W
Manipulator	12:37	388	Rocks (3)	26°23.9090'S, 177°15.0377' W
Scoop (green)	12:53	386	Sediment/shell	26°23.8949'S, 177°15.0770' W
Suction (jar #3)	13:22	347	Flatfish	26°23.8339'S, 177°15.0401' W
Manipulator	13:40	337	Mussels	26°23.8141'S, 177°15.0249' W
Probe	13:42	337	Temperature	26°23.8141'S, 177°15.0249' W
D-port	13:46	337	H_2S	26°23.8141'S, 177°15.0249' W
Niskin (green)	14:48	367	Plume	26°23.8137'S, 177°15.0533' W
WHATS (red)	14:53	371	Fluid	26°23.8151'S, 177°15.0641' W
Major sampler (black)	15:34	347	Plume	26°23.8151'S, 177°15.0641' W
Major sampler (white)	15:37	354	Plume	26°23.8151'S, 177°15.0641' W

Dive Summary

Hinepuia is Maori for guardian god of geothermal activity. What an incredible dive we had, to a place that is not that far to get to, but felt like was on a different planet such were the scenes that awaited us. Indeed, we set a record for depth in our dive with the *Shinkai*, a record *shallow* depth with the summit of the volcano at 304 m! The whole dive only covered a depth range of 192 m from the landing point at 496 m to the summit. But as is common with submarine volcanoes and associated hydrothermal activity, big things can occur over small depth intervals.

The dive began with us landing around 10:23 at a depth of 496 m (26°24.1202'S, 177°14.6352' W). We found our bearings before sampling nearby animals (squat lobsters x 3; a spikey bivalve, a gastropod and a pencil urchin), 1 rock and sediments in a push core (see Table), before heading ~North upslope to where we hoped the vent field would be. Back in 2004, during the NZAPLUME III cruise, we had surveyed Hinepuia volcano with a CTDO (conductivity-temperature-depth-optical) package towed behind the ship. Results from that survey of Hinepuia showed there was intense hydrothermal activity occurring atop a cone inside a larger caldera. And it all occurred between ~400 and 300 m with the strongest plumes around 350 m. We also knew that plumes don't rise very much in shallow water, so our plan was to search the cone on its southern side along the 400 m contour.

Around 10:59 we ascended up the flank of the cone to the summit. The slopes were covered in debris and sand with locally large blocks (several m high) of lava (11:02; 11:18; 11:26; 11:30; 11:44) and some lava surfaces having a 'bread crust' like texture (11:08). We saw large shoals of fish (11:12), several large sharks (11:08) and one large octopus (11:35). But there was no sign of hydrothermal activity. We noted an abundance of coral with distinct yellow polyps covering the outcrops during the ascent. The outcrops neat and at the summit locally looked like that might have bacteria covering them (11:44; 11:57)? Large grouper were also seen at the summit.

At 12:09 we went back to the plan and descended to 400 m and started driving westwards along the 400 m contour. First, we saw numerous chutes of debris cascading down the slopes adjacent to outcrops of massive, locally blocky and sometimes flow banded lava (12:23). Then, we saw a whitish sandy material in an area of brownish colored sediment though did not look like of hydrothermal origin and possibly bioturbated? Took the blue push core sample here (388m; 12:28). We checked the temperature of the sediment before the seafloor but it was the same (11°C as the ambient water). We also collected what looked like a crust at this location (12:37). Soon after, we noted a few shells of dead clams and mussels. Always a good sign in the hunt for hydrothermal activity as these animals invariably live near the vents. Next, at around 386 m we came across several large piles of dead shellfish (12:50), with trails of shells heading back up the slope. This was the sign we were looking for. *Shinaki* followed the trail of shells with seastars becoming increasingly more common and seen further upslope to be easting the clams. Near the top of the slope, beginning at 348 m was a ridge that was completely covered in a fine white dust, almost certainly sulfur (13:14), covering many 10s of m^2. Numerous small holes pockmarked the surface of the sediment with bubbles streaming from them. Almost certainly they are CO_2. Then, once our eyes focused, we realized that the entire surface was completely covered by small flatfish. I had seen this once before, at Dikoku volcano of the Mariana arc, and to a lesser degree Giggenbach volcano of the southern Kermadec arc. We suctioned the flatfish (13:17) and got several specimens. We noted that the seafloor in this area also had crusts of probably sulfur.

