NE Lau Basin Rock Dredging Expedition. R/V *Kilo Moana* KM1024.

Dec 9 - Dec 15, 2010. Nuku'alofa Tonga to Pago Pago American Samoa.

Cover images (upper left to lower right):
Recovering the dredge. The computer lab during a dredge. Ken tending to the samples. Chris and Richard in the geology lab. Drying rocks on the back deck. Rock samples ready for description. The massive dredge sample! All the samples ready for further analysis on the beach.

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EXPEDITION PARTICIPANTS

Science Party. Back left to right: Chris Russo, Cornel de Ronde, Marc Norman, Ron Greene, Richard Arculus, Susan Merle. Front left to right: Sione Nonu, Tineke Berthelsen, Doug Pyle, Ken Rubin

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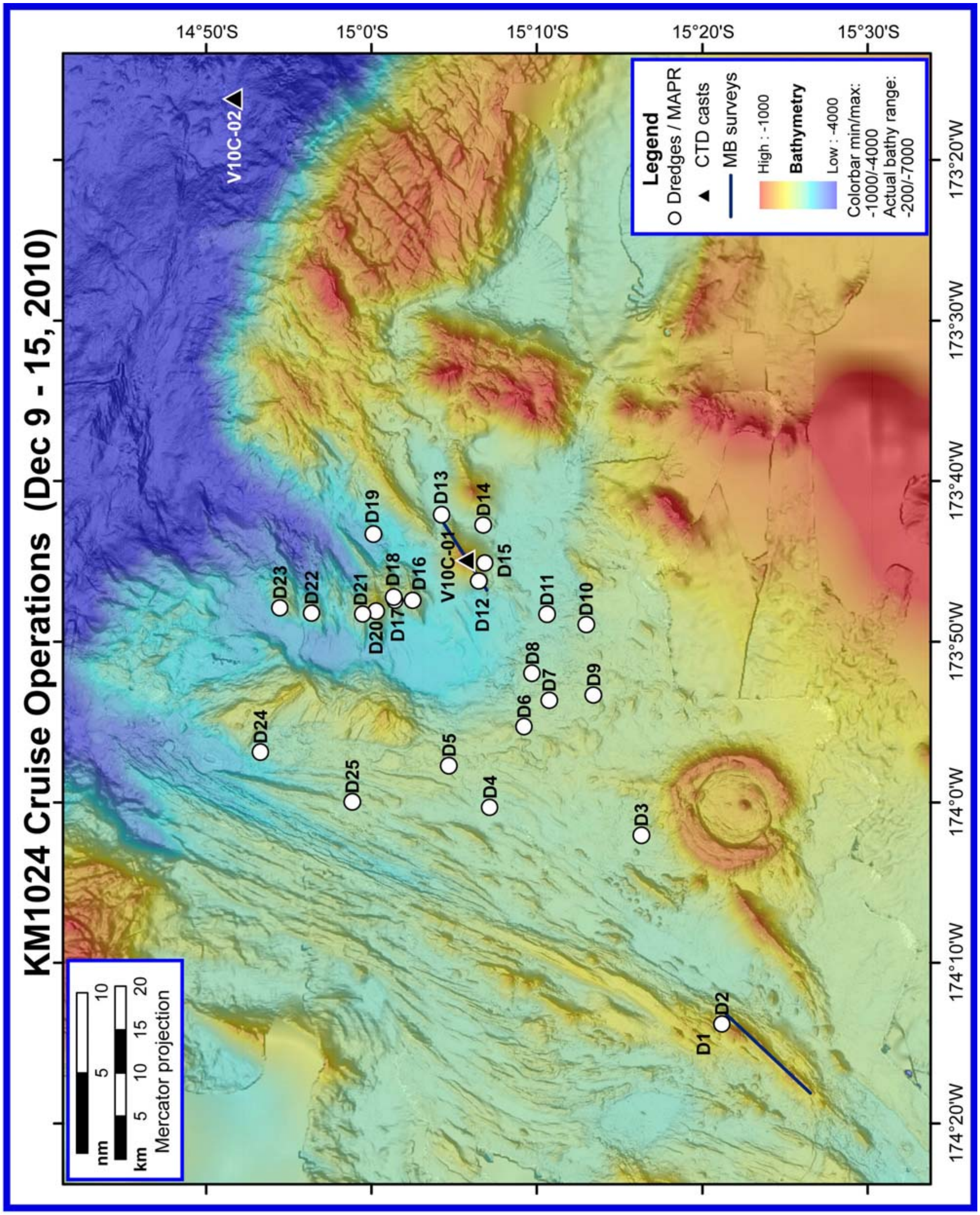


Fig. 1. Science operations in the NE Lau Basin during expedition KM1024.

1.0 NE Lau 2010b (KM1024) Expedition Summary

Ken Rubin, Chief Scientist

Cruise KM1024 aboard the *RV Kilo Moana* in Dec 2010 was a short (7 day), targeted cruise that focused almost entirely on bottom sampling of volcanic landforms in the NE Lau basin via dredging (Fig. 1). Water column properties (temperature, pressure, optical backscatter, and oxidation reduction potential) were measured during each dredge with a PMEL MAPR (Miniature Autonomous Plume Recorder). Small amounts of mapping and CTD work were conducted as well. It was the second expedition for our group to the NE Lau Basin in 2010, continuing exploration of the region and building directly upon observations made during a May 2010 cruise (KM1008) and two earlier *R/V Thompson* cruises, TN227 (Nov 2008) and TN234 (May 2009). The goal of KM1024 was to retrieve rock samples from as many of the apparently active and recently active volcanic features in the area as possible for shore-based petrologic and rock geochronologic studies. Twenty five of twenty seven planned dredges were executed over 4.5 days, each recovering rock samples, nearly all of them fresh and relatively young. Sampling sites included multiple volcanoes with hydrothermal sites discovered during KM1008 or on the earlier cruises, and sites we expected to be young based on bathymetric and backscatter maps of the region. Most dredge targets were on two main regional features: (a) stations 12-23 (Figs. 4&5) in the Mata seamounts (a series of nine NE-SW trending elongate volcanoes of varying heights and sizes) and (b) stations 6-11 (Fig. 3) within a large, relatively deep, low relief, thinly sedimented lava flow field that sits between the Mata volcano group, Volcano 'O', and NE Lau Spreading Center (NELSC). Additional stations (1-5 & 24-25) were at young volcanic sites just to the west of these two areas, as described below. Among our multiple discoveries are (a) that the Mata volcanoes all appear to be composed primarily of boninite or boninite-like lithologies; (b) that the deep lava flow field is a fresh, young feature comprised of very glassy, sparsely phyric, very similar appearing lavas with the texture and appearance of basaltic andesite; and (c) confirmation of very fresh lavas at a suspected recent eruption site north of Tafu seamount on the NELSC. The observations on this cruise add to the discoveries of the earlier expeditions to collectively show that the NE Lau Basin is a very active and volcanically diverse terrain having complex tectonics and a high number and density of active volcanic sites, all of which are ripe for continued exploration and discovery.

Background

In November 2008, the NOAA-Vents group discovered water column evidence for two active submarine eruptions in the NE Lau basin (plumes with high levels of light scattering, volcanic glass shards, and large temperature, pH, hydrogen and methane anomalies). The sites were on the neovolcanic zone of the southernmost segment of the NELSC (Fig. 2) and at West Mata volcano (Fig. 4) 60 km to the NE. Site revisits by NOAA-Vents personnel and partners in May 2009 with the *Jason-2* remotely operated vehicle (ROV) found extremely young, sediment-free, glassy lava devoid of sessile organisms amid older flows at the NELSC site and mixed pillow lava and pyroclastic volcanic eruptions from a number of active vents near the summit of W. Mata volcano (ca 1200m water depth). The latter were the first ever observations of active lava flows in the deep sea. Two dives at W. Mata explored the volcano flanks and rift zones within a few km of summit and found relatively young, but no longer active pillow lava formations. Shore-based studies of the 2009 lava collection indicated that W. Mata is composed almost entirely of boninite, a rare supra-subduction zone magma type known from a handful of sites in the western Pacific, but never before seen erupting. In addition, the hydrothermal activity at W. Mata is unusual and appears to typify active submarine arc volcanoes such as W. Mata and NW-Rota-1 by having extremely low pH, high sulfur content, and high concentrations of hydrogen and other volcanic gases, creating hydrothermal habitat conditions that are in many ways the most extreme ever encountered.

Cruise Goals

The work conducted on KM1024 was not originally slated for its own expedition. Originally, it was part of the plan for KM1008 (May 2010), which was designed as a multidisciplinary expedition to extend the discoveries of the 2008 and 2009 cruises with targeted hydrographic surveys and a series of co-located observations of the bottom using a camera sled (the Woods Hole "TowCam") and rock sampling via dredging or wax corer. Failures with various systems on the *Kilo Moana* during legs just before the May 2010 cruise prevented dredging on KM1008, so the second (Dec 2010) cruise was devised to revisit the study area to complete that work. The short cruise was inserted into the beginning of a transit from Nuku'alofa, Tonga to Honolulu, using funds provided by NSF, NOAA and the University of Hawaii, and because we received 2.5 days more than the 2 we estimated were lost on KM1008, we were able to plan for and accomplish much more on KM1024 than we would have with a fully functioning ship in May 2010.

We set out with three main goals for the cruise:

a. Lava sampling by dredging
b. CTD casts and MAPRs for comparison to earlier work by our group
c. Seabed mapping and acoustic water column observations using the EM122 system

Objective "a" was the primary goal of the trip and most of the non-transit shipboard time was dedicated to this activity. Collected rock specimens not only provide a first-hand look of the volcanic substrate at these sites, but petrologic and geochronologic studies of them on shore will also allow us to say something about when they were erupted and how magma compositions vary within and between the volcanoes we studied. Adding MAPRs to each dredge was an opportunistic way to acquire additional hydrographic and plume data for comparison with results from earlier cruises, as well as to possibly identify additional sources of hydrothermal activity in the region.

Results from earlier cruises in the area indicated that one of the Mata volcanoes was erupting and that at least 6 others had active hydrothermal systems, that high acoustic backscatter terrain between volcano O, the Matas and the NELSC was thinly sedimented lava flows, and that the southern NELSC was the site of one or more recent eruptions that did not generate an active hydrothermal system of any significant duration. With the three previous expeditions to the region we had only seen rock specimens from a handful of the many active or recently active volcanoes in the region. So one of the primary goals of this cruise was to sample as many of the other sites as possible to see what types of rocks were present and how they varied in apparent (visual) indicators of age.

Based on our prior work and that of collaborators working in the region, we targeted multiple sites for discovery by bottom sampling (Fig. 1). With so many potentially young volcanic features to choose from, we had to be selective about which we would target for dredging. We opted for high density sampling of two main areas (the Matas and the large lava flow field) plus a few other sites, rather than a more widespread sampling campaign. In this way we sought to obtain a statistically significant representation of the makeup and apparent age of the targeted features. Discoveries made along the Mata volcano "group" will also be important for future planned studies there on an as-yet-unscheduled cruise using the ROV *Jason-2*.

Our exploration goals at each site are summarized below. Actual dredge station numbers are given in parentheses after the site name:

West Mata (stations 12,13,15). (Fig. 4) This volcano was discovered to be erupting in Nov. 2008, and the first known rock samples were collected there in May 2009. Samples from the latter cruise are mostly boninite, a rare high temperature mafic magma type that is high in water, comes from a refractory mantle source, and is only found in subduction zone settings. The volcano was a site of intense scrutiny and discovery on TN234 (May 2009). We had 3 main goals in Dec. 2010: (a) catch a glimpse of early volcano history by sampling lavas from deep on the volcano on each of its rift zone features to get an idea of the types of rock erupted there and their apparent ages; (b) conduct a vertical CTD cast to compare the character of the hydrothermal plume to observations on the prior three cruise and to determine if the volcano was still erupting; and (c) map the topography of the bottom to look for changes due to ongoing volcanic or tectonic activity, and to determine if the plume above the volcano had a significant water column acoustic signature that could be detected by the EM122 multibeam system. A single camera sled run over a high acoustic backscatter feature at the base of the NE rift zone in May 2010 revealed a thinly sedimented, low relief lobate and sheet lava flow, with small pillow ramparts at is edges, which we dredged on KM1024 (station 13).

East Mata (station 14). (Fig. 4) Less is known about this volcanic cone that sits just eastward of W. Mata. CTD casts in Nov. 2008 and May 2010 indicated that East Mata is hydrothermally active, although probably not erupting. There are no known rock specimens of this volcano. We targeted rock outcrops deep on the SW rift zone for sampling because the more conical shape of the edifice suggested that it would be difficult to sample in-place lavas by dredging near the summit.

North Matas (stations 16-23). (Fig. 5) The seven elongate volcanoes of the N. Mata group sit quite close together, at just 1 to 1.5 km lateral distance between each of their summits. One of the main discoveries of the May 2010 cruise was that six of the seven N. Mata Volcanoes are hydrothermally active. Camera sled observations at three of them discovered relatively youthful terrain, but nothing that looked like it had erupted in the past decade or two. Their close proximity and apparent co-activity are unusual and suggest either a common magma source and concurrent eruptions (as in monogenetic volcanic fields) or a rapid succession of activity through the group. Dredge sampling was planned for each of these volcanoes to see if either of these scenarios applies.

Large Lava Flows (stations 6-10). (Fig. 3) Prior seafloor mapping had shown that a large area, roughly 15 x 10 km, between W. Mata volcano to the north, volcano O to the south, and NELSC to the west was covered by high acoustic backscatter terrain that had limited relief, and no clear relationship to other volcanic structures in the region, leaving a major question as to their source, age(s) and composition(s). Two camera sled runs in May 2010 revealed that they were thinly sedimented pillow lava and lobate lava flows ideally suited for sampling by dredge. The very presence of a flow field that occurs between three major volcanic structures in the area but isn't clearly related to any of them in map view begs exploration. The size and homogeneity of sea bed depth and backscatter raise other important questions about when and how these lavas formed, how they relate to regional patterns of magmatic activity, and whether or not any of them could be a source for the deep hydrothermal plumes seen on earlier cruises to the area.

North of Tafu (stations 1-2). (Fig. 2) This seamount forms the southern anchor of the segment of the NELSC just north of, and somewhat overlapping to, the site of the Puipui eruption in Nov. 2008. The seabed on the ridge axis just north of the summit appeared to have gotten significantly shallower between bathymetric surveys in 2006 and 2009, prompting a single camera survey in May 2010 that discovered very fresh, unsedimented lavas containing what appeared to be small native sulfur deposits in cracks near the volcanic vents. A few small pieces of lava were recovered when the camera sled intersected the seabed during the survey. Hydrocasts in May 2010 found no evidence of hydrothermal activity over the potential eruption site. Nevertheless, we deemed it important to collect additional lavas from this site in Dec 2010 for geochronologic study and to compare lava compositions to the nearby Puipui deposits.

Volcano "O" (station 3). (Fig. 2) This large, hydrothermally active caldera volcano lies ~15 km east of the NELSC and is ringed by high backscatter terrain. It sits westward of the active Tofua volcanic arc and eastward of the NELSC, and was a focus of water column and camera sled work in May 2010. Although the volcano and surrounding ridges and low-lying flows are ripe for additional study, time limitations in Dec. 2010 did not allow for this. We planned one sampling stop in the large lava flow field just north of the caldera, as a means of characterizing the flow field and as a point of comparison to samples we planned to collect from the large lava flow field to the north of this (see above.)

North-South Ridges North of 'O' (stations 4-5, 24-25). (Fig. 6) North of volcano 'O', there are a series of ridges and valleys that trend roughly N-S and that contain high acoustic backscatter sea bed. The ridges continue to the northern terminus of the Lau basin, which in this region is a deep formed by a transform boundary that is contiguous with the Tonga trench. At this terminus, the N-S ridge terrain intersects the trace of the NELSC, which runs NE-SW and produces a seabed fabric with a corresponding rotation to the abyssal hill fabric. One camera sled run in a valley on the west side of the N-S ridges, just westward of the large lava flow in May 2010, revealed a young, lightly sedimented lava flow with generally similar appearance to the flow field itself and at a similar seafloor depth. The high backscatter of the region and its position between the NELSC and the Matas makes it an interesting and possible additional active volcanic terrain, as well as a candidate source region for the large lava fields.

We therefore targeted four sites in this terrain for dredging from the latitude of the large flow field north to near the terminus of the basin.

Summary and Highlights

The cruise was an unqualified success, with all twenty five dredges conducted returning rock at a rate of roughly 100 lbs rock per dredge, on average. Nearly all of the lavas collected were fresh and relatively young, so that we have something over a ton of rock collected from throughout the study region to conduct petrologic and geochronologic studies. The factors that led to the success of the study were a detailed pre-cruise plan of dredge targets and least-transit station order, a close interaction with the OTG group to set and improve tactics for maximum dredge recovery over short on-bottom distances (300-400m), a properly operating ship, well prepared officers and crew, and a dedicated and hardworking science party. At the last minute Bob Embley was unable to join the cruise as chief scientist for health reasons, but he was heavily involved in all aspects of the cruise (planning mob/demob, and execution).

Site specific results:

We occupied 12 dredge stations in the Mata volcano group (D12 through D23), all but one of which contained boninite or boninite-like lithologies. *The sheer number of boninitic volcanoes and range of apparent compositions is heretofore unknown on Earth, making this a seminal rock collection*. Not enough is known about the rare boninite magma type to say with certainty what its full range of compositions and mineralogy is, or if there are identifiable sub-types. But the diversity of broadly boninitic-appearing samples that we collected suggests that this sample set will go a long way towards setting this range, towards understanding what causes boninite volcanism, and towards knowing how widespread it can be at any one point in time at an active volcanic arc.

Our hydrographic and mapping work at W. Mata show that the volcano is still active (Fig. 12), with a plume that is somewhat lower in particles, at similar reducing potential (ORP), than was observed in May 2010, based on the limited data we collected. See the CTD and MAPR sections toward the end of this document for more information on the hydrographic work. Very fresh lavas were recovered from >2000m water depth at all 3 rift zones at W. Mata.

We occupied 7 sites in the large lava flow field (D6 through D11) and 2 sites in the immediately adjacent N-S ridges terrain (D4 and D5), all of which produced young appearing lavas with 10 to 20 cm thick glass rinds, a characteristic flow top texture, and similar mineralogy and vesicularity, suggesting that they are collectively a group of genetically related magmas, if not the same magma, erupted over a relatively short time interval.

We occupied two sites in the N-S ridges terrain that are broadly due west of the N. Matas, one of which (D25) was the most northerly site of the expedition (i.e., closest to the northern edge of the NE Lau basin), and the other of which was a small conical seamount within the terrain (D24). Neither appears to be either boninite or a direct match for the large lava flow field and more southerly N-S ridges samples, although follow-up study will reveal more about their parentage and age.

The lone site at volcano 'O' (D3) recovered only one small sample that looks like an evolved magma type, similar in appearance to the lava flow field samples, although possibly more differentiated.

One thing is clear at the end of this cruise: there is much that remains to be learned about the NE Lau basin, which appears to host a very large number and range of volcanically active landforms and associated hydrothermal sites. On the basis of this cruise, we may now be looking at the new type-locality for boninite volcanism, which opens up all sorts of possibilities for understanding the early evolution of arc terrains and for discovery related to the types of hydrothermal systems it produces and the ecology of those vent sites. In addition, we have only just begun to unravel how the complex and very active terrain in this region has evolved, and what it implies for submarine volcanism and hydrothermal activity at other arcs around the globe.

