PRELIMINARY REPORT ON THE RESULTS OF THE JAPAN/SOPAC DEEPSEA MINERAL RESOURCES SURVEY IN THE REPUBLIC OF THE FIJI ISLANDS WATERS

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INTRODUCTION

As a part of the third five-year Japan/SOPAC programme, a research cruise was carried out in the Exclusive Economic Zone (EEZ) of the Republic of the Fiji Islands from 20 May to 2 July 1999. The purpose of the survey was to assess the potential for resources of submarine hydrothermal deposits in the EEZ of the Fiji Islands.

Prior to the survey, cruise plans were finalised by the Metal Mining Agency of Japan (MMAJ) and SOPAC. The survey plan was finalised by the Japan International Cooperation Agency (JICA) and carried out on the RV Hakurei Maru No. 2 by MMAJ with participation from Deep Ocean Resources Development Co. Ltd, (DORD), Geological Survey of Japan (GSJ) and Ocean Engineering Development Company (OEDC). Mr Luna Wong and Mr Viliame Baleivanualala of Mineral Resources Department, Fiji, participated in the cruise as trainees, while the author played the part of SOPAC representative.

This report shows the preliminary results of the survey based on the data available at the moment. Further analysis and interpretation will be carried out during 1999 and early 2000.

SELECTION OF SURVEY AREA

Many research cruises have been carried out in the EEZ of the Fiji Islands. Though several hydrothermal deposits were found through the previous surveys, there remain many yet un-surveyed areas with mineralisation potential (see Figure 1).

As shown in Table 1, three areas of hydrothermal activity have already been found in the Fiji EEZ. Many scientific studies have been conducted in these areas, but with respect to resources assessment, further studies are required to evaluate the potential of mineralisation. For example, it is necessary to collect data on extension of mineralised area both laterally and vertically.

Table 1. Hydrothermal Activity in the EEZ of the Fiji Islands

No	Name	Latitude	Longitude	Depth (m)	Type of Deposit
1	Station 4, Triple Junction ("White Lady" Site)	16°59'S	173°55'E	1980	Active (T=290C) anhydrite chimneys standing on dead sulphide mound. Forest of dead sulphide chimneys.
2	Station 14	18°50'S	173°30'E	2720	Warm (T=5.2C) fluid discharge through mussel bed. No hydrothermal minerals. Site of megaplume.
3	Extensional Relay Zone A	16°10'S	177°25'E	1860-2335	Hydrothermal sulphide impregnation in MORB-like basalt dredged from axial valley.

(After Ishibashi and Urabe, 1995)

Previous research cruises in the Fiji EEZ have concentrated on these three areas, the main interest being scientific. Most of the detailed studies have in fact concentrated in the location known as Triple Junction (White Lady). However the extent of spreading ridge and related structures are quite extensive and therefore other areas should also be investigated to assess their potential as mineral fields.

For these reasons, two survey areas were selected: one for a detailed survey of a recognised hydrothermal area and the other for a regional survey (see Figure 1).

Area I [Triple Junction] (detailed survey)

A couple of hydrothermal deposits have been found in this area during previous cruises [Part of the STARMER Program with FRANCE/JAMSTEC using research vessel KAIYO]. Diving by a submersible has also been attempted at this site. The recent Sonne cruise in late 1998 also looked at mineralisation and hydrothermal activity in this general area. Drilling operations employing Deepsea Boring Machine System (DBMS) was planned to help quantify the size of deposit and its stratigraphy.

Area II (regional survey)

This area is part of the continuation of the Fiji Fracture Zone and its linkage with the Triple Junction of the North Fiji Basin Spreading Centre. Mineralisation is known at the Triple Junction [White Lady field] and at the eastern end [mineralisation discovered by *Sonne*, Cruise SO35]. The purpose is to check for the existence of any further mineralisation. Any such find would be a significant increase in knowledge of mineralisation in Fiji EEZ. Scientific data gathered will assist in the better understanding of the tectonics of the Fiji Fracture Zone, a major zone of seismic activity.

