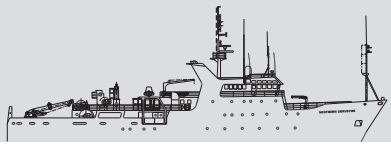

MARINE
NATIONAL FACILITY

2008 program

RV *Southern Surveyor*

CSIRO

voyage summary SS07/2008

SS07/2008

Northern Lau Vents Expedition (NoLauVE)

Voyage period

Depart: 30/04/2008
PORT OF DEPARTURE (Noumea, New Caledonia)

Return to port: 07/06/2008
PORT OF RETURN (Suva, Fiji)

RESPONSIBLE LABORATORY

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OBJECTIVES AND BRIEF NARRATIVE OF VOYAGE

Scientific Objectives

This Voyage had two legs separated by a refuelling stop in Fiji (26th to 27th May, 2008). The First Leg of SS07/2008 focussed on these objectives:

The fastest spreading backarc region on Earth forms the northern Lau Basin (NLB), and is the strongest source of mantle-derived 3He-rich hydrothermal plumes in the southwestern Pacific. Following success of RV Southern Surveyor NoToVE voyage (SS11/04) to the northern Tofua arc-Fonualei Rifts (Tonga) system, and building on international collaborative efforts, we propose to survey the bathymetry, magnetic characteristics, petrology, hydrothermal activity, and hence origins and evolution of two of four spreading centres within this region (Northwest Lau [NWLSC] and Niuafo'ou [NSC]) which are essentially unstudied. As the Pacific Plate rolls back along strike of the Tonga Trench, rapid backarc crust formation in northern Lau is accommodated by four known centres connected by transform faults and distributed deformation. Recent voyages have surveyed the Fonualei Rifts (east) and Futuna Spreading Center (west), but the NWLSC and NSC in the central NLB are only known from reconnaissance 12 kHz surveys.

Following high resolution 30 kHz multibeam bathymetric surveys, vertical CTD hydrocasts and "tow-yos" coupled with rock (glass) dredging will be used to sample along/across-strike of the spreading centres. Post-voyage laboratory 3-D magnetisation inversions accompanying seafloor geomorphology will be used to construct the tectonic evolution of the Basin. Glasses and bulk rock samples will be analysed for major, trace and volatile elements together with isotopic (radiogenic and stable)

abundances to determine the volatile contents and melting processes, and identify mantle sources likely including "Pacific"- and "Indian"-type mid-ocean ridge and Samoan plume components, and hence obtain insights into upper mantle flows.

The Second Leg with support from Teck-Cominco and endorsed by the Steering Committee of the Marine National Facility used the opportunity of vessel mobilisation in the region to extend our survey with the same scientific objectives of submarine volcano-hydrothermal activity to the Peggy Ridge, and thence southwards to the Lau Extensional Transform Zone.

1. Voyage Objectives

How does the plate tectonics of the rapidly extending NLB work? In detail, we aim to determine the location and types of the current microplate boundaries, and extents and duration of motions on each of them. Answers to these studies will reveal how the rapid extension and shear deformation of the NLB is accommodated, and how the present configuration of the Basin has evolved. Results will have global significance for plate tectonic process studies, and have relevance for zones of rapid sea floor extension and formation, particularly for periods when high ridge length/area of sea floor was prevalent, as deduced for the Archean. With the help of reconnaissance 12 KHz (RV Kilo Moana) data, we will complete coverage of the NWLSC and NSC, determine the nature of the tectonic boundary that connects the NWLSC with the NW Peggy Ridge, and characterise the connection between the FFZ, NSC, and the western termination of the Tonga Trench. The NLB between the Tonga Trench and the Peggy Ridge-NFFZ (Fig. 1) forms a large extensional shear and relay zone between the WNW-moving Pacific Plate and east-moving Australian Plate. How this works in detail will be determined by our survey in conjunction with data for the FSC and Fonualei Rifts, and is of basic importance for plate tectonic mechanisms (Schouten et al., 1993).

2. What are the nature and source characteristics of the magmatism accompanying the different crustal accretion variables in the NLB? We know that at MOR, the primary variables controlling crustal accretion are the spreading rate, upper mantle potential temperature, and mantle composition or fertility with respect to basalt production (e.g., Macdonald, 1982). In backarc settings, the advection induced in the overlying mantle wedge coupled with the extra melting triggered by fluid released from the subducting lithosphere are additional variables (Martinez & Taylor, 2002). In the NLB, analysis of dredged samples will allow us to address all of these variables: a large range of likely spreading rates, proximity to the adjacent Tofua Arc, morphologies (inflated, depressed, rifted, segmented, off-axis seamounts), mantle sources (Indian, Pacific, Samoan plume), and extents of melting. Much of the NLB is anomalously shallow possibly reflecting unusually hot upper mantle and possibly consequent to the rapid subduction rate (Davies & Stevenson, 1992). The high FeO and low Na2O at MgO = 8 wt% of the Fonualei Rift basalts are consistent with a higher than average mantle temperature beneath the NLB than other backarc basins globally. Coupling the compositions of the dredged rocks with the geophysical and tectonic studies outlined in (1) is a powerful approach known to yield results. Recovery of samples from the multiple concurrent spreading centres will allow detailed geochemical mapping of the mantle isotopic domains.

3. Does the Samoan mantle plume penetrate beneath the NLB? Based on the He, Sr, Nd, and Pb isotopic compositions of several off-axis (temporally and geomorphologically poorly constrained) dredged samples, it has been proposed that mantle material from the Samoan plume has penetrated the NLB (Volpe et al., 1988; Ewart et al., 1998; Poreda & Craig, 1992; Turner & Hawkesworth, 1998). The strongest evidence for this hypothesis is high 3He/4He of samples straddling the NSC (Fig. 3) but these samples lack full geochemical (including radiogenic isotope) characterisation. Clearly further progress with this problem requires spatially well constrained sampling and comprehensive post-voyage laboratory analytical study.

4. What are the characteristics of volatile distribution in the mantle sources of NLB basalts? The recycling of volatile elements and compounds such as H2O, CO2, S and halogen compounds from subducted slab to mantle and thence via arc and backarc basin magmatism to the hydrosphere/atmosphere is one of the first order geochemical processes (e.g., Arculus, 2004). A major voyage objective will be to recover fresh glassy rock samples for detailed chemical analysis, particularly of volatile elements and compounds. Our overall primary objective with these (glassy) rock samples is to quantify the volatile fluxes in supra-subduction zone settings, and attempt to distinguish the components involved (mantle wedge, subducted crust, overriding arc lithosphere). Submarine-quenched backarc basin basalts with variable arc influence have been particularly useful in defining characteristics of the volatile component released from the subducted slab (Stolper and Newman, 1994; Kent et al., 2002). Our planned sampling of the NLB will complement those previously recovered in the Fonualei Rifts and represent a very large range of distances from the adjacent Tofua Arc, subjacent subducted Pacific lithosphere, and possible Samoan Plume ingress. In addition to the geochemical significance of these studies, it is known that H2O contents of the upper mantle have significant implications for geophysical properties such as viscosity (hence controlling mantle flow), extents of melting, seismic attenuation and anisotropy (e.g., Karato, 2003; Wiens & Smith, 2003; Billen & Gurnis, 2003).

5. What are the hydrothermal characteristics of the NLB? On MOR, hydrothermal venting is strongly correlated with spreading rate (with the interesting exception of hot spot–affected ridges), evidently because spreading rate is a reliable proxy for the magma budget. In back-arc basins, the magma budget may be complicated by subduction-induced variations of the melt supply and the systematics of plume incidence, ridge morphology, and chemical characteristics are in the early stages of study (Massoth et al., 2003). Baker et al. (2005) have reported the results of hydrothermal plume surveys along relatively slow-spreading (40–60 mm/yr) and arc-proximal (10–60 km distant) sections of the southern Mariana Trough and the Valu Fa Ridge. On both sections, multiple plumes have been found overlying ~15–20% of the total length and comparable to mid-ocean ridges spreading at similar rates. In the case of the Valu Fa, we know from geomorphological characteristics and magma compositions that an extra increment of melting (and hence ridge inflation) is triggered by slab-derived fluid ingress (Martinez et al., 2005). In the NLB, we have the opportunity to study hydrothermal activity associated with backarc spreading centres relatively remote from the subducting slab but also with variable distance (N-S) from any Samoan plume ingress. Our global understanding of the fundamental controls on the geochemically important ocean inputs of backarc hydrothermal plume activity will be significantly advanced through this study.