We surveyed the area and noted that nearby outcropping rocks were completely covered by squat, black mussels that I have also seen at Giggenbach and Macauley volcanoes, similarly rich in sulfur and which also occur at shallow sites. They had a fine, white coating of bacteria on their exterior surfaces. We sampled about 7 mussels (337 m; 13:40) sampling, deployed the D-port device over a clump of mussels, and measured the temperature of the fluid within the mussels of 13.0°C when ambient was 12.7°C.

It was then time to try and find the source of what had to be vigorous hydrothermal venting (14:16). But we were close, as a waft of smoke just drifted across our path. We followed the trial of smoke and went over the ridge and slowly descending down the other side. What greeted us was familiar, yet unexpected. We found our source, as huge thick clouds of smoke rose from the seafloor below us, but they were not black. They were white, and closer to the seafloor they were yellow. Sulfur-rich plumes, just like those at the presently erupting NW Rota-1 volcano of the Mariana arc. Down we went until we were at the bottom, with the depth reading 372 m. They were right were they should be. We called it the "Iou" (Japanese for "sulfur") vent field. We sampled the plume in the green Niskin at 367 m (14:48).

At 14:50 the smoke clearly momentarily and we saw, for the first time, actual vents pouring smoke into the ocean from a mound of mostly sulfur. Here, the vent fluids included white, yellow and some slightly blackish plumes from the same site. We noted some mussels around the various vents (there were several) and also flatfish and some lesser orange crabs. The WHATS (red) sampler was deployed and

we were almost finished sampling the red bottles when a current pushed us off the site and the submersible was completely enshrouded in thick plumes. We noted liquid sulfur suddenly started squirted out from some of the highly altered rocks nearby (15:03), forming spaghetti-like ribbons on the rock face. A quick search of the immediate area showed more of these recently extruded 'rivulets' of sulfur. No doubt reservoirs of liquid sulfur were just below where the sub was sitting.

The area is best described as a harsh environment, with thick layers of sulfur, choking plumes of sulfur-rich smoke and the entire area dusted by sulfur particles. The rocks showed tell tale signs of having been etched by acid fluids. But this is an increasingly familiar sight on hydrothermally active volcanoes along arcs, especially those recently (or still) volcanically active.

It was time to go. We could not see the vent site for the choking smoke, so fired the two Major water samplers in the plume (15:34 to 15:38). It had been an exhilarating experience, full of surprise, wonder, amazement and respect for this planet of ours, with Hinepuia still actively keeping watch on these brooding volcanoes and all their activity. But it was hard work, with the temperature inside the sub up to 30°C when normally much cooler (as we were working in such shallow depths) and the pressure was on to find the vents on our last dive of the expedition. We returned exhausted, but happy.

Written by Cornel E.J. de Ronde

Dive Log

Time	Depth	GridX	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
1003	0	-200.8	399					Begin descent
1023	494	-221.9	606.5		0			Landing point. Close to desired point.
1030	496	-221.9	606.5		0	sediment	yellow push core	Sampled sandy, debris slope with push core and placed in starboard basket
1033	496	-221.9	606.5		0	rock 1	starboard basket	Sampled rock placed in front right corner of starboard basket. Sea temp = 10.1°C
1042	498	-230	593.9		0	squat lobster	Slurp jar #1	Sampled a single squat lobster
1046	498	-230	593.9		0	gastropod	Slurp jar #1	Sampled a gastropod off rock face
1048	498	-230	593.9		0	squat lobsters	Slurp jar #1	Put two more squat lobster samples in slurp jar #1
1053	499	-230	593.9		0	bivalve	Slurp jar #2	Sampled single spikey bivalve (white) with orange spikes
1055	499	-229.3	589.2		0	urchin	Bio box	Sampled a single pencil urchin and put in front compartment of bio box
1059								Slope covered in debis and sand; lots of corals and squat lobsters; blocks of lava
1102	472							Steep rock face; blocky lavas
1105								Saw an eel with bright yellow-green flourescent head (seen before in S Kermadecs)
1108	452							Massive lava flow; mostly continious talus with some outcropping boulders of lava that are locally are flow banded
1112								Lots of blue fish and others silver colored with bulging eyes
1116	422							Really big crab
1118								Large outcrop
1126	389							Lots of sharks! And fish. Large outcrop

