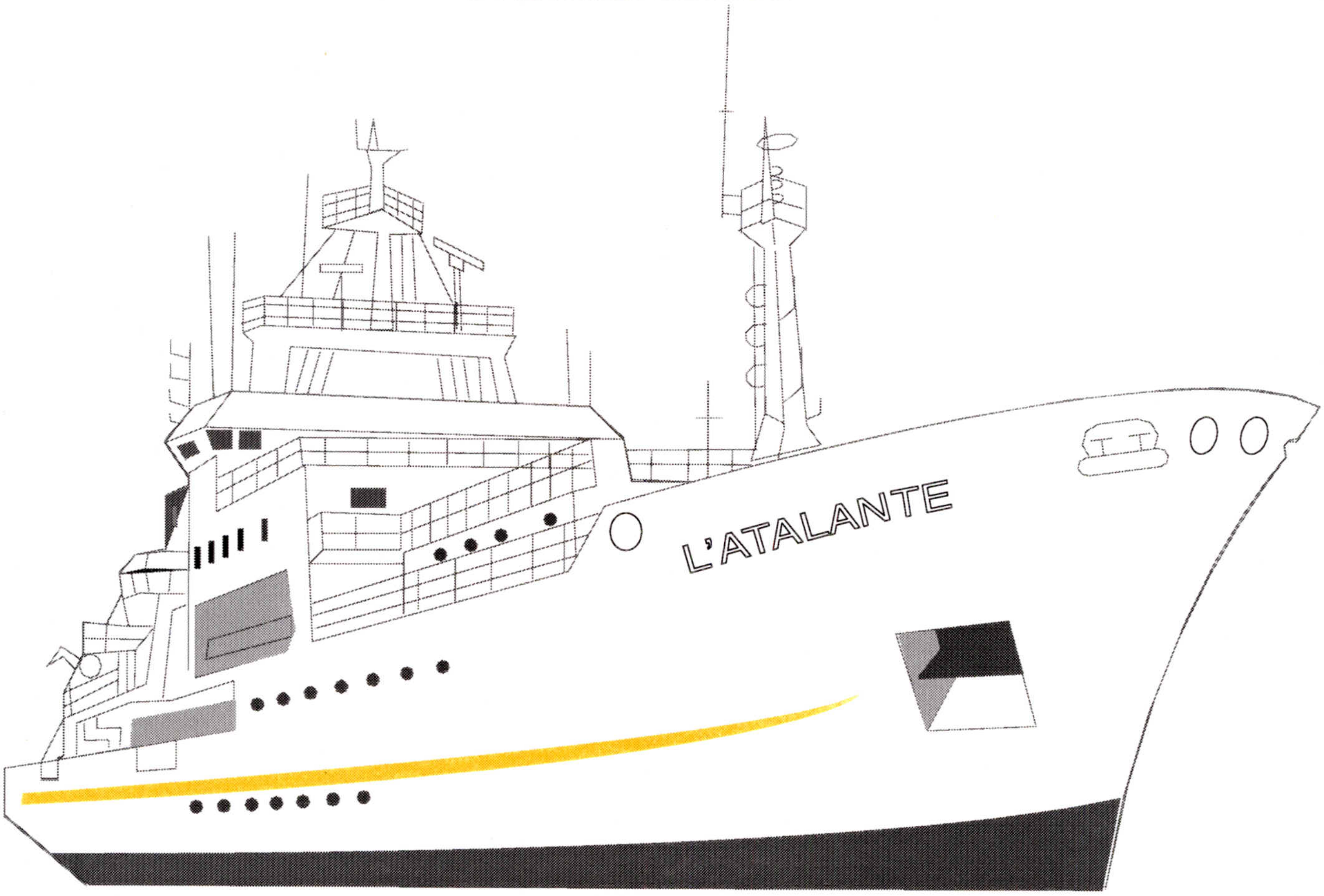
SOPACMAPS
PROJECT

FINAL REPORT

MALAITA



SOPAC Technical Report 194

EXECUTIVE SUMMARY

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The SOPACMAPS Project was designed to investigate as much area as possible of the EEZs of the SOPAC member countries: Solomon Islands, Vanuatu, Fiji and Tuvalu.The main objectives were to map the bathymetry, investigate the resource potential and to study geological processes, including geological hazards. A total area of approximately 730,000 km^2 was mapped during a total of 87 days at sea, using the Dual Multibeam Swath echosounder on the research vessel *L'Atalante*, operated by IFREMER under contract to SOPAC and funded by the European Union.

The data are a very important source of information for the understanding of the nature of the seafloor of the South Pacific, and establish an understanding of seafloor process and resources at a level which could not have been imagined as recently as 20 years ago.