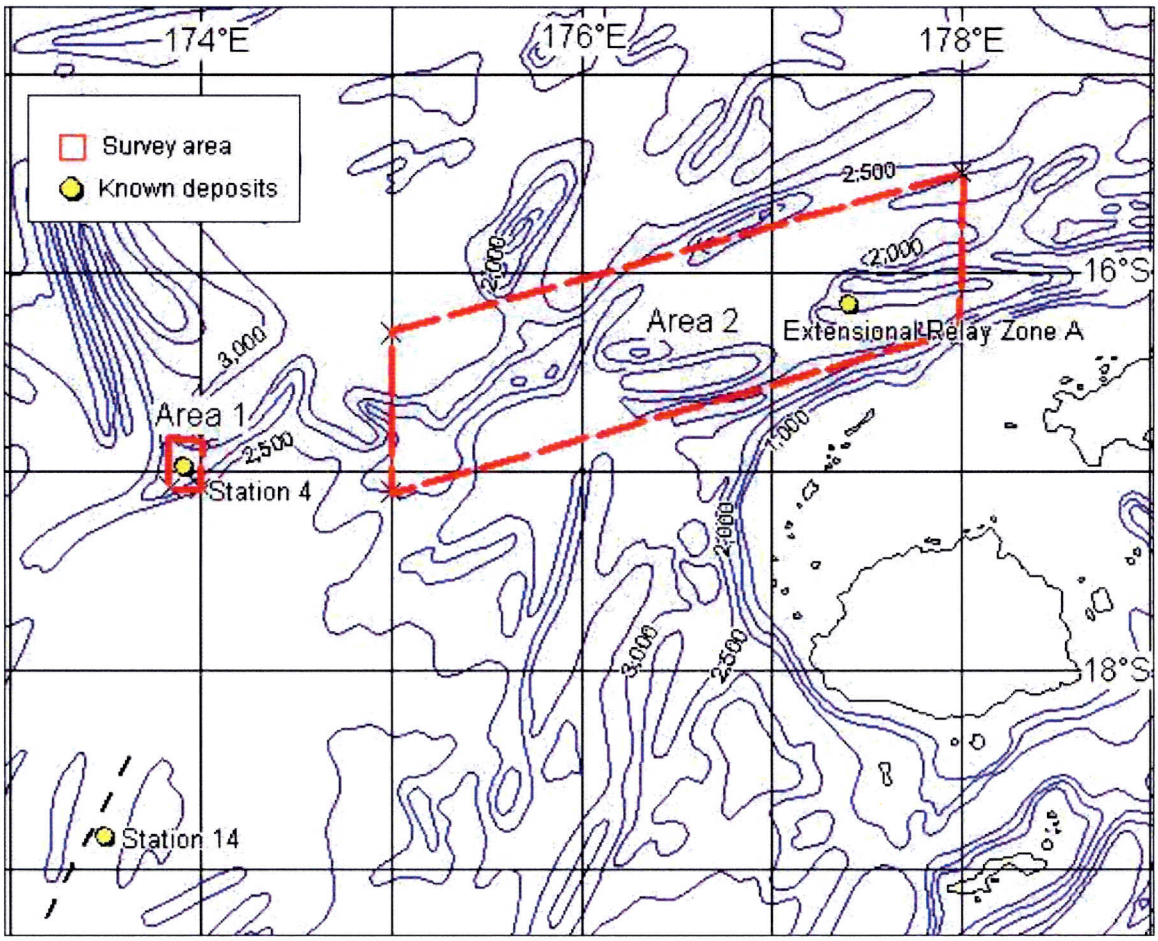

Figure 1. Survey area and known deposits in the EEZ of Fiji

PRELIMINARY RESULTS OF THE SURVEY

Area I (Triple Junction)

A detailed topographical survey, a Side-scan Sonar (SSS) survey and seafloor observation by Finder-equipped Deep-sea Camera (FDC) were conducted during the first leg. Drilling operations were scheduled during the second leg, but no operation was carried out because of bad weather and sea conditions in the area.

Topography

According to the previous studies (e.g. Scientific Party on Board Kaiyo, 1988), three rift valleys extend from a hill around 17°S, 174°E to SSW, NNW and NE at the "Triple Junction". The detailed topographical survey was carried out around the hill (see Figure 2).

The hill forms a knoll that has two summits. Both summits have SSW-trending axes and can be clearly divided. The western margin of the east summit forms a SSW-trending cliff, of which relative height ranges from 40 to 60 m. The axis of the west summit extends to the north, changing its direction to NW, and forms a NW-trending ridge, of which the shallowest depth is 1820 m. The NE slope of the ridge forms a steep cliff.

Geology

The FDC survey suggested that sheet lava is widely distributed in the area. Flat lava ponds were identified along FDC03, 04, 05 and 06. Rovate lava, which suggests rapid movement of lava flows, was recognised within the lava ponds. Pillow lava is locally distributed on the sheet lava and is several meters high.

Unconsolidated sediments cover the seafloor in general. The sediments are generally thin enough to identify the rocks below.

Hydrothermal Activity

About 30 chimneys were recognised in the area covered by the FDC survey. The survey also revealed that some chimneys are accompanied by supposed-sulphide mounds, of which diameters range from 100 to 150 m. The chimneys are distributed along fissures striking N-S. The chimneys are 1 to 2 m high in general, but a couple of chimneys exceed 3 m in height.

An altered rock sample, which contains euhedral pyrite, was recovered by gravity corer (LC). The sampling was conducted at a mound recognised by FDC04, of which the diameter is estimated to exceed 130 m.

The SSS survey suggested that mounds are densely distributed in bottoms of valleys north to 16°58'S. The observed distribution of mounds is accordant with the reported results of "Hyfiflux Project" (Halbach et al., 1998).

Some evidence of possible hydrothermal vent community were identified at several chimneys: a white prawn and yellow tubes, which might be nests of Errantia *Nereis*. White dots on sediments, which could have originated from bacterial mats, were also recognised.