Results

During the Northern Lau Vents Expedition (NoLauVE) SS07/2008, 68 dredges, 1 grab, 54 hydrocasts, and 2 (1 unsuccessful) video tows were completed between the southern New Hebrides Arc, the northern Lau Backarc Basin, and the northernmost volcano in the Tofua Arc (Tonga). The total distance travelled was about 10,000 km, and approximately 34,000km2 of seafloor was ensonified by the EM300kHz multibeam (swath) system.

The primary voyage results of NoLauVE for the First Leg are: 1. The so-called Niuafo'ou Spreading Centre is misnamed. Instead, this region we now call the Rochambeau Rifts (RR) is characterised by diffuse magmatism over a wide region of rifted crust with no single developed spreading centre, together with some localisation of magmatic activity in very large volcanic edifices, some of which are hydrothermally active. The Rifts terminate to the north in a major left-lateral transcurrent fault system linking with the NW-SE-striking Tonga Trench wall; 2. The Northwest Lau Spreading Centre (NWLSC) forms an asymmetric, inflated ridge terminated by right-lateral transcurrent faulting at both northern and southern terminations, with two large calderas (about 6*3*0.2km) astride the Ridge. The northern caldera is hydrothermally active. The southern termination is characterised by transtensional tectonics and widespread volcanic activity at the Peggy Ridge. Both the RR and NWLSC are dominated by sparsely olivine-plagioclase microphyric, poorly vesicular, glassy pillow basalts; 3. A large (45 km diameter) volcano (Dugong) is located 25km northwest of the subaerial backarc volcano of Niuafo'ou, and is surmounted by a caldera with a small hydrothermal plume near its base; 4. The northernmost volcano (P) in the Tofua Arc comprises several edifices and a NE-SW-striking rift complex that has erupted quartz-phyric, rhyolitic pumice and welded flows; 5. In the southern part of the New Hebrides Arc, the previously known "Eva" edifice is a stratovolcano located on top of faulted basement, and is accompanied by a smaller volcano ("Evita") to the southeast. A small hydrothermal plume was detected in the vicinity of Eva; 6. The edifice called "Alis" to the southeast of Eva is a highly symmetrical cone; 7. A magmatically active ridge striking northwest from the island of Matthew culminates in a large submarine volcano (Mont Gilbert).

The primary voyage results of NoLauVE for the Second Leg are: 1. The Peggy Ridge is currently dominated by right-lateral transtensional tectonism, but its elevation (~900m) above the surrounding Lau Basin seafloor is not necessarily consistent with this activity and merits further study; 2. Numerous magmatically-leaky faults and widespread lava flows accompanying right-lateral transtensional tectonic activity, characterise the Lau Extensional Transform Zone (LETZ) to the south of the Peggy Ridge. We did not detect any distinctive isolated hydrothermal plumes associated with either the Peggy Ridge or the LETZ, but a widespread diffuse transmission anomaly several hundred metres thick generally deeper than about 2000m and averaging around 2250m depth was noted; 3. The LETZ merges southwards with two inflated spreading ridges, in a N-S overlapping, en échelon arrangement called the Central Lau Spreading Centre. A distinctive hydrothermal plume was detected at the southern end of the southern ridge. Both ridges are dominated by sparsely olivine-plagioclase microphyric, poorly vesicular, glassy pillow basalts.

Following the Voyage, the rock and water samples will be distributed to the scientific crew and collaborators for laboratory studies in concordance with the Voyage objectives. We achieved an excellent coverage for investigating the effects of distance from the Tonga Trench and possible ingress of the Samoan Plume in the genesis of the Lau Backarc Basin magmas.

Voyage Narrative

All times in local time (New Caledonia and Fiji Standard Time = UTC + 11 and 12 hours, respectively)

Leg 1

Day 1 Wednesday April 30th Southern Surveyor thrust away from the Quai des Transportes Longues at Noumea at 1100 hours, experiencing a short delay while a critical spare part for the A-Frame was delivered from the airport. The Ship's Master, Neil Cheshire and the Chief Officer gave the induction of the scientific party shortly after leaving the wharf. We were headed SE through the "Canal" and thence northeast towards the southern New Hebrides Arc.

Day 2 Thursday May 1st

At 0715, the first of two ARGO floats that the Voyage had been asked to deploy was launched by Pete Dunn at 170oE, in a water depth exceeding 2000m. At 0900, we had arrived at our first station to the northwest of "Eva Seamount", planned to be a 100m "dip and recovery" to test the CTD functions followed by extended sampling (including 3He/4He) to establish water column characteristics. The operation had to be postponed because of a combination of software and hardware difficulties. Instead we swath mapped the Eva edifice, identifying several cones and craters as potential targets. Mapping completed at 1300 hours, the first hydrocast (NLH-01) was completed as the 100m test, followed by NLH-02 in 1890m of water to the north of the summit of Eva. The first dredge of the Voyage (NLD-01) was then deployed on the north flank of Eva, recovering glass-rinded, fresh basalt/basaltic andesite containing olivine, clinopyroxene, and plagioclase phenocrysts. A hydrocast (NLH-02) in 1250m of water to the west of the main craters of the summit of Eva identified a small plume at 1093m depth; 8 samples were taken for He and 3 for trace metal analysis. We continued to swath map the area identifying a smaller edifice to the southeast of Eva ("Evita"). A dredge (NLD-03) of the north flank of this edifice recovered a full load of glass-rinded, very vesicular pillow fragments and sheet flows characterised by varying modal quantities of bright green clinopyroxene phenocrysts accompanied by olivine and plagioclase.

Day 3 Friday May 2nd

Swathmapping to the southeast of Eva towards La Pérouse Seamount commenced at 0025 hours, following recovery of NLD-03. We deviated from the track towards La Pérouse having encountered a major conical structure to port (northeast), likely to be a seamount named "Alis". After a couple of reciprocal tracks, and completion of swathmapping of this near-perfect cone, we continued towards La Pérouse. At 0445hours, NLD-03 was deployed on the north flank of this seamount, recovering ¼ bag of rubbly, slightly weathered and iron-stained mafic, olivine-rich volcanic rock. A hydrocast (NLH-04) to the north of La Pérouse in 1700m of water did not detect any plumes. We continued swathmapping eastwards towards and around the emergent Matthew Volcano. A bright brown sediment slick could be easily seen drifting away from the island towards the northeast. A hydrocast (NLH-05) in 830m of water to the northeast of the island, launched in the vicinity of the slick, did not identify any plumes. Some of the swath data collected around Matthew was noisy, and we retraced our course to recollect data. We then turned back westwards to the Alis

Cone. A dredge (NLD-04) of the north flank of the summit recovered a full load of black mafic, olivine-phyric blocky lava, slightly weathered with small corals growing on some of it, and a minor amount of iron hydroxide-rich clayey material. Following completion of the dredge, and a minor swath line to fill-in a gap in data coverage, we commenced a long transit towards the north and then northeast across the North Fiji Basin. At 1900 hours, preparation of the magnetometer for launch was initiated and the instrument was safely deployed and functioning by 2000 hours.