During the three legs of 29 days each, multibeam (bathymetry and acoustic imagery), 6-channel reflection seismic, magnetics, gravimetry and sub-bottom profiler data were collected along 439 profiles totalling 15,680 nautical miles.

All data are of very fair to excellent quality. Preliminary reports and on-board processed charts at 1:250,000 scale were delivered to SOPAC shortly after each leg. Reprocessing of the data by IFREMER produced several sets of charts: navigation, bathymetry and acoustic imaging at 1:250,000 scale, and bathymetry, acoustic imaging and morpho-structural interpretation at 1:500,000 scale.

Interpretation of the data, conducted for SOPAC by IFREMER and ORSTOM, produced comprehensive final reports focused on eight areas:

- Central Solomon Trough,
- Malaita Area,
- Melanesian Arc Gap Area,
- North New Hebrides Back Arc Area,
- New Hebrides Intra-Arc Basin,
- Pandora Bank Area,
- Alexa/Charlotte Banks Area,
- South Tuvalu Banks Area.

This report describes the results obtained on the MALAITA Area which is located in Solomon Islands EEZ, between Central Solomon Trough (CST) to the west, and Melanesian Arc Gap (MAG) to the east.

The SOPACMAPS study allowed to obtain precise and extensive data in the Solomon Islands economic zone. Over MALAITA Area, located on the ancient boundary of the Australian and Pacific plates, we have now a fair bathymetric map on the east coast of Malaita. The Indispensable Basin, on the west side is not fully covered but the slopes from 1,000 m to 1,500 m in depth are well documented.

The SOPACMAPS cruise seismic profiles indicate that the North Solomon Trench is infilled by a 1 to 2 thick sedimentary cover dipping to the south. This dipping could be interpreted as a small amplitude present-day deformation within the southwestward dipping North Solomon Trench. Some indication of gentle folding have been observed at the foot of Malaita margin.

The major part of the Malaita margin is constituted by deformed alternation of highs and lows joining the northern Malaita Island with the Ulawa zone. This deformed zone is cut by an important NS fault at 162°E. This fault separates the Malaita Anticlinorium from the 6,000 m-deep nodal trough created by the junction between the North Solomon and Cape Johnson trenches.

The two flanks of the Malaita Anticlinorium are different as, for example, Indispensable Basin and adjacent basins show a greater amount of sediments, than in the eastward basins.

The SOPACMAPS cruise was mainly designed for bathymetric purpose and the profiles were run for the maximum of efficiency of the multibeam EM12 echosounder of the *R/V L'Atalante*. Nevertheless, seismic reflection profiles recorded continuously, in conjonction with magnetism and gravity, give valuable informations allowing to discuss the deep structure of the area in term of potentialities.

In the field of living resources, the major target is constituted by the summit of the central ridge which is characterized by water depths less than 1,000 m.

Polymetallic nodules are probably non existent in the area, but polymetallic crusts may be present on the summits of the central ridge.

The confirmation of oil potential in places such as the 3,000 m deep graben located immediately east of the Malaita Island, the Indispensable Basin needs additional and specific multichannel seismic survey.

Geological hazards are important in Malaita Area; they are related to the central volcanic ridge and the slides triggered by volcanic activity and associated earthquakes.

A scarce shallow seismicity is present in the region, but quite less intensive than on the southwest Guadalcanal and south San Cristobal coasts in association with the present subduction.

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INTRODUCTION

1.1 - SOPACMAPS PROJECT PRESENTATION

A contract for the SOPAC (SOuth Pacific Applied geosciences Commission), swath mapping project funded by the EEC (Lome III - European Development Fund n° 6) known as SOPACMAPS, was awarded to IFREMER (Institut Français de Recherche pour l'Exploitation de la MER), the French government research organization that operates the new high-tech oceanographical research vessel *L'Atalante*.

The tender process saw six bids received for the work. Of these, three bids stood out. EEC procedures ruled one of these ineligible, narrowing the final selection down to two. IFREMER's bid was found to be the most technically competent and was recommended by SOPAC and accepted by the EEC.

The 85 m R/V*L'Atalante*, launched in 1990, was built specifically for swath mapping surveys and carries a dual Simrad EM12 multibeam bathymetric system.

The dual EM12 system produces 160 cross-track beams of 1° angle which radiate from hull mounted transducers. These provide depths over a swath of up to 5 times the water depth. The ship surveys at a speed of 10 knots, or more under the right conditions. An associated acoustic side-scan imagery is obtained in the same time.