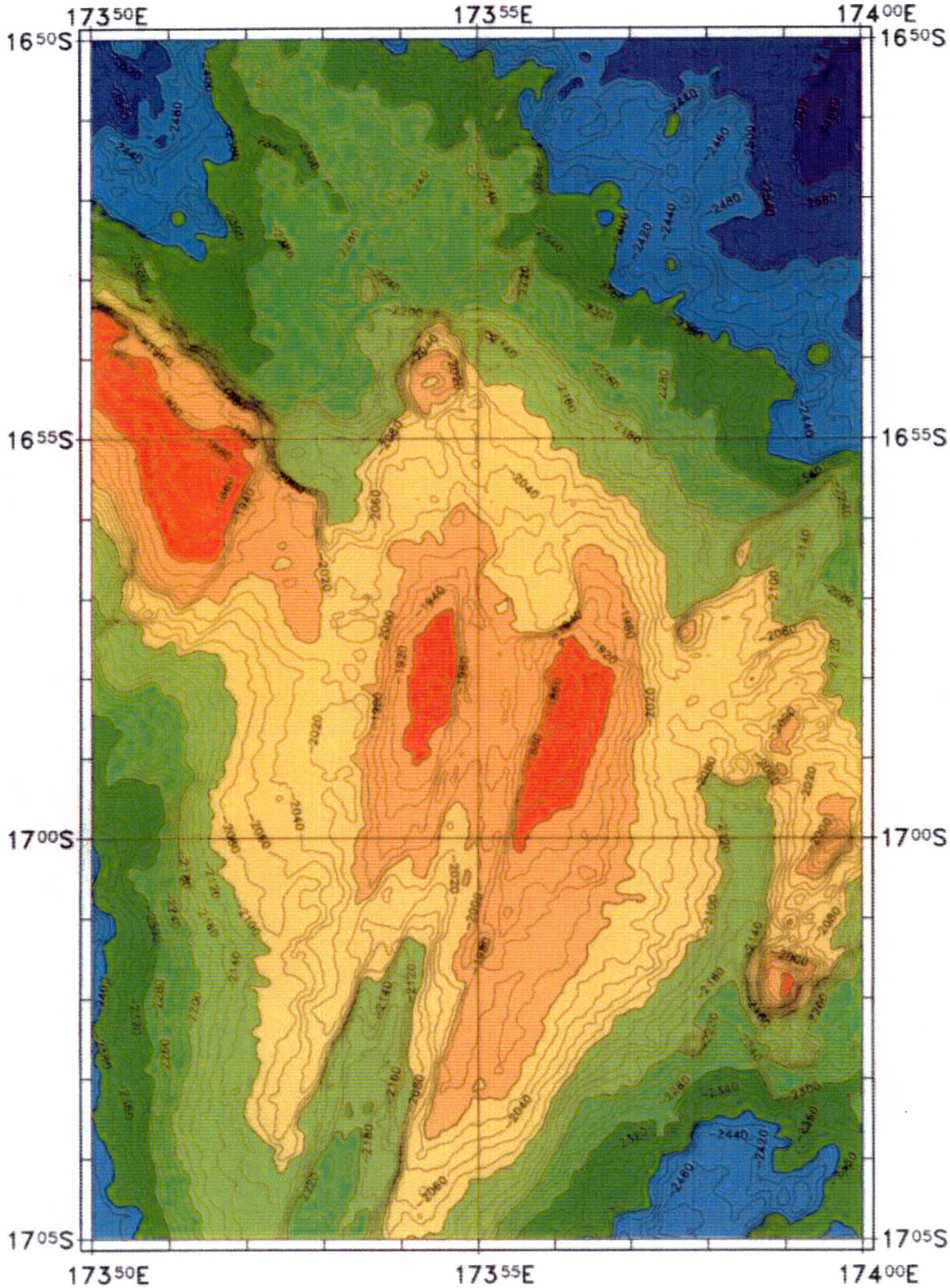

Figure 2. Bathymetric map around the Triple Junction

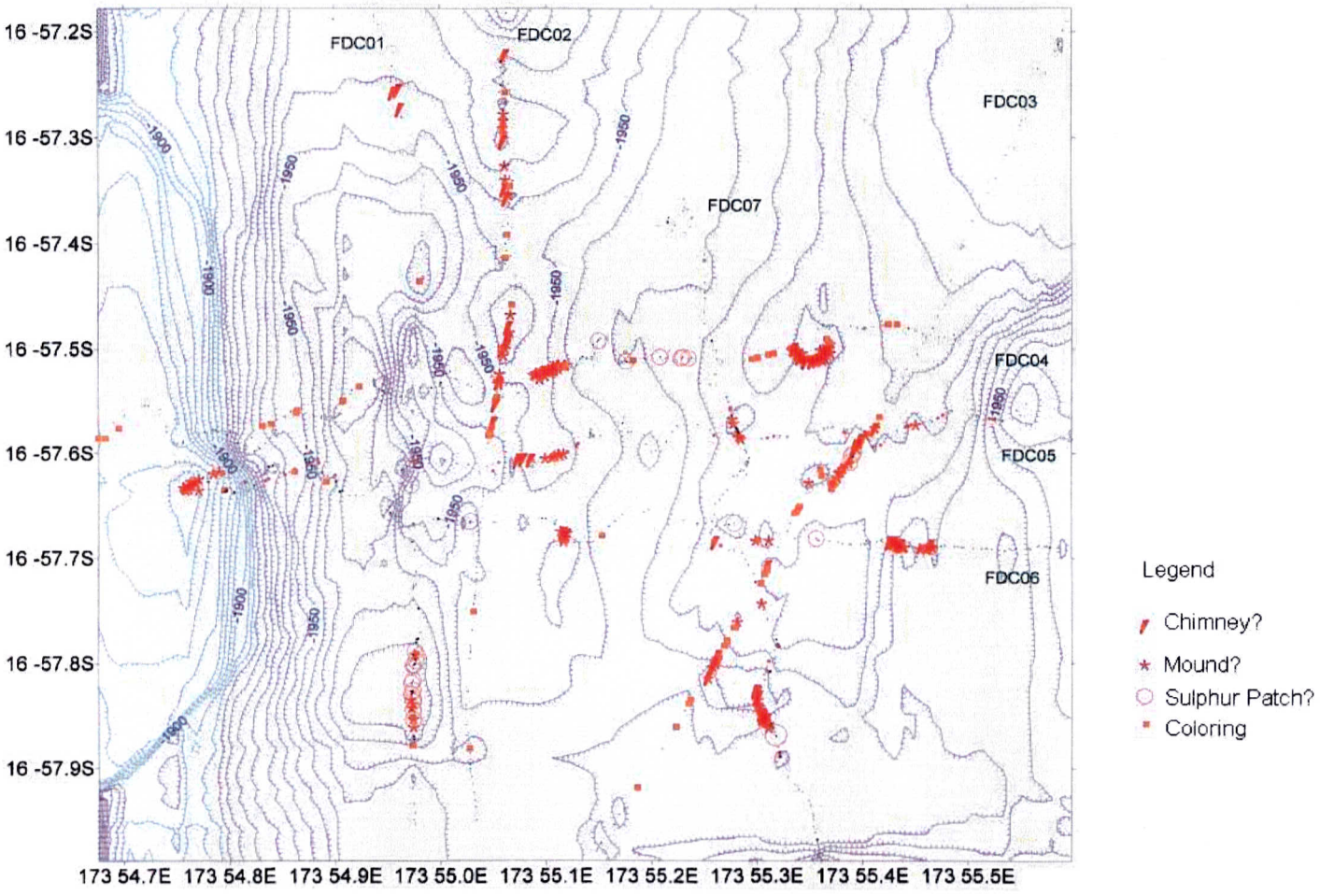

Figure 3. Hydrothermal Activity around the Triple Junction

Area II (Fiji Fracture Zone)

A regional survey, which was composed of topographical and magnetic surveys at intervals of two nautical miles, was conducted during the first leg in order to study the geological structure in the area. Seafloor observation by Finder-equipped Deep-sea Camera (FDC) and sampling by Chain Bucket Dredge (CB) were also conducted in "Extensional Relay Zone A" (ERZA) and "Central Hill" during the first leg. Five drilling operations were carried out during the second leg: two in the ERZA and three in the Central Hill.

