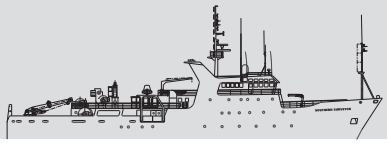

MARINE
NATIONAL FACILITY

2012 program

RV Southern Surveyor

voyageplan
ss2012_v02

The northern Lau Backarc Basin: magmatism, tectonics, and hydrothermal activity

Itinerary

Mobilise Brisbane 0800hrs,
Wednesday 02 May, 2012

Depart Lautoka (Fiji) 1000hrs,
Saturday 12 May, 2012

Arrive Lautoka (Fiji) 1000hrs,
Tuesday 05 June, 2012

Demobilise Sydney 0800hrs,
Saturday 16 June, 2012

Principal Investigators

Professor Richard Arculus (Chief Scientist)
The Australian National University
Research School of Earth Sciences
Australian National University, Canberra, ACT 0200
Phone: +61 2 6125 3778 **E-mail:** Richard.Arculus@anu.edu.au

Professor Leonid Danyushevsky
CODES CoE and School of Earth Sciences
University of Tasmania, Private Bag 79
Hobart, TAS 7001
Phone: +61 3 6226 2469 **E-mail**: L.Dan@utas.edu.au

Professor Simon Turner
Earth and Planetary Evolution CoRE
Macquarie University
Sydney NSW 2109
Phone + 61 2 9850 8363 **E-mail:** simon.turner@MQ.edu.au

CSIRO

Scientific Objectives

The northern Lau Basin is a region of rapidly extending and newly-forming crust, seamed by multiple zones of sea-floor spreading, rifting, and faulting consequent to the clockwise rotation of the Tonga Arc away from the Fiji-Lau Ridge (Fig. 1a). Demise of the former Vitiaz Arc has led to the establishment of a new Australian-Pacific plate boundary that wraps around the north end of Fiji, and connects with the Tonga Trench via a set of ridges (e.g., Futuna Spreading Centre, Northwest Lau Spreading Centre), rifts (e.g., Rochambeau Rifts), transform faults, and extension zones (Fig. 1b). Voyage ss2012-v02 will explore via a west to east reconnaissance of these tectonic elements, the accompanying magmatism and hydrothermal activity.

As the Tonga Trench wraps around the northern end of the Lau Basin, rather than subduction as occurs for the Pacific Plate beneath the Tonga Arc, the relative motion between the Pacific Plate and the Basin becomes overall left-lateral transform. A window into the mantle wedge southwards below the Lau Basin is developed– through this window, upper mantle underlying the Pacific Plate including components of the Samoan Plume is invading the wedge and most clearly identified so far beneath the Rochambeau Rifts and Northwest Lau Spreading Centre (Fig. 1b). The majority of studies to date have concentrated on the north-south striking ridges and rifts in the northern Lau Basin, along which the bulk of the extension must be occurring. Variations in mantle composition in a north-south direction have been documented. Over the past few years, we have also learned there is a considerable west-east variation in magma types coupled with Pacific mantle ingress from the North, so a targeted survey of magmatic types and hydrothermal activity is now essential to make further progress in understanding the 4-D character of the Lau Basin. Unravelling the extent of subducted slab-derived inputs, respective roles of advected mantle from the west and north and also poloidally into the mantle wedge, thermal characteristics of the wedge, and evolution through time of these parameters are the targets of ss2012-v02 (Fig. 2).

The principal investigators and their shipboard scientific colleagues will collaborate in studies of the petrology and geochemistry of the volcanic rocks (including major and trace element abundances, isotopic characteristics), and water column geochemical compositions.

Voyage Objectives

A series of target areas have been selected with reference to available coarse-to-fine bathymetric details, earthquake distribution, and previous scientific voyage results (Fig. 3). The shipboard techniques to be used will be the same as those previously successfully employed during RV *Southern Surveyor* voyages in the last few years:

- 30 kHz swath mapping for surveying spreading centre and shear/rift zone morphologies, and detailed identification of dredge targets;
- dredging and "sticky wax coring" of major features to "ground truth" and check geological interpretations. On ridges, our aims have been to sample at spacings ~10km apart; for isolated cones and edifices, our dredging campaigns target distinct features and in the event hydrothermal vent systems are located, multiple attempts to retrieve sulfides may be made;
- CTD-transmissometer hydrocasts, to detect hydrothermal particulate plumes and the "eyes" of vent fields; waters to be collected by Niskin bottles for immediate analysis of pH onboard, and subsequent analysis of dissolved metals and $^{3}He/^{4}He$ onshore.