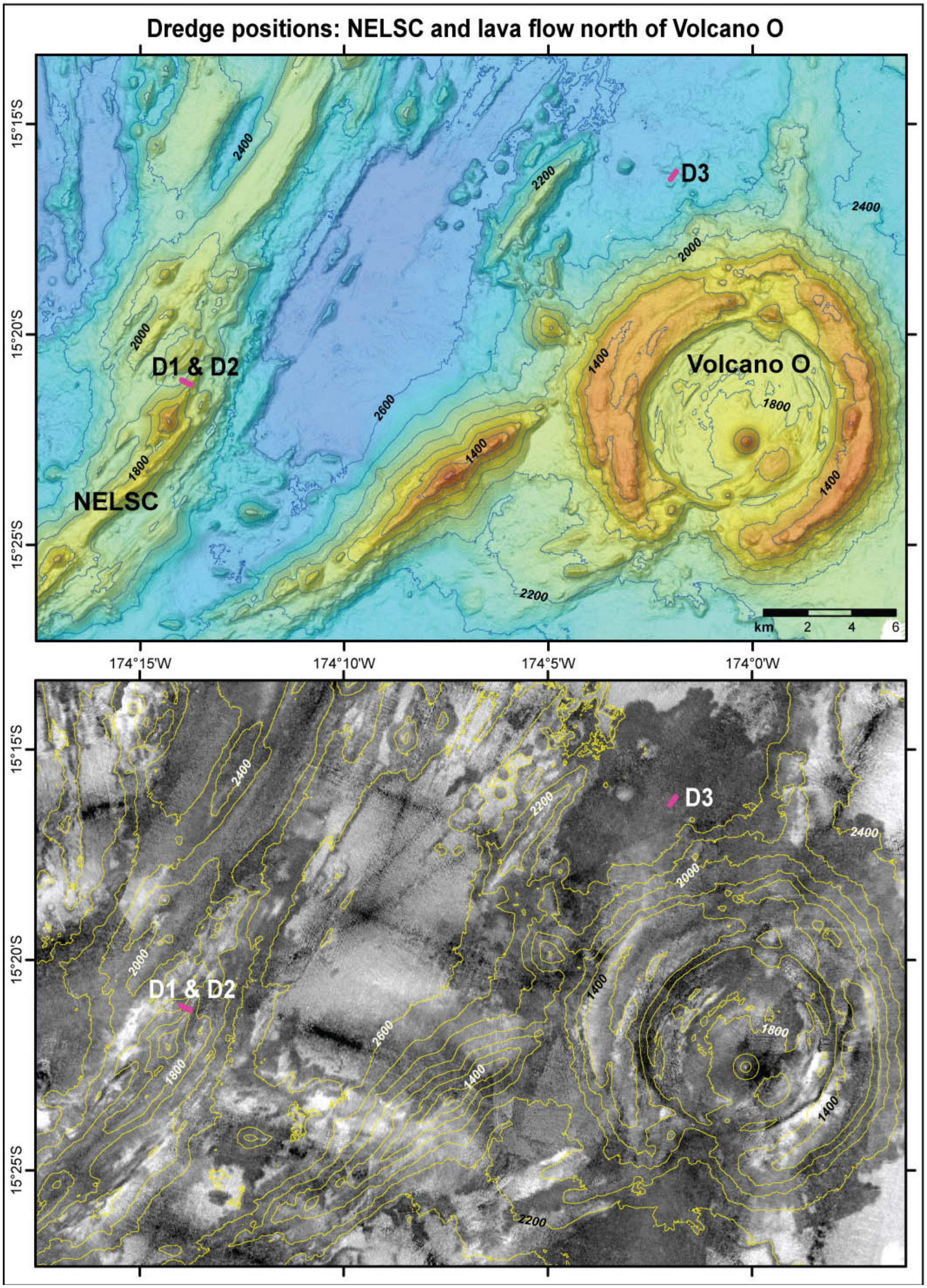


Fig. 2. Magenta lines represent dredge positions on the seafloor, overlaid on combination grids of EM300 and EM122 bathymetry (top) and backscatter (bottom). 200 m contour interval. Mercator projection.

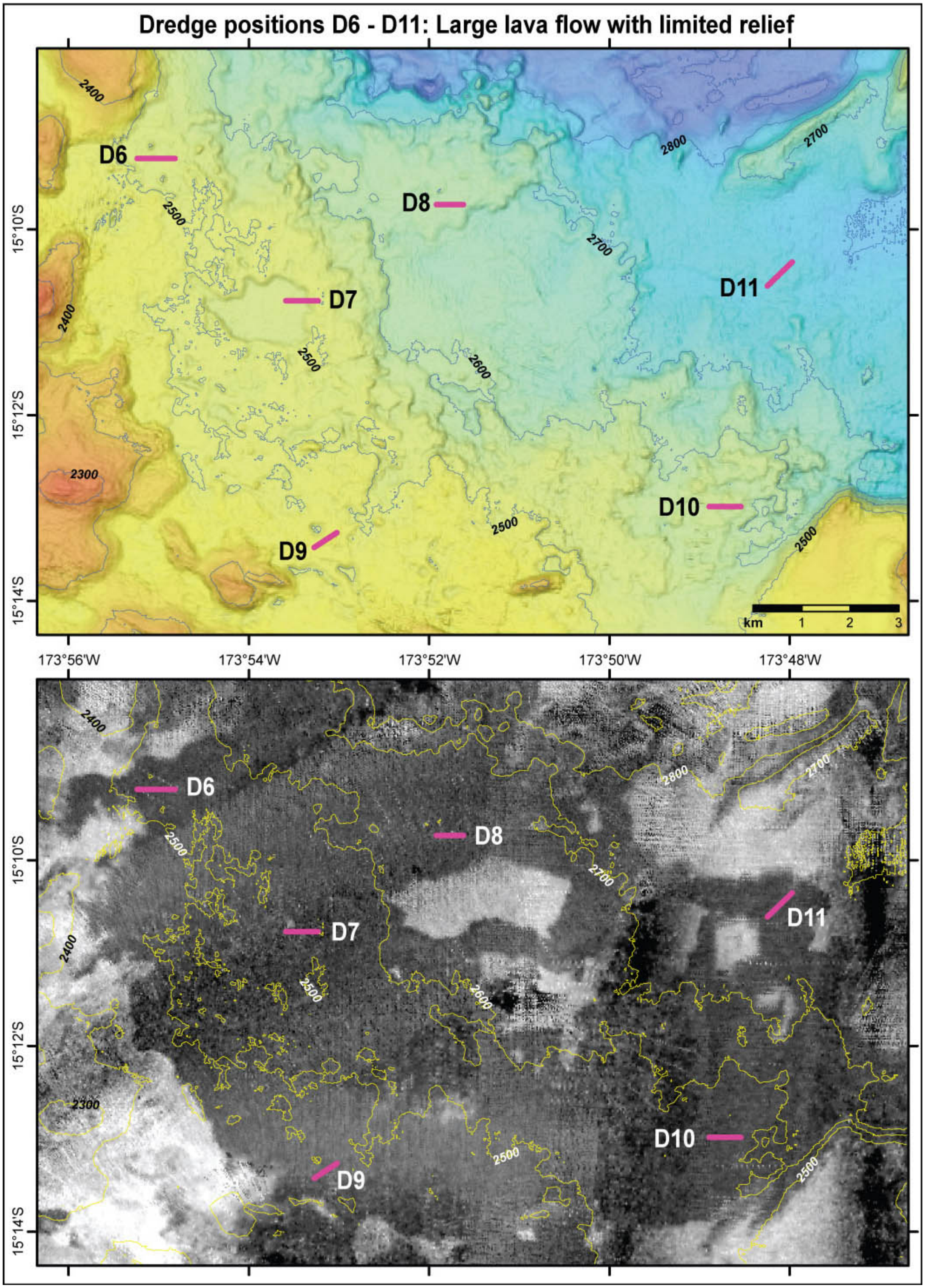


Fig. 3. Magenta lines represent dredge positions on the seafloor, overlaid on combination grids of EM300 and EM122 bathymetry (top) and backscatter (bottom). 100 m contour interval. Mercator projection.

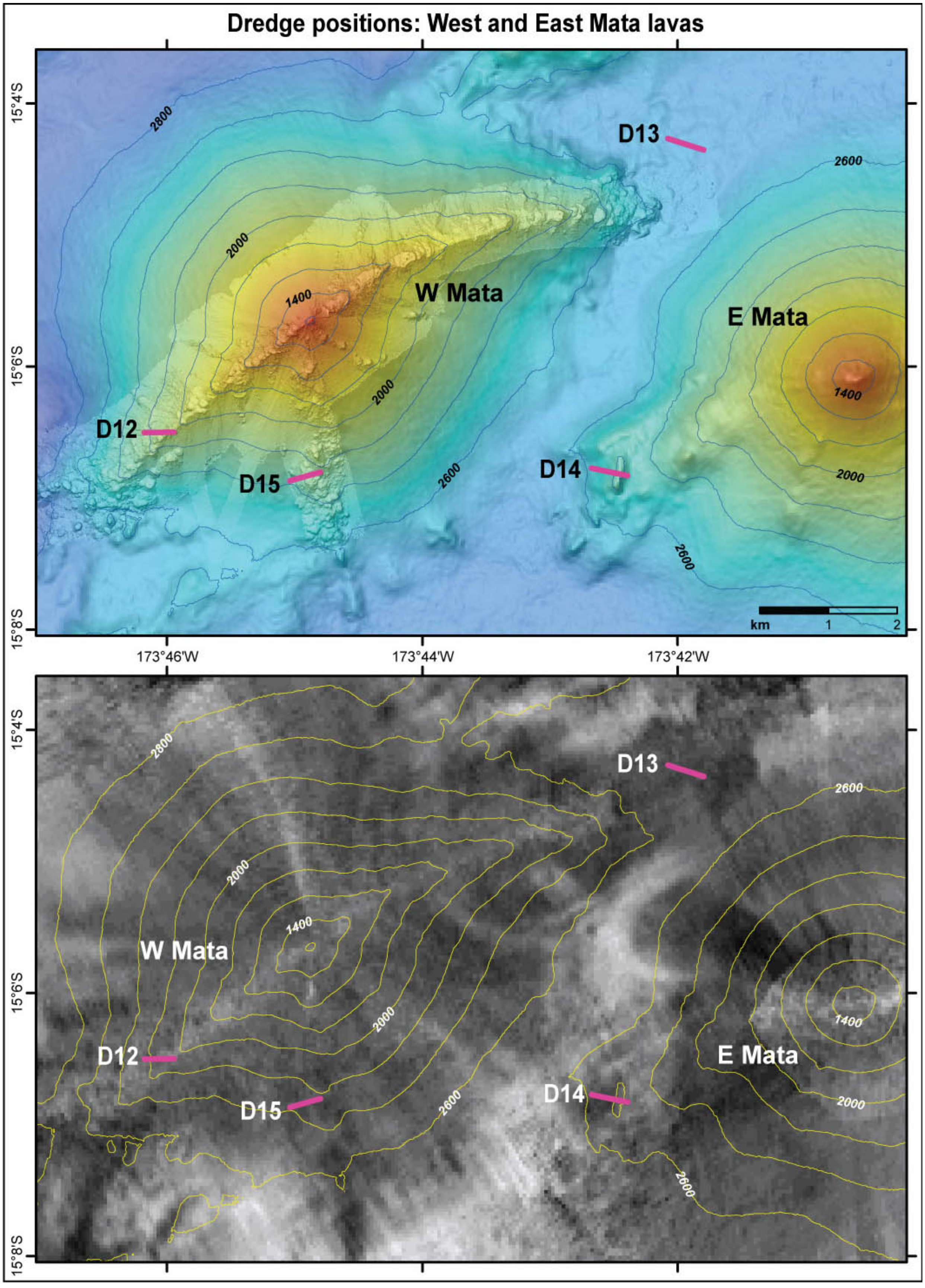


Fig. 4. Magenta lines represent dredge positions on the seafloor, overlaid on combination grids of MBARI AUV, EM300 and EM122 bathymetry (top) and backscatter (bottom). 200 m contour interval. Mercator projection.

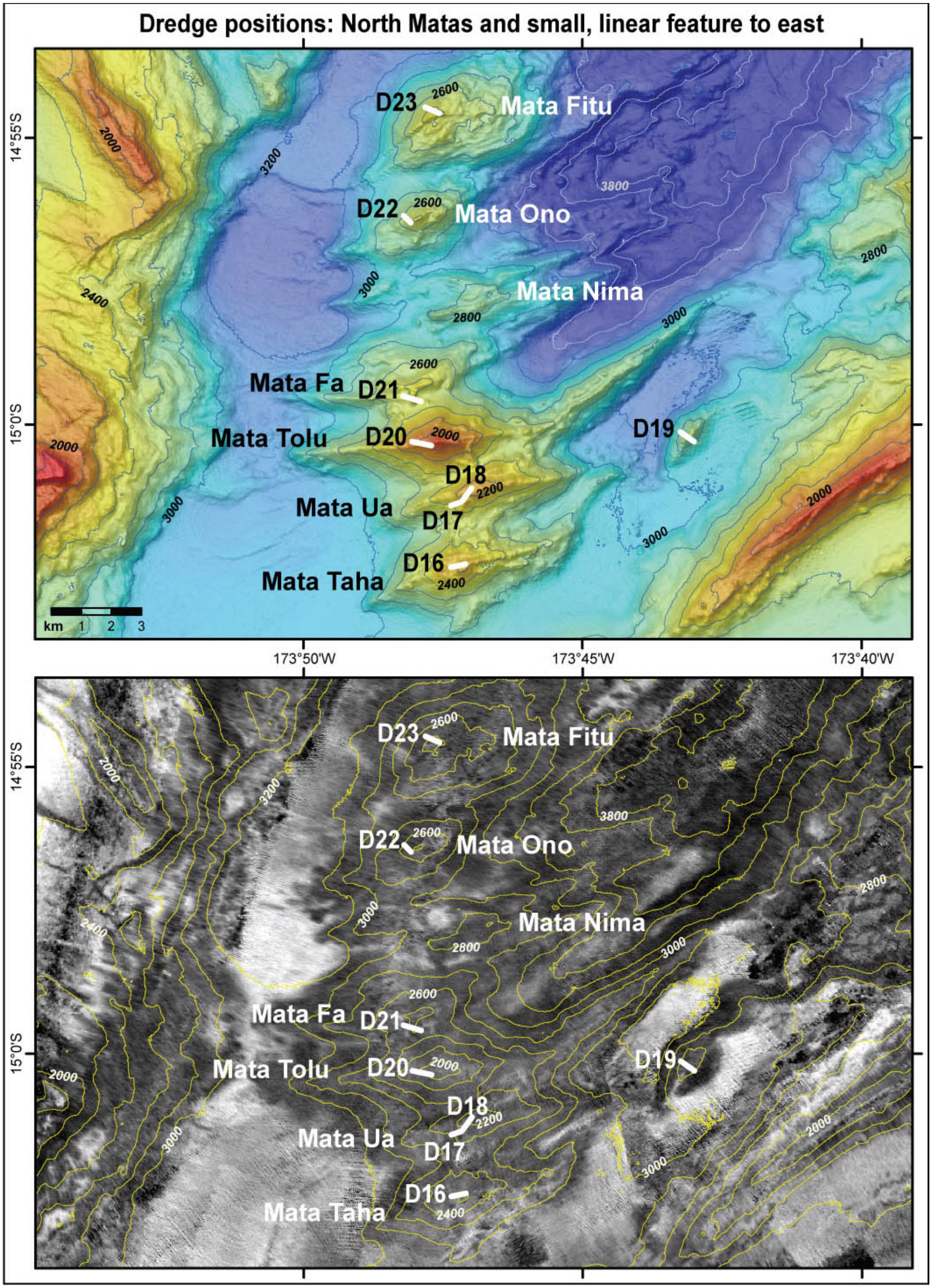


Fig. 5. White lines represent dredge positions on the seafloor, overlaid on combination grids of EM300 and EM122 bathymetry (top) and backscatter (bottom). 200 m contour interval. Mercator projection.

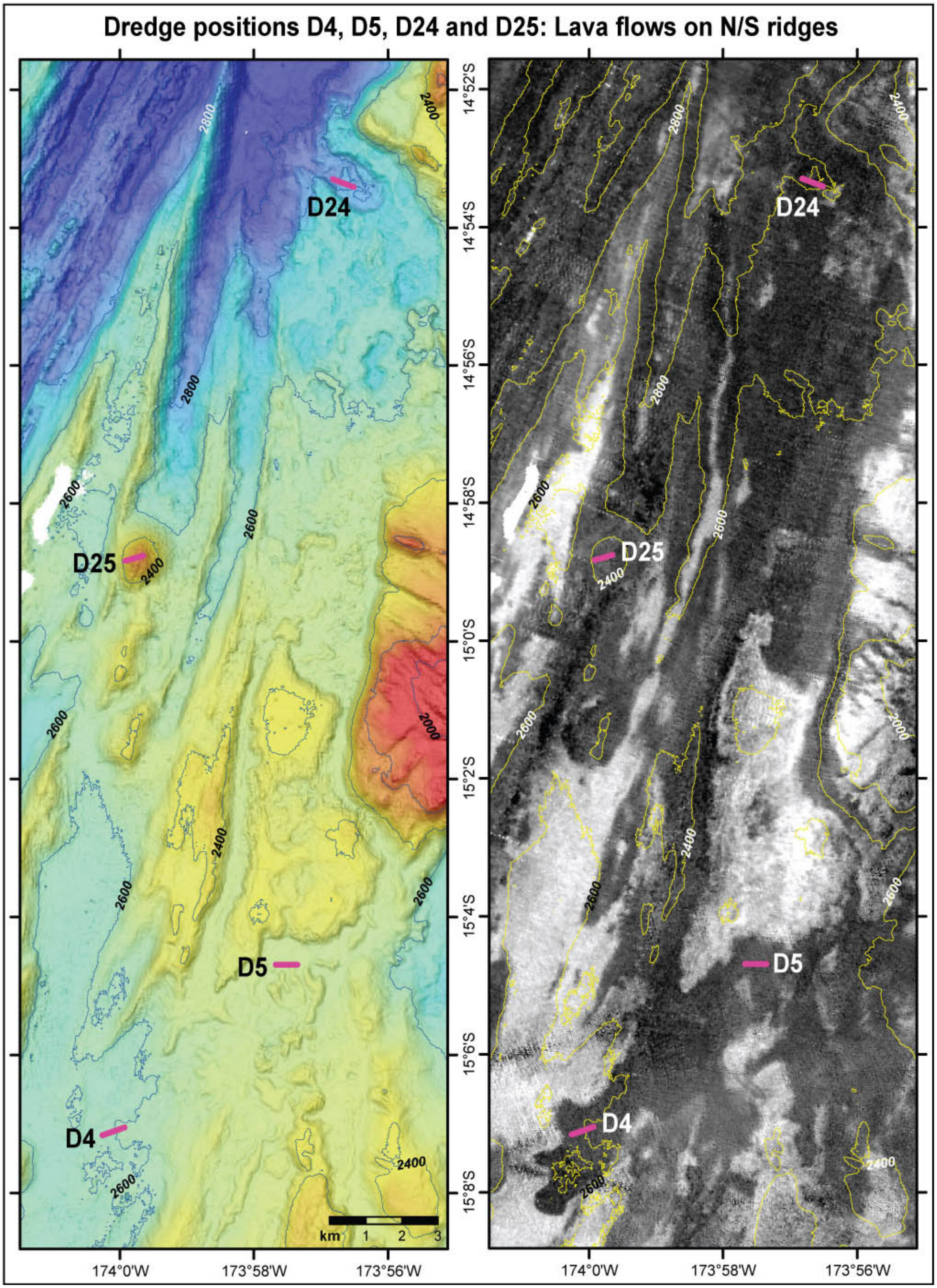


Fig. 6. Magenta lines represent dredge positions on the seafloor, overlaid on combination grids of EM300 and EM122 bathymetry (left) and backscatter (right). 200 m contour interval. Mercator projection.