Day 4 Saturday May 3rd

We deviated from our chosen course towards the southern portion of the Central Spreading Ridge (CSR) of the North Fiji Basin in order to find at least 2000m of water depth at 172o East in order to deploy the 2nd Argo Float – successfully achieved at 0200 hours. Swath mapping of a transect of the CSR at the request of Leonid Danyushevsky (Chief Scientist of cancelled voyage SS08/2008) commenced, and by 1000 hours, sufficient morphological detail had been revealed to select the currently active axis of the Ridge. A hydrocast (NLH-06) on this axis to 2880m depth revealed no sign of current hydrothermal plumes. A successful dredge (NLD-05) at the same location recovered a full bag of glass-rinded pillow basalt fragments, a minority of which had minor associated hydrothermal alteration. We completed a 3rd swath pass over the CSR and proceeded northeast towards another area of interest (temporarily referred to as "Danyushevsky") for the erstwhile SS08/2008 at 20o 22.7'S, 175o 12'E. The northern flank of a normally and transcurrently faulted volcanic edifice was mapped; a deep hydrocast (NLH-07) at this location undertaken to establish regional water column characteristics revealed no plume activity.

Day 5 Sunday May 4th

Our transit towards and past the Fiji island group continued, paused to make another deep hydrocast to the southwest of Kandavu at 19o 33'S, 176o 56'E in about 3340m of water. No transmission anomalies were observed. After this hydrocast, a shift of ship time to local Fiji Time (AEST + 2 hours; UTC + 12hours) was made.

Day 6 Monday May 5th

While the ship was between Kandavu and Viti Levu at 0915 hours, the main engines were stopped to repair a fuel line leak, and restarted at 1322 hours; we made a slight detour to investigate a potential change in structural fabric between Kandavu and Gau, proceeding around the southeast corner of the latter island and then northeastwards again.

Day 7 Tuesday May 6th

At 0230 hours, a 2600m deep hydrocast (NLH-09) was made to investigate water column characteristics of the Koro Sea; no plumes were observed. We continued northeastwards towards the southwestern limit of our target area in the Northern Lau Basin. The Peggy Ridge defines the southwestern boundary of the area, and we decided to make a hydrocast in deep water prior to crossing the Ridge to define the water column characteristics; the hydrocast (NLH-10) was deployed in 2950m of water. No transmission anomalies were observed.

Day 8 Wednesday May 7th

Our plan now was to traverse all the way northeastwards to the northern limit of our survey area and then to work back towards Fiji. The ground is remarkable with many obvious lava flows and protrusions on the ocean floor, and patches of heavily faulted terrain. As we approached the potential shallow ground of Foss Bank, we retrieved the magnetometer. Available bathymetric information indicates Foss Bank shallowing to 9m northwest of our northern survey limit, and another shallow edifice eastwards and within our area. The latter proved to be a very large, old-looking, extensively faulted, planated volcanic edifice. We planned a hydrocast in deep (i.e., >3000m) water at the northeastern limit of our survey area on the southern wall of the Tonga Trench. But a problem with the CTD cable required cutting the cable and reterminating; curing of the resin pot would require at least 24 hours so we began a grid survey with E-W lines working southwards from the Tonga Trench wall north of the edifice, over its summit region, and continuing southwards.

Day 9 Thursday May 8th

Just after midnight, the bottom rose from ~500m to 25m within a horizontal distance of less than 400m. Despite the potential importance to future navigators of mapping the shallows of this edifice, our own scientific purposes would not be served by such an effort and we made for deeper water and continued working southwards with the E-W swath grid. Two edifices appear on the 1o satellite gravity map: Foss Bank to the west and what we have now called "Turtleback" to the East. The bathymetry unfolded as a remarkable left-lateral transtensional system on the southern flank of Turtleback terminating the northern end of the so-called Niuafo'ou Spreading Centre (NFSC). There are other left-lateral transtensional basins on the northern flank of Turtleback on the southern wall of this portion of the NW-SE-trending segment of the Tonga Trench. There are at least three generations of rifting in the NFSC, with current orientations of 15, 35 and 45o; the latter is the currently active one. We selected a number of dredge sites within the surveyed portion of the NFSC, for survey purposes called Northern Rift Zone 1. The first of these (NLD-06) in the older, western part of the SC complex, on the flank of a "donut-shaped" crater, recovered a meagre haul of two rock types: black, glassy pillow rinds of essentially aphyric, plagioclase-olivine-bearing, very sparsely vesicular basalt; woody-textured, pale grey, pyroxene-bearing pumice; and some milk chocolate-coloured mud. The next dredge (NLD-07) on a cone in the currently active portion of the SC recovered a large haul of glass-rinded, plagioclase-olivine-bearing pillow basalt, some blocks with minor hydrothermal iron staining.

Day 10 Friday May 9th

A pancake-shaped feature in the active rift was the target of the next dredge (NLD-08). A 2/3-full chain bag of glass-rinded, plagioclase-olivine-phyric basalt was recovered, together with brown mud containing glass shards. Our initial approach to sampling this SC was to target morphologically different volcanic features; the relationship for example, between donuts and pancakes was not clear. Continuing the sampling strategy, NLD-09 targeted a linear volcanic ridge in the northern part of the active portion of the SC. One glassy pillow rind (plagioclase-olivine-bearing basalt) and a number of glassy chips were recovered. Following completion of the dredge, the EM300 system had a major crash. The combined efforts of Scott, Pete, and Michael had the

system running again after a couple of hours. In the meantime, NLD-10 recovered a 1/3-full bag of black, glass-rinded, plagioclase-pale olivine-phyric, sparsely (but large ~ 10mm) vesicular, basalt pillow fragments. The final dredge (NLD-11) in this area targeted a donut-shaped cone. We suspect the dredge missed this cone and in fact recovered ¼-full bag of rocks from the ~2800m-deep, flat floor north of this donut. Nevertheless, the samples proved to be the usual black, glass-rinded pillow basalt fragments. Mineralogy again is plagioclase and olivine, the latter being a very pale yellow. With the repotted termination of the CTD ready for deployment, we made a hydrocast (NLH-12) to within 15m of this floor, and detected a very minor plume at ~2756m. Samples both for He isotopic analysis plus a number for total metals (including 2 filtered) were taken of this plume. Following completion of the hydrocast, we made an anticlockwise traverse of the northern end of Rift Zone 1 to fill in some gaps in the swath bathymetry, and then commenced our E-W-oriented survey grid.

Day 11 Saturday May 10th

In order to pin down the water column characteristics at the margins of the survey area, complementing our hydrocast (NLH-10) to the southwest of the Peggy Ridge, we made a hydrocast (NLH-13) in the deep (~3,700m) fault basin on the southeastern flank of Turtleback. The left-lateral fault that terminates the northern end of the NFSC, strikes E-W through the floor of this Basin. A broad small plume between 1700 and 2150m was detected in this cast. Swath mapping then resumed on the E-W grid.

Day 12 Sunday May 11th

With a variety of potential targets identified, we attempted to sample a 500m-high cone with ~N-S oriented dyke at the eastern margin of the Rift Zone with NLD-12. Nothing was recovered. A hydrocast (NLH-14) in a trough at the eastern margin of this Zone to ~2360m depth identified no particulate plumes. A dredge (NLD-13) from a ridge recovered plagioclase-olivine sparsely microphyric, flaky glass-rinded basaltic pillows together with some mud in the pipe dredge. The camera housing was pressure tested satisfactorily with a dip to 200m, and then NLD-14 deployed in the active rift of Northern Rift Zone 2. A 1/2–full dredge bag of black, glass-rimmed pillow fragments and lava tubes was recovered. The pillows are sparsely plagioclase-olivine-phyric basalt with very few vesicles. One thumb-end-sized particle of quartz-pyroxene-bearing rhyolitic pumice was also recovered.