Time	Depth	GridX	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
								of lava and scree. Some hydrothermally altered?
1130	372							Very large outcrops of lava
1135								~1.5 m long octopus!
1144	335							Near summit; blocky lavas; no sign of hydrothermal activity; though possibly see bacteria on rock surfaces?
1151								Saw a huge groper!
1157	305							Reached the summit; no venting! See bacterial mat-like material on rock surfaces; another huge groper!
1209								Had lunch(!) then move south, downslope to ~390 m contour to search for source of venting and plumes; all talus as we traverse the slope
1223	384							Rugged slopes of blocky lava
1228	388							See whitish sandy material in area of brownish colored sediment; does not look like any shimmering and possibly is bioturbated (or a 'dead' area of diffuse venting?)
1231	388	168	-62.6		0	sediment	blue push core	Sampled these sediments and placed front starboard basket
1234	388	168	-62.6		0	temperature	WHATS probe	Measured temperature of these sediments and found same as ambient (11.0°C)
1237	388	168	-62.6		0	rock 2	biobox	Sampled what looked like a crust (3 pieces) and put in back compartment of biobox
1250	386							Saw large beds of dead shellfish (clams) concentrated in several debris 'chutes'
1253	385	194	-128		0	green scoop	starboard	Sampled scoop of dead shell fish and

Time	Depth	GridX	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
							basket	accompanying sediments
1302								Loads of dead shellfish see in trial upslope so we followed; lots of starfish; same red type seen at Rumble V; appear to be eating alive clams; latter hydrothermal species?
1314	348							See distinct, white area of hydrothermal material (S) on slope and up to summit ridge; same flatfish as seen on Rumble V and I think Giggenbach, or Macauley?
1317	347	306.6	-66.6		0	flatfish	Slurp jar #3	Suctioned up several of the flatfish that were sitting ontop of the white, S material
1330	337	306.6	-66.6					See numerous, small (several cm in diameter) 'vents' in S sediment with gas bubbles (CO_2) streaming out of them; see crusts of probably sulfur; white top of ridge all covered in fine-grained S and crusts and see outcrops covered by S; local outcrops covered with black, squat mussels.
1340	337	343.2	-41.4		0	mussels	biobox	Sampled mussels.
1350	337	343.2	-41.4		0	temperature	WHATS probe	Sampled temperature inside clump of mussels = 13.0°C; ambient 12.7°C; deployed D-port instrument in same clump of mussels.
1416	339							Trying to find ridge covered in S sediment with CO_2 bubbles because lot of smoke and difficult to see as bottom also disturbed by submersible.
1423	367							Thick white (and locally yellow) smoke; landed on seafloor; area thick with flatfish and a few orange crabs.

Time	Depth	GridX	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
1434	383							Sitting right on top of some vents but complete white- and yellow-out; incredibly thick roiling plume; very S rich locally.
1448	367	343.9	-88.6		0	green Niskin	plume	Sampled plume with Niskin.
1450								Found some vents as plume cleared! Mostly are white, some yellowish, a few slightly blackish.
1455	371	341.3	-106.5			WHATS	fluid	Used red WHATS sampler to give hydrothermal fluid from vent; max temp 140°C but only 2/3rd full before submersible blown off site by currents and completely enveloped in smoke. Tried hard to get back to site but zero visibility! Saw abundant evidence for liquid sulfur with rivulets of molten S extruding from rock and elsewhere extensive S flows. Same at Giggenback and Macauley and in Mariana arc.
1534	347	341.3	-106.5			Major	port basket	Fired black major water sampler in plume as could not see to get back to vents.
1537	354	341.3	-106.5			Major	port basket	Fired white major water sampler in plume as could not see to get back to vents.
1540	354	79.9	76.6					Leaving for surface; end of dive.
1543	1285	-440	-580					End of dive, begin ascent.
								SUMMARY of samples:
								Push cores: 2
								Scoop (type M core): 1
								Slurp-gun biology: 3 (squat lobsters, gastropod, spikey bivalve)
								Manipulator Biology: 2 (urchin and

Time	Depth	GridX	GridY	Hdg	Alt(m)	Samp_type	Location	Comment/observation
								mussels)
								Rock samples: 2
								Niskin: 1
								Major water samples: 2
								WHATS water samples: 1