1.1 KM1024 Operations Log

Samoan time = UTC minus 11 hours (UTC is 11 hours ahead of local Samoan time). Tonga time = UTC +13 hours.
Latitude is south. Longitude is west.
Brown text: Dredge ops. Green text: CTD ops. Blue text: Mapping Ops

Date (UTC)	Time (UTC)	Data (local)	Time (local)	KM1024 Events	Z(m)	Latitude	Longitude
Dec 9	0400	Dec 9	1700 Tonga	Depart Nuku'alofa harbor, Kingdom of Tonga. 1700 local Tongan time.		-21.13333	-175.20000
Dec 9	0532	Dec 9	1832 Tonga	EM122. Start logging data. Line 0. Heading north with the Tongan Islands mainly to the east during the transit. 12.2 kts. ~4X water depth coverage (1570/1221 cov).	700	-20.92100	-175.19800
Dec 9	0647	Dec 9	1947 Tonga	EM122. 353°hdg. 2956/1525 cov.	1063	-20.68480	-175.22670
Dec 9	0710	Dec 9	2010 Tonga	Slowing to deploy the magnetometer.			
Dec 9	0718	Dec 9	2018 Tonga	Magnetometer deployed. Collect magnetometer data during the transit. The gravimater is not functioning so there will be no gravity data - only magnetics.			
Dec 9	0828	Dec 9	2128 Tonga	EM122. 356°hdg. 2677/2844 cov.	1550	-20.36256	-175.26269
				Waypoint. Turning NE to map along the arc. 40°hdg. 2790/3380 cov.	1695	-20.27730	-175.27540
Dec 9	1100	Dec 10	0000 Tonga	Waypoint? 3062/2965 cov.	1725	-19.96385	-175.03207
Dec 9		Dec 10		At midnight (local Tongan time) we switched to Samoan local time. "Groundhog day" - we repeated the same day. Tonga is on the other side of the dateline. **All official times will be in UTC. Local times will be Samoan from this point on.**			
Dec 9	~1215	Dec 9	0115 Samoa	Main computer that controls the engines shut down so there was no propulsion for about a half hour or more.			
Dec 9	1255	Dec 9	0155	Main engine computer back up and running.			
Dec 9	1257	Dec 9	0157	EM122. 85°hdg. 3540/2865 cov.	1732	-19.93988	-175.03750
Dec 9	1548	Dec 9	0448	EM122. 22°hdg/ 12 kts. 3860/2500 cov.	1611	-19.43400	-174.83500
Dec 9		Dec 9		EM122 data look noisy about 10° out from nadir. Lots of spikes on port side.			
Dec 9	1623	Dec 9	0523	EM122. Same nasty data appears on the port and starboard sides now.			
Dec 9	1628	Dec 9	0528	EM122. Going to try to eliminate the nasty beams. First forcing the depth. Then bring the angles in to 60°.			
Dec 9	1638	Dec 9	0538	EM122. Changed the spike filter range to medium (from low). That cleaned up the data nicely. Brought the angles back out to 65°.			
Dec 9	1800	Dec 9	0700	EM122. 29°hdg. 11 kts. 2530/2860 cov.	1473	-19.06100	-174.65300

Date (UTC)	Time (UTC)	Data (local)	Time (local)	KM1024 Events	Z(m)	Latitude	Longitude
Dec 9	1816	Dec 9	0716	EM122. Increasing angles from 65/65 to 68/68.			
Dec 9	2030	Dec 9	0930	EM122. 27°hdg. 11.6 kts. 2102/2320 cov.	1132	-18.66500	-174.42700
Dec 9	2158	Dec 9	1058	EM122. One of the volcanoes in the Tonga chain is to port. Turning onto 360°hdg.			
Dec 9	2200	Dec 9	1100	The UH tech turned on the Knudsen subbottom (3.5kHz) system to make sure it is working. Don't notice any interference with the EM122 system.			
Dec 9	2224	Dec 9	1124	EM122. See a seabed channel in the multibeam data. 2°hdg. 11.6 kts	843	-18.30250	-174.29820
Dec 9	2335	Dec 9	1235	EM122. Change course to maneuver around an island. 36°hdg. 1070/1170 cov.	590	-18.06900	-174.29600
Dec 10	0002	Dec 9	1302	Turning on the EM1002 multibeam system because we are very shallow right here.			
Dec 10	0055	Dec 9	1355	EM122. 359°hdg. 2460/2570 cov.	?	-17.84160	-174.30100
Dec 10	0057	Dec 9	1357	Slowing down to collect a sound velocity profile (XBT). First have to pull in the magnetometer so the wires don't get tangled with the XBT. Then will lower the magnetometer after the XBT. Apply new SVP.			
Dec 10	0123	Dec 9	1423	Speeding back up to 11.6 kts.			
Dec 10	0154	Dec 9	1454	New SVP applied to bathy data during collection.	1280		
Dec 10	0230	Dec 9	1530	EM122. Hdg 359°. 11.6 kts. 2720/2330 cov.	1240	-17.55200	-174.30200
Dec 10	0231	Dec 9	1531	Heading change to 45°. Have to make a dog-leg around a shallow feature.			
Dec 10	0253	Dec 9	1553	Change heading to 310°. - about a 90° turn - Hard to port.			
Dec 10	0300	Dec 9	1600	EM122. Still off course due to shallow area. 310° hdg. 11.6 kts. 2650/2425 cov.	1312	-17.48300	-174.27100
Dec 10	0313	Dec 9	1613	Change course again back toward the original line.			
Dec 10	0330	Dec 9	1630	EM122. Back on course. 358° hdg. 12 kts. 3270/2275 cov.	1522	-17.41270	-174.30330
Dec 10	0609	Dec 9	1909	EM122. 1.7° hdg. 3300/3800 cov. 11.6 kts.	2092	-16.87502	-174.30644
Dec 10	0931	Dec 9	2231	EM122. 358° hdg. 11.1 kts. 3670/3390 cov.	1952	-16.23470	-174.31019
Dec 10	1114	Dec 10	0014	EM122. 359° hdg. 11.5 kts. 3175/3490 cov.	1960	-15.80935	-174.31267
Dec 10	1332	Dec 10	0232	At a waypoint. Turning NNE. 28° hdg. 12 kts. 5200/3750 cov.	2480	-15.46690	-174.31420
Dec 10		Dec 10		EM122. Turning at Waypoint 14 - the start of the NELSC re-survey (for surface differencing). 31° hdg. 5425/4740 cov. 11.2 kts.	1860	-15.44188	-174.30053
Dec 10	1412	Dec 10	0312	EM122. Approaching dredge#1 site. 46° hdg. 6.1 kts. 4540/4390 cov.	1720	-15.37530	-174.23680

Date (UTC)	Time (UTC)	Data (local)	Time (local)	KM1024 Events	Z(m)	Latitude	Longitude
Dec 10	1422	Dec 10	1322	Turning at waypoint to set up for dredge 1.	1721	-15.37530	-174.23680
Dec 10	1442	Dec 10	1342	Stop logging EM122. At dredge#1 (D1) site.			
Dec 10	1533	Dec 10	0433	**D1 in the water. North NELSC – north of Tafu.**			
Dec 10	1639	Dec 10	0539	D1 on bottom. MAPR 44 on wire.	2009	-15.35192	-174.23225
Dec 10	1724	Dec 10	0624	D1 off bottom.	1804	-15.35330	-174.22953
Dec 10	1810	Dec 10	0710	D1 on deck.			
Dec 10		Dec 10		D1 only had 1 fist-size rock in the dredge. Will re-do that dredge. A little different start point.			
Dec 10		Dec 10		D2 - very close to D1 - just starting a bit farther downslope. This line will be ~450m long instead of 250m. All subsequent dredges are 450m lines.			
Dec 10	1852	Dec 10	0752	**D2 in the water. North NELSC.**			
Dec 10	1950	Dec 10	0850	D2 on bottom. MAPR 44 on wire.	2060	-15.35150	-174.23315
Dec 10	2042	Dec 10	0942	D2 off bottom.	1807	-15.35332	-174.22948
Dec 10	2125	Dec 10	1025	D2 on deck.			
Dec 10	2130	Dec 10	1030	Heading to **D3 site - lava flow north of Volcano O.**			
Dec 10	2257	Dec 10	1157	At D3 site.			
Dec 10	2310	Dec 10	1210	**D3 in the water. Lava flow north of Volcano O.**			
Dec 11	0010	Dec 10	1310	D3 on bottom. MAPR 45 on wire.	2521	-15.27187	-174.03348
Dec 11	0052	Dec 10	1352	D3 off bottom.	2502	-15.26882	-174.03113
Dec 11	0148	Dec 10	1448	D3 on deck.			
Dec 11		Dec 10		Moving to D4 site now (lava flow at CT5 location).			
Dec 11	0250	Dec 10	1550	Performing tension test on the dredge winch wire. Results were that the tension (load) was good so there is not a problem. Test was because all 3 dredges did not have many rocks. Also discussing adding a weight to the dredge.			
Dec 11	0308	Dec 10	1608	Finished tension test.			
Dec 11		Dec 10		Decided to add a weight above the dredge.			
Dec 11	0328	Dec 10	1638	**D4 in the water. Lava flow at Camtow5 location.**			
Dec 11	0440	Dec 10	1740	D4 on bottom. MAPR 44 on wire.	2628	-15.11947	-174.00440
Dec 11	0544	Dec 10	1844	D4 off bottom.	2591	-15.11752	-173.99885
Dec 11	0646	Dec 10	1946	D4 on deck. Very large haul.			
Dec 11		Dec 10		Move to D5 site. Up flow from Camtow5 site (~17 km north of previous dredge).			
Dec 11	0804	Dec 10	2104	**D5 in the water. Up flow from Camtow5 site.**			
Dec 11	0915	Dec 10	2215	D5 on the bottom. MAPR 45 on wire.	2523	-15.07820	-173.96127
Dec 11	1012	Dec 10	2312	D5 off the bottom.	2513	-15.07820	-173.95590
Dec 11	1120	Dec 11	0020	D5 on the deck.			
Dec 11	1130	Dec 11	0030	Moving to D6 site. ~10 km S/SE on lava flow near Camtow2 location.			
Dec 11	1236	Dec 11	0136	**D6 in the water. Near Camtow2 location.**			
Dec 11	1339	Dec 11	0239	D6 on the bottom. MAPR 44 on wire.	2525	-15.15390	-173.92068
Dec 11	1443	Dec 11	0343	D6 off the bottom.	2526	-15.15392	-173.91367

Date (UTC)	Time (UTC)	Data (local)	Time (local)	KM1024 Events	Z(m)	Latitude	Longitude
Dec 11	1535	Dec 11	0435	D6 on the deck. Heading to D7 site ~4km SE.			
Dec 11	1620	Dec 11	0520	**D7 in the water. Small lava pond - area of camtow 1.**			
Dec 11	1722	Dec 11	0622	D7 on the bottom. MAPR 45 on wire.	2531	-15.17943	-173.89317
Dec 11	1824	Dec 11	0724	D7 off the bottom.	2506	-15.17943	-173.88722
Dec 11	1920	Dec 11	0820	D7 on the deck.			
Dec 11	1930	Dec 11	0830	Transit to D8 site ~3.5km NE.			
Dec 11	1958	Dec 11	0858	**D8 in the water. Center of lava flow area near deep helium anomaly cast V10B07.**			
Dec 11	2100	Dec 11	1000	D8 on the bottom. MAPR 45 on wire.	2617	-15.16220	-173.86535
Dec 11	2110	Dec 11	1010	EM122. Logging water column data near helium anomaly site.			
Dec 11	2112	Dec 11	1012	EM122. Stopped logging 3.5kHz to avoid interference with water column data. Seeing something near the seafloor but could be interference from ADCP.			
Dec 11	2154	Dec 11	1054	D8 off the bottom.	2620	-15.16218	-173.86030
Dec 11	2208	Dec 11	1108	EM122. Stop logging water column data. Too much noise.			
Dec 11	2302	Dec 11	1202	D8 on the deck.			
				Transit to next dredge site ~7km S/SW.			
Dec 11	2338	Dec 11	1238	Stopped for CTD dip test.			
Dec 11	2350	Dec 11	1250	CTD in the water for the dunk test.			
Dec 12	0025	Dec 11	1325	CTD back on deck.			
Dec 12	0035	Dec 11	1335	**D9 in the water. Hummocky terrain on lava flow.**			
Dec 12	0150	Dec 11	1450	D9 on the bottom. MAPR 45 on wire.	2478	-15.22373	-173.88793
Dec 12	0239	Dec 11	1539	D9 off the bottom.	2483	-15.22107	-173.88372
Dec 12	0332	Dec 11	1632	D9 on deck.			
Dec 12		Dec 11		Transit to D10 site ~8km E.			
Dec 12	0518	Dec 11	1818	**D10 in the water. SE corner of large lava flow.**			
Dec 12	0625	Dec 11	1925	D10 on the bottom. MAPR 44 on wire.	2536	-15.21640	-173.81488
Dec 12	0726	Dec 11	2026	D10 off the bottom.	2579	-15.21640	-173.80902
Dec 12	0825	Dec 11	2125	D10 on deck.			
Dec 12		Dec 11		Transit to D11 site. 4.8km N/NE.			
Dec 12	0934	Dec 11	2234	**D11 in the water. Deeper lava flow field. SW of W Mata in the deep basin.**			
Dec 12	1041	Dec 11	2341	D11 on the bottom. MAPR 45 on wire.	2765	-15.17680	-173.80407
Dec 12	1147	Dec 12	0047	D11 off the bottom.	2779	-15.17248	-173.79953
Dec 12	1251	Dec 12	0151	D11 on deck.			
Dec 12	1320	Dec 12	0220	XBT while transiting to site D12 ~8km NE of previous dredge.			
Dec 12	1347	Dec 12	0247	**D12 in the water. Deep SW rift zone of West Mata.**			
Dec 12	1442	Dec 12	0342	D12 on the bottom. MAPR 44 on wire.	2232	-15.10838	-173.76965

Date (UTC)	Time (UTC)	Data (local)	Time (local)	KM1024 Events	Z(m)	Latitude	Longitude
Dec 12	1536	Dec 12	0436	D12 off the bottom.	2053	-15.10835	-173.76577
Dec 12	1621	Dec 12	0521	D12 on deck.			
Dec 12	1635	Dec 12	0535	Setting up for West Mata EM122 survey of bathymetry and water column data. ADCP and 3.5 kHz shut down during survey to not interfere with water column data.			
Dec 12		Dec 12		Port and stbd angles at 65/65. New SVP applied just previous to survey. Survey speed 5-6 kts. Will surface difference the bathymetry data. Also will look for the eruptive vents in the water column data.			
Dec 12	1648	Dec 12	0548	EM122 start logging to Line 20. West Mata survey from SW to NE along the rift zone. 57°hdg. 4700/44230 cov.	1648	-15.11700	-173.78000
Dec 12	1705	Dec 12	0605	Water column data are a bit noisier as we approach the summit. See zooplankton (?) in wcd near (~200 m) the sea surface.			
Dec 12	1715	Dec 12	0615	Water column data have lots of noise - especially at the outer sectors. The bathy looks good. Did not see a large wcd signal. Really not much of anything more than noise in the water column data this pass.			
Dec 12	1741	Dec 12	0641	EM122 - end of West Mata survey. 2760/3030 cov.	2701	-15.07100	-173.70800
Dec 12		Dec 12		Transit ~1km to D13 site - the lava flow on the flat area between W and E Mata.			
Dec 12	1826	Dec 12	0726	**D13 in the water. On flat lava flow between W and E Mata.**			
Dec 12	1933	Dec 12	0833	D13 on the bottom. MAPR 44 on wire.	2708	-15.07108	-173.70125
Dec 12	2017	Dec 12	0917	D13 off the bottom.	2714	-15.07255	-173.69658
Dec 12	2114	Dec 12	1014	D13 on deck.			
Dec 12	2124	Dec 12	1024	Transit to D13 site 4.7km S/SW.			
Dec 12	2210	Dec 12	1110	**D14 in the water. SW rift zone of East Mata. Dredge up a little elongate high backscatter feature.**			
Dec 12	2308	Dec 12	1208	D14 on the bottom. MAPR 44 on wire.	2574	-15.11292	-173.71125
Dec 12	2359	Dec 12	1259	D14 off the bottom.	2372	-15.11387	-173.70653
Dec 13	0055	Dec 12	1355	D14 on deck.			
Dec 13	0106	Dec 12	1406	Underway to D15 site ~4.5 km west.			
Dec 13	0155	Dec 12	1455	**D15 in the water. West Mata proto south rift zone.**			
Dec 13	0250	Dec 12	1550	D15 on the bottom. MAPR 45 on wire.	2390	-15.11452	-173.75065
Dec 13	0335	Dec 12	1635	D15 off the bottom.	2244	-15.11342	-173.74665
Dec 13	0425	Dec 12	1725	D15 on deck.			
Dec 13		Dec 12		Transit to West Mata summit for CTD cast. Will also collect water column data during the cast. A pinger on the CTD may cause noise in the wcd.			

