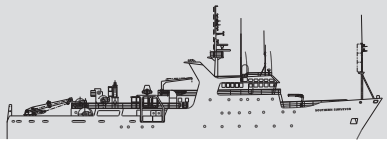

MARINE
NATIONAL FACILITY

2009 program

RV *Southern Surveyor*

voyageplan
SS03-2009

Hot Subduction – recycling of oceanic crust in a dynamic W Pacific setting. Part 3.

Itinerary

Depart Lautoka, Fiji, 1600hrs Friday 3 July, 2009
Arrive Noumea, New Caledonia, 0800hrs Monday 27 July, 2009
Demobilise: Hobart, Tasmania 1000hrs Saturday 08 August, 2009

Principal Investigators

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CSIRO

Scientific Objectives

This project aims to study the seafloor between Fiji and Vanuatu in the SW Pacific. This is a continuation of research undertaken during voyages SS10/2004 and SS08/2006.

This fundamental research in petrology and geochemistry addresses magma generation processes at active transition zones between continents and oceans. In such areas, the Earth's oceanic lithosphere is subducted back into the mantle triggering extensive volcanic activity. These processes form complex chains of volcanic islands separated from continents and from each other by extensional backarc basins. It is widely accepted that this magmatism plays an important role in the formation of the Earth's crust, atmosphere and hydrosphere.

The submarine Hunter Ridge (between Fiji and Vanuatu) contains unusual magmatic rocks not normally associated in time and space, some of which require abnormally hot temperatures during subduction. One of these magma types was discovered for the first time in a modern setting during voyage SS10/2004. Such rocks are a subject of international interest as they have implications for magma genesis on the early Earth, for which theoretical and experimental studies have proposed abnormally hot (cf. modern day) subduction zones.

To fully understand the significance of this new exciting discovery, we need to know the age and spatial distribution of magmatic rocks on the Hunter Ridge and their relationship to young magmatic rocks exposed on Kadavu Island at its northern end. This also has implications for tectonic reconstructions of the SW Pacific and understanding of SE Australia geology.

As parts of the study area are currently volcanically active, one of our objectives is to detect the presence of any active hydrothermal systems on the seafloor, which are potential sites of formation of modern Seafloor Massive Sulphides. Much of Australia's mineral rich Phanerozoic geology developed in complex subduction-related plate boundaries similar to the study. Thus an improved understanding of the connection between magmatism and sulphide mineralisation forming processes in the study area will have direct relevance to the interpretation of Australia's geological history and lead to a better understanding of the formation and consequent exploration for new deep earth ore deposits.

Voyage Objectives

We intend to conduct a multibeam survey, a possible magnetics survey (depending on the seafloor morphology on the Hunter Ridge at ~ 177 ºE), rock sampling in three areas along the Hunter Ridge, and measuring water properties using MAPR sensors (Miniature Autonomous Plume Recorders). The questions which we are seeking to answer are as follows:

The central part of the Hunter Ridge (area 1)

Questions: 1) The highly deformed nature of the southern end of the Hunter ridge discovered during SS10/2004 raises the question of whether the deformation is the result of recent and ongoing deformation associated with the triple junction or is this style of deformation a feature of the entire Hunter Ridge? 2) How old is the magmatism along the entire Hunter Ridge? To answer these questions we plan to do detailed swath mapping, sound-bottom profiling and dredge sampling in area 1 (Fig. 1; between 178 - 174.5 ºE, 20.5 – 22 ºS). The use of the sub-bottom profiler will be vital in determining whether the seafloor has a volcanic, sediment-poor, basement or alternatively the seafloor is formed by sediments. This information will significantly help the interpretation of the swath mapping.

North Fiji Basin propagating spreading centre (area 2)

Questions: 1) What is the range of chemical variations in magmas erupted along the spreading centre? 2) Is there current active hydrothermal activity along the spreading centre? To answer these questions we plan to conduct in area 2 (Fig. 1; ~ 174 ºE, 21.5 – 22 ºS) volcanic glass sampling using a specially modified piston corer, designed for sampling glassy pillow rinds of young lavas; and water property measurements using MAPR sensors.

Rift Zone at the southern end of the Hunter Ridge (area 3)

During SS08/2006 we were able to image the western most end of the rift (Figure 2), which revealed incipient fracturing of the Hunter Ridge extending towards Hunter Island, the southern most active volcano of the Vanuatu Island arc. This is the first time that the process of incipient arc rifting has been discovered in an active setting.

What is particularly important for our research project is the nature of volcanics associated with this rifting. The seafloor swath mapping, shows numerous young volcanic features, some of which are clearly cut by large fault scarps. We need to know the composition of the magmas erupted by these volcanoes, whether they are similar to or different to what is found in the well developed rift discovered and characterised during SS10/2004 and SS08/2006 voyages.