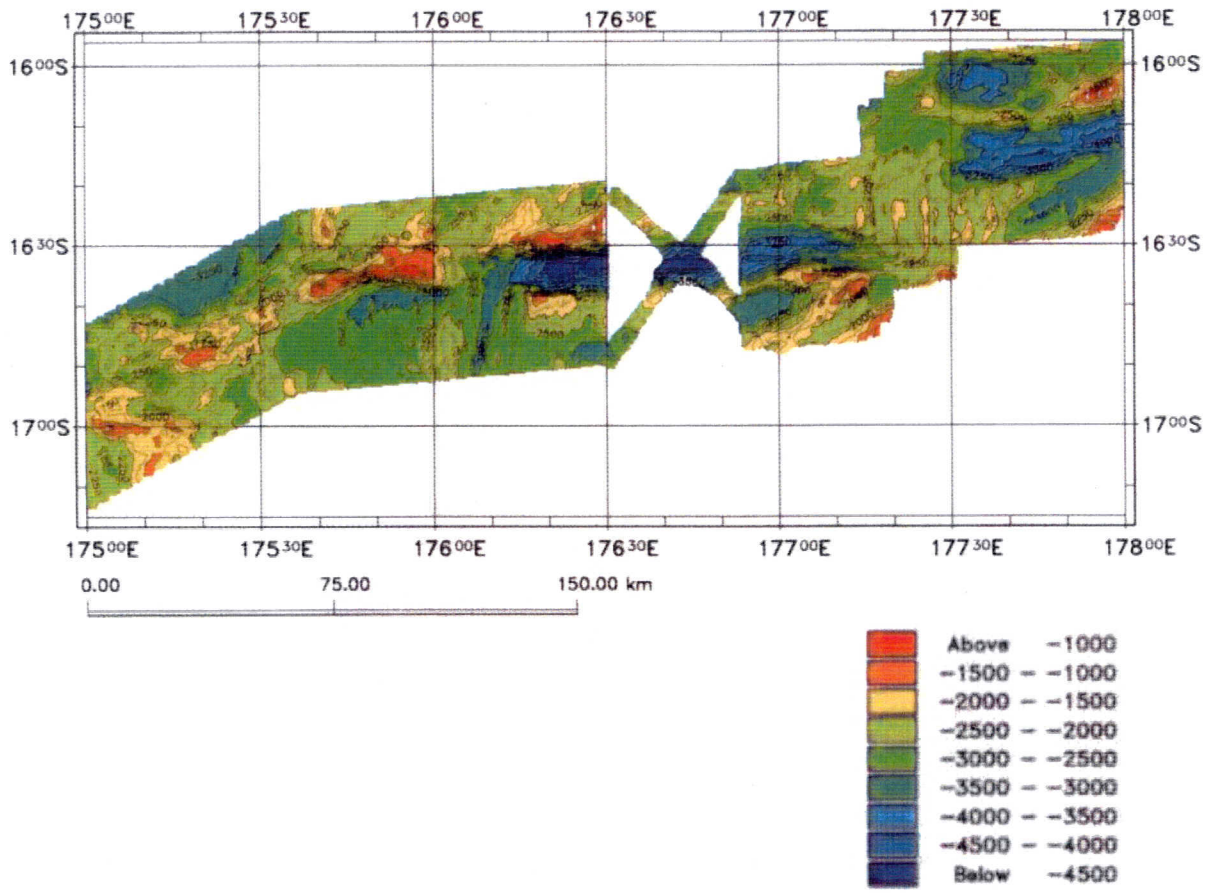

Figure 4. Bathymetric map of Area II

ERZA

Topography

The ERZA is located between the Yasawa Trough and the Yandua Trough and is characterised by a N-trending structure that was brought about by east-west movement of the two troughs. Figure 5 shows the topography of the area.

Geology

The FDC survey suggests that sheet lava predominates in the area and pillow lava is locally distributed. Ridges in the area are composed of sheet lava and the slopes are covered with fallen masses of sheet lava and pillow lava. Results of Sub-bottom Profiling indicate that rock is exposed or that thin layers of unconsolidated sediment cover the seafloor.

Hydrothermal Activity

Although no significant hydrothermal activity was recognised, reddish-brown altered rocks were identified in the eastern area. A dredge recovered an altered rock that contains fine-grained pyrite. A drilling operation obtained a 70-cm core, which is mainly composed of basalt, but no altered rock was recovered by drilling.