Date (UTC)	Time (UTC)	Data (local)	Time (local)	KM1024 Events	Z(m)	Latitude	Longitude
Dec 13	0453	Dec 12	1753	Start logging water column data while parked over the summit of West Mata. EM122 line 21. Pulled angles in to 55/55. 3715/3500 cov.		-15.09400	-173.74800
Dec 13	0500	Dec 12	1800	Blip in water column data			
Dec 13	0502	Dec 12	1802	Brought angles in to 40/40. Seeing activity in the water column data.			
Dec 13	0507	Dec 12	1807	Brought angles in to 35/35. 1270/1240 cov. Seeing lots of activity in the water column data. Can see the eruptive plume at the summit.	1202		
Dec 13	0516	Dec 12	1816	CTD in the water for vertical cast over the summit of West Mata. V10C-01. 10 helium and 10 trace metal samples.	1180	-15.09450	-173.74882
Dec 13		Dec 12		CTD Samples: 10 helium, 10 trace metals. Cast extent: 1151 meters.			
Dec 13	0557	Dec 12	1857	CTD at deepest (wire out 1160).			
Dec 13	0647	Dec 12	1947	CTD back on deck.			
Dec 13	0705	Dec 12	2005	Transit to D16 site 7.2 km N/NW - Mata Taha.			
Dec 13	0809	Dec 12	2109	**D16 in the water. Near the summit of Mata Taha (#1) - north side.**			
Dec 13	0905	Dec 12	2205	D16 on the bottom. MAPR 44 on wire.	2236	-15.04140	-173.78923
Dec 13	0954	Dec 12	2254	D16 off the bottom.	2191	-15.04043	-173.78495
Dec 13	1043	Dec 12	2343	D16 on deck.			
Dec 13				Transit ~2km to D17 site at Mata Ua			
Dec 13	1125	Dec 13	0025	**D17 in the water. Climbing up slope from the SW at Mata Ua (#2).**			
Dec 13	1227	Dec 13	0127	D17 on the bottom. MAPR 45 on wire.	2411	-15.02348	-173.78922
Dec 13	1316	Dec 13	0216	D17 off the bottom.	2290	-15.02247	-173.78622
Dec 13	1408	Dec 13	0308	D17 on deck.			
Dec 13		Dec 13		Not much in dredge. Just a few small pieces. Will repeat in same general area. The previous endpoint is the new start point.			
Dec 13	1431	Dec 13	0331	**D18 in the water. Climbing up slope to the summit of Mata Ua (#2).**			
Dec 13	1529	Dec 13	0429	D18 on the bottom. MAPR 44 on wire.	2263	-15.02205	-173.78593
Dec 13	1625	Dec 13	0525	D18 off the bottom.	2173	-15.01838	-173.78318
Dec 13	1713	Dec 13	0613	D18 on deck.			
Dec 13	1720	Dec 13	0620	Underway to D19 site 7 km E/NE.			
Dec 13	1808	Dec 13	0708	**D19 in the water. Small linear feature east of the North Matas. High backscatter.**			
Dec 13	1914	Dec 13	0814	D19 on the bottom. MAPR 44 on wire.	2816	-15.00207	-173.72082
Dec 13	2015	Dec 13	0915	D19 off the bottom.	2786	-15.00485	-173.71670
Dec 13	2112	Dec 13	1012	D19 on deck.			

Date (UTC)	Time (UTC)	Data (local)	Time (local)	KM1024 Events	Z(m)	Latitude	Longitude
Dec 13	2120	Dec 13	1020	Underway to next dredge site at Mata Tolu ~8 km west.			
Dec 13	2215	Dec 13	1115	**D20 in the water. Will cross the summit of Mata Tolu (#3) - the shallowest of the North Matas.**			
Dec 13	2300	Dec 13	1200	EM122 is not giving accurate depth information - it just stopped working. All subsequent depths for dredges were gleaned using ArcGIS (added lat/long point to arc and obtained the depth from the bathy).			
Dec 13	2303	Dec 13	1203	D20 on the bottom. MAPR 44 on wire.	2065	-15.00492	-173.80087
Dec 14	0004	Dec 13	1304	D20 off the bottom.	1935	-15.00600	-173.79513
Dec 14	0052	Dec 13	1352	D20 on deck.			
Dec 14		Dec 13		Transit to next dredge site at Mata Fa ~1.5 km north.			
Dec 14	0132	Dec 13	1432	**D21 in the water. Mata Fa (#4) center lava flow from W to E.**			
Dec 14	0231	Dec 13	1531	D21 on the bottom. MAPR 45 on wire.	2443	-14.99165	-173.80347
Dec 14	0330	Dec 13	1630	D21 off the bottom.	2458	-14.99320	-173.79830
Dec 14	0423	Dec 13	1723	D21 on deck.			
Dec 14		Dec 13		Transit to site D22 - 5.5 km north to Mata Ono.			
Dec 14		Dec 13		The start position of D22 was changed slightly to ensure we finish at the top of the ridge.			
Dec 14	0523	Dec 13	1823	**D22 in the water. Mata Ono (#6) NW to SE over ridge crest.**			
Dec 14	0636	Dec 13	1936	D22 on the bottom. MAPR 45 on wire.	2598	-14.93937	-173.80342
Dec 14	0724	Dec 13	2024	D22 off the bottom.	2482	-14.94142	-173.80130
Dec 14	0817	Dec 13	2117	D22 on deck.			
Dec 14		Dec 13		Transit to D23 site - 3.6 km N/NE			
Dec 14	0850	Dec 13	2150	**D23 in the water. Mata Fitu (#7) NW to SE up to the summit.**			
Dec 14	0955	Dec 13	2255	D23 on the bottom. MAPR 45 on wire.	2488	-14.90780	-173.79703
Dec 14	1018	Dec 13	2318	D23 off the bottom.	2400	-14.90960	-173.79280
Dec 14	1142	Dec 14	0042	D23 on deck.			
Dec 14		Dec 14		Transit to D24 site - ~16 km west.			
Dec 14	1306	Dec 14	0206	**D24 in the water. Northerly lava flow (60km NE of NELSC dredges).**			
Dec 14	1411	Dec 14	0311	D24 on the bottom. MAPR 44 on wire.	2852	-14.88822	-173.94695
Dec 14	1510	Dec 14	0410	D24 off the bottom.	2793	-14.89008	-173.94182
Dec 14	1607	Dec 14	0507	D24 on deck.			
Dec 14		Dec 14		Transit to last dredge site - D25. 11.5 km S/SW.			
Dec 14	1701	Dec 14	0601	**D25 in the water. Little cone on lava flow (48 km NE of NELSC dredges).**			
Dec 14	1802	Dec 14	0702	D25 on the bottom. MAPR 44 on wire.	2404	-14.98048	-173.99862
Dec 14	1903	Dec 14	0803	D25 off the bottom.	2240	-14.97930	-173.99427

Date (UTC)	Time (UTC)	Data (local)	Time (local)	KM1024 Events	Z(m)	Latitude	Longitude
Dec 14	1953	Dec 14	0853	D25 on deck.			
Dec 14	2010	Dec 14	0910	Transiting to the Tonga trench for a CTD deep vertical cast.			
Dec 14	2357	Dec 14	1257	On station for CTD cast V10C-02 at the Tonga trench site.			
Dec 15	0014	Dec 14	1314	**CTD in the water. Vertical cast at the Tonga trench site: V10C-02.**	6045	-14.86000	-173.27000
Dec 15		Dec 14		CTD Samples: 13 helium, 13 trace metals. Cast extent: 3300 meters.			
Dec 15	0250	Dec 14	1550	CTD on deck			
Dec 15	0255	Dec 14	1555	End of operations. Heading to Pago Pago American Samoa to disembark.			
No EM122 data collected on the transit from NE Lau to Pago Pago. The system was still not functioning at that point.							
Dec 15	1900	Dec 15	0800 Samoa	Alongside the pier at Pago Pago American Samoa.		-14.26667	-170.71667
Aside: The EM122 system was repaired on the transit from American Samoa to Hawaii. One additional day worth of bathymetry data were collected in the area of the Hawaiian Islands that did not fit onto the data disks provided, but Vic has the data if we want it. UH will probably utilize those data.							

2.0 Dredging Operations Log *(includes MAPR information)*

Dredge	on seafloor	lat deg	lat min	long deg	long min	Z (m)	Area, etc.	JD	hr	min	MAPR # data?
D01	on bottom	15	21.118	174	13.926	2009	**North NELSC** - north of Tafu	344	16	39	*44-yes*
D01	off bottom	15	21.198	174	13.772	1804	117°hdg. 310m on bottom.	344	17	24	
D01 Description: 1 fist-sized rock - basalt crust. Highly vesicular olivine phyric lava. Only sample in dredge.											
D01 MAPR 5m above the pinger. Pinger 200m above the dredge. MAPR 44 collected data.											
D02	on bottom	15	21.090	174	13.989	2061	**North NELSC** - repeat of D1	344	19	50	*44-yes*
D02	off bottom	15	21.199	174	13.769	1807	116°hdg. 440m on bottom.	344	20	42	
D02 Description: ~100 grams. Pillow basalt fragments, small pieces of glassy crust, basalt and pumice. Pillow fragments have dark black glassy exteriors. Some mm olivine and microphenocrysts.											
D02 MAPR 5m above the pinger. Pinger 200m above the dredge. MAPR 44 collected data.											
D03	on bottom	15	16.312	174	2.009	2521	Center of **lava flow** field just north of Volcano O	345	0	10	*45-no*
D03	off bottom	15	16.129	174	1.868	2502	38°hdg. 420m on bottom.	345	0	52	
D03 Description: 1 small piece of pumice and ~20 small glassy fragments. Larger glassy rock fragments possibly rare pyroxene (opx?) 1mm and 1mm long feldspar. Brownish coatings on all surfaces. Looks like high silica (dacite?)											
D03 MAPR 5m above the pinger. Pinger 200m above the dredge. MAPR 45 NO DATA.											
D04	on bottom	15	7.168	174	0.264	2628	**Lava flow** at Camtow 5 location	345	4	40	*44-yes*
D04	off bottom	15	7.051	173	59.931	2591	70°hdg. 635m on bottom.	345	5	44	
D04 Description: Big haul. Lava flow interiors and glassy rinds. Pillow and tube lava fragments, chips and boulders. Poorly vesicular, aphyric black glass, dark grey microcrystalline interiors.											
D04 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											
D05	on bottom	15	4.692	173	57.676	2523	**Lava flow** - upflow from Camtow 5 site (17km NE of D4)	345	9	15	*45-yes*
D05	off bottom	15	4.692	173	57.354	2513	90°hdg. 575m on bottom.	345	10	12	
D05 Description: Good haul. Massive bulbous glass, glass sheet, glass breccias. Relatively young. Rare vesicles to very sparsely vesicular. Some plagioclase microphenocrysts and occasional glomerocrysts.											
D05 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 45 collected data.											
D06	on bottom	15	9.234	173	55.241	2525	**Lava flow** - near Camtow 2 location	345	13	39	*44-yes*
D06	off bottom	15	9.235	173	54.820	2526	90°hdg. 755m on bottom.	345	14	43	
D06 Description: 1/4 bag full of ~20cm-size (< fingernail size) mainly glassy lava flow lobes. Striated flow 'layers' with elongated vesicles parallel to the layers. Sparse plagioclase phyric with rare opx phenocrysts. Also some welded pumice.											
D06 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											

Dredge	on seafloor	lat deg	lat min	long deg	long min	Z (m)	Area, etc.	JD	hr	min	MAPR # data?
D07	on bottom	15	10.766	173	53.590	2531	**Small lava pond** - Camtow 1 location	345	17	22	*45-yes*
D07	off bottom	15	10.766	173	53.233	2506	90°hdg. 640m on bottom.	345	18	24	
D07 Description: 1/8 bag full of brick-size-slivers of pillow lobes (some beautiful samples) and end lava flow lobes. Mineralogy: sparse plagioclase (sub mm) with rare olivine. Minor pumice fragments (quartz, pyroxine and plagioclase).											
D07 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 45 collected data.											
D08	on bottom	15	9.732	173	51.921	2617	Center of **lava flow** - area of helium anomaly cast V10B-07	345	21	0	*45-yes*
D08	off bottom	15	9.731	173	51.618	2620	89°hdg. 540m on bottom.	345	21	54	
D08 Description: 1/8 bag full. Pillow and tube lava - flow tops and interiors as well as bread crust flow tops - mostly aphanitic with some plagioclase microphenocrysts. Also samples of glassy flow interior with sparse plagioclase microphenocrysts. One pumice fragment (quartz, feldspar and amphibole).											
D08 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 45 collected data.											
D09	on bottom	15	13.424	173	53.276	2478	Hummocky terrain on lava flow between Volcano O and Matas	346	1	50	*45-yes*
D09	off bottom	15	13.264	173	53.023	2483	57°hdg. 540m on bottom.	346	2	39	
D09 Description: Good haul. Glassy lava. Lava flow lobe and tube margins. Some mud coating and fractures. Plagioclase microphenocrysts. Moderately evolved - minor staining along fractures.											
D09 MAPR 5m above the pinger. Pinger 400m above the dredge. MAPR 45 collected data.											
D10	on bottom	15	12.984	173	48.893	2536	SE corner of large **lava flow**	346	6	25	*44-yes*
D10	off bottom	15	12.984	173	48.541	2579	90°hdg. 630m on bottom.	346	7	26	
D10 Description: Lava flow tube margins. Fresh glass - entire samples were thin glass. Fairly young, not much alteration. Very sparse plagioclase microphonocrysts, some with rare pyroxene (opx?). Small angular fragments. One older sample with heavy staining.											
D10 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											
D11	on bottom	15	10.608	173	48.244	2765	**Lava flow** field - center of flow. SW of West Mata in the deep basin	346	10	41	*45-yes*
D11	off bottom	15	10.349	173	47.972	2779	46°hdg. 680m on bottom.	346	11	47	
D11 Description: 1 – 2 pounds of material. 2 rock samples of massive lava with very sparse sub mm plagioclase and pyroxene plus Mn-oxide coating. 2 glassy flow lobe samples with very sparse sub mm plagioclase microphenocrysts plus minor staining along interior fractures.											
D11 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 45 collected data.											
D12	on bottom	15	6.503	173	46.179	2232	Deep SW rift zone of **West Mata**	346	14	42	*44-yes*
D12	off bottom	15	6.501	173	45.946	2053	89°hdg. 415m on bottom.	346	15	36	
D12 Description: 2 boulders and many fist sized rocks. 9 out of 10 rock samples are boninite. 1 older vesicular lava sample. No crust on any of the boninites (fresh samples). Mineralogy includes orthopyroxene, olivine and clinopyroxene, with some large olivine phenocrysts with cr-spinel inclusions. Some samples strongly vesiculated with spherical to elongate bubbles.											
D12 MAPR 5m above the pinger. Pinger 400m above the dredge. MAPR 44 collected data.											

Dredge	on seafloor	lat deg	lat min	long deg	long min	Z (m)	Area, etc.	JD	hr	min	MAPR # data?
D13	on bottom	15	4.265	173	42.075	2708	**Lava flow** between East and West Mata	346	19	33	*44-yes*
D13	off bottom	15	4.353	173	41.795	2714	107°hdg. 525m on bottom.	346	20	17	
D13 Description: Boninite. 2 rock samples were dense black glass; the other sample had a 1-2mm glass rind. Small round vesicles. Mineralogy: olivine with cr-spinel inclusions and orthopyroxene.											
D13 MAPR 5m above the pinger. Pinger 400m above the dredge. MAPR 44 collected data.											
D14	on bottom	15	6.775	173	42.675	2574	SW rift zone of **East Mata**. Up a little elongate high backscatter feature.	346	23	9	*44-yes*
D14	off bottom	15	6.832	173	42.392	2372	101°hdg. 520m on bottom.	346	23	59	
D14 Description: Lava flow tops (possible pillows), flow lobes and interiors as well as vesicular basalt. Mostly aphanitic. Some rare olivine and olivine-orthopyroxene phenocrysts. Also glassy boninite pebbles and 1 pumice sample.											
D14 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											
D15	on bottom	15	6.871	173	45.039	2390	**West Mata** proto south rift zone	347	2	50	*45-yes*
D15	off bottom	15	6.805	173	44.799	2244	74°hdg. 445m on bottom.	347	3	35	
D15 Description: Boninite. Pillow fragments and interiors, with euhedral olivine. Some ortho and clino pyroxine. Fresh pieces, no alteration. Highly vesicular.											
D15 MAPR 5m above the pinger. Pinger 400m above the dredge. MAPR 45 collected data.											
D16	on bottom	15	2.484	173	47.354	2236	Near the summit of **Mata Taha (#1)** - N side	347	9	5	*44-yes*
D16	off bottom	15	2.426	173	47.097	2191	77°hdg. 475m on bottom.	347	9	54	
D16 Description: Large chunks, pillow fragments. All samples had very fresh interiors when cut open. Brown staining, with some iron and manganese coated. Some large vesicles. Olivine and plagioclase phenocrysts and microphenocrysts. Some spinel inclusions and rare clinopyroxene laths.											
D16 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											
D17	on bottom	15	1.409	173	47.353	2411	Climbing up slope from the SW at **Mata Ua (#2)**	347	12	27	*45-yes*
D17	off bottom	15	1.348	173	47.173	2290	71°hdg. 340m on bottom.	347	13	16	
D17 Description: Small dredge samples were suspect but differ from those sampled in D16. Total recovery was 4 small, marble-size pieces. Aphyric to sparsely olivine phyric. Variably vesicular.											
D17 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 45 collected data.											
D18	on bottom	15	1.323	173	47.156	2263	Climbing up slope to the summit of **Mata Ua (#2)**	347	15	29	*44-yes*
D18	off bottom	15	1.103	173	46.991	2173	37°hdg. 500m on bottom.	347	16	25	
D18 Description: 1 boulder (pillow fragment), 2kg of fist-sized to finger-joint chips of varied lithologies. Most have a thin glass rind. Weakly vesicular to coarse vesicles. Pillow fragments 2-3% clinopyroxene up to 1cm long with sparse olivine. Other samples all have sparse olivine.											
D18 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											

Dredge	on seafloor	lat deg	lat min	long deg	long min	Z (m)	Area, etc.	JD	hr	min	MAPR # data?
D19	on bottom	15	0.124	173	43.249	2816	Small **linear feature** E of the North Matas - high backscatter	347	19	14	*44-yes*
D19	off bottom	15	0.291	173	43.002	2786	124°hdg. 540m on bottom.	347	20	15	
D19 Description: 1 palm-sized, flat, greenish-white altered rock (greenstone-metabasalt) with heavy Mn-stained exteriors. 4 marble-sized Mn coated pieces - 1 piece with plagioclase phenocryst.											
D19 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											
D20	on bottom	15	0.295	173	48.052	2065	Across the summit of **Mata Tolu (#3)** - the shallowest of the North Matas	347	23	3	*44-yes*
D20	off bottom	15	0.360	173	47.708	1935	100°hdg. 630m on bottom.	348	0	4	
D20 Description: Torso-sized block, fist-sized to knuckle-sized fragments. Largest block is a pillow showing excellent cross-section from quenched glass exterior to awesomely vesicular interior over 25cm. Pillow mineralogy includes olivine, ortho and clino pyroxene phenocrysts in a gray cryptocrystalline matrix. Most smaller fragments are from glassy flow top rinds - highly vesicular, frothy-scoriaceous. Similar to main lithology of D15.											
D20 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											
D21	on bottom	14	59.499	173	48.208	2443	**Mata Fa (#4)** across lava flow just S of summit	348	2	31	*45-yes*
D21	off bottom	14	59.592	173	47.898	2458	107°hdg. 580m on bottom.	348	3	30	
D21 Description: Very small haul. ~4 fist-sized rocks. Pillow fragments, flow top and tube wall samples. Vesicular basaltic rock, possibly boninite(?). Fresh glass. Mineralogy: Sub mm very sparse pale green olivine. Some with orthopyroxene microphenocrysts.											
D21 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 45 collected data.											
D22	on bottom	14	56.362	173	48.205	2598	**Mata Ono (#6)** NW to SE over ridge crest.	348	6	36	*44-yes*
D22	off bottom	14	56.485	173	48.078	2482	135°hdg. 320m on bottom.	348	7	24	
D22 Description: Large lava fragment! Variably Fe-Mn (iron-manganese) stained. Sample has dark and light bands of matrix swirled together. Olivine, ortho and clino pyroxene phenocrysts. Other samples include lava fragments (clasts). One sample had pale green olivine phenocrysts up to 2cm long.											
D22 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											
D23	on bottom	14	54.468	173	47.822	2488	**Mata Fitu (#7)** NW to SE up to the summit.	348	9	55	*45-yes*
D23	off bottom	14	54.576	173	47.568	2400	113°hdg. 500m on bottom.	348	10	18	
D23 Description: Large pillow fragments and rubble. ~1mm coating of Mn-oxide covering all exterior sides. Mineralogy: olivine and orthopyroxene, some with clinopyroxene as well. No fresh breaks apparent, but after sawing, sample is fresh and porphoritic. Highly vesicular.											
D23 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 45 collected data.											
D24	on bottom	14	53.293	173	56.817	2852	**Northerly lava flow** (60km NE of NELSC dredges)	348	14	11	*44-yes*
D24	off bottom	14	53.405	173	56.509	2793	110°hdg. 590m on bottom.	348	15	10	

Dredge	on seafloor	lat deg	lat min	long deg	long min	Z (m)	Area, etc.	JD	hr	min	MAPR # data?
D24 Description: 1/10 bag of head to fingernail-sized lava flow fragments and glass flow tops. Majority of material is a lightly Mn and Fe-stained, conchoidally-fractured, dark grey, non-vesicular. Mineralogy: sparse olivine and plagioclase microphenocrysts.											
D24 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											
D25	on bottom	14	58.829	173	59.917	2404	**Little cone** on lava flow (48 km NE of NELSC dredges).	348	18	2	*44-yes*
D25	off bottom	14	58.758	173	59.656	2240	75°hdg. 485m on bottom.	348	19	3	
D25 Description: Pillow and other lava fragments - head-sized to fist-size. Some Mn staining. Mineralogy: olivine and black clinopyroxene. Some fragments strongly phyric with abundant 4-5 mm olivine and black clinopyroxene. Pumice pieces mineralogy includes fledspar, quartz and pyroxene.											
D25 MAPR 5m above the pinger. Pinger 500m above the dredge. MAPR 44 collected data.											