All 3 of the swath mapping, dredging, and hydrocasting activities have equal priority; in terms of time spent, the durations are shown in the table below.

Voyage Track

The area of operation and the intended voyage track is shown in Figure 2. Schematic outlines of the individual target areas along this track are shown in Figure 3.

Time estimates	transit	area of operations	swathmapping	hydrocast	dredging
	ex Lautoka 12 hours	Fi1	8 hours	3 hours	6 hours
	Fi1 to Fi2 6 hours	Fi2	12 hours	3 hours	9 hours
	Fi2 to Fi3 3 hours	Fi3	12 hours	3 hours	9 hours
	Fi3 to Fi4 3hours	Fi4	9 hours		6 hours
	Fi4 to Fi5 5 hours	Fi5	15 hours	3 hours	6 hours
	Fi5 to Fi6 1 hour	Fi6	20 hours	3 hours	6 hours
Total Fiji operations	*30 hours*		*76 hours*	*15 hours*	*42 hours*
	Fi6 to ZC1 1 hour	ZC1	9 hours	6 hours	12 hours
	ZC1 to ZC2 1 hour	ZC2	6 hours	6 hours	9 hours
	ZC2 to ZC3 I hour	ZC3	5 hours	6 hours	9 hours
Total FSC operations	*3 hours*		*20 hours*	*18 hours*	*30 hours*
	ZC3 to Fs1 6 hours	Fs1	10 hours	3 hours	9 hours
	Fs1 to Fs2 2hours	Fs2	12 hours	3 hours	9 hours
	Fs2 to Fs3 5 hours	Fs3	15 hours	6 hours	9 hours
	Fs3 to Fs4 2 hours	Fs4	10 hours	3 hours	9 hours
	Fs4 to Fs7 4 hours	Fs7	12 hours	6 hours	12 hours
	Fs7 to To1 12 hours	To1	24 hours	9 hours	15 hours
	To1 to Rochambeau 12 hours	Rochambeau	10 hours	6 hours	9 hours
	Rochmbeau to Fs6 6 hours	Fs6	9 hours	6 hours	9 hours
	Fs6 to Fs5 I hour	Fs5	9 hours	6 hours	9 hours
Total Fs, To, and R'beau	*51 hours*		*111 hours*	*48 hours*	*90 hours*
	Fs5 to Lautoka 35 hours				
Totals	119		207	81	162

Total is 569 hours (operations and transits) = 23.7 days.

Southern Surveyor Equipment

CTD & Niskin bottles
rock dredges, safety links, and spares
Smith-McIntyre grab
Milli-Q water
stern ramp cover to be in place for dredging operations

User Equipment

He water sampling crimping gear (as used on SS07/2008) from NOAA (Newport, Oregon)
equipment for filtering and analysing hydrocast samples
microscopes
"glass-chipping head"for gravity corer.
rock sampling equipment (hammers), chisels, sample bags, plastic sample pails
still and video cameras
tripods for same
photographic stand
small step ladder
small gravity corer

Special Requests

Lashing of small step ladder to aft deck for photographing activities on the deck
Flying of small camera on kite from aft deck
Photography with submersible camera on boom for launch/recover of CTD

Personnel List

Name	affiliation	role
Richard Arculus	Australian Nat. Univ.	Chief Scientist
Raul Brens	Macquarie University	Petrology
Nathan Buck	NOAA	Hydrochemistry
Neil Cheshire	Australian Nat. Univ.	Swath Mapping, Hydrochem.
Trevor Falloon	Univ. of Tasmania	Petrology
Ron Greene	NOAA	Hydrochemistry
Frances Jenner	Carnegie Inst.Wash.	Petrology
Meryl Larkin	Australian Nat.Univ.	Petrology, Hydrochem.
Allison Price	Boston University	Petrology
Ken Rubin	Univ. of Hawaii	Petrology
Charles Tambiah	Australian Nat. Univ.	Photography
Karl Forcey	CMAR	MNF Voyage Manager
Rod Palmer	CMAR	MNF Electronics Support
Anoosh Sarraf	CMAR	MNF Computing Support
Rick Smith	CMAR	MNF Swath Mapping

As per AMSA requirements for additional berths on Southern Surveyor, the following personnel are designated as System Support Technicians and are required to carry their original AMSA medical and AMSA Certificate of Safety Training on the voyage:

Name	AMSA Certificate of Safety Training No.
Karl Forcey	BB02062
Rod Palmer	BB05328
Anoosh Sarraf	BB02998

This voyage plan is in accordance with the directions of the Marine National Facility Steering Committee for the Research Vessel Southern Surveyor.