The ultimate purpose of the SOPAC seabed swath mapping project is to gain an accurate and reliable assessment of the potential living and non-living resources of selected areas of the ocean floor within the EEZs of Fiji, Solomon Islands, Tuvalu and Vanuatu.

In order to produce the complete scientific study with interpretative maps and geological reports, acoustic side scan imagery and multi-beam bathymetric profiles of the seafloor were needed, along with high resolution 3.5 khz sub-bottom profiles, 6-channel seismic reflection, gravity and magnetic data. These data and images had to be fully processed and co-registered on mosaics.

The schedule of the cruises was:

* **Leg 1** - 19 July in Noumea (New Caledonia) to 15 August 1993 in Honiara (Solomon Islands),
* **Leg 2** - 19 August in Honiara (Solomon Islands) to 16 September 1993 in Suva (Fiji),
* **Leg 3** - 22 September in Suva (Fiji) to 20 October 1993 in Noumea (New Caledonia).

The swath mapping and geophysical data collected by R/V *L'Atalante* were processed and interpreted by teams of French scientists belonging to IFREMER, ORSTOM and French Universities..

The SOPACMAPS project was managed at IFREMER by Guy PAUTOT (from the beginning of the project to the end of 1993) and Raymond LE SUAVÉ in 1994, both from the "Départément Géosciences Marines" at IFREMER Brest.

1.2 - PRELIMINARY NOTES

1.2.1 - Sheet assemblage

Prior to the at-sea operations, a sheet assemblage (at 1/250,000 scale - see Fig. 1.4) was established and used during the survey and for the processing of the first set of charts (that is: navigation, bathymetry and acoustic imagery).

For the final report, and with the on-board SOPAC Representatives' agreement, a new sheet assemblage was adopted; it covers eight areas at a 1/500,000 scale (see following table and Fig. 1.5). This 1/500,000 sheet assemblage was defined so as to take into account the main structural and regional units and to facilitate the presentation of the data.

For legibility reasons, the Central Solomon Trough is not presented at the 1/500,000 scale, but in three sheets named:

- New Georgia Sound (scale 1/250,000),
- Mborokua Basin (scale 1/150,000),
- and Iron Bottom Sound (scale 1/100,000).

Note that the legend block was added after the sheet assemblage was done and all the basic bathymetry processing was completed; so that the over-all format of the charts, legend blocks included, exceeds the AO size.

CST	Central Solomon Trough
MALAITA	Malaita
MAG	Melanesian Arc Gap
NNHBAA	North New Hebrides Back Arc Area
NHIAB	New Hebrides Intra-Arc Basins
PBA	Pandora Bank Area
ACBA	Alexa/Charlotte Banks Area
STBA	South Tuvalu Banks Area

- Abbreviations and names of the 8 studied areas - (see Fig. 1.5)

1.2.2 - Specific aspects relative to the coastline

The basic coastline files were provided by SOPAC, and the files format adapted by IFREMER for the charting processing. It was observed in several places that the coastline was not consistent with the ship positioning accuracy. Assuming that the GPS positioning accuracy during the survey period was around 100 to 150 metres, a few corrections of land masses were proposed to SOPAC and introduced during charting processing.

Three coastline shift modes have been used:

mode a: when possible, the radar position of at least one remarkable point of the coast was calculated and the correction made;

mode b: when the original landmass position was in obvious overlap with the surveyed area, and considering the GPS positioning accuracy, the best landmass position was decided, taking into account the shape of the coastline and the observed submarine morphology; these considerations resulting in a shift ofthe landmass as a whole;

mode c: in one case (see below), there was not enough room available to move the landmass; in this particular case, it was supposed that the coastline section position concerned is doubtful.

Charts concerned by the coastline modifications:

◊ **Melanesian Arc Gap:**

Tinakula Island	:	3.8 nm shift to N72°E (mode b)
Nukapu Island	:	4.2 nm shift to N67°E (mode b)
Nupani Island	:	4.2 nm shift to N67°E (mode b)

◊ **Malaita:**

Ulawa island	:	2 nm shift to N115°E (mode b)

Maramasike : the south termination of Malaita overlaps with the bathymetric survey; as there is no place for a satisfactory shift, the coastline must be considered as doubtful and has consequently been presented as a dashed line (mode c).

◊ **Mborokua Basin:**

Mborokua Island	:	0.7 nm shift to East (mode a)

◊ **New Hebrides Intra Arc basin:**

Aoba Island	:	1.4 nm shift to North (mode b)

IMPORTANT

1) The geodetic positioning of the landmasses is not one of the objectives of the SOPACMAPS survey, and it must be stressed that the proposed new position of a few islands corresponds only to an optimal adjustment based on the three different modes listed above;

2) The landmasses shifted positions are the same for the different charts; nevertheless, and due to specific technical problems (incompatibility between the vector and raster computer formats), it was not possible, within the available time, to bring the same landmass modifications to the acoustic imagery charts.
The same difficulty occured for the size of lettering (text of the legend block, positions) which are different for navigation, bathymetry charts and the acoustic imagery charts.