2.1 Summary and Highlights of Dredge Operations

Ken Rubin

Fig .7. Watching the pinger trace and wire tension in the main lab during a huge bite on dredge 22.

This section describes the dredge operations and highlights of each dredge. A detailed log of dredge ops, sample lists, site descriptions, and rock descriptions occur elsewhere in this report.

Dredge Logistics

Most of the station time on KM1024 involved dredging. We used a 3.5 kHz pinger on the wire to track the approach to the bottom, monitored from the computer lab (Fig. 7), where ship's crew and OTG personnel monitored the wire tension and ship's position, and controlled the winch during dredges. A PMEL MAPR was deployed on each dredge 5 meters above the pinger (as described in the Dredging Ops Log and the MAPR section). Science party personnel were directly involved in deployments and recoveries on the back deck (Fig. 8).

Fig 8a and 8b. Dredge recovery.

Selection of targets

Dredge targets (Fig. 1) were selected prior to the cruise, using bathymetric and backscatter maps of the regional seabed, results of camera tow ("CT") deployments from KM1008 (May 2010), and results of May 2010 and earlier hydrocasts. Notes about these observations are given in the below "Highlights and Brief Summary of Each Dredge". The station order was chosen to have a general progression from south to north, taking into account the priority of the target site and planning for the minimum amount of transit time between consecutive sites. Dredge track lines were planned to be 400-500m long, starting from initial way points based on typical seas and winds in the area. Dredge start and end points were refined and moved during the cruise as needed to achieve optimal recovery based on our experiences up to that point. Setting the actual start and end way points of the dredges was a bit of a challenge in some instances: we often needed to change them after the ship settled on site, because the bridge was in general only comfortable taking the ship along a vector with a narrow (± 5°-10°) range from ideal dictated by the sea conditions. Some dredge starts were delayed 15 to 20 min. as we developed a smooth system to modify existing points, and in some cases, to move the ship to a new start point. Way point selection became more routine as the cruise progressed.

Number of dredges completed

Twenty five of 27 planned dredges were executed on the cruise. We sampled all of the highest priority targets, and all but 2 of the next priority. These latter sites were "lost" because we opted to repeat dredges at the NELSC (D2 and D3) and Mata Ua (D17 and D18), which were repeated because of low recovery in the first attempt at the site. We planned for 6 dredges a day, including transits, and accomplished 5.5 of them per day (i.e., 25 dredges spread over ~4.5 days), which equates to just over 4 hours per dredge. Dredge operations were conducted on twelve hour shifts, with most of the science party participating in parts of one or both shifts.

Fig 9a. Fifty-five buckets containing KM1024 rock samples are staged for offloading in port. The five buckets in the foreground were collected by the preceding science party, in about 2/3 as much time.

Fig. 9b. D22-Rock01, seen here in Pago Pago harbor, was sub-sampled aboard ship and returned to Honolulu largely intact.

Sample recovery

Recovery from the first 3 dredges was quite small, this coming on the heels of the previous cruise where only 5 of 12 dredge hauls contained any rock whatsoever, and all were small (P. Michael, personal communication). At this point the most experienced dredgers in our group sat down with the OTG techs and devised a scheme to improve recovery, which was to lay out more wire scope on ground, deploy a weight on the wire, move the pinger further up wire from the dredge, and allow closer pinger approach to the bottom. Once these changes were initiated (placing the pinger 400 m above the dredge and lowering it to within 50-100 m of the bottom), recovery increased dramatically, with only a couple of small dredge hauls after that (D13 and D17).

Sample Numbering

Samples were brought into the hydrolab after each dredge in heavy paint buckets and laid out under heat lamps to dry (or on sunny occasions, placed on plywood on the fantail). Generally, all rocks in a dredge were examined and quickly typed by visual morphology, freshness, mineralogy, and glassiness. Numbers were assigned to anywhere from 1 to 13 specimens, with other unnumbered bits mostly going into buckets as unnumbered material. Some nice unnumbered specimens were left out for the crew, which became very popular items as the cruise progressed, and excessive material from a couple of early dredges was returned to the sea. Samples were photographed with a name card and cm scale bar. All samples were named by the convention DXX-RockYY or DXX-PumiceYY, where DXX is the dredge number, and YY is the sample number. The few pumices we sampled were rhyolitic exotics, presumably floated and then sunk from eruptions on the active arc to the east. The pumices were described and catalogued, but we have no immediate plans to work on them at this time.

Sample Description and Mineralogy/Petrology Notes

Dimensions of numbered samples were measured, after which samples were described following standard petrological conventions for matrix and phenocryst texture, mineralogy, vesicle number and shape, glass thickness, rock freshness, and coatings, if present. There are some differences in the level of detail and in the nomenclature in these preliminary descriptions, so we urge some caution to readers about the details, particularly for mineral assignments, which in some cases were difficult because the rocks were fine-grained or coated by alteration deposits, and because some olivine crystals are very pale and small, making them look somewhat like plagioclase.

A graphical summary of the typical phenocryst content of rocks from each dredge is given in Fig. 10 to help draw out similarities and differences between dredges. Sample-by-sample preliminary mineralogy observations are given in the subsamples table. The broad similarity of samples from both the Mata volcanoes as a group, and the Lava Flow Field terrain are evident in this summary, which does not however speak to mineral size or abundance differences between the rocks. One thing is clear, which is that a broadly-boninitic lithology is widespread in the region, occurring at all of the Mata volcanoes. Differences between the lavas of each Mata may reflect conditions of melting and/or crystallization, and might even point to various steps along a petrologic sequence of low pressure differentiation amongst magmas of boninite parentage. In this last regard, the KM1024 sample set is unique, and may very well be recognized in the future as an important contributor to the understanding of the diversity of compositions within this rare magma type.

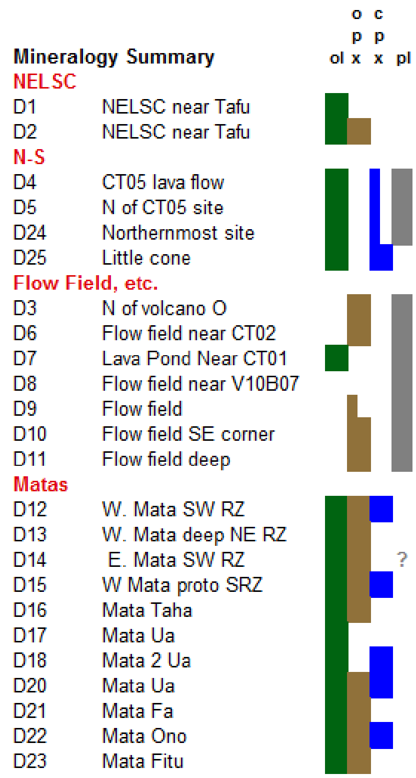


Fig. 10. Summary of phenocryst mineralogy by dredge and dredge region on KM1024. Colored boxes beneath the mineral indicators in the upper right corner indicate that the mineral was common in rocks of that dredge. Ol is olivine, cpx and opx are clino and ortho pyroxene, and pl is plagioclase. Half-filled columns indicate occasional occurrence.

Sample Processing, Subsampling, Packing and Archiving

Samples were dried, described and bagged by watch standers soon thereafter (usually within 24 hours of them reaching the deck). After the bulk of the science party departed the ship in Samoa, Rubin and Russo systematically went through each dredge in an attempt to normalize the sample descriptions during the transit from Samoa to Honolulu. They also sawed thin section billets. Separated glass was subsequently cleaned in purified water (2 MΩ) in a sonic bath until the water ran clear, dried in an oven, and subsampled for microprobe analysis and "bulk glass" fractions. All of these subsample splits were brought to U. Hawaii after the ship docked in Honolulu, while the remainder of the samples were packed into numbered 5 gallon paint buckets and placed into storage at the university's Snug Harbor facility (see subsample table).

Samples are archived at the University of Hawaii (send sample requests to Ken Rubin). IGSNs (International Geo Sample Number) have been assigned by SESAR (the System for Earth Sample Registration, http://www.geosamples.org/) to simplify the compilation of sample data, metadata, and data arising from subsequent shore-based analysis via digital data collections such as PetDB. IGSNs for each sample are listed in the table in section 2.3.

2.2 Highlights and Brief Summary of Each Dredge

<table>
<tr>
<td>

KM1024-D01-Rock01</td>
<td>D01 was at the site of a suspected recent eruption on the ridge segment north of Tafu seamount. The dredge went in the water at ~ 4 AM, after which we dredged up slope from the W/NW (117° hdg), near the crossing of CT07 during KM1008. Very little material was recovered (just one small rock), but it was extremely fresh and glassy, and broadly similar to the accidental clasts recovered on the camera tow.</td>
</tr>
<tr>
<td>

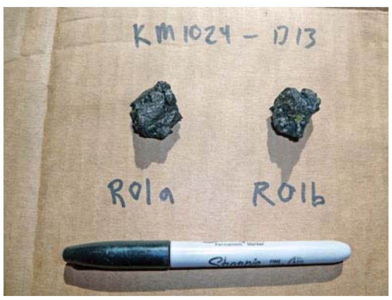
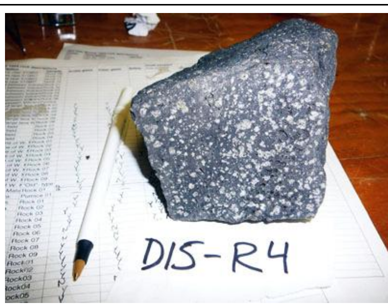
KM1024-D02-Rock01</td>
<td>D02 was at the same site as the prior dredge, although we lengthened the track line and started further down slope. Recovery was still small, but greater than D01. There was very a fresh D01-like lithology and a somewhat older lithology among the few rocks in the dredge. After the dredge, we determined that the method used to estimate the pinger distance off the bottom was quite conservative, and with a trackline that did not account for dredge layback, the dredge probably didn’t reach the steep approach to the axis summit.</td>
</tr>
<tr>
<td>

KM1024-D03-Rock01</td>
<td>D03 was run in the center of the large region of high backscatter sea floor north of volcano ‘O’, which has been interpreted by Embley et al., 2009 (AGU abstract) as one or more extensive, extra-caldera lava flows associated with that volcanic center. Recovery was very small in this dredge: one glassy rock fragment, possibly dacite, about twenty small glassy frags like rock01, and one small piece of pumice. Rock 01 is sparsely plagioclase phyric, has rare pyroxene phenocrysts, and had mild brownish coatings on all surfaces.</td>
</tr>
<tr>
<td>

KM1024-D04-Rock06</td>
<td>D04 was run across a lava flow in the “N-S” ridge terrain. The lava flow sits in the depression between two ridges. It was imaged by KM1008-CT05 and is thinly sedimented. This was a large dredge haul, containing mildly stained, fresh, glassy lava, with spare plagioclase phenocrysts and olivine or cpx microphenocrysts, generally thick glass rinds, and glassy matrix interiors. Some glass rind upper surfaces had unusual ropey striations characteristic of the region, which, along with rind thickness, we ascribed to higher silica content than basalt.</td>
</tr>
<tr>
<td>

KM1024-D05-Rock01</td>
<td>D05 was also run in the “N-S” ridge terrain, at a somewhat shallower area of high backscatter terrain to the NNE, which could be a source region for the D04 lava flow, and/or parts of the large lava flow terrain to the east sampled on D06-D10. The lavas are similar to D04 and the dredge recovery was likewise good. Samples have thinker glass rinds than D04. Small bronze microphenocrysts might be olivine or pyroxene.</td>
</tr>
</table>

 KM1024-D06-Rock05	D06 was the first dredge in the large “lava flow terrain” between the Matas, Volcano O and the NELSC. This dredge was at the site of KM1008-CT02, which had showed thinly sedimented pillows and lobate lavas flowing eastward from the N-S terrain. Dredge recovery was good. Samples were mostly thick glassy lava rinds with elongate vesicles, sparely plagioclase phyric with rare opx phenocrysts, and mild coating on outer surfaces and fracture faces.
 KM1024-D07-Rock01	D07 was run just southeast of D06, in the same lava terrain. It was at the site of KM1008-CT01, which had showed thinly sedimented pillows and lobate lavas of a small lava shield that hosted a ponded/drained central crater. This dredge started in the center of the crater and dragged up across the crater wall. Dredge recovery was good (about ½ as much material as D06). Lava samples look very much like D06, with somewhat more loosely adhering mud on exterior surfaces and interior vesicles.
 KM1024-D08-Rock02	D08 was also in the large lava flow field terrain, NE of the D07 site, on ~100m deeper sea bed. This spot was near the location of a near-bottom possible He anomaly detected on KM1008. Recovery was similar to D07 and samples appear quite similar in texture, appearance, glassiness, and alteration degree. Sparse plagioclase microphenocrysts were observed. Many samples preserve the characteristic ropey texture of the glassy flow top, which we started to refer to as “water-buffalo head hair” texture in descriptive notes.
 KM1024-D09-Rock02	D09 was likewise in the large lava flow field, this time in hummocky, shallow sea bed near the southern margin of the terrain. This was the shallowest of the lava flow field dredges, located near the high point of the flow field. Recovery was similar to D08 and samples appear quite similar in texture, appearance, glassiness, and alteration degree. Sparse plagioclase microphenocrysts were observed in these samples as well. Despite the location, there wasn’t a strong indication that we had sampled a near-vent facies on this dredge.
 KM1024-D10-Rock01	D10 was likewise in the large lava flow field, due east of D09. Recovery was similar to D09 and samples appear quite similar in texture, appearance, glassiness, and alteration degree. Sparse plagioclase microphenocrysts were observed in these samples as well, with similar elongated sparse vesicles. One piece of much older appearing lava was also sampled.

 KM1024-D11-Rock03	D11 was run in the deep NE region of the large lava flow field, near its closest approach to W. Mata volcano. This site is roughly 150m deeper than the next deepest part of the field that we sampled on D08. Recovery was lower on this dredge (~1 kg total). Two types of material were in the dredge: small glassy rock fragments (pictured) that were generally similar to D04-D10 and somewhat larger, flow interior fragments with thin (1 mm) glass bands/rinds.
 KM1024-D12-Rock01	D12 was run at from ~2230m up to 2050m depth along the SW rift zone of W. Mata volcano. These samples were collected ~500-600m deeper than the deepest known SW rift zone samples, which were collected by Jason during the May 2009 eruption response cruise (TN234). Recovery was good. Most of the samples were fresh, moderately to highly vesicular boninite with orthopyroxene, olivine and clinopyroxene phenocrysts and the occasional cm-scale olivine megacrysts (see photo).
 KM1024-D13-Rock01a+01b	D13 was run at the base of the W. Mata NE rift zone, in an area of high backscatter sea floor of moderately sedimented pillow and sheet lavas imaged by KM1008-CT04. At just 4 small rock chips of 1-2 cm size, dredge recovery was very poor, probably because the relief on the flow top was small and we were forced by sea conditions to dredge obliquely to flow top lineaments. We can't be certain that samples aren't D12 leftovers, but the dredge bag was cleaned in between, and the consensus was that the D13 samples looked different. D13 glass nuggets had 0.3-0.5 cm olivine and opx grains.
 KM1024-D14-Rock03	D14 was the only dredge conducted at East Mata volcano (deep on the SW rift zone, at a depth of 2.5 ± 0.1 km). Dredge recovery was good. Lavas are highly to moderately vesicular, fresh to mildly altered, have cm-thick glass rinds, and olivine and opx phenocrysts. No cpx was observed in the rock. Plagioclase was suspected as a phenocryst in one or two samples in the dredge, marking this out as the only dredge among the Mata volcano group (D12 to D23) that might contain feldspar, making this perhaps a more evolved boninitic composition.
 KM1024-D15-Rock04	D15 was run on a constructional ridge at W. Mata that runs due south from the summit, perhaps making it a proto south rift zone. Dredge recovery was good. Samples were highly to moderate vesicular, extremely fresh, had cm think glass rings, and were among the most crystal rich of those recovered on the cruise, containing up to 50% by volume phenocrysts with classic boninitic mineralogy (ol-opx-cpx). The freshness of the samples (e.g., clean vesicle walls and no fracture coatings) suggests they are relatively young.