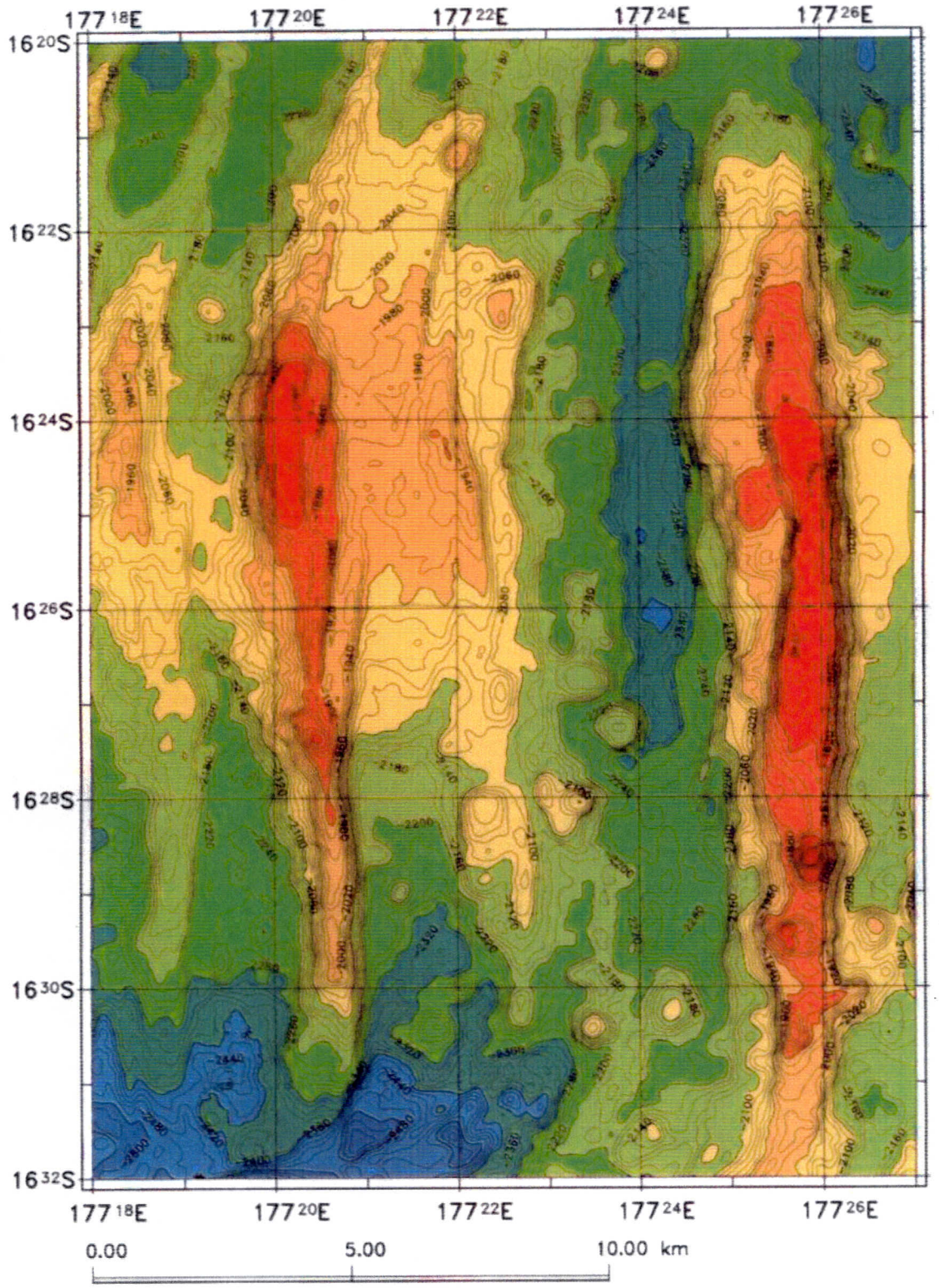

Figure 5. Bathymetric map of the ERZA

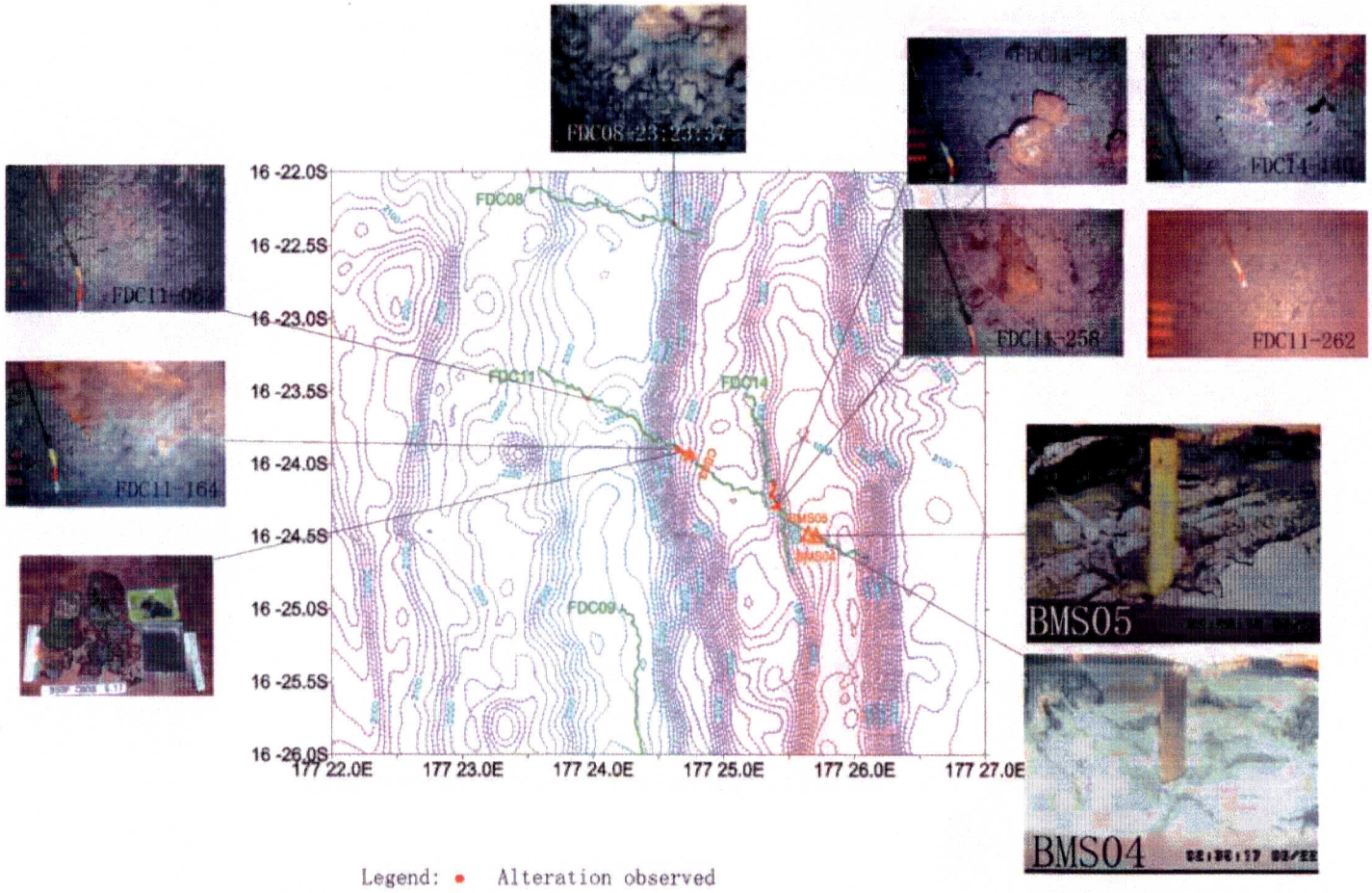

Figure 6. Hydrothermal Acrivity and Sampling Locations in the ERZA

Central Hill

Topography

Central Hill is located where the N-trending axis of the ERZA changes its direction to the east. The hill is approximately 700 m high and an equilateral triangle in plain. The hill slopes gently in general. Figure 7 shows the topography of the Central Hill area.