3) **The charts produced during the SOPACMAPS survey are not marine charts and these charts must not be used for navigation.**

	Date		Ports of call		Average speed (knots)
	Start	End	From	To	
LEG 1	18/07/93 (08:31)	15/08/93 (01:09)	Noumea	Honiara	10.43
LEG 2	19/08/93 (05:20)	16/09/93 (03:35)	Honiara	Suva	8.45
LEG 3	22/09/93 (21:48)	20/10/93 (04:30)	Suva	Noumea	10.33
TOTAL	18/07/93 (08:31)	20/10/93 (04:30)	Noumea	Noumea	9.74

	Duration				
	Transit	Profiles	Data collecting	Manoeuvring	Total at sea
LEG 1	1 day 08 h 14 mn	23 days 21h 28 mn	25 days 05 h 42 mn	3 days 10 h 56 mn	**28 days 16 h 38 mn**
LEG 2	2 days 10 h 28 mn	23 days 18 h 46mn	26 days 05 h 14 mn	2 days 17 h 11 mn	**28 days 22 h 15 mn**
LEG 3	4 days 06 h 03 mn	21 days 23 h 54 mn	26 days 05 h 57 mn	2 days 01 h 45 mn	**28 days 07 h 42 mn**
TOTAL	8 days 00 h 45 mn	69 days 16 h 08 mn	77 days 16 h 53 mn	8 days 05 h 52 mn	**85 days 22 h 35 mn**

	Number of lines*		Distance N.m.		Number of Sippican Probes
	Transit	Profiles	Transit	Profiles	
LEG 1	6	214	380.91	5,577.72	30
LEG 2	4	110	439.29	5,420.40	44
LEG 3	11	115	1,099.12	4,686.07	45
TOTAL	21	439	1,919.32	15,684.19	119