Day 13 Monday May 12th

A ridge in the Northern Rift Zone 2 was then sampled by NLD-15, recovering a full bag of glass-rinded pillows of sparsely olivine-plagioclase microphyric basalt. The next dredge target was a "pancake"-looking extrusive pile, but NLD-16 came back empty except with a few glassy, olivine-microphyric chips in the pipe dredge. We then attempted to sample a rubbly volcanic fissure flow (NLD-17). Two fist-sized fragments of highly plagioclase-phyric basalt pillows were recovered. The next dredge (NLD-18) had better returns from a flat-lying flow, with a ¼-full bag of mostly glassy, variably oxidised highly plagioclase-phyric basaltic pillow fragments; some fragments have thin black Mn coatings. A pancake was sampled by NLD-19 returning a ¼ -full bag with dark grey, glass-rinded pillow fragments comprising sparsely plagioclase-olivine microphyric basalt. A camera tow (NLV-01) executed in text-book fashion across this pancake unfortunately returned no video footage; a post mortem initially suggested interference with the sledge wiring

by the Chief Scientist prior to launch likely interfered with the timing of the video-light combination triggering – later electronic forensics also discovered a faulty timing switch for this combination. A hydrocast (NLH-15) in ~2310m depth of water adjacent to the pancake detected no particulate transmission anomalies. The next dredge target was a rubbly-looking ridge; NLD-20 retrieved several kg of very fresh, black glass-rinded pillows and lava tubes, comprising very sparsely plagioclase-olivine microphyric, weakly vesicular basalt, and about 1 kg of glass chips in the closed pipe dredge. Continuing with the geomorphological variety of targets, NLD-21 targeted a donut-shaped crater, and recovered hydrothermally-altered, sparsely plagioclase-phyric pillow basalt.

Day 14 Tuesday May 13th

A rubbly flow southwest of a donut-shaped crater was sampled with NLD-22, recovering a 1/3-full bag of moderately weathered and oxidised plagioclase-phyric basaltic pillows; the pipe dredge also contained reddish-brown mud with glass shards and 4 lumps of grey pumice. A hydrocast (NLH-16) was then deployed in ~ 2145m of water at the eastern margin of the Rift Zone 2; although the trace of a possible particulate plume was logged at 1495m, and a very small broad plume at 2090m, the transmissometer print-out shows no such anomalies. Swathmapping then resumed identifying a large volcanic edifice ("Lobster") in the centre of the Rift Zone and a spreading ridge to its west.

Day 15 Wednesday May 14th

With more of the Northern Rift Zone defined, and targets located, a circular "scone"-like feature on the southeastern flank of Rochambeau Volcano was dredged (NLD-23) first. Four rock types were recovered: 1. vesicular basalt with ~1% plagioclase phenocrysts; 2. non-vesicular basalt with ~1% plagioclase phenocrysts; 3. plagioclase-phyric (~20 to 25%) pillow basalt and lava tubes; 4. pyroxene-quartz-bearing pumice. The next target was a lava flow emerging from a double-donut to the east of Rochambeau. Glass-rinded pillows composed of plagioclase-phyric, sparsely vesicular basalt were recovered by NLD-24. An acoustically-reflective, flat-lying flow was targeted with NLD-25; brown mud with foraminiferal ooze containing much blackish brown glass and some pumice fragments was recovered in the pipe dredge.

Day 16 Thursday May 15th

Both pipe dredges and the bottom of the chain bag were lost on the next dredge (NLD-26); the consumptive target was a rubbly lava ridge. A retry (NLD-26B) came back empty. Chastened, we moved to a rubbly flow associated with a donut (NLD-26) recovering a 2/3-full bag of glassy-rinded pillow basalt containing a few large (2 to 5mm) plagioclase phenocrysts, variably weathered. Pillow rims and glass were recovered from the grilled pipe and brown mud in the closed pipe. A hydrocast (NLH-17) in a deep rift on the eastern margin of the Northern Rift Zone in ~2454m of water detected no transmission anomalies. A rubbly lava flow in the base of this Rift was sampled with the next dredge (NLD-28). A 1/3-full bag of variably weathered basalt pillow fragments, a few pumice lumps, and brown mud containing fragments of basalt was retrieved. We then attempted to dredge the "antenna" of Lobster; NLD-29 came back with nothing, but NLD-30 of the same target recovered olivine-plagioclase-bearing, sparsely microphyric basalt pillows and tubes some with oxidised iron staining and coatings. A pancake on the antenna was targeted with NLD-31; old-looking, aphyric, non-vesicular basaltic pillows were retrieved, most with Mn coatings and oxidised

iron staining. Given the returns from the regional sampling, and the time available, we decided to concentrate on the potentially most active targets. A hydrocast (NLH-18) bore immediate fruit of this policy, with a distinct particulate plume (0.4% Tx anomaly) identified at 60m off bottom in the SE corner of the 1500m-deep summit caldera (2.5 km diameter) of Lobster. A dredge (NLD-32) of the smooth caldera floor recovered a full bag of markedly fresh, thick black glass-rinded, aphyric pillows and flows.

Day 17 Friday May 16th

Another cast (NLH-19) in the NW corner of the caldera again identified a Tx anomaly, albeit weaker between 1479 to 1375m depth. We then resumed swath mapping noting the development of the spreading rift southwards, eastern and western rifts showing extensive normal faulting, and the diminution of the Lobster edifice southwards. At 1330 hours, the Master decided to head for Apia in Western Samoa to evacuate a crew member and terminated the swath survey. We set a course across previously unmapped terrain north of Niua Fo'ou, the NE Lau Spreading Centre and the northern part of "Volcano P" in the northern Tonga Arc (swathmapped during SS11/2004; NoToVE).

Day 18 Saturday May 17th

In the course of the swath, a 45 km-diameter volcano was discovered ~25km north of Niua Fo'ou; a 5 km-diameter caldera forms the summit region of this volcano; subsequently we named this volcano "Dugong". We arrived at Apia at 1500 hours, the 2nd Engineer disembarked, some fruit and vegetables embarked, and we were out of the harbour by 1700 hours.

Day 19 Sunday May 18th

We took advantage of the diversion to Western Samoa to examine "Volcano P", the furthest north volcanic edifice in the Northern Tonga (Tofua) Arc, swathmapped on SS11/2004 (NoToVE) en route to the voyage termination in Apia. Upon approach to P, we made a hydrocast (NLH-20) to examine the regional water column characteristics in a deep (~2350m) on the northeastern side of the edifice. A small transmission anomaly was seen at ~720m, a very small transmission anomaly at ~1138m. and a broad anomaly ranging over 1915 to 2500m with a maximum at 2150m. Pale particulates clogging the filter accompanied by an elevated pH characterised the shallowest plume, perhaps consistent with a serpentinising source. The edifice was then remapped because the SS11/2004 version could not negotiate the Hobart email filter in time. A complex structure was revealed dominated by a rift trending ~040 with numerous obvious cones and flows. The first dredge (NLD-33) of the northernmost edifice 675mbsl encountered a transient tension >8 tons, a twang on the trawl winch, shake of the whole ship, and returned with nothing but frayed cable and no dredge assembly. Subsequent problems with the A-frame suspended further dredging. So a hydrocast (NLH-21) was made above a crater in the main rift zone; a small anomaly was present at 690m, and a larger transmission anomaly from 890m increasing towards the base of the cast at 10m above bottom. An initial grab (NLG-01) of the floor of this crater did not fire; a second attempt (with bounce; NLG-02) recovered several fist-sized rock fragments comprising welded rhyolitic tuff with flow banding, fiammé, and individual pumice clasts. With the A-frame still arthritic, a jerry-rigged system of recovery with the gilsons allowed deployment of a dredge (NLD-34) on a flow in the Rift Zone, A ¾-full bag of quartz-phyric, woody-textured, variably altered rhyolite clasts was recovered.

Day 20 Monday May 19th

The Dugong volcano was swathmapped en route to the main field area revealing an enormous structure with hundreds of individual eruptive "blobs" and transacted by numerous faults; some of the latter may be the source of the earthquakes reported for this location in the global seismicity catalogs. A hydrocast (NLH-22) to the caldera floor (~1170m depth) showed a very small transmission anomaly (~0.1%) between 1090 and 1160m depth. A dredge (NLD-35) of the southwestern floor of the caldera recovered a few fresh basaltic pillow fragments, glass in the pipe dredge, and two small pieces of pumice.

Day 21 Tuesday May 20th

We resumed our survey of the so-called Niuafo'ou Spreading Centre with a hydrocast (NLH-23) at the northern end of the central rift. From about 1450m to the bottom of the cast at 2190m, a very slight (~0.05%) transmission anomaly was observed. A dredge close by (NLD-36) recovered one pumice fragment and rock-free mud in the pipe dredge despite a couple of ~9t pulls. A hydrocast (NLH-24) towards the southern end of the central rift displayed no clear transmission anomalies. A dredge (NLD-37) of a flat-lying lava flow near a pancake structure in the vicinity retrieved a ¼-full bag of volcanic rocks plus chips in the pipes; much of this material was fresh and glassy but some was variably oxidised. A small amount of pumice was also recovered.