<table>
<tr><td>

KM1024-D16-Rock02</td><td>D16 was at Mata Taha, near the summit on the north side. Dredge recovery was good. Samples are highly vesicular and only mildly to sparsely phyric with olivine and pyroxene phenocrysts. Samples had thin to no glass rinds and generally had brown staining on all sides exposed to sea water, but had very fresh interiors when they were subsequently cut open. We suspect that these samples were collected near a source of hydrothermal activity.</td></tr>
<tr><td>

KM1024-D17-Rock01</td><td>D17 was at Mata Ua, on a flat area near the summit from the SW flank. Dredge recovery was very small (4 pieces) that may have come from an earlier dredge, but mostly differ from those sampled on D16. Three of the rocks were aphyric to sparsely olivine phyric, had little to no glass, and were moderately vesicular. One of these was given a sample number (see photo at left). A fourth rock was suspected to be from D16 on the basis of coatings and general appearance.</td></tr>
<tr><td>

KM1024-D18-Rock01</td><td>D18 was a repeat at Mata Ua, essentially just upslope of the prior dredge. Recovery was better, although rocks were substantially more altered, suggesting nearby hydrothermal activity. Samples had thin glass rinds, some mildly altered, a few percent cpx phenocrysts, sparse and nearly colorless, and rare to no opx.</td></tr>
<tr><td>

KM1024-D19-Rock01</td><td>D19 was at a small unnamed seamount due east of Mata characterized by very high backscatter seabed. Dredge recovery was very small, despite multiple large tension spikes. The dredge contained one piece of serpentinite and one piece of rhyolite pumice.</td></tr>
<tr><td>
KM1024-D20-Rock01</td><td>D20 was at the western rift zone of Mata Tolu, near the summit. Dredge recovery was good, and contained a single lithology including one very large sample displaying an excellent cross-section from quenched glass exterior to highly vesicular interior over ~25 cm. The lavas are very fresh, with no alteration or mud, and appear similar to the main lithology of D15, with the classic boninite orthopyroxene, olivine and clinopyroxene phenocryst assemblage and cm thick glass rinds.</td></tr>
</table>

 KM1024-D21-Rock01	D21 was at Mata Fa, on a small south-pointing spur near the summit. Dredge recovery was small and of one lithology, all of which was fresh, very vesicular, with thin glass rinds and sparsely phyric with sub mm very pale green olivine and deep brown opx.
 KM1024-D22-Rock01  Rock01-sawed fragments	D22 was run on the NW flank of the Mata Ono, near the summit. Recovery was good, including one huge sample that didn't fit into the dredge and that was heroically brought on deck whilst teetering precariously in the swinging dredge (see photo upper at left). This sample has dark and light bands of matrix swirled together at short (1 cm) and long (5-10 cm) wavelengths (e.g., see photo of sawed fragments). Both magma types are associated with glass rinds. The phenocryst assemblage looks different between the two types, with generally more clinopyroxene and no olivine in the light gray bands and ol-opx-cpx in the dark bands, but this varies widely through the rock. The darker bands also appear to be more vesicular. Other rock fragments in the dredge look like one or the other magma type.
 KM1024-D23-Rock04	D23 was run at the northernmost Mata volcano, Mata Fitu, along a trajectory from the northwest that mimicked that of KM1024-CT07, and avoiding the large hydrothermal field south east of the summit. Dredge recovery was huge. All of the material looks to be a single lithology, with mild to moderate Mn and Fe-oxide staining on moderately vesicular lavas having sub cm thick glass rings and predominantly olivine-opx phenocryst mineralogy (sometimes as intergrowths), with rarer occurrences of cpx.
 KM1024-D24-all_rocks	D24 was the northernmost dredge of the expedition, run in an east-facing embayment in high backscatter sea floor near the northern terminus of the N-S ridge terrain. Dredge recovery was good. Rocks are all very glassy, with sparse plagioclase and olivine microphenocrysts, limited vesicularity, minor staining on some exterior surfaces, and the water buffalo head hair texture of the upper glass surface that is also characteristic of samples from more southerly N-S ridge terrain (D4-D5) and the large lava flow terrain (D6-D11). The samples had the unusual characteristic of a strong S smell during glass chipping on the transit. All seven numbered specimens and the remaining unnumbered rocks can be seen laid out on the hydro lab table in the picture at left.

 KM1024-D25-Rock04	D25 was run up the west side of a small, circular volcanic cone in high backscatter sea floor near the of the N-S ridge terrain. These lava samples were moderately vesicular, with some vesicles reaching 3 cm in diameter, and contained sparse microphenocrysts of olivine and black clinopyroxene. The samples had variable thick to no glass rinds. Some had sediment trapped in vesicles and all had slight Mn staining in places, and mild Fe-oxide stains on some interior fracture surfaces.

2.3 R/V Kilo Moana KM1024 rock subsample information

compiled from handwritten notes on ship, IGSN numbers assigned postcruise

(Ol is olivine, cpx and opx are clino and ortho pyroxene, and pl is plagioclase)

Description	Dredge	sample	IGSN	probe glass	Other glass	Billets	small sample?	XRF hunk	comments	buckets*	mineralogy summary (see note)	ol	opx	cpx	pl
NELSC near Tafu	D1	Rock 01	KHR00002E	Y	Y	1	Y			UH 1/5	ol-sp	x			
NELSC near Tafu	D2	Rock 01	KHR00002F	Y	Y	1	Y			UH 1/5	ol	x			
NELSC near Tafu	D2	Rock 02	KHR00002G	Y	Y	N	Y		some glass left on sample		ol-sp	x			
NELSC near Tafu	D2	Rock 03	KHR00002H	Y	Y rest of sample	N	Y= other glass				ol-sp	x			
NELSC near Tafu	D2	Rock 04	KHR00002I	Y	Y	2	Y				ol-sp, pl-r	x	x		
NELSC near Tafu	D2	Rock 05	KHR00002J	Y	Y	N	Y		some glass left on sample		ol-sp, pl-r	x	x		
NELSC near Tafu	D2	Pumice	KHR00002K	N	N	N									
lava field N of volcano O	D3	Rock 01	KHR00002L	Y	Y rest of sample	N	Y= other glass			UH 1/5	pl, px-r		x		x
CT05 lava flow	D4	Rock 01	KHR00002M	Y	Y	4	N		plenty of glass left	3	ol, pl-sp	x			x
CT05 lava flow	D4	Rock 02	KHR00002N	Y	Y	2	N				ol, pl-sp	x			x
CT05 lava flow	D4	Rock 03	KHR00002O	Y	Y	N	N		plenty of glass left		ol, pl-sp	x			x
CT05 lava flow	D4	Rock 04	KHR00002P	Y	Y	N	N (all glass)		tons of mud during sonify		ol	x			
CT05 lava flow	D4	Rock 05	KHR00002Q	Y	Y	N	N (all glass)				ol, pl-r, cpx-r	x		x	x
CT05 lava flow	D4	Rock 06	KHR00002R	Y	Y	2	N		plenty of glass left		ol, pl-r, cpx-r	x		x	x
CT05 lava flow	D4	Rock 07	KHR00002S	Y	Y	N	N (all glass)		plenty of glass left		ol	x			
CT05 lava flow	D4	Rock 08	KHR00002T	Y	Y	N	N (all glass)				ol, pl-r, cpx-r	x		x	x
CT05 lava flow	D4	Rock 09	KHR00002U	Y	Y	N	N (all glass)		plenty of glass left		ol	x			
N of CT05 site	D5	Rock 01	KHR00002V	Y	Y	N	N (all glass)		plenty of glass left	3	pl-sp, ol-sp	x			x
N of CT05 site	D5	Rock 02	KHR00002W	Y	Y	N	N (all glass)		plenty of glass left		pl-sp, px-sp			x	x
N of CT05 site	D5	Rock 03	KHR00002X	Y	Y	N	N (all glass)		plenty of glass left		pl-r				x
N of CT05 site	D5	Rock 04	KHR00002Y	Y	Y	N	N (all glass)		plenty of glass left		pl-sp, ol-sp	x			x
N of CT05 site	D5	Rock 05	KHR00002Z	Y	Y	N	N (all glass)		plenty of glass left		pl-sp				x
lava flow near CT02	D6	Rock 01	KHR000030	Y	Y	N	N (all glass)		plenty glass left/interior mud	3	pl-sp, opx-r		x		x
lava flow near CT02	D6	Rock 02	KHR000031	Y	Y	N	N (all glass)		plenty glass left/interior mud		pl-sp, opx-r		x		x

Description	Dredge	sample	IGSN	probe glass	Other glass	Billets	small sample?	XRF hunk	comments	buckets*	mineralogy summary (see note)	ol	opx	cpx	pl
lava flow near CT02	D6	Rock 03	KHR000032	Y	Y	N	N (all glass)		plenty glass left/interior mud		pl-sp, opx-r		x		x
lava flow near CT02	D6	Rock 04	KHR000033	N	N	N	N (all glass)				pl-sp, opx-r		x		x
lava flow near CT02	D6	Rock 05	KHR000034	N	N	N	N (all glass)				pl-r				x
lava flow near CT02	D6	Rock 06	KHR000035	Y	Y	N	N (all glass)		plenty of glass left		pl-r				x
lava flow near CT02	D6	Rock 07	KHR000036	Y	Y	N	N (all glass)		plenty of glass left		pl-r				x
lava flow near CT02	D6	Rock 08	KHR000037	N	N	N	N (all glass)				pl-r				x
lava flow near CT02	D6	Rock 09	KHR000038	Y	Y	N	Y all glass		about 1/2 left		pl-r				x
lava flow near CT02	D6	Pumice	KHR000039	N	N	2	N		cut 1 piece in 1/2, mud inside		qz, pl, opx, cpx	-	-	-	-
Lava Pond Near CT01	D7	Rock01	KHR00003A	Y	Y	N	N (all glass)		tons left	3	pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock02	KHR00003B	Y	Y	N	N (all glass)		tons left		pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock03	KHR00003C	Y	Y	N	N (all glass)		tons left		pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock04	KHR00003D	Y	Y	N	N (all glass)		tons left		pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock05	KHR00003E	Y	Y	N	N (all glass)		tons left		pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock06	KHR00003F	Y	Y	N	N (all glass)		tons left		pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock07	KHR00003G	N	N	N	N (all glass)		didn't work on these since they all look to be the same as the first 6 samples from this dredge		pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock08	KHR00003H	N	N	N	N (all glass)				pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock09	KHR00003I	N	N	N	N (all glass)				pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock10	KHR00003J	N	N	N	N (all glass)				pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Rock11	KHR00003K	N	N	N	N (all glass)				pl-sp, ol-r	x			x
Lava Pond Near CT01	D7	Pumice	KHR00003L	N	N	N	N				qz, pl, px	-	-	-	-
lava flow near V10B07	D8	Rock 01	KHR00003M	N	N	N	N		all glass looks like rock#2	3	pl				x
lava flow near V10B07	D8	Rock 02	KHR00003N	Y	Y	N	N		all glass/plenty left		pl				x
lava flow near V10B07	D8	Rock 03	KHR00003O	Y	Y	N	N		all glass/plenty left		pl				x
lava flow near V10B07	D8	Rock 04	KHR00003P	N	N	N	N		all glass/plenty left		pl				x

Description	Dredge	sample	IGSN	probe glass	Other glass	Billets	small sample?	XRF hunk	comments	buckets*	mineralogy summary (see note)	ol	opx	cpx	pl
lava flow near V10B07	D8	Rock 05	KHR00003Q	Y	Y	N	N		all glass/plenty left/bottom tube		pl				x
lava flow near V10B07	D8	Rock 06	KHR00003R	Y	Y	N	N		all glass/some left		pl				x
lava flow near V10B07	D8	Rock 07	KHR00003S	N	N	N	N		all glass/some left		pl				x
lava flow near V10B07	D8	Rock 08	KHR00003T	Y	Y	N	N		all glass/some left		pl				x
lava flow near V10B07	D8	Rock 09	KHR00003U	N	N	N	Y		similar to #10		pl-ab				x
lava flow near V10B07	D8	Rock 10	KHR00003V	Y	Y	1	N	X	some glass left on sample		pl-sp				x
lava flow near V10B07	D8	Rock 11	KHR00003W	Y	Y	N	Y				pl-sp				x
lava flow near V10B07	D8	Rock 12	KHR00003X	N	N	N	Y				pl-sp				x
lava flow near V10B07	D8	Pumice	KHR00003Y	N	N	N	N				q, pl, amph	-	-	-	-
lava flow between Volcano O and Mata's	D9	Rock 01	KHR00003Z	Y	Y	N	N		all glass/plenty left	3	pl-r				x
lava flow between Volcano O and Mata's	D9	Rock 02	KHR000040	Y	Y	N	N		all glass/plenty left		pl-r				x
lava flow between Volcano O and Mata's	D9	Rock 03	KHR000041	Y	Y	N	N		all glass/plenty left		pl-r				x
lava flow between Volcano O and Mata's	D9	Rock 04	KHR000042	Y	Y	N	N		all glass/plenty left		pl-r				x
lava flow between Volcano O and Mata's	D9	Rock 05	KHR000043	Y	Y	N	N		all glass/plenty left		none				x
lava flow between Volcano O and Mata's	D9	Rock 06	KHR000044	Y	Y	N	N		all glass/plenty left		pl, px+pl-r		x		x
lava flow between Volcano O and Mata's	D9	Pumice	KHR000045	N	N	N	N								
SE Corner of large lava flow	D10	Rock 01	KHR000046	Y	Y	N				2	pl-r				x
SE Corner of large lava flow	D10	Rock 02	KHR000047	Y	Y	N					p-l-r, opx-r		x		x

Description	Dredge	sample	IGSN	probe glass	Other glass	Billets	small sample?	XRF hunk	comments	buckets*	mineralogy summary (see note)	ol	opx	cpx	pl
SE Corner of large lava flow	D10	Rock 03	KHR000048	Y	Y	N					p-l-r, opx-r		x		x
SE Corner of large lava flow	D10	Rock 04	KHR000049	Y	Y	N					pl-r				x
SE Corner of large lava flow	D10	Rock 05	KHR00004A	Y	Y	N					pl-r				x
SE Corner of large lava flow	D10	Rock 06	KHR00004B	Y	Y	Y					pl-sp				x
deep lava flow field	D11	Rock 01	KHR00004C	N	N	Y	Y			UH 2/5	p-l-r, px-r		x		x
deep lava flow field	D11	Rock 02	KHR00004D	N	N	2	Y				p-l-r, px-r		x		x
deep lava flow field	D11	Rock 03	KHR00004E	Y	Y	N	Y				pl-r				x
deep lava flow field	D11	Rock 04	KHR00004F	Y	Y	N	Y				pl-r				x
Deep SW rift zone of W. Mata	D12	Rock 01	KHR00004G	Y	Y	1		X	huge-lots of glass	3	opx, ol, cpx	x	x	x	
Deep SW rift zone of W. Mata	D12	Rock 02	KHR00004H	Y	Y	3			huge-lots of glass		opx, ol, cpx	x	x	x	
Deep SW rift zone of W. Mata	D12	Rock 03	KHR00004I	Y	Y	N			plenty of glass left		opx, ol, cpx	x	x	x	
Deep SW rift zone of W. Mata	D12	Rock 04	KHR00004J	Y	Y	N	smaller		tube feature		opx, ol, cpx-sp	x	x	x	
Deep SW rift zone of W. Mata	D12	Rock 05	KHR00004K	Y	Y	2	smaller		all glass		opx, ol, cpx-sp	x	x	x	
Deep SW rift zone of W. Mata	D12	Rock 06	KHR00004L	Y	Y	N	smaller		all glass		opx, ol	x	x		
Deep SW rift zone of W. Mata	D12	Rock 07	KHR00004M	Y	Y	N	smaller		all glass		opx, ol, cpx-sp	x	x	x	
Deep SW rift zone of W. Mata	D12	Rock 08	KHR00004N	Y	Y	N					opx, ol, cpx-sp	x	x	x	
Deep SW rift zone of W. Mata	D12	Rock 09	KHR00004O	Y	Y	N	smaller		all glass		opx, ol, cpx-sp	x	x	x	
Deep SW rift zone of W. Mata	D12	Old type		N	N	N					none				
Lava flow east of W. Mata	D13	Rock 01a	KHR00004P	Y	Y	N	very small		all glass	UH 2/5	ol, opx	x	x		
Lava flow east of W. Mata	D13	Rock 01b	KHR00004Q	Y	Y	N	very small				ol, opx	x	x		
SW rift zone of E Mata.	D14	Rock 01	KHR00004R	Y	Y	N	large		thin layer of glass	3	none				

Description	Dredge	sample	IGSN	probe glass	Other glass	Billets	small sample?	XRF hunk	comments	buckets*	mineralogy summary (see note)	ol	opx	cpx	pl
SW rift zone of E Mata.	D14	Rock 02	KHR00004S	Y	Y	3		X	similar to #1, thicker glass		none				
SW rift zone of E Mata.	D14	Rock 03	KHR00004T	Y	Y	3			large 4-5cm vessicles		none				
SW rift zone of E Mata.	D14	Rock 04	KHR00004U	Y	Y	2			large olivine for thin section		ol-r	x			
SW rift zone of E Mata.	D14	Rock 05	KHR00004V	Y	Y	1					ol-sp, pl?-r	x			?
SW rift zone of E Mata.	D14	Rock 06	KHR00004W	Y	Y	2					none				
SW rift zone of E Mata.	D14	Rock 07	KHR00004X	N	N	2					px, pl, ol-r	x	x		x
SW rift zone of E Mata.	D14	Rock 08	KHR00004Y	N	N	N					ol, opx	x	x		
SW rift zone of E Mata.	D14	Rock 09	KHR00004Z	Y	Y	N					ol, opx	x	x		
SW rift zone of E Mata.	D14	Pumice 01	KHR000050	N	N	1	big		fresh						
W Mata proto SRZ	D15	Rock01	KHR000051	Y	Y	2		X	plenty of glass left	2	ol, opx, cpx-r	x	x	x	
W Mata proto SRZ	D15	Rock02	KHR000052	Y	Y	N			some glass left on sample		ol, opx	x	x		
W Mata proto SRZ	D15	Rock03	KHR000053	Y	Y	N			no glass left on rock		ol, opx, cpx-r	x	x	x	
W Mata proto SRZ	D15	Rock04	KHR000054	N	N	2		X	wow, crystal rich		porph: ol, opx, cpx	x	x	x	
W Mata proto SRZ	D15	Rock05	KHR000055	Y	Y	2			blocky glass-some left		ol-sp, opx-sp, cpx-r	x	x	x	
W Mata proto SRZ	D15	Rock06	KHR000056	Y	N	1					ol-sp, opx-cpx-Gl-r	x	x	x	
W Mata proto SRZ	D15	Rock07	KHR000057	N	N	2					ol, opx, cpx-r	x	x	x	
W Mata proto SRZ	D15	Rock08	KHR000058	N	N	2					ol, opx, cpx-r	x	x	x	
N Mata 1-Taha. Sw side near summit.	D16	Rock 01	KHR000059	Y	Y	1		X		4	ol-sp	x			
N Mata 1-Taha. Sw side near summit.	D16	Rock 02	KHR00005A	Y	Y	N					ol-ab, pl-ab	x			x
N Mata 1-Taha. Sw side near summit.	D16	Rock 03	KHR00005B	N	N	1					ol-sp, cpx-r	x		x	

Description	Dredge	sample	IGSN	probe glass	Other glass	Billets	small sample?	XRF hunk	comments	buckets*	mineralogy summary (see note)	ol	opx	cpx	pl
N Mata 1-Taha. Sw side near summit.	D16	Rock 04	KHR00005C	N	N	1					ol, cpx-r	x	x		
N Mata 1-Taha. Sw side near summit.	D16	Rock 05	KHR00005D	N	N	1					ol, cpx-r	x	x		
N Mata 1-Taha. Sw side near summit.	D16	Rock 06	KHR00005E	N	N	3		X			ol	x			
Mata 2 Ua. SW side near summit.	D17	Rock 01	KHR00005F	Y	Y	N	Y		other 2 "type1" pieces are "unnumbered"	UH 2/5	none				
Mata 2 Ua. SW side near summit.	D17	Type 02		Y	Y	N	Y				ol	x			
Mata 2 Ua. 'New site' SW side	D18	Rock 01	KHR00005G	Y	Y	3		X		1	cpx, ol-sp	x		x	
Mata 2 Ua. 'New site' SW side	D18	Rock 02	KHR00005H	Y	Y	1					cpx, ol-sp, opx-r	x	x	x	
Mata 2 Ua. 'New site' SW side	D18	Rock 03	KHR00005I	Y	Y	N			not much glass		ol-sp	x			
Mata 2 Ua. 'New site' SW side	D18	Rock 04	KHR00005J	Y	Y	N					ol-sp	x			
Mata 2 Ua. 'New site' SW side	D18	Rock 05	KHR00005K	Y	Y	1					ol-sp	x			
Mata 2 Ua. 'New site' SW side	D18	Rock 06	KHR00005L	Y	Y	N	yes, very		very little glass		ol, cpx-r	x		x	
Small linear feature E of N matas - high b'scat	D19	Rock 01	KHR00005M	N	N	2	Y			UH 3/5	altered				
Small linear feature E of N matas - high b'scat	D19	Pumice	KHR00005N	N	N	N	Y				pl				
Mata Tolu (#3)	D20	Rock 01	KHR00005O	Y	Y	3		X	Huge rock	2	ol, opx, cpx	x	x	x	
Mata Tolu (#3)	D20	Rock 02	KHR00005P	Y	Y	N	Y				ol, opx, cpx	x	x	x	
Mata Tolu (#3)	D20	Rock 03	KHR00005Q	Y	Y	N	Y				ol, opx, cpx	x	x	x	
Mata Tolu (#3)	D20	Rock 04	KHR00005R	Y	Y	N	Y				ol, opx, cpx	x	x	x	
Mata Tolu (#3)	D20	Rock 05	KHR00005S	Y	Y	N					ol, opx, cpx	x	x	x	
Mata Fa. Up centre lava flow from E to W.	D21	Rock 01	KHR00005T	Y	Y	N				1	ol-r, opx-sp	x	x		