** Bathymetry, acoustic imagery and seismic lines.*

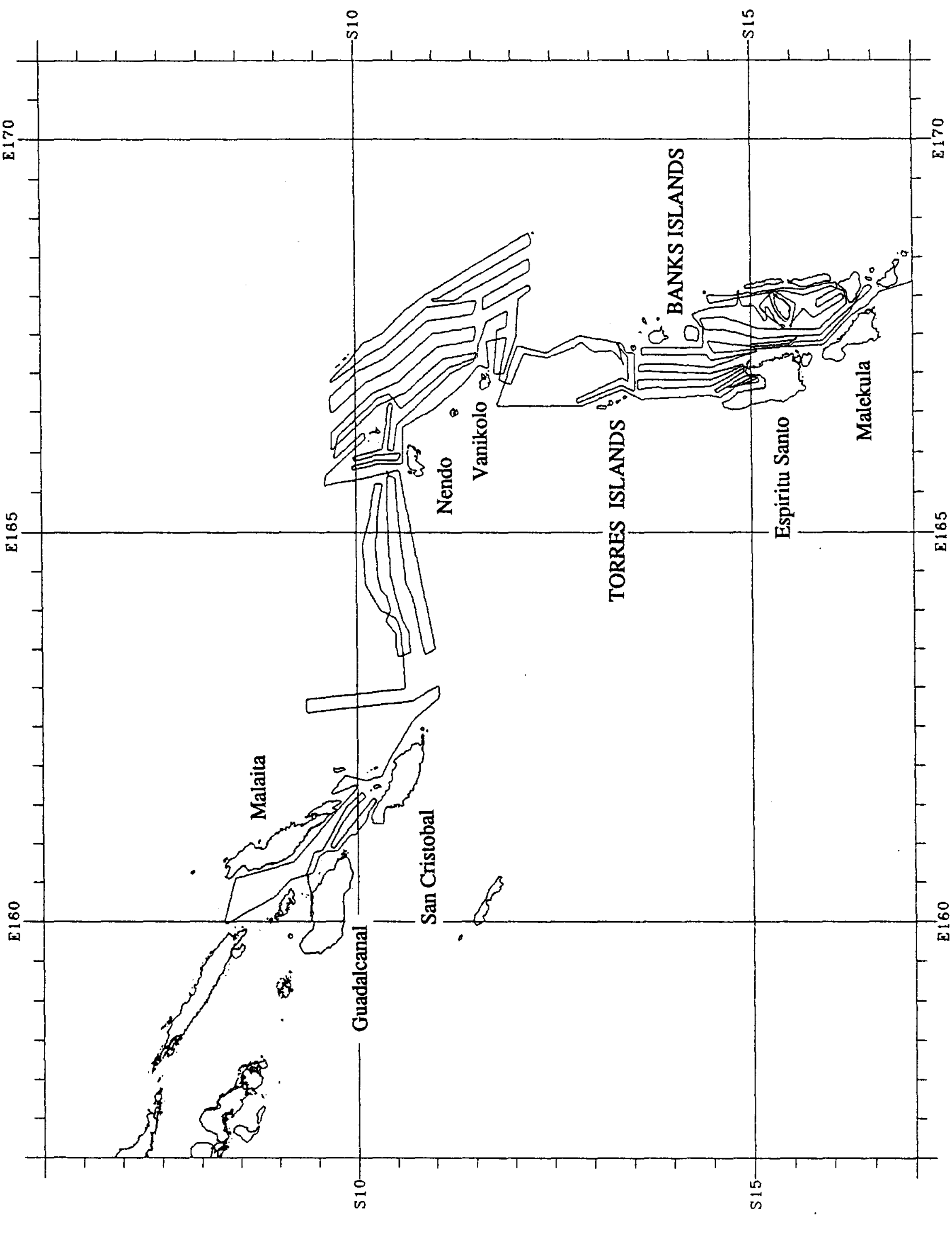


Fig. 1.1 - General navigation map of SOPACMAPS - Leg 1