To answer these questions we will perform dredges on volcanoes associated with incipient arc rifting between 1500-2500m water depth between 173 – 172 ºE, ~ 22.5 ºS.

Voyage Track

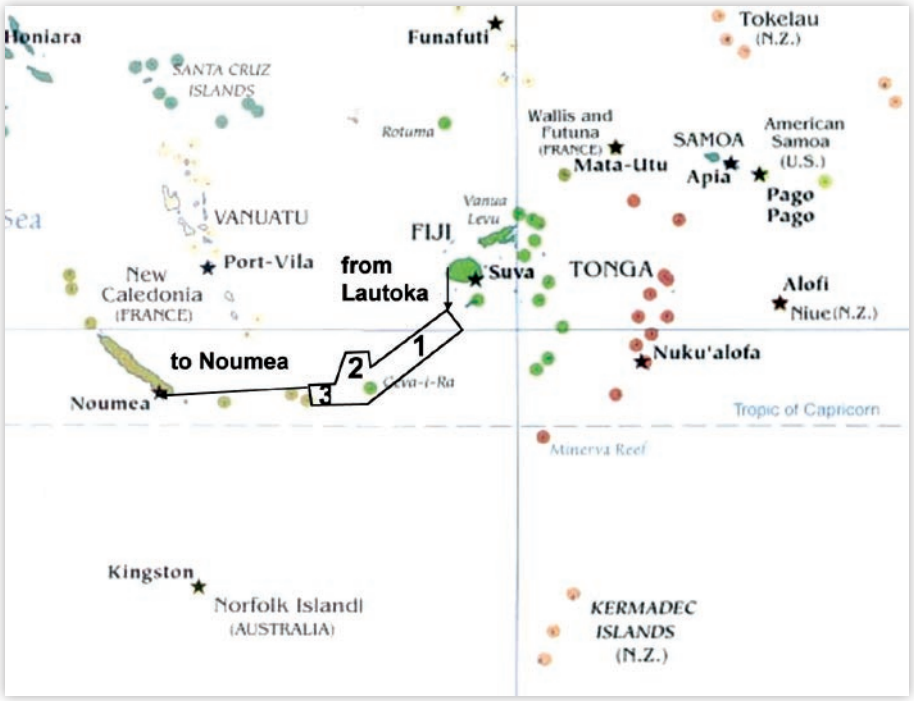

Figure 1. Voyage track with research areas marked by numbers 1, 2 and 3.

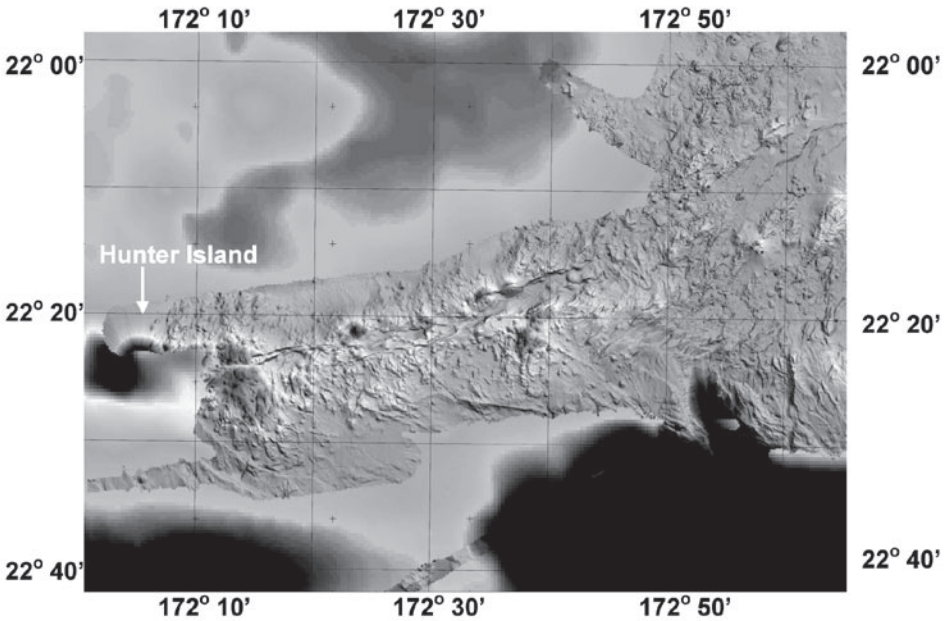

Figure 1. Research area 3.

Time Estimates

Transit to Area 1 from Lautoka will take ~ 8 hours.

Swath mapping, dredging and possible short magnetics survey in Area 1 will take from 15 to 17 days. The exact timing will depend on the tectonic features present on the seafloor and the extent of sedimentary cover. We plan to conduct 20-25 dredges in this area.