Richard Arculus

Chief Scientist

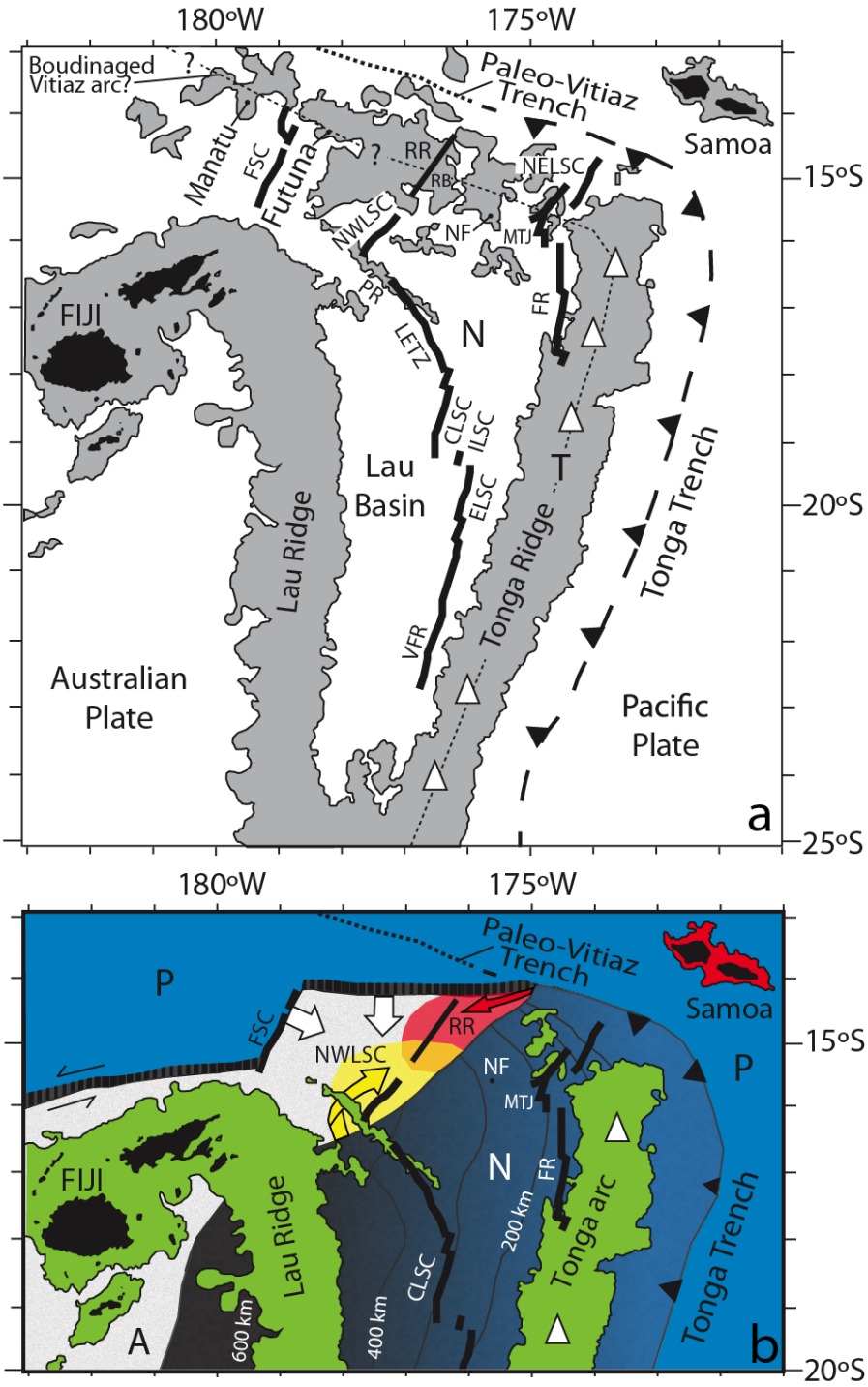

Figure 1a:. Map showing the major tectonic features of the Lau Basin. Areas shallower than 2000 m are shaded grey (adapted from map provided in Martinez and Taylor, 2003). The locations of the North West Lau Spreading Centre (NWLSC), Rochambeau Rifts (RR), Rochambeau Bank (RB), Valu Fa Ridge (VFR), Niuafo'ou Island (NF), Mangatolu Triple Junction (MTJ), Northeastern Lau Spreading Centre (NELSC), Fonualei Rifts (FR), East Lau Spreading Centre (ELSC), Futuna Spreading Centre (FSC), Intermediate Lau Spreading Centre (ILSC), Central Lau Spreading Centre (CLSC), Peggy Ridge (PR), Lau Extensional Transform Zone (LETZ), Tonga Plate (T) and Niuafo'ou Plate (N) are shown. The approximate location of the Paleo-Vitiaz Trench is shown as a dotted line extending west from the presently active Tonga Trench. Triangles along dotted line show the approximate location of the subaerial volcanoes of the presently active Tonga arc; portions of the Paleogene to early Neogene Vitiaz arc are mostly located to the east of this line. Notably, the areas shallower than 2000 m in the northern part of the Lau Basin trend approximately parallel to the Paleo Vitiaz Trench.