Day 22 Wednesday May 21st

Given the remaining time available, we decided to head west to the Northwest Lau Spreading Centre (NWLSC), encountering the spreading axis as predicted by the regional bathymetry compiled by the University of Hawaii. A hydrocast (NLH-25) at 15º 43.1'S to the northwest of the axis encountered a structured transmission anomaly (~0.2%) with peaks at ~1790m, 1855m and between 1900 and 1990m depth. A dredge close by on the axis recovered a ½-full bag pf black glassy pillow and lava tube fragments. A single piece of low grade, hydrothermally altered greyish rock was also retrieved. After mapping northwards towards the termination of the Spreading Centre at ~ 15º 31'S, we made a hydrocast (NLH-26) and encountered a small transmission anomaly (~0.1%) between ~1778 and 2100m depth. A dredge (NLD-39) close by recovered a ¼-full bag of glassy black aphyric basalt pillow flow tops and 4 tiny pieces of grey pumice. A dredge at ~ 15º 36'S along the ridge axis recovered two rock types: glass-rinded black plagioclase-olivine-phyric pillow basalts; highly vesicular (flow-aligned and elongated up to 8cm) aphyric basalt.

Day 23 Thursday May 22nd

A hydrocast on "Shannon's Mounds" at 15º 40'S on the Ridge axis detected a structured transmission anomaly between 1733m and 2060m. A dredge (NLD-41) of these mounds recovered a ¼-full bag of glassy basaltic rocks, some with low grade pale grey alteration and Fe-staining; in some large glass-rimmed pillows, the vesicles are lined with sulfide (marcasite?). A hydrocast (NLH-28) in the western side of a large (6*2.8*0.2km) caldera located on ridge overlappers at ~15º 48'S, encountered a major structured transmission anomaly (~1.6%) extending over ~300m depth range between 1790 and 2190m. A dredge (NLD-42) close by recovered a ½-full bag of black, glassy, non-vesicular basaltic pillow fragments, some with incipient low-grade alteration and oxidation. A hydrocast (NLH-29) on the northwest side of the Ridge axis adjacent to the caldera detected a

strong transmission anomaly (~1.4%) between 1800 and 2000m. A dredge (NLD-43) of small mounds on the axis in this area recovered a full bag of black glassy basaltic flows, some with low grade Feoxyhydroxide alteration, plus glass fragments in the pipe dredge. We continued then to swath map southwest along the NWLSC axis, discovering a second caldera of similar size to the first, again located at ridge overlappers.

Day 24 Friday May 23rd

A dredge (NLD-44) of a mound to the southwest of the 2nd caldera at ~ 15º 57'S recovered a 1/3-full bag of black glassy, variably vesicular basaltic pillows, flow tops and tubes; some of this material has low grade (pale grey) hydrothermal alteration. A small amount of pumice was also recovered. A dredge (NLD-45) of the southern floor of the southern caldera retrieved two basaltic pillows with trace amounts of olivine and plagioclase plus glass shards in the pipe dredge. Overheating of the hydraulic pump oil delayed further operations; to cool off, we continued swathmapping of the NWLSC axis to the south, and then returned to hydrocast (NLH-30) the centre-west wall of the southern Caldera. In 2160m depth, we observed a small transmission anomaly at the base of the cast and "fuzziness" from 1855m down with a peak at ~2035m. A dredge (NLD-46) of the NW rim of this caldera retrieved a ½-full bag of pillow basalts and pahoehoe-textured tubes, variably iron-oxyhydroxide-stained. Large glass rind fragments were in the pipe dredge. All material is aphyric and sparsely vesicular. An off-axis small knob, northeast of the southern caldera was targeted on the next dredge (NLD-47); a ¾-full bag was recovered with 3 rock types of varied apparent age but all sparsely vesicular (~1%): 1. pillow basalts with sparse olivine phenocrysts; 2. moderately altered (with iron-oxide stains) aphyric pillow basalts; 3. light grey, aphyric, old and weathered pillow basalts. We next returned to the plume-rich northern caldera, hydrocasting in the deepest (~2230m) part on the eastern wall; a moderate hydrothermal plume between 1850 to 2224m was present, indicating a source somewhere to the west. A dredge (NLD-48) on the floor of the northern caldera recovered a ¼-full bag of glass-rinded basaltic pillow fragments, many with ropey external textures. In a final attempt to narrow down further the source of the plume in this caldera, we made a hydrocast (NLH-32) near the southeastern wall, to the south of the previous cast. The most intense transmission anomaly (~1.5%) seen to date was present between 1776 and 2200m with a peak at 1925m.

Day 25 Saturday May 24th

A dredge (NLD-49) of a lava flow between the northern and southern calderas recovered a ¼-full bag of black glassy basaltic pillows and flows with a few pieces of pumice and many glass shards in the pipe dredge. We then traversed along the ridge axis to several mounds southwest of the southern caldera. A dredge (NLD-50) of these mounds recovered a ¼-full bag of black, glass-rinded pillow basalts and glass chips in the pipe dredge. One fragment of a possible tube-worm was also present in the pipe dredge. Further to the southwest along the NWLSC axis, we dredged (NLD-51) several more mounds recovering a ½-full bag of black glassy basaltic pillows and glass shards plus 1 small piece of pumice, and lost the closed pipe dredge. A hydrocast (NLH-33) in ~2450m of water off the ridge axis to the east detected no transmission anomalies. A N-S oriented lava flow plus donut complex several km to the west of the ridge axis was our final dredge (NLD-52) target for the NWLSC. We recovered a full bag of partially weathered basalt pillow fragments, some with glassy surfaces. The pipe dredges contained mud and rock chips (including glass) and some pumice.

Day 26 Sunday May 25th

We swathmapped the intersection of the NWLSC with the Peggy Ridge (called Donna Ridge on the Admiralty chart), revealing a visually remarkable complex of transtensional faulting accompanied by pull-apart basin development, plus a large volcanic field of donuts, flows and individual steeply-ridged volcanic edifices. The number of volcanic constructs decreases southeast towards the Waypoint (16.41o S, 177.42oW) marking the start of the 2nd Leg, but the Ridge narrows to a "twisted rope" appearance of ~900m height above the surrounding sea floor. A spackly cone astride two faults was dredged (NLD-53) in the main volcanic field, retrieving a ½-full bag of weathered basaltic pillow fragments with partially consolidated mud and some fist-sized white pumice blocks. The final operation of the First Leg of NoLauVE was a hydrocast (NLH-34) to the north of the Peggy Ridge and east of the termination of the NWLSC. No transmission anomalies in ~2180m of water were seen, but some "fuzzy bits" noted at 1762, 1805, and 1900m. At 0530 hours, the ship was turned towards Suva and the magnetometer deployed. After reaching the Nanuku Passage, we ran a reciprocal swath course to our outward track.

Day 27 Monday May 26th

We arrived at the pilot station off Suva at 0530 hours, collected the pilot at 0610 hours, and were at anchorage awaiting a clear berth by 0700 hours marking the formal end of the First Leg of SS07/2008. A frustrating delay in bunkering ensued, with our ship awaiting the departure of a container vessel from the fuel bowser-equipped berth. We finally docked at 1800 hours.

Leg 2

Day 28 Tuesday May 27th

With 120 tons of fuel, water and fresh food loaded, trash from the Green Room and sludge from the bilges relict from Leg 1 removed, we set off in overcast and drizzle at 1000 hours from Suva. We took the shortest course northwest of Gau Island to the Nanuku Passage and so back into the Lau Basin. We were headed for the waypoint marking the southeastern limit along the Peggy Ridge that we had reached on the First Leg.