Description	Dredge	sample	IGSN	probe glass	Other glass	Billets	small sample?	XRF hunk	comments	buckets*	mineralogy summary (see note)	ol	opx	cpx	pl
Mata Fa. Up centre lava flow from E to W.	D21	Rock 02	KHR00005U	Y	Y	2		X			ol-r, opx-sp	x	x		
Mata Fa. Up centre lava flow from E to W.	D21	Rock 03	KHR00005V	Y	Y	N					ol-r, opx-sp	x	x		
Mata Fa. Up centre lava flow from E to W.	D21	Rock 04	KHR00005W	Y	Y	N					ol-r, opx-r	x	x		
Mata 6 Ono.	D22	Rock 01	KHR00005X	Y	Y	4		XX	mixed magma/hunks of both	2	ol, opx, cpx	x	x	x	
Mata 6 Ono.	D22	Rock 02	KHR00005Y	Y	Y	1				+pallate	ol-sp, opx-sp	x	x		
Mata 6 Ono.	D22	Rock 03	KHR00005Z	N	N	N			similar to 2		ol-sp, opx-sp, cpx-r	x	x	x	
Mata 6 Ono.	D22	Rock 04	KHR000060	N	N	N			similar to 1		ol-sp, opx-sp, ol+cpx-r	x	x	x	
Mata 6 Ono.	D22	Rock 05	KHR000061	N	N	N			similar to 1		ol, opx	x	x		
Mata 6 Ono.	D22	Rock 06	KHR000062	N	N	N			tiny		ol-sp	x			
Mata 7 Fitu. N side.	D23	Rock 01	KHR000063	Y	Y	2		X	more glass om sample	8	ol, opx	x	x		
Mata 7 Fitu. N side.	D23	Rock 02	KHR000064	Y	Y	N			more glass om sample		ol, opx	x	x		
Mata 7 Fitu. N side.	D23	Rock 03	KHR000065	Y	Y	N			more glass om sample		ol, opx	x	x		
Mata 7 Fitu. N side.	D23	Rock 04	KHR000066	Y	Y	2			more glass om sample		ol, opx	x	x		
Mata 7 Fitu. N side.	D23	Rock 05	KHR000067	N	N	N					ol, cpx-r	x		x	
Mata 7 Fitu. N side.	D23	Rock 06	KHR000068	N	N	N					ol, opx, cpx-r	x	x	x	
Mata 7 Fitu. N side.	D23	Rock 07	KHR000069	N	N	N					ol, opx	x	x		
Northerly E of NELSC lava flow	D24	Rock 01	KHR00006A	Y	Y	N			all glass	3	ol-sp, pl-sp	x			x
Northerly E of NELSC lava flow	D24	Rock 02	KHR00006B	Y	Y	N			all glass		ol-sp, pl-sp	x			x
Northerly E of NELSC lava flow	D24	Rock 03	KHR00006C	Y	Y	N			all glass		pl+ol-Gl, cpx	x		x	x
Northerly E of NELSC lava flow	D24	Rock 04	KHR00006D	Y	Y	1		X	all glass		pl-sp				x
Northerly E of NELSC lava flow	D24	Rock 05	KHR00006E	N	N	N					pl-sp, ol-r	x			x

Description	Dredge	sample	IGSN	probe glass	Other glass	Billets	small sample?	XRF hunk	comments	buckets*	mineralogy summary (see note)	ol	opx	cpx	pl
Northerly E of NELSC lava flow	D24	Rock 06	KHR00006F	N	N	1		X	added to the list later/no glass		pl-sp, ol-r	x			x
Northerly E of NELSC lava flow	D24	Rock 07	KHR00006G						added to the list later						
Little cone on lava flow NE of NELSC	D25	Rock 01	KHR00006H	Y	Y	2		X	glass left/S smell in samples	1	ol, cpx-sp	x		x	
Little cone on lava flow NE of NELSC	D25	Rock 02	KHR00006I	N	N	1		X			ol, cpx	x		x	
Little cone on lava flow NE of NELSC	D25	Rock 03	KHR00006J	N	N	1		X			ol	x			
Little cone on lava flow NE of NELSC	D25	Rock 04	KHR00006K	Y	Y	1			not much glass left		porph: ol, cpx	x		x	
Little cone on lava flow NE of NELSC	D25	Rock 05	KHR00006L	N	N	N					porph: ol, cpx	x		x	
Little cone on lava flow NE of NELSC	D25	Rock 06	KHR00006M	N	N	N					ol, cpx	x		x	
Little cone on lava flow NE of NELSC	D25	Pumice	KHR00006N	N	N	N					qz, pl, px	-	-	-	-

	* (5 buckets went right to campus with glass and small samples, etc..)							
other buckets:	mineralogy note: (sp= sparse, ab= abundant, r=rare, gl=glomerocrysts)							
D1-D25 probe glass								UH 5/5
D1-D25 thin section billets								UH 5/5
All XRF								UH 4/5
D1-7 chipped glass								UH 1/5
D8-15 chipped glass								UH 2/5
D16-25 chipped glass								UH 3/5
Total buckets: 55								

3.0 CTD Operations

Ron Greene and Sharon Walker

Two vertical CTD casts were performed on the KM1024 leg (Fig. 1). The *Kilo Moana* rosette had a total of 24 Niskin bottles available. The sensors mounted on the package included conductivity, temperature, pressure, oxidation-reduction potential (ORP), transmissometer and optical backscatter (LSS). Samples were collected for trace metals and helium isotopes from all bottles used.

V10C-02 was located northeast of the study area beyond the trench with a bottom depth of 6035m, 14 deg 51.602' S and 173 deg 16.190' W. Thirteen bottles were closed and sampled within the depth range of 749 to 3300m. There were no real time particle anomalies but the samples will be helpful in the ongoing study for the regional ^{3}He signal.

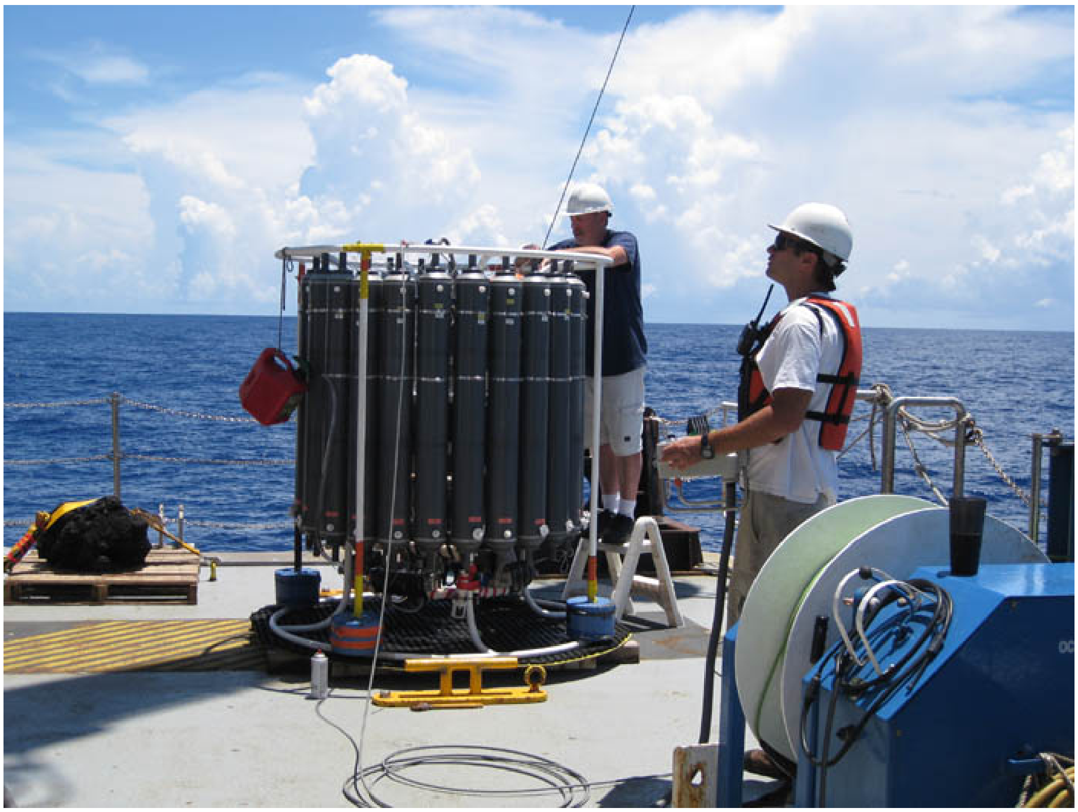


Fig. 11. CTD operations. Ron Greene makes last minute adjustments to the CTD before the cast at West Mata. Vic Polidoro (right) is supervising operations.

V10C-01 was located at the West Mata site with a bottom depth of 1170m, 15 deg 5.661' S and 173 deg 44.924' W. Ten bottles were closed and sampled within the depth range of 798 to 1151m with the deepest bottle 20m above bottom. LSS (particle) and ORP (reduced chemical species) anomalies were present deeper than 1050 m, with an above-bottom layer centered at ~1100 m. The LSS anomaly measured during this cast was much less intense than the 2008, 2009 and May 2010 values (dNTU~0.06 in December 2010 compared to dNTU=1-5v at earlier times), however, the ORP anomaly was comparable to previous casts (figure 12). The most optically intense plume was observed in 2008 when dNTU values exceeded 1.0 from 100 m above bottom all the way to the seafloor, with maximum sustained values of 5.0 (the upper limit of the sensor) throughout much of that depth range. The greatest plume rise height was observed during the event response cruise in 2009 when concurrent ROV observations confirmed vigorous eruptive activity. The greatly reduced particle concentration in December 2010 suggests there may be less volcanic ash and/or sulfur particles in the plume compared to previous visits. The comparable ORP anomaly suggests the dissolved composition of the plume (at least with respect to the reduced chemical species that the platinum electrode is sensitive to) may be more consistent over time.

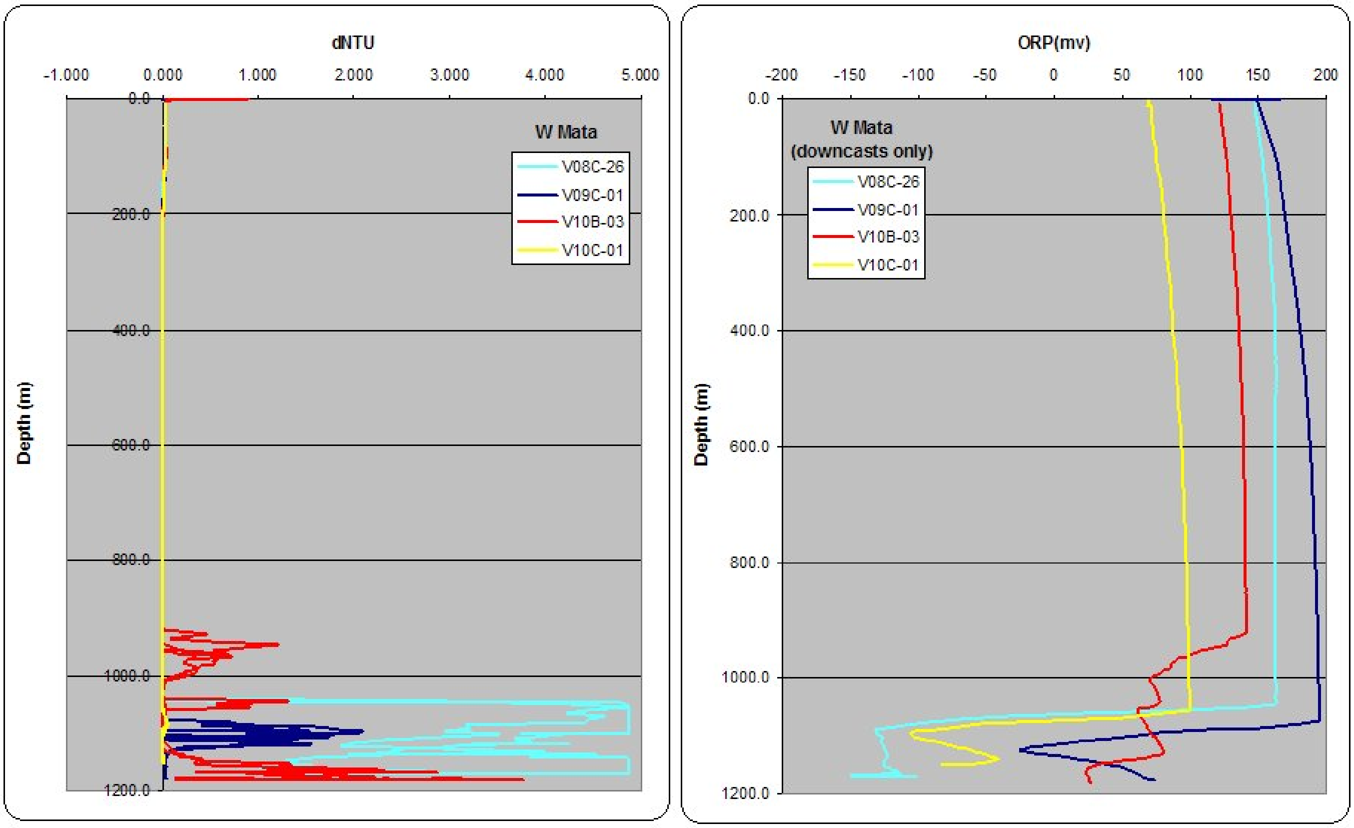


Fig 12. Particle (left) and ORP (right) profiles over the summit of West Mata during this cruise (yellow), May 2010 (red), 2000 (navy blue), and 2008 (aqua blue).

4.0 MAPR Operations

Sharon Walker

PMEL MAPRs (Miniature Autonomous Plume Recorders) are self-contained instruments that measure pressure, temperature, optical backscatter (LSS), and oxidation-reduction potential (ORP). They require very little additional time to attach/remove from a dredge wire, thus provide the opportunity to detect and map hydrothermal plumes throughout the target area without requiring additional CTD casts. Two MAPRs were provided for this cruise. One MAPR was attached to the dredge cable 5 meters above the pinger for every dredge operation during this cruise. The pinger was placed 200, 400 or 500 m above the dredge, but lowered to within 50-80 meters of the seafloor, so most MAPR profiles extended through the depth range where plumes are most common. On several dredges, however, the MAPR did not get much closer than 100-200 meters above bottom. Data return from the MAPRs was 96% with loss of one profile due to a data file error (dredge D03). It is possible that with further effort the error can be resolved and the data from that profile recovered.

The purpose of including a MAPR on each dredge was to (a) determine if the deep particle plumes around the flanks of West Mata and in the deep basin to the west of West Mata that were observed in 2008 and May 2010 were still present (no deep casts were done in 2009); (b) to collect data at additional sites in the NE Lau basin to explore for new deep hydrothermal sources; and (c) to acquire plume profiles over the North Mata volcanoes as a continuation (time series) of the survey that was conducted in May 2010 without having to dedicate extra ship time for CTD operations.

The deep particle plumes that had been observed in the basin west of West Mata in 2008 and May 2010 were composed predominantly of fresh ash shards characterized by sharp edges and conchoidal fractures, similar to those found at other actively erupting volcanoes where fine ash is transported to distances of 10's of kilometers via down-slope sediment gravity flows. No such deep particle plumes were present in the basin west of West Mata when one CTD cast was done in the region in 2004. The presence or absence of these deep particle plumes may reflect the concurrent level of eruptive activity at West Mata volcano.

Fig. 13. Cornel de Ronde (right) and Trevor Goodman attach the MAPR to the dredge cable.

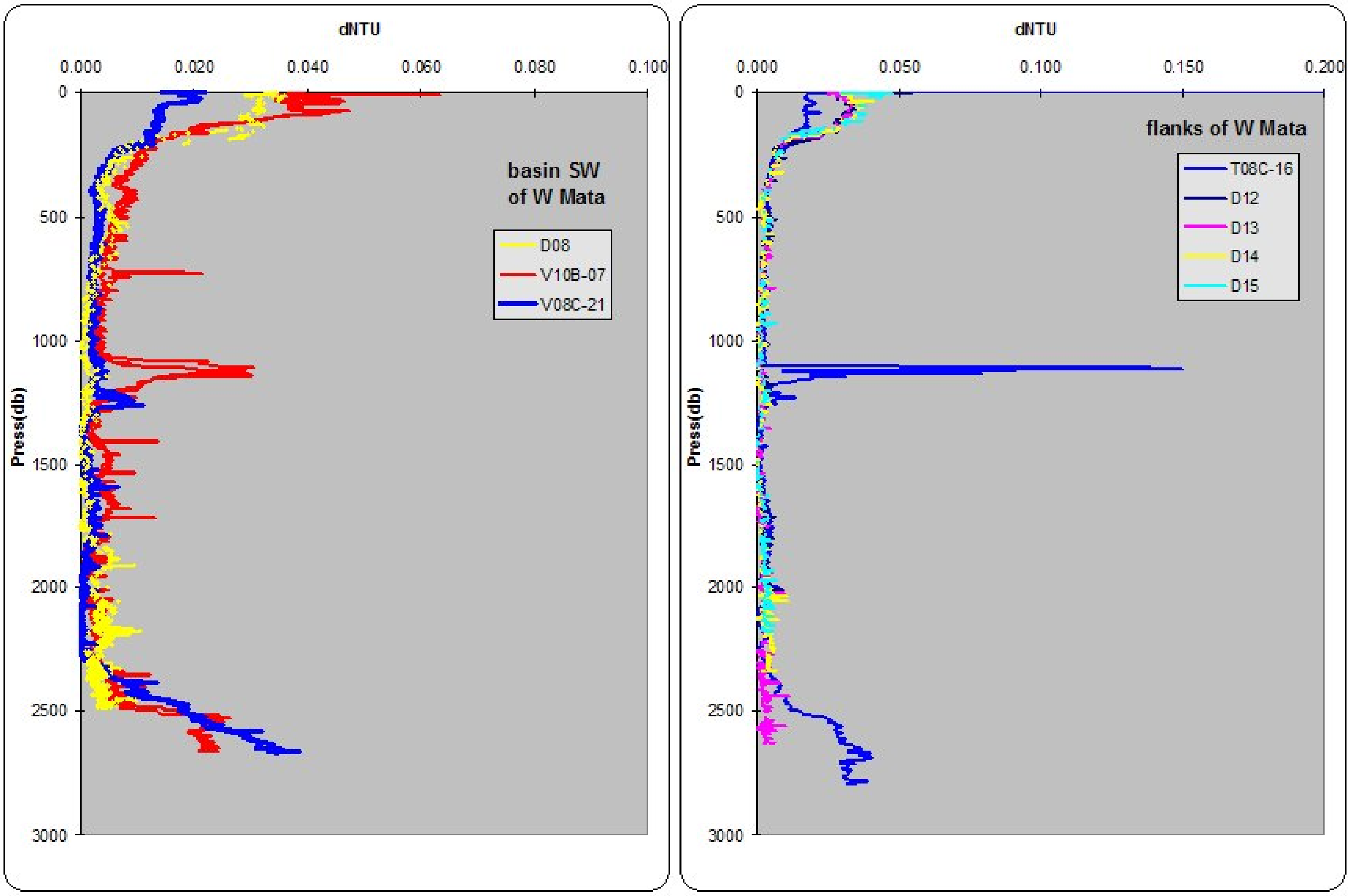


Fig. 14 (left panel) Far field particle distributions at the time of this cruise are defined by the profile at D08 (yellow) which was located in the same area as CTD casts V08C-21 (blue) and V10B-07 (red) about 10-15 km from the summit of West Mata. A particle layer that correlates with the summit depth of West Mata is clearly evident in the 2008 and May 2010 profiles (~1100-1275 m), as is the particle layer deeper than ~2250 m. The profile at D08 has only a slight dNTU increase at ~1125m and negligible increase below 2250 m. (right panel) Profiles around the flanks of West Mata (within 5 km of the summit) in December 2010 (D12, D13, D14 and D15) show significantly decreased particle concentrations both at the depth of the summit plume (~1100 m) and deeper than 2250 m compared to the plumes measured in 2008 (blue line).