Transit to area 2 will take ~ 10 hours.

Wax piston coring and MAPR measurement (conducted simultaneously) along the spreading axis in Area 2 will take ~ 60 hours. We plan to conduct ~ 20 closely spaced sampling stations.

Transit from Area 2 to Area 3 will take ~ 15 hours.

We plan to spend around 4-5 days in Area 3 depending on the time spent in Area 1. During this time we will perform limited swath mapping and extensive dredging. A maximum of 25 dredges will be done in this area.

Transit from Area 3 to Noumea will take ~ 24 hours.

Southern Surveyor Equipment

Dredges (2), including winches and wire for dredging, safety pins, spare weak link, spare chain bag links and shackles for attaching the chain bag to the dredge.

- We plan on conducting a maximum of 50 dredges during the voyage at water depths less than 3,500 metres.
- To optimise the number and ratio of successful dredges we are planning to dredge under the following conditions:
- Rate of dredge deployment ~ 60-70 metres/minute until the length of wire out equals the depth under the ship;
- Speed of the ship during deployment approaching the touch down position ~ 5-6 kn;
- Rate of dredge recovery once off the bottom ~ 60-70 metres/minute;
- To ensure representative sampling of the seafloor, we will need to dredge both into the wind and with the wind - the use of bow thrusters is essential when dredging with a tail wind;
- It is important, while sea conditions allow, that the scientific personnel are able to process the sample from the dredge on deck while the ship proceeds to the next station.

CTD winch with the 8 mm conducting cable for piston corer and MAPR sampling:

- The cable should be equipped with a pressure meter calibrated to depths of at least 4,000 metres.
- We plan to conduct ~ 20 sampling stations. The ship must remain stationary during coring, which, in some conditions, will make the use of bow thrusters essential. The procedure involves:
- Attaching both the wax corer and MAPR sensor to the cable (the exact procedure for attaching the MAPR sensor will be developed by Nautilus Minerals staff on board "Southern Surveyor" prior to the start of SS03/2009. so that the crew will be familiar with the procedure.
- Deploying the corer to the depths ~ 50 m above the sea floor with a rate of > 70 metres/minute;
- When at that depth, an extra 80 metres of wire is deployed with the maximum possible rate to ensure the highest impact on the seafloor. The corer should be recovered at the fastest possible rate.

Access to **differential GPS** is highly desirable within the study area.

Swath mapper EM 300. Swath mapping is one of the major activities during the voyage. During mapping surveys the swath mapper will be running 24 hours/days. To ensure 24 hour operation Andrew Stacey from the scientific party will receive appropriate training at GA prior the start of the voyage.

Sub-bottom profiler

Single-beam echo sounder EA 500.

The use of the single-beam echosounder is essential when the ship is stationary over a sampling station to monitor water depth.

Rock cutting saw in the fish sorting room will be used to cut rock samples on board.

The **Fish laboratory** will be used for washing, sorting, initial description and packing of dredge and piston corer samples.

User Equipment

Piston wax corer

The corer (~ 2 metres long) will be transported to the ship in a wooden case and needs to be secured on deck close to the winch with the 8 mm conducting cable.

MAPR sensors

The MAPR sensors will be provided by Nautilus Minerals, and they will be left on board from the preceding voyage.

Binocular microscope to be positioned in the photo preservation laboratory.

Preliminary Personnel List

Name	Affiliation	Role
Leonid Danyushevsky	Univ. of Tasmania	Chief Scientist
Trevor Falloon	Univ. of Tasmania	Watch leader/Geochemist
Patrick Quilty	Univ. of Tasmania	Palaeontologist
Pavel Plechov	Moscow State Univ., Russia	Geochemist
Roman Leslie	Univ. of Tasmania	Geochemist
David Hutchinson	Univ. of Tasmania	Geochemist
Julie Hunt	Univ. of Tasmania	Geochemist
Sandrin Feig	Univ. of Tasmania	Geochemist
Gisela Cobenas	Univ. of Tasmania	PhD student
Woitec Zukovski (if no Fijian observer)		Geochemist
French rep., TBC		Geologist
Fijian rep., TBC	MRD, Fiji	Geologist
Vanuatu rep., TBC	Vanuatu geological survey	Geologist
Ron Plaschke	CMAR	MNF Voyage Manager
Tony Veness	CMAR	MNF Swath mapping support
Bob Beattie	CMAR	MNF Computing Support
Lindsay MacDonald	CMAR	MNF Electronics Support

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.
Ron Plaschke	As02925
Tony Veness	BB1071
Bob Beattie	AS02396
Lindsay MacDonald	AS04157

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

Leonid Danyushevsky
Chief Scientist