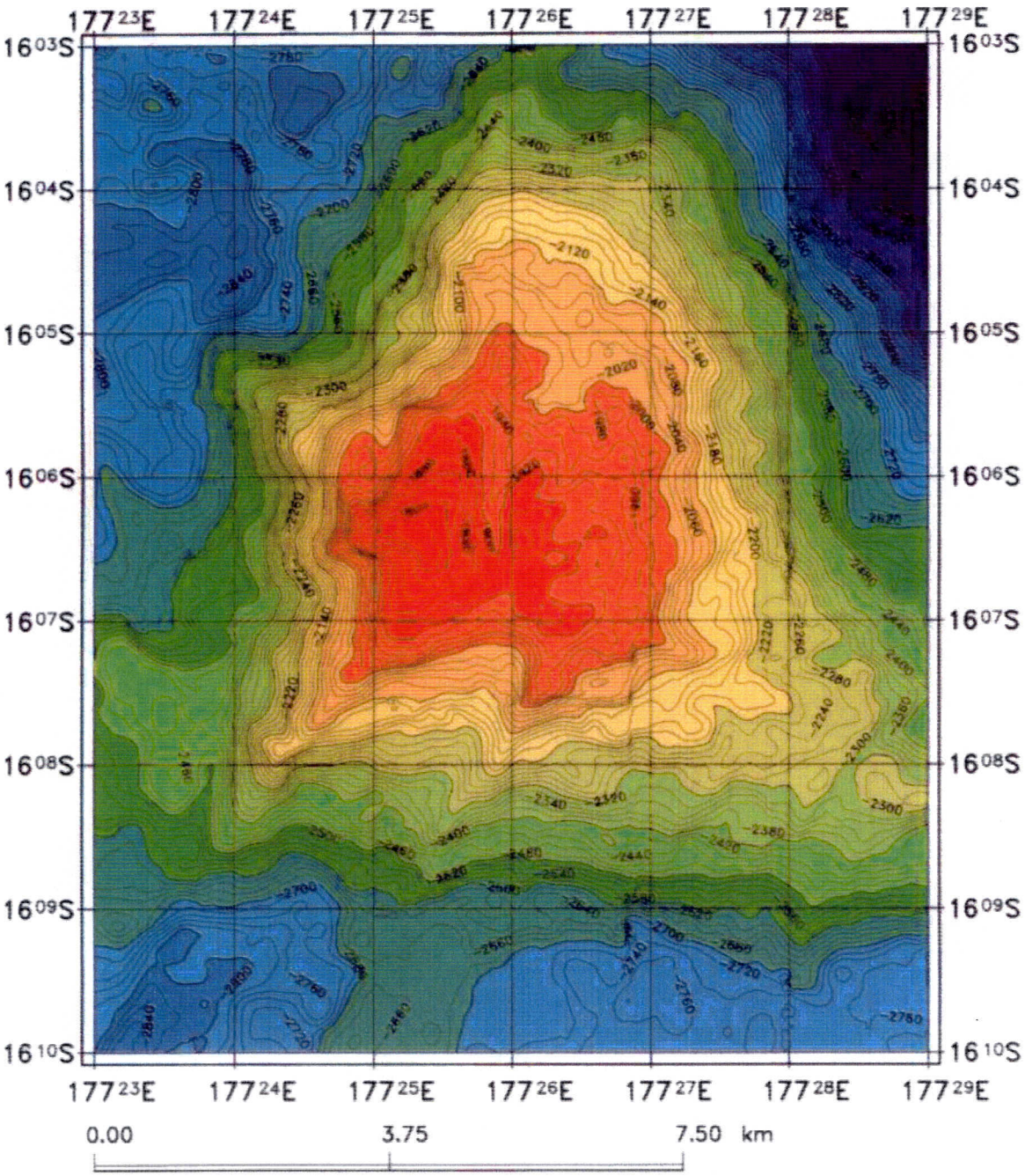

Figure 7. Bathymetric map of the Central Hill

Geology

The FDC survey suggests that sheet lava is widely distributed in the area and is generally covered with muddy unconsolidated sediment. Pillow lava was locally recognised on the sheet lava. Results of Sub-bottom Profiling indicate that rock is exposed, or thin layers of unconsolidated sediment cover the seafloor.

Hydrothermal Activity

The FDC survey revealed that huge quantities of shell fragments, which are considered to have belonged to a hydrothermal vent community, are accumulated in an area of 0.5 km^2. A chimney was identified on the FDC12 track line.

A drilling operation obtained black silt that contains pyrite and smells of sulphur. Dredged samples include altered rocks that show chloritisation. Manganese oxide coatings were recognised on shell fragments and rocks recovered by CB.