CTD tows in May 2010 mapped hydrothermal plumes at the North Mata volcanoes where: 1) plumes at the northernmost hydrothermally active volcanoes (Fitu, Ono and Fa) were within the depth range of 2400-2500 m; 2) the plume at Tolu, the shallowest of the North Mata volcanoes, was centered at about 1750 m water depth; and 3) plumes at Ua and Taha, the two southernmost volcanoes of the group, were centered at about 2150-2200 m. Separate plume sources were able to be determined for 6 out of 7 of the North Mata volcanoes because the CTD tows provided discrete water samples for chemical analysis and adequate horizontal resolution of dNTU and ORP anomalies. The dredge stations were far more sparse, and the 2400-2500 m depth range was not very well sampled, so it is a bit more difficult to determine which volcano the plumes detected in the MAPR profiles originate from. However, plumes within the three main depth horizons (1750 m, 2150-2200 m, and deeper than ~2300 m) were present in the December 2010 MAPR profiles.

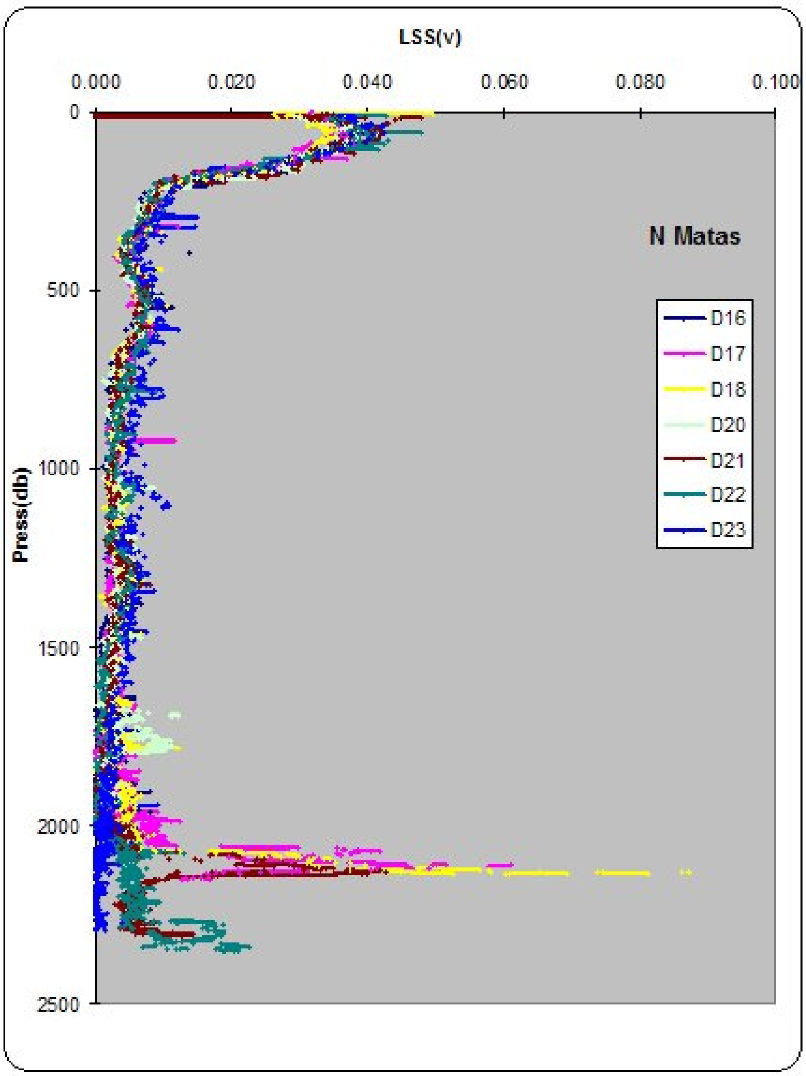


Fig. 15. MAPR profiles for the North Matas.

5.0 Multibeam Seafloor and Acoustic Water Column Mapping

Susan Merle

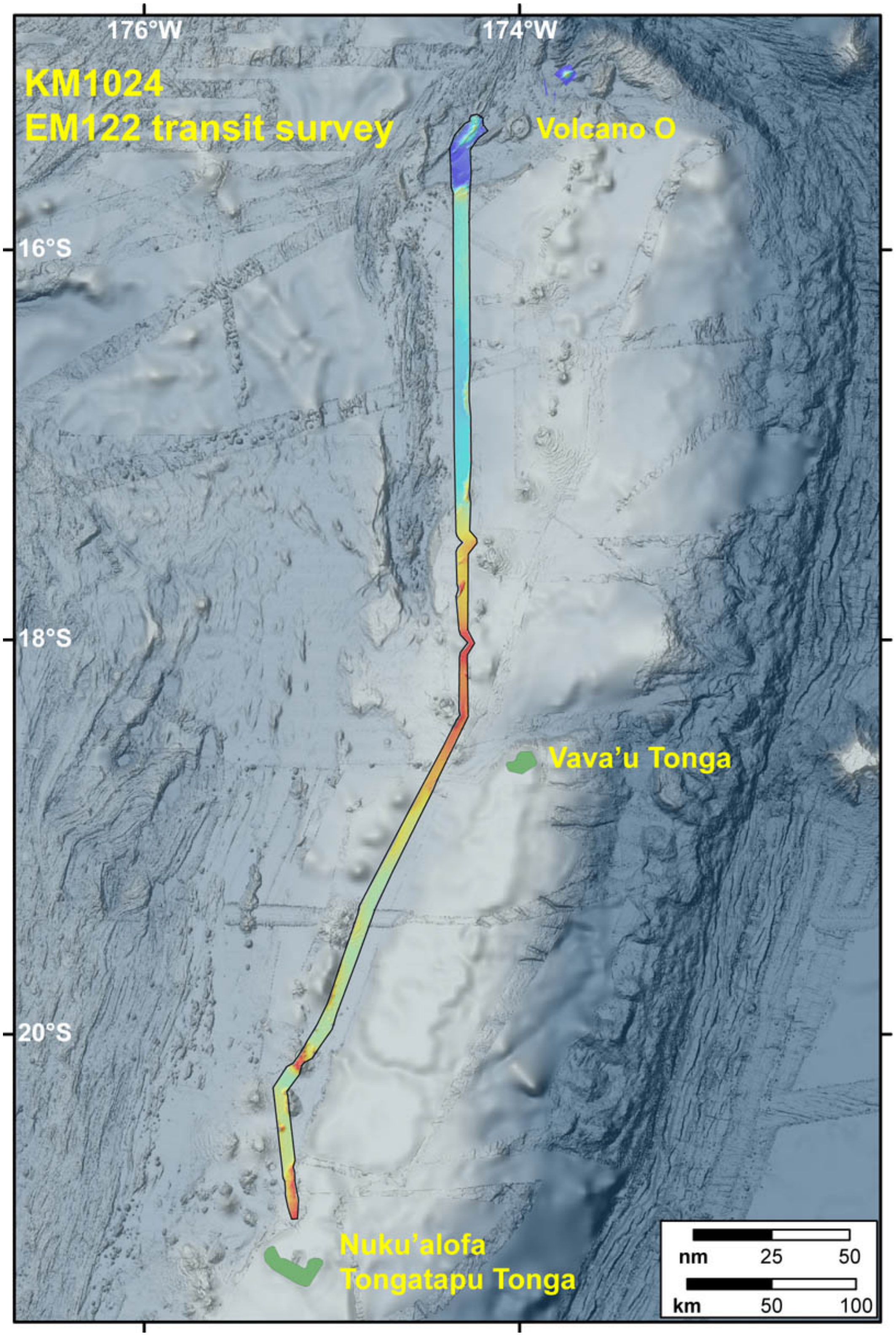


Fig 16. EM122 bathymetric data collected during the KM1024 expedition are show above in color (outlined in black). A recent compilation of existing data is shown in grayscale (courtesy of Fernando Martinez, UH).

The expedition departed from Nuku'alofa Tongatapu, Tonga Dec 9th 0400 UTC and arrived at the Northeast Lau Spreading Center (NELSC), our first operations area, Dec 10th 1330 UTC. During the transit, which covered 1835 kilometers in 35.5hours, EM122 multibeam bathymetry/backscatter data were collected (Fig 7). The transit survey route was requested by the University of Hawaii to increase the bathymetric coverage in the Lau Basin, filling in data gaps of particular interest along the way. Only two small surveys were conducted after arrival at the expedition site. NELSC and West Mata were re-surveyed on this expedition and bathymetric surface differencing was performed at each site. Water column data were collected above West Mata in an attempt to evaluate the eruptive activity. The total bathymetric coverage during the expedition was 5050 km^2. No EM122 surveying was performed during the transit to Pago Pago as the system was still not up and running at that time.

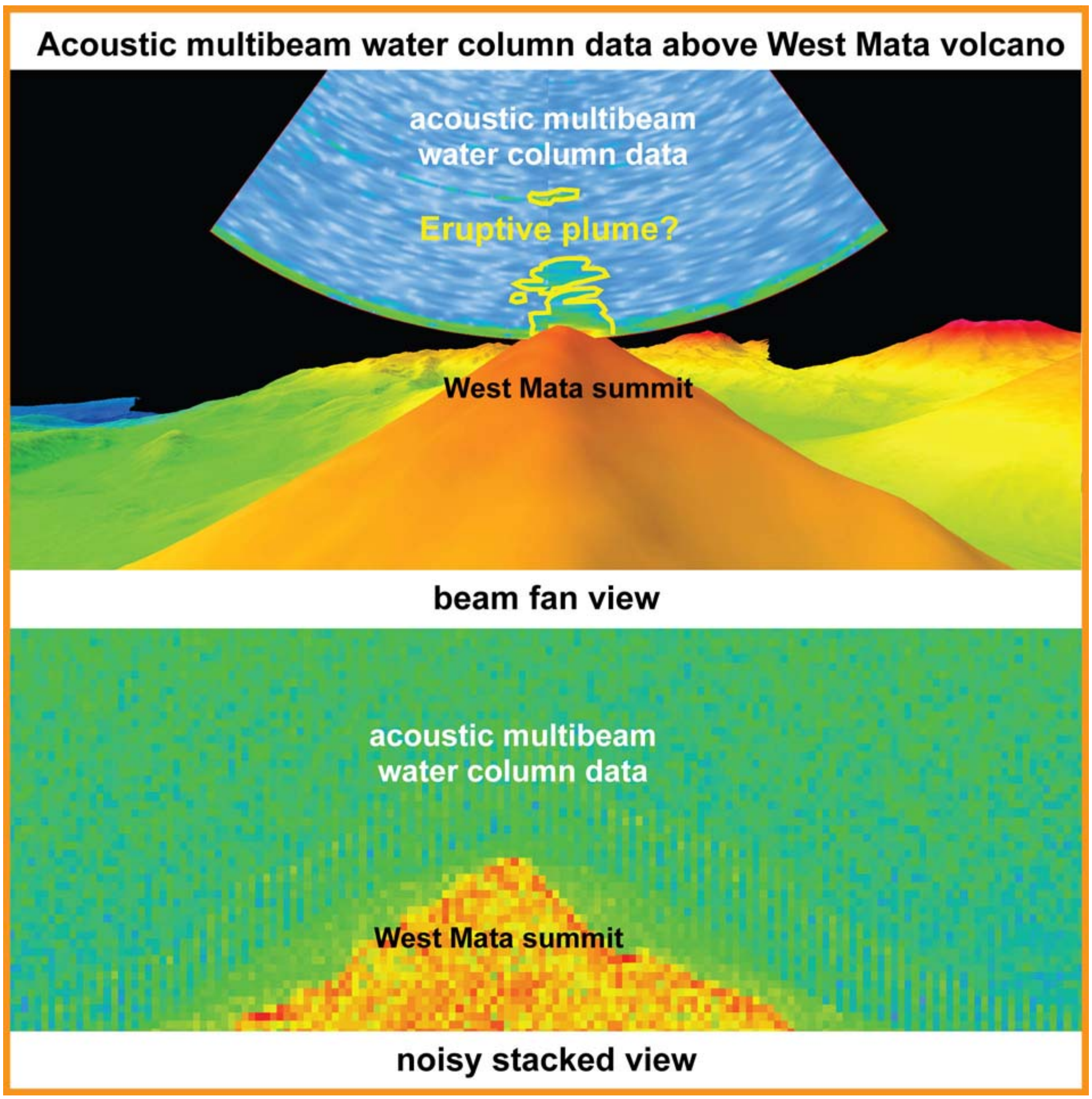


Fig. 17. Beam fan and stacked views of acoustic water column data above West Mata.

The EM122 water column data was processed using the Fledermaus midwater tool (FMMidwater). The Fledermaus manual states that the purpose of the FMMidwater program is to rapidly extract relevant water column features from a range of sonar file formats. The data can then be converted to GWC (generic water column) format, features of interest can be identified using threshold filtering, and those features can be exported to Fledermaus for visualization. http://www.ivs3d.com/products/

The beam fan view (Fig. 8 top) does show a plume rising (~300m) above the summit of West Mata, but it is hard to discern due to all the noise in the data. The noise is apparent in the stacked view (Fig. 8 bottom). The water column data are so noisy that a 3D object cannot be created. If one filtered out all the noise there would be very little water column data left to work with.

Shortly after our bathymetric and water column survey of West Mata (Fig. 9) the EM122 system went down and was inoperable for the rest of the expedition. The above images could indicate that the system was already failing when this survey was undertaken.

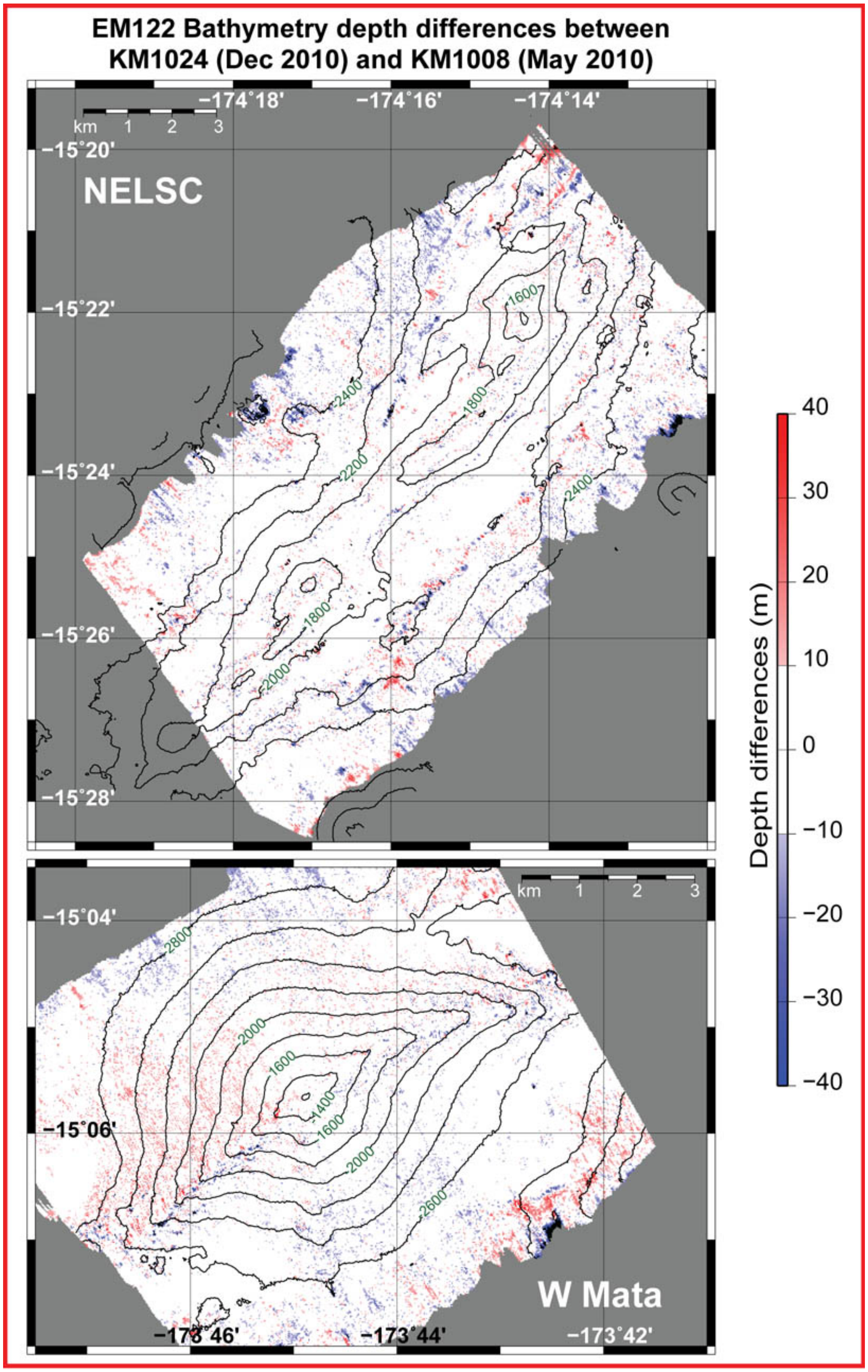


Fig. 18. The depth differences at both sites are minimal, if any. Red and blue colors on the maps are probably indicative of noise in the data. 200 meter contours overlaid on the difference grids are the latest data (KM1024). The white swath areas are where the 2 surveys, May and December, overlap.