Figure 1b: schematic map outlining the boundaries of the major and minor plates in the region, including the subducted portion of the Pacific Plate projected to the surface based on the contouring of the seismicity . Abbreviations are: A: Australian Plate; N: Niuafo'ou Plate; P: Pacific Plate.

Voyage Track

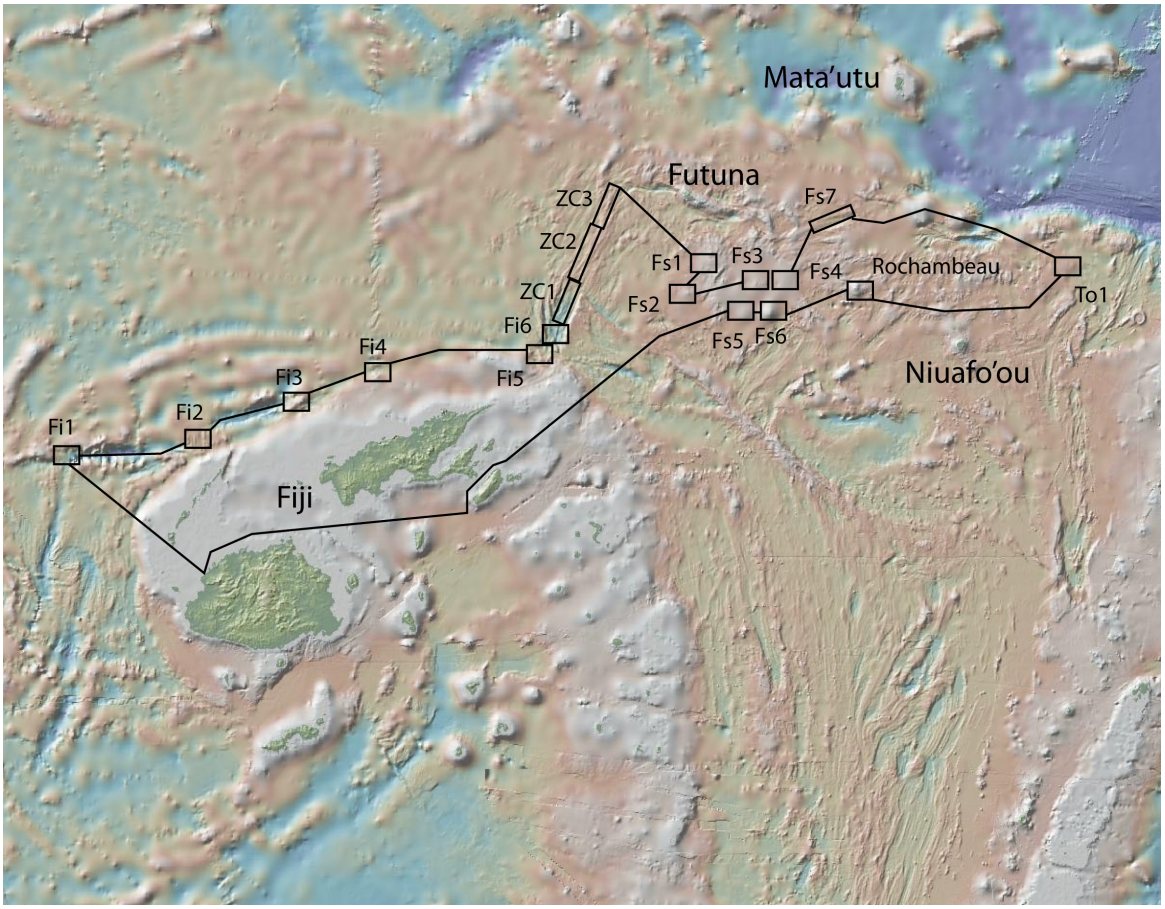

Figure 2. Voyage Track showing departure from and return to Lautoka in Fiji, to a series of targets shown in more detail in Figure 3.

Figure 3. Locations and schematic outlines of areas of operations at specific target areas.