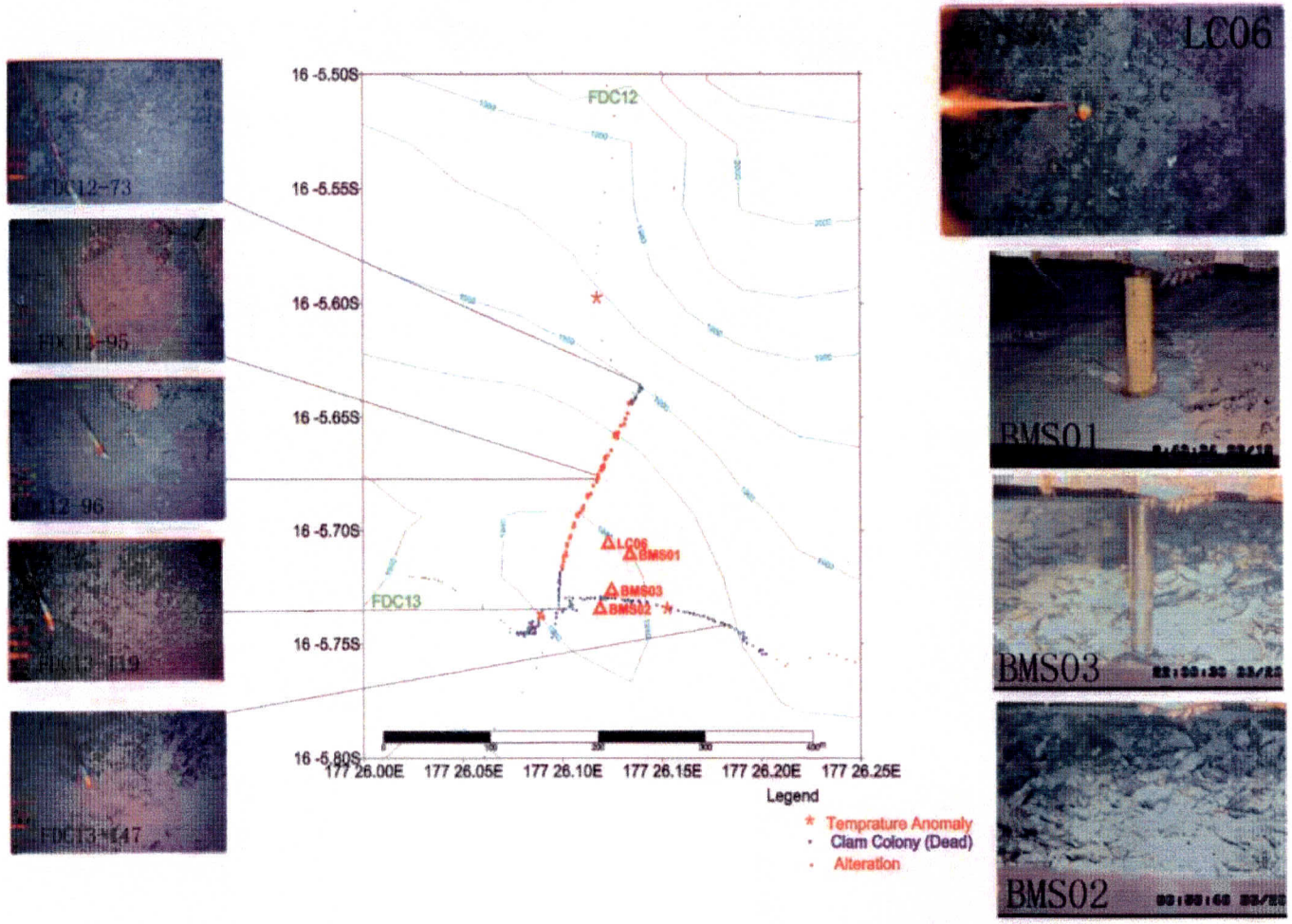

Figure 8. Hydrithermal Activity and Sampling Locations in the Central Hill

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APPENDIX

Photo 1. Pahoehoe Lava in the Triple Junction (FDC06)

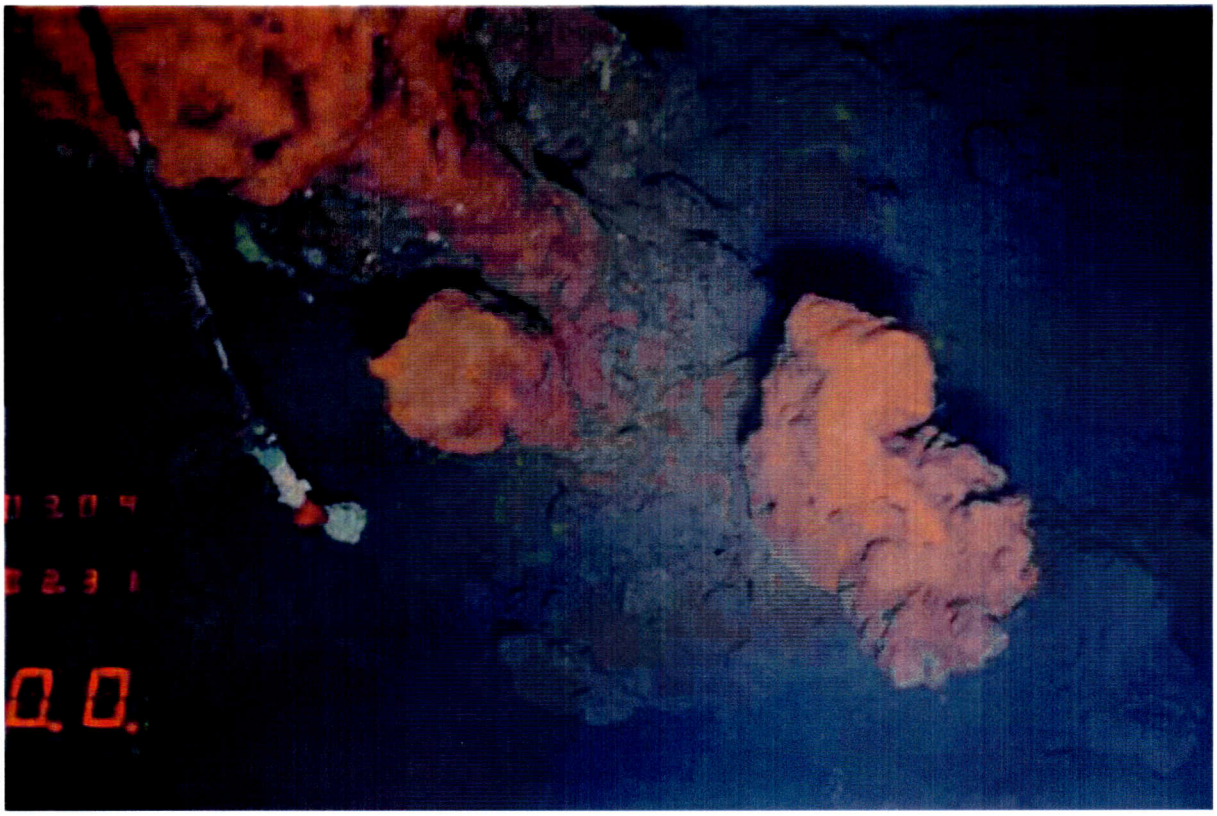

Photo 2. Chimney in the Triple Junction (FDC06)

Photo 3. Sheet Lava in the ERZA (FDC08)