Day 29 Wednesday May 28th

We arrived at the first waypoint at 1300 hours (27 hours from Suva) and spent until the early hours of the next day swathmapping from this waypoint further southeast and on reciprocal courses mapping the Peggy Ridge.

Day 30 Thursday May 29th

Our first operation in the area was a hydrocast (NLH-35) in the northwest of the survey region, looking to define the regional water column characteristics and in particular search for any particulate plumes. No particulate anomalies were detected in this cast of ~2180m depth. A dredge (NLD-54) of a prominent donut-shaped cone near the

hydrocast site recovered only small pumice fragments in brown mud in the pipe dredge together with a sponge spicule and shell fragment. We continued swathmapping and launched a hydrocast (NLH-36) at the southeastern limit of the Peggy Ridge area, again to investigate regional water column characteristics. No particulate anomalies were seen in ~2400m water depth. A prominent donut-shaped cone close-by was dredged (NLD-55) recovering a ¼-full bag of old, plagioclase-olivine-phyric pillow fragments (including one torso-sized piece blocking the mouth of the dredge bag) plus pumice fragments; pumice and brown mud were also retrieved in the pipe dredges.

Day 31 Friday May 30th

Our swathmapping continued to extend southwestwards using NW-SE reciprocal lines, revealing a complex system of right-lateral transtensional faulting with numerous pull-apart basins. A rubbly ridge in the northwestern part of the study region was dredged (NLD-56) recovering a ¾-full bag of poorly glass-rinded, weathered, sparsely plagioclase-olivine-phyric pillow basalt. A hydrocast (NLH-37) between the NW and SE "regional pins" in ~2470m water detected no transmission anomalies. Another hydrocast (NLH-38) in the deepest (3240m) pull-apart basin also detected no transmission anomalies.

Day 32 Saturday May 31st

So far, none of the dredged rocks had the appearance of being recently erupted. Volcanism seems to be distributed rather than localised along a spreading centre. A reflective rubbly ridge adjacent to a recent-looking NW-SE-striking fault was the target of the next dredge (NLD-57). A ½-full bag of fresh black glass-rinded pillows and flow tubes, sparsely plagioclase-phyric basalt with ~1% vesicularity was recovered; the freshest haul to date. We next headed southeastwards on a single pass through our projection of the en échelon arrangement of pull-apart basins in the Lau Extensional Transform Zone (LETZ) and then southwards in a N-S grid to swathmap the Central Lau Spreading Centre (CLSC).

Day 33 Sunday June 1st

A striking sinusoidal arrangement of ridges and basins dominated by two major axes of inflated, apparently young-looking spreading ridges was revealed by the mapping. Towards the southern end of our survey area at 18.5oS and on the western side of the southern ridge, a hydrocast (NLH-39) detected a small structured transmission anomaly at 2150 to 2230m depth. A dredge (NLD-58) on the adjacent axial high recovered a 1/3-full bag of glassy pillow basalts and flow tops; the basalt is sparsely olivine-plagioclase-phyric with variable Fe staining. One of the pipe dredges contained abundant glass shards; the other had been ripped off. Moving northwards, the next hydrocast (NLH-40) was deployed on the eastern side of the southern ridge. No distinct transmission anomalies but some general "fuzziness" below 2220m depth was observed. We found similar features in the next hydrocast (NLH-41) on the west side of the ridge at about 18o 23'S: a diffuse fuzz below ~2110m depth. Mounds on the axial high of the ridge at this latitude were the target of our next dredge (NLD-59). A ¼-full bag of glassy, very sparsely olivine-microphyric pillow basalts, flow tops and buds was retrieved. Some of the interiors are moderately stained with Fe oxides. A small amount of glass was

trapped in one of the pipe dredges. We then targeted a seamount between the northern end of the southern ridge and the southern end of the northern ridge. A dredge (NLD-60) retrieved a small amount of older-looking, poorly glass-rinded, Fe oxide-stained and Mn oxide-coated pillows and flow tops. A hydrocast (NLH-42) in the deep between this seamount and the southern end of the northern ridge detected no particulate plumes in about 2700m water depth. Again some fuzziness was observed from about 1680 to 2240m depth. We moved to a chain of rubbly mounds on the crest of the adjacent ridge and dredged (NLD-61) one large (30cm) and a few small pillow fragments and some glass shards in the pipe dredge. We planned a hydrocast to the west of the ridge, but this had to be postponed because of an increase in wind speed and rising swells. So we proceeded northwards to swathmap the remainder of the LETZ target zone.

Day 34 Monday June 2nd

While our initial northwesterly course was with the wind and swells abaft, the reciprocal line was somewhat bumpy. Nevertheless, at 1500 hours, we were back at the northern end of the CLSC target area. The ship was pulled up and an assessment of conditions made; wind was still averaging 25 to 30 knots from the southeast, but the consensus was to attempt the next hydrocast (NLH-43) located on the west side of the northern portion of the northern ridge. No distinct transmission anomalies were observed but some fuzziness at ~1300 and ~2400m. We moved southwards along this ridge nearer the bathymetric culmination to ~18o 5.6'S, 176o 22.3'W and recast (NLH-44), but no transmission anomalies were observed. A hydrocast (NLH-45) on the west side of the mid-southern portion of the same ridge produced the same result. And a final hydrocast for this northern ridge adjacent to the southernmost portion (NLH-46) found no distinct transmission anomalies but rather fuzziness between 2300 to 2490m.

Day 35 Tuesday June 3rd

With the weather still continuing to be windy and the seas bouncy, we were able to hydrocast but not dredge. So the southern ridge was our next target for and the first of the hydrocasts (NLH-47) was deployed adjacent to high ground at ~18o 24'S, 176o 26.9'W. No distinct plumes were observed but fuzzy transmission deeper than ~2100m in a total depth of 2275m. The final hydrocast (NLH-48) for the CLSC was made into an acoustically reflective crater on a ridge to the west of the southern ridge. No distinct transmission anomalies were detected but some fuzziness deeper than ~2200m. With an abatement of the wind and decrease in swell amplitude, we were able to dredge and the first of our targets was the same reflective crater (NLD-62). A 1/8-full bag of plagioclase-olivine-phyric, glass-rinded somewhat weathered pillow basalt was recovered together with light brown mud containing glass rinds in the pipe dredge. Moving northwards along this ridge, we dredged some mounds (NLD-63) retrieving a ¼-full bag of glass-rinded pillow fragments and lava tubes plus glass and rock chips in the pipe dredge. The rock is very sparsely olivine-microphyric basalt, and lightly weathered in places. The summit of the northern ridge was our next dredge target (NLD-64); we recovered 10 fragments of a very fresh, black, glass-rinded, sparsely olivine-microphyric basaltic pillow buds and lava tubes together

with several hundred grams of glass chips in the pipe dredge. Moving northwards along the same ridge, we dredged a prominent mound (NLD-65) recovering a ¼-full bag of very fresh glass-rinded, pahoehoe-textured, sparsely plagioclase-microphyric basaltic pillows. A topographically less prominent ridge to the west of the main northern ridge was our next dredge target (NLD-66). We retrieved plagioclase-phyric pillow basalt flow tubes and flow tops plus glass shards in the pipe dredge.

Day 36 Wednesday June 4th

We now planned to finish swath mapping of the LETZ and execute more hydrocasts. The first of the latter (NLH-49) was near a ridge in the northwest of the mapped area; in 2338m of water, no transmission anomalies were seen. A prominent cone in this northwest region was dredged (NLD-67) recovering heavily weathered and both Fe-stained and Mn-coated pillow basalt and rhyolitic pumice. Coral and shell fragments together with milk chocolate-coloured mud was also recovered in the pipe dredge. Our next hydrocast (NLH-50) was east of a ridge in the northwest part of the LETZ; no transmission anomalies were seen. Hydrocast NLH-51 in a relatively deep basin in the northwest part of the LETZ also detected no transmission anomalies. Likewise NLH-52 in a basin to the south of these previous casts found no visible plumes but some scattered fuzziness around 2265m. We next dredged (NLD-68) a prominent acoustically-reflective ridge in the central western part of the LETZ; several pumice blocks and Mn-coated, high altered vesicular basalt were retrieved in the main bag while the pipe dredge contained light brown mud with pumice fragments and one mudstone plus shell debris.