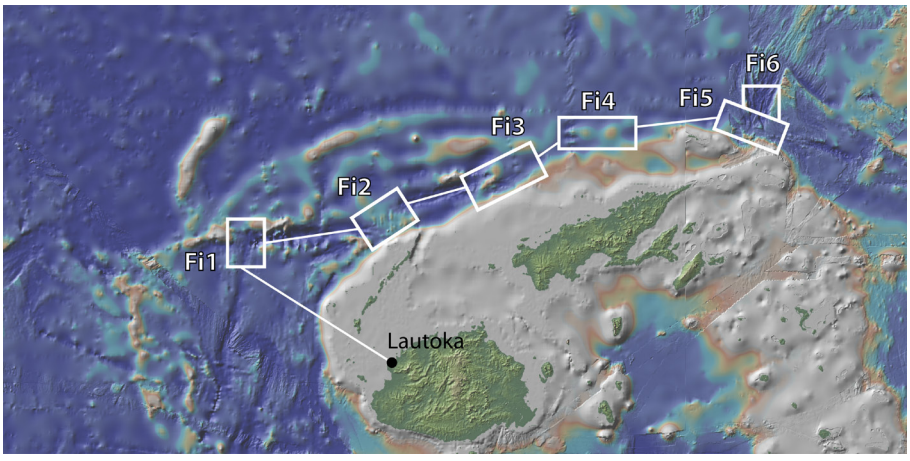

Figure 3a. Fijian targets concentrating on probably axes of spreading activity along the current Pacific-Australia plate boundary.

Figure 3b. Targets along the putative spreading axis of the Futuna Spreading Centre

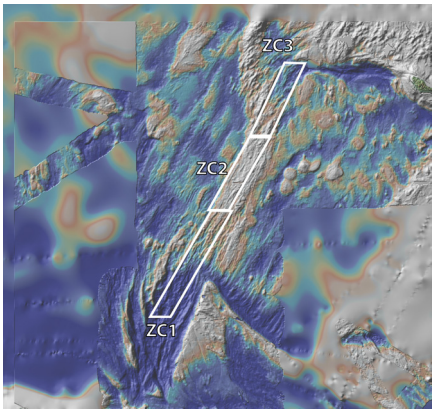

Figure 3c. Targets comprising possible major, isolated volcanoes between the Northwest Lau and Futuna spreading centres.

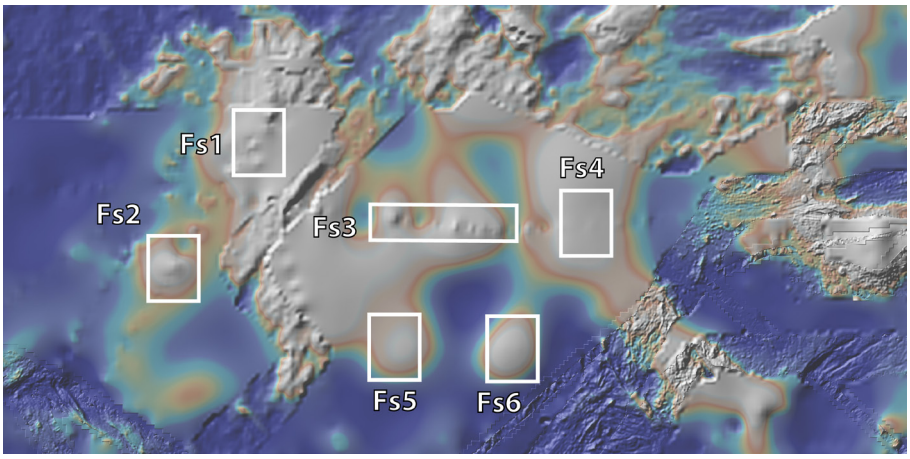

Figure 3d. Spreading centre target along the Pacific-Australia plate boundary proximal to the western termination of subduction along the Tonga Trench (Fs7), and the prominent Rochambeau volcano.

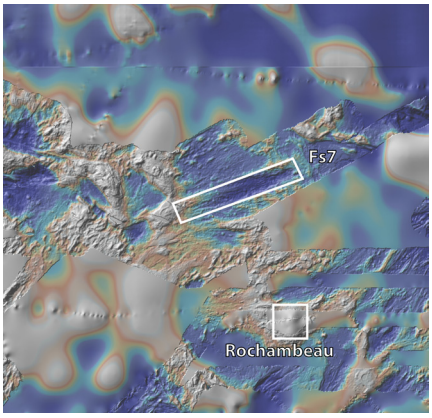

Figure 3e. Unexplored terrain between the Rochambeau Rifts and the Northeast Lau Spreading Centre.