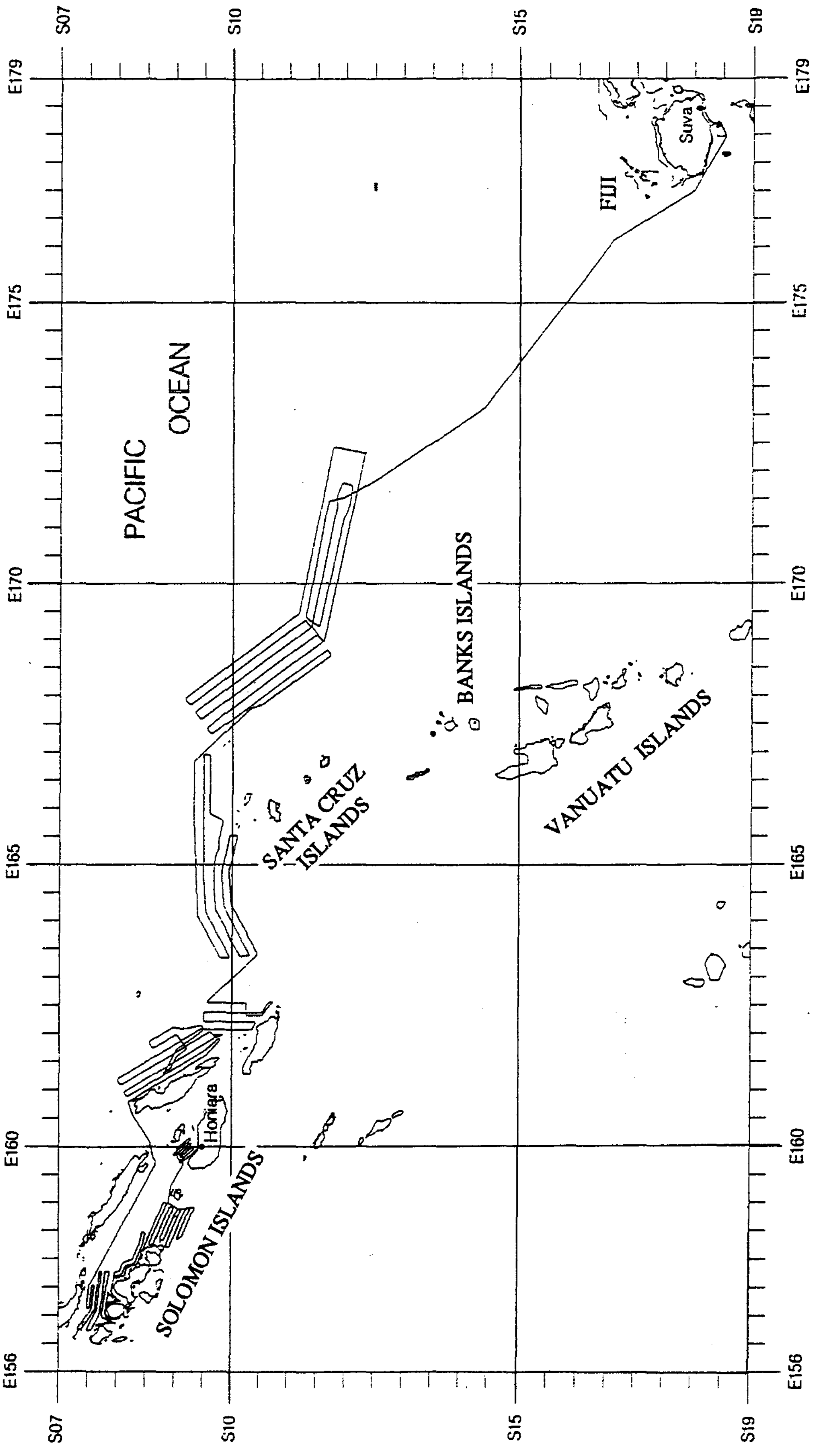


Fig. 1.2 - General navigation map of SOPACMAPS - Leg 2

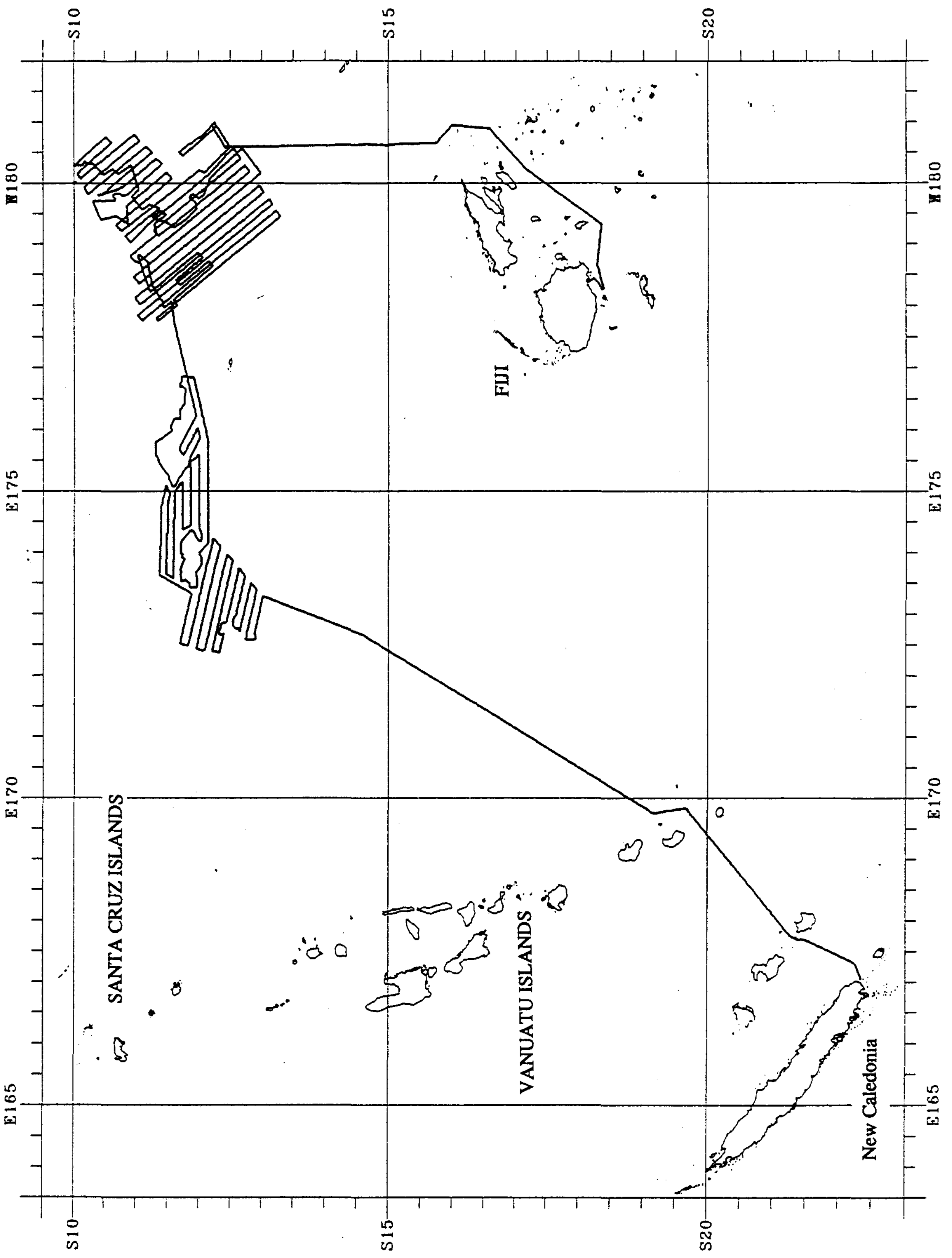