Day 37 Thursday June 5th

Our final operation for the CLSC-LETZ area was to attempt to capture images of the flank and summit plateau of a "pancake" volcanic edifice. NLV-02 was launched just before 0600 hours, but encountered an uncontrolled coring winch runaway near the bottom colliding with the same at 100m/minute. The rest of the operation was conducted impeccably, but ongoing problems with the winch terminated the effort after 90 minutes of towing. Recovery was straightforward, the camera cage was undamaged and the SeaLite still on! And to add icing to the cake and to Shannon Johns' persistent credit, good video footage was obtained of the base, scarp, and top of the pancake. We then set off to swath map to the northeast and then around the northern flank of the Peggy Ridge. We interrupted the survey of the northern flank for two hydrocasts to check water column characteristics north of the Peggy Ridge. Both of these (NLH-53 and NLH-54) detected no transmission anomalies in 2350 and 2650m of water respectively.

Day 38 Friday June 6th

The early hours found us tripling the swath coverage between the last waypoint on the Peggy Ridge of Leg 1 and the first of Leg 2. At 0600 hours we had finished this effort and headed for Suva; in clear sunny weather, we berthed at the King's Wharf at 0930 hours, marking the end of Leg 2.

Summary

Overall, SS07/2008 achieved all of its major voyage objectives with the bonus of covering the extra ground of the northern end of the Central Lau Spreading Centre. We generated high resolution 30 KHz swath maps of the most tectonically and magmatically significant rifting and spreading centres in the central portion of the northern Lau Basin, from the junction of the Rochambeau Rifts with the northwestward curving Tonga Trench, through the caldera-dominated and inflated Northwest Lau Spreading Centre and right-lateral, partially magmatically leaky, Peggy Ridge transform fault, to the inflated and overlapping ridges in the Central Lau Spreading Centre. We identified a number of individual hydrothermal plumes and also evidence of diffuse venting over a widespread portion of the study area. The predominant rock type we recovered was glassy, mostly olivine-plagioclase microphyric, poorly vesicular basalt. The extensive sampling coverage we achieved in a north-south direction will be particularly useful in the shore-based geochemical analyses for determining the potential linkages between mantle wedge fertility, volatile contents, characteristics of melting regimes, role of downgoing Pacific Plate, and possible ingress of the Samoan Plume to the generation of the Lau Backarc Basin magmas.

Principal investigators

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Summary of measurements and samples taken

See attached lists (Operations, Dredge Stations, Dredge Subsampling Log, Hydrocasts)

Track chart

See Figures 1 to 3

General ocean areas(s)

New Hebrides Arc, North Fiji Basin, Northern Lau Basin

Specific areas

We worked mainly in the area between Fiji, Tonga, and Samoa (see Figures 2 and 3)

Personnel list

Scientific Participants

Name	Affiliation	Role
Richard J. Arculus	ANU-Earth & Marine Sciences	Chief Scientist/ petrology/tectonics
Charles Tambiah (Leg 1)	ANU	Photographer
Merinda Nash (Leg 2)	ANU	Geology
Joanna Parr (Leg 1)	CSIRO E&M	Hydrothermal activity
Shannon Johns	CSIRO E&M	Geology
Zarah Heyworth (Leg 1)	UQ	Petrology
Katie Kelley	URI	Petrology
Marion Lytle	URI	Petrology
James Cowlyn	MU	Petrology
Ron Greene (Leg 1)	NOAA	CTD & helium
Michael Sawyer (Leg 2)	Teck-Cominco	Geology
Michael Chandler	UH	Magnetics
Pete Dunn (Leg 1)	CMAR	MNF Voyage Manager/ Electronics
Jeff Cordell (Leg 2)	CMAR	MNF Voyage Mananger/ Electronics
Bernadette Heaney (Leg 1)	CMAR	MNF Computing Support
Hiski Kippo (Leg 2)	CMAR	MNF Computing Support
Scott McCarty	Goss Consultants	MNF Swath Support

Marine Crew

Name	Role
Ian Taylor	Master
Neil Cheshire	Chief Officer
Darren Lack	Second Officer
John Morton	Chief Engineer
Dave Jonker	First Engineer
Andrew Lowery (part Leg 1)	Second Engineer
Seamus Elder (Leg 2)	Second Engineer
Graham McDougall	Bosun
David Persson	Integrated Rating
Tony Kennard	Integrated Rating
John Hall	Integrated Rating
Josh Liley	Integrated Rating
Ashleigh Pollock	Chief Steward
Andy Goss	Chief Cook
John Leonard	Second Cook

Acknowledgements

Prior to SS07/2008, the assistance received by the Chief Scientist in designing the research and operations plan from the Southern Surveyor Operations Officer and other CSIRO support personnel, was timely, competent, constructive, and comprehensive. The cooperative approach to mobilization and demobilization offered by Geoscience Australia (GA) and Leonid Danyushevsky (Chief Scientist of cancelled voyage SS08/2008) is greatly appreciated; the use of GA's magnetometer and ancillary equipment was also critically useful for our Voyage. Aboard ship, the support of and enthusiasm for the Voyage objectives displayed in the First Leg by Pete Dunn coupled with his invaluable electronics support and classical music tastes are much appreciated. Bernadette Heaney was typically efficient in general computational problem solving and support of the hydrocasting effort. Likewise, during the Second Leg, Jeff Cordell handled the electronic and Hiski Kippo the computational side of our operations with enthusiasm and aplomb. The safe and productive conduct of operations by the RV Southern Surveyor's crew was exemplary, and the vital nutritional support during these efforts much appreciated.