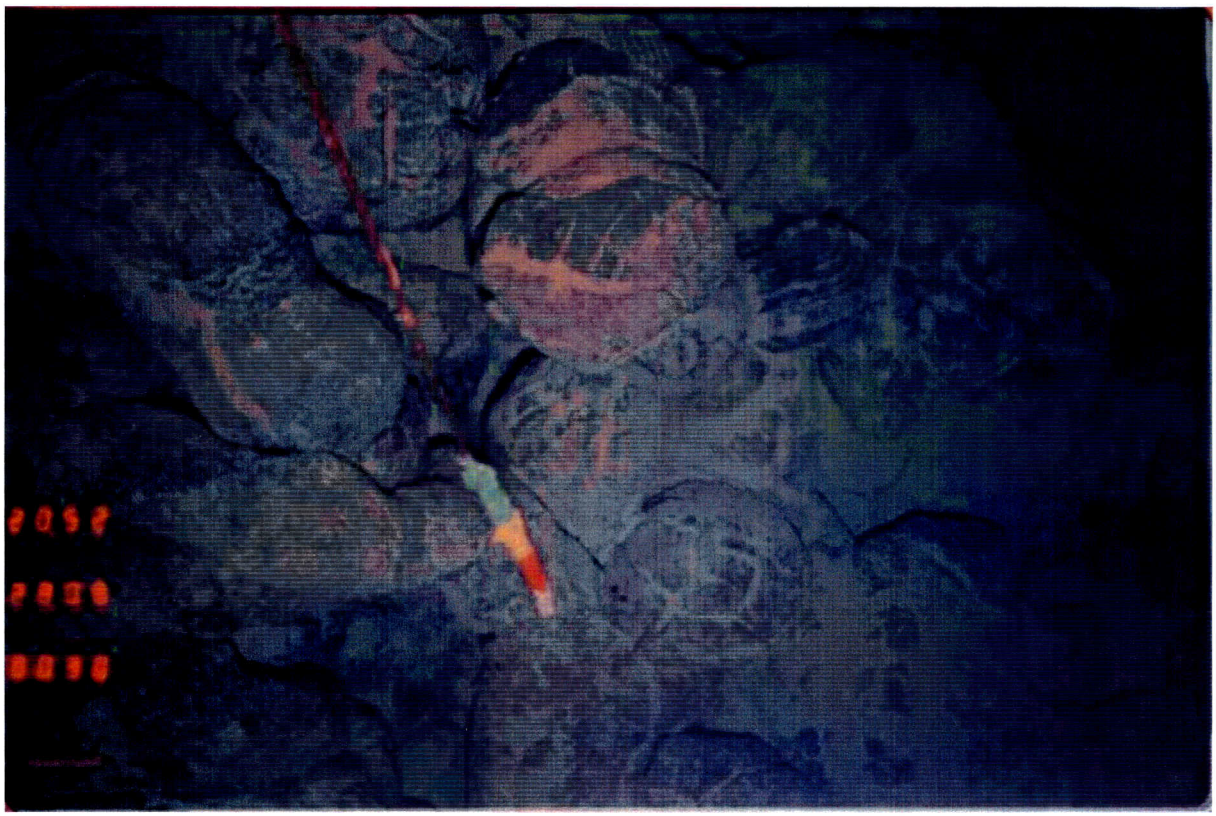

Photo 4. Pillow Lava in the ERZA (FDC10)

Photo 5. Shell Fragments in the Central Hill (FDC12)

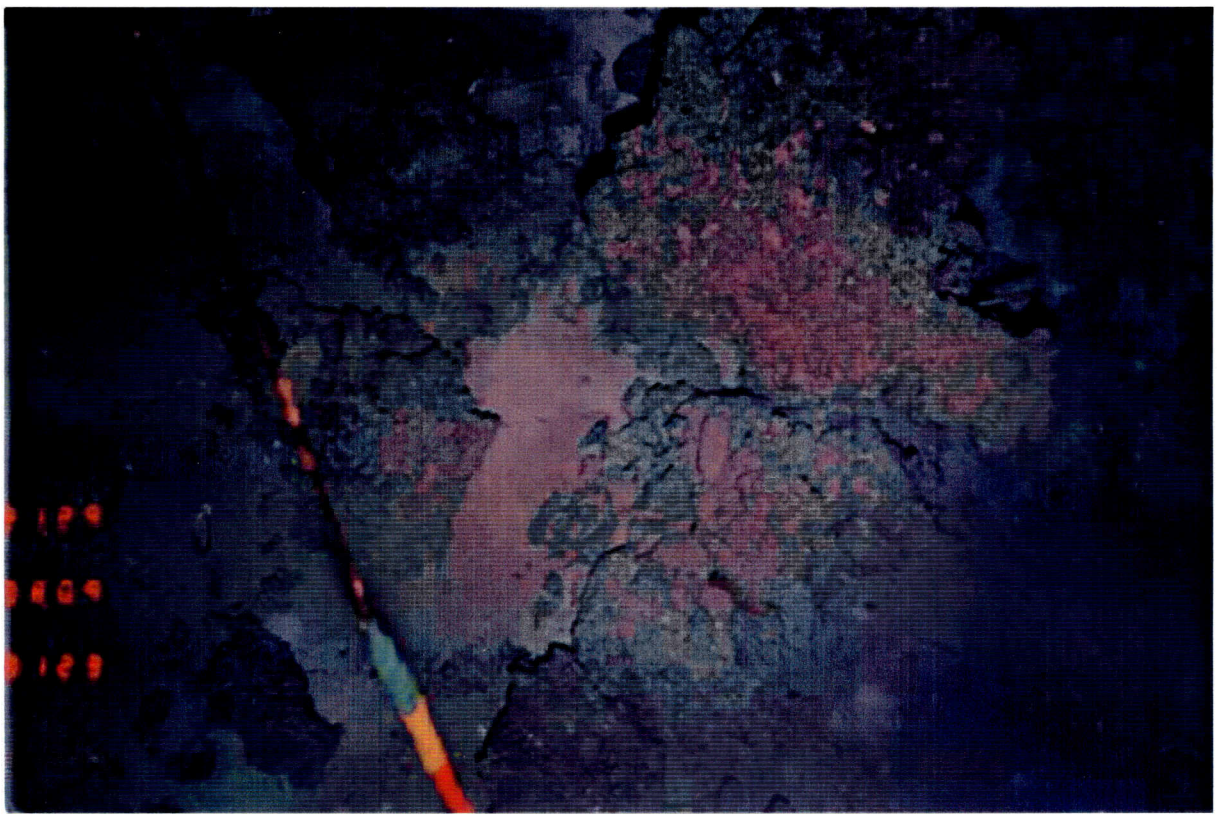

Photo 6. Brecciated basalt showing alteration in the Central Hill (FDC12)

Schedule and Achievements of Research Cruise

Cruise Schedule		
Departure from Suva	May 20 16:00	
Start of the First Leg	May 21 15:00	
Finish of the First Leg	June 12 9:30	
Arrival at Suva	June 13 9:00	
Departure from Suva	June 17 9:00	
Start of the Second Leg	June 18 14:00	
Finish of the Second Leg	June 23 17:00	
Arrival at Guam	July 2 9:00	
Survey Areas	Area 1	Area 2
Acoustic Survey		
Length of Lines	305.0 n.m.	3223.4 n.m.
Seafloor Observation		
Side Scan Sonar (SSS)		
Number of Lines	3	2
Length of Lines	9.9 n.m.	19.4 n.m.
Deep Tow Camera (FDC)		
Number of Lines	7	7
Length of Lines	5.4 n.m.	13.0 n.m.
Number of Photos	1068 sheets	1534 sheets
Sampling		
Number of Stations		
Large Corer (LC)		3
Chain Bucket Dredge (CB)		3
Recovered Amounts		
Rock		97 kg
Sediment		3 kg
Drilling (BMS)		
Number of Stations		5
Drilling Length		9.1 m
Recovered Core Length		
Rock		152 cm
Sediment		31 cm