Fig. 1.3 - General navigation map of SOPACMAPS - Leg 3

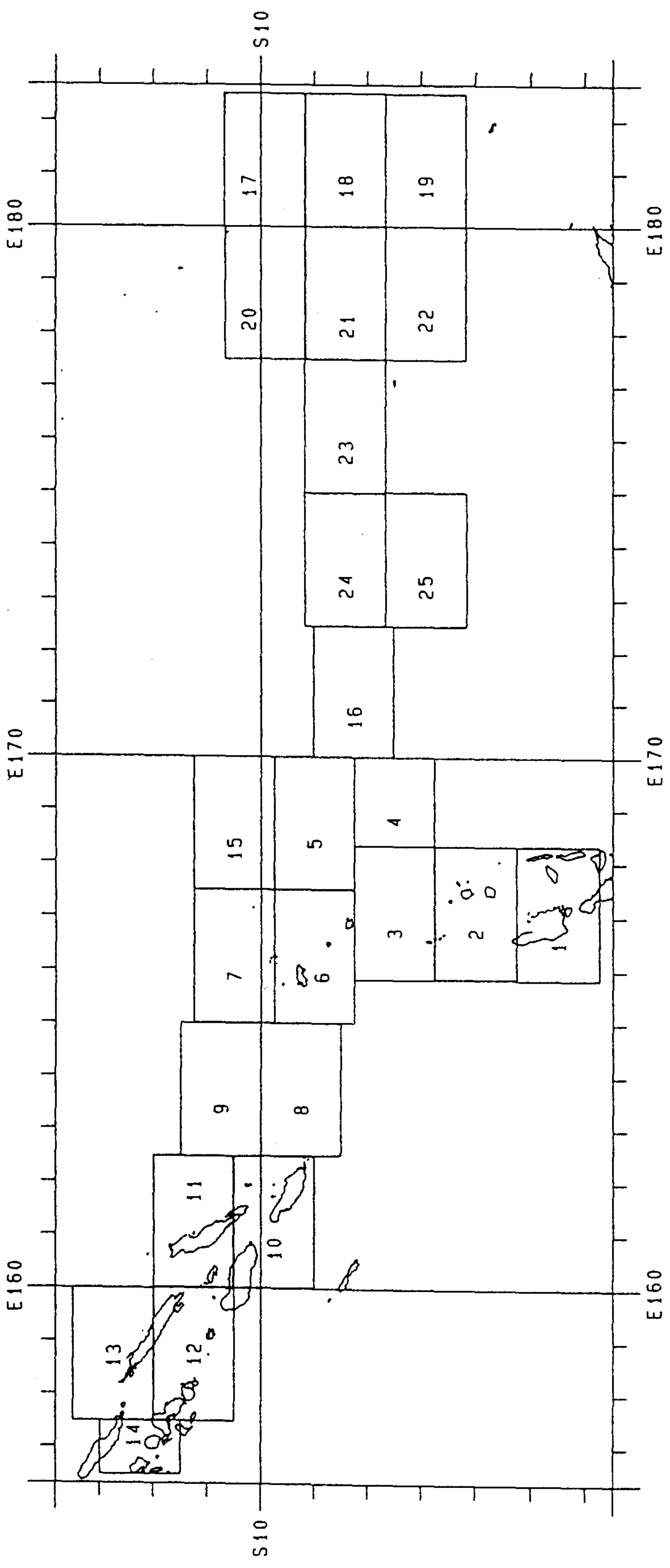


Fig. 1.4 - General sheet assemblage (1/250,000)

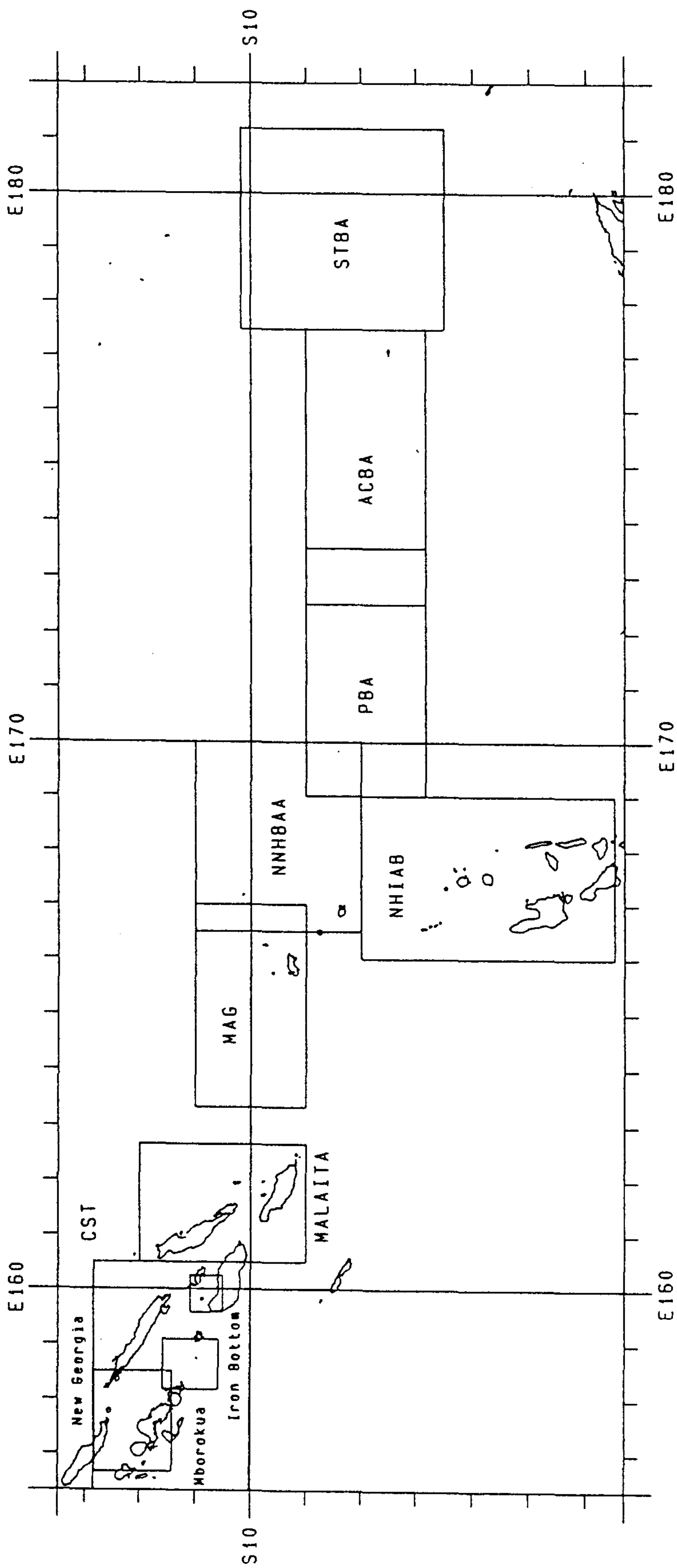


Fig. 1.5 - General sheet assemblage (1/500,000 and details)

GEOLOGICAL FRAMEWORK

CHAPTER 2

GEOLOGICAL FRAMEWORK

2.1 - REGIONAL SETTING: THE SOUTHWEST PACIFIC

The Southwest Pacific (Fig. 2.1 and 2.2) is bounded westwards by Australia, northwards and eastwards by a succession of islands different in size and nature, and southwards by New Zealand. Morphologically, it is characterized by successive submerged ridges surrounding the eastern Australian continent, separated by basins of depths that are less than large oceanic basins. Structurally, this large zone, lying between the Australian continent and the deep Pacific Ocean, is often described as a "transitional" zone where the crust is not clearly either continental or oceanic. However, recent studies, especially from satellite altimetric data, could show the oceanic or continental nature of different features. In terms of plate tectonics, the present situation has resulted from the evolution, in time and space, of the boundaries between the Indo-Australian Plate and the Pacific Plate. The present boundary is well defined by shallow seismicity (Fig. 2.3a and 2.3b) at active subduction zones and more diffuse seismicity in active marginal basins, but fossil boundaries are more or less recognizable, depending on their age (Récy and Dupont, 1982).

2.1.1 - Present plate boundaries

According to the model of global plate tectonics established by Minster *et al.,* (1974) from magnetic lineations, the Indo-Australian and Pacific plates are converging in a relative motion about a rotation pole situated at 59°8'S latitude and 178°E longitude. This convergence implies the subduction of one plate under the other, but the situation is complicated as in the northern part of the region, the Indo-Australian Plate is sliding under the Pacific Plate, while in the south-eastern part, it is the other way round. These two opposite subduction polarities are accommodated by a borderland pattern of microplates, transform faults and active spreading ridges recently revised by Pelletier and Louat (1989) (Fig. 2.4).

2.1.2 - Subduction of the Pacific Plate

The subduction of the Pacific Plate occurs at the Tonga-Kermadec Trench with a rate of plate convergence decreasing from north to south, in accordance with the position of the pole of rotation of the two plates. The subduction rate, very high in the northern part, is subject to no linear variations explained by the activity of the Lau and Havre back-arc spreading centers.