Professor Richard J. Arculus
Chief Scientist

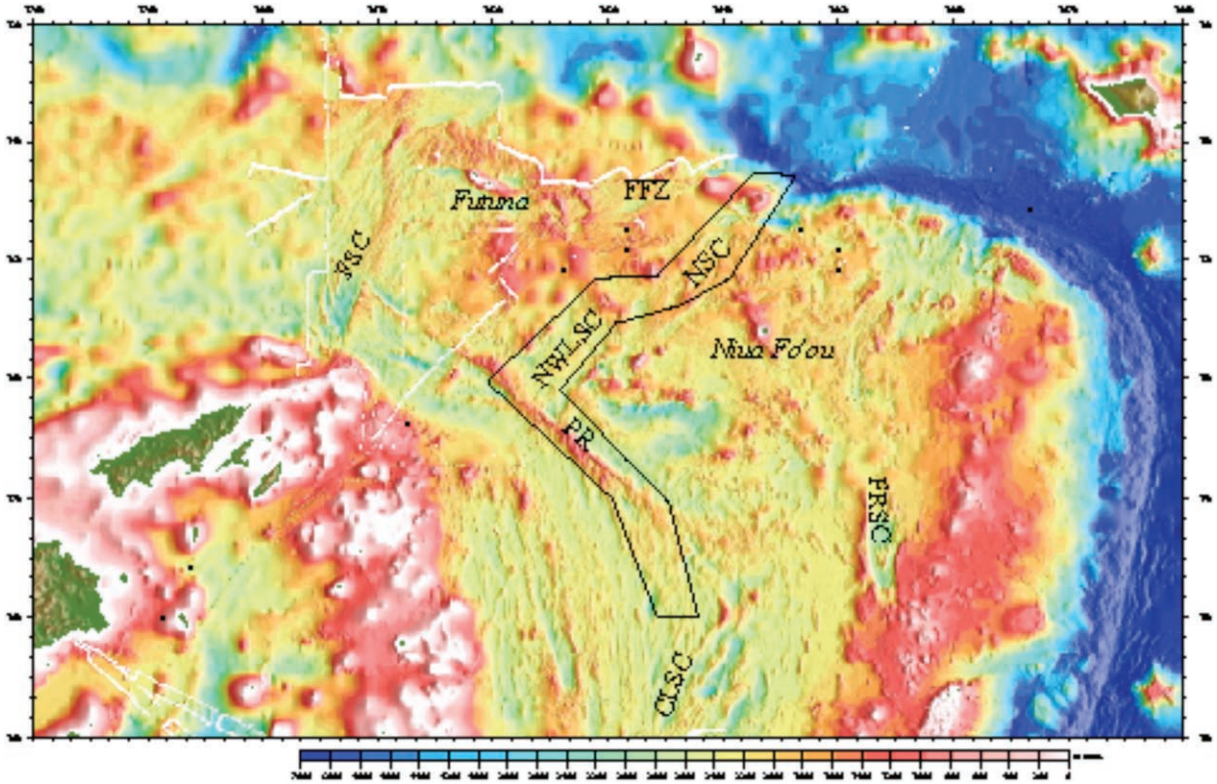

Figure 1. General area of operations for SS07/2008 showing available bathymetry from the University of Hawaii (F. Martinez, pers. comm. 2008) for the northern Lau Basin. Abbreviations are: CLSC–Central Lau Spreading Centre; FFZ-Futuna Fracture Zone; FRSC–Fonualei Rifts Spreading centre; FSC–Futuna Spreading Centre; NSC- Niuafo'ou Spreading Centre – now called by us the Rochambeau Rifts; NWLSC–Northwest Lau Spreading Centre; PR-Peggy Ridge

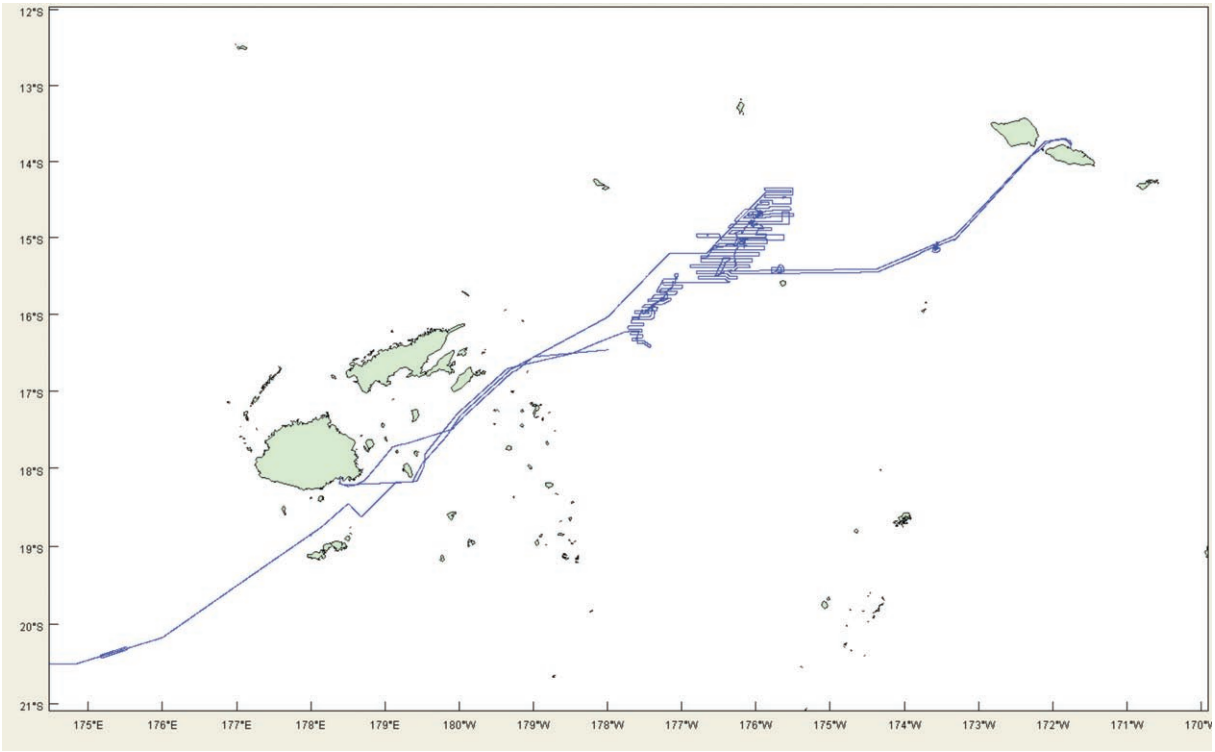

Figure 2. Ship's Track for Leg 1 of SS07/2008.

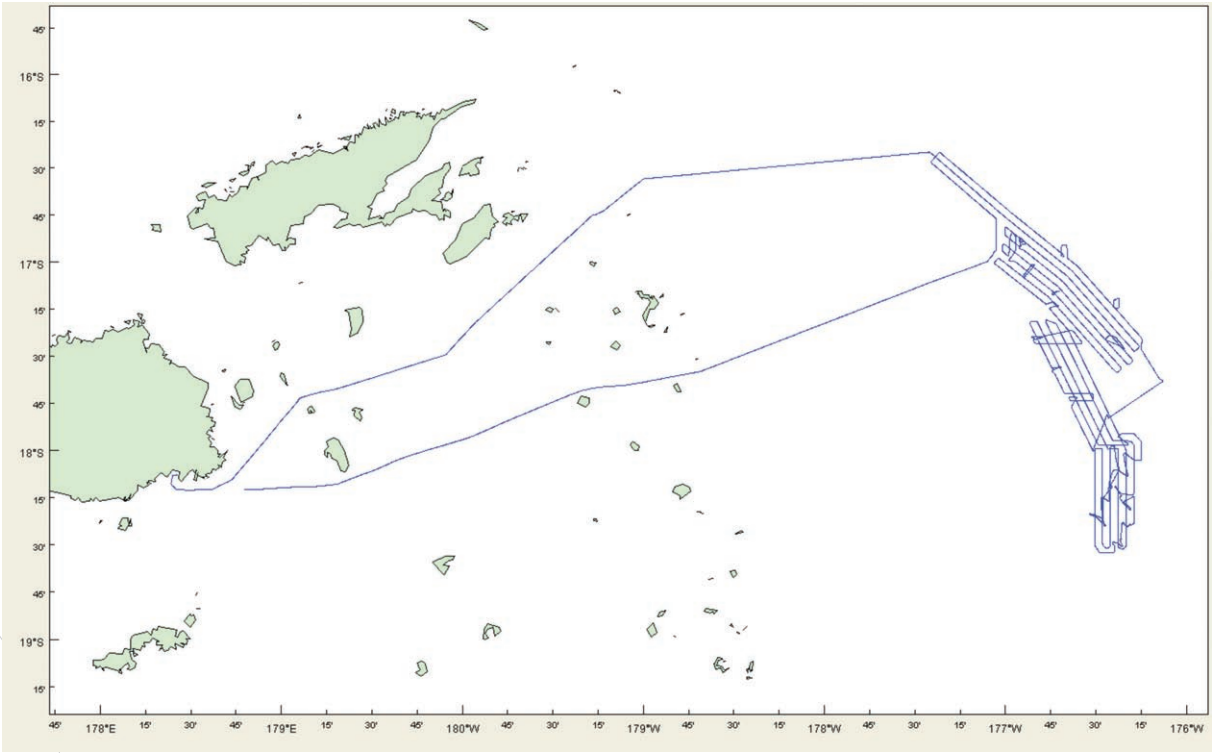

Figure 3. Ship's Track for Leg 2 of SS07/2008.

Figure 4. Scientific crew for Leg 1 of SS07/2008 with swath map of the Northwest Lau Spreading Centre; from left to right: Shannon Johns, Katie Kelley, Ron Greene, Michael Chandler, Scott McCarty, Richard Arculus, Berndaette Heaney, Joanna Parr, Peter Dunn, James Cowlyn, Zarah Heyworth, Charles Tambiah, Marion Lytle.

Figure 5. Scientific crew for Leg 2 of SS07/2008 with swath map of the Central Lau Spreading Centre; from left to right: Ron Greene, Shannon Johns, James Cowlyn, Hiski Kippo, Katie Kelley, Scott McCarty, Merinda Nash, Mick Sawyer, Richard Arculus, Marion Lytle, Jeff Cordell, Michael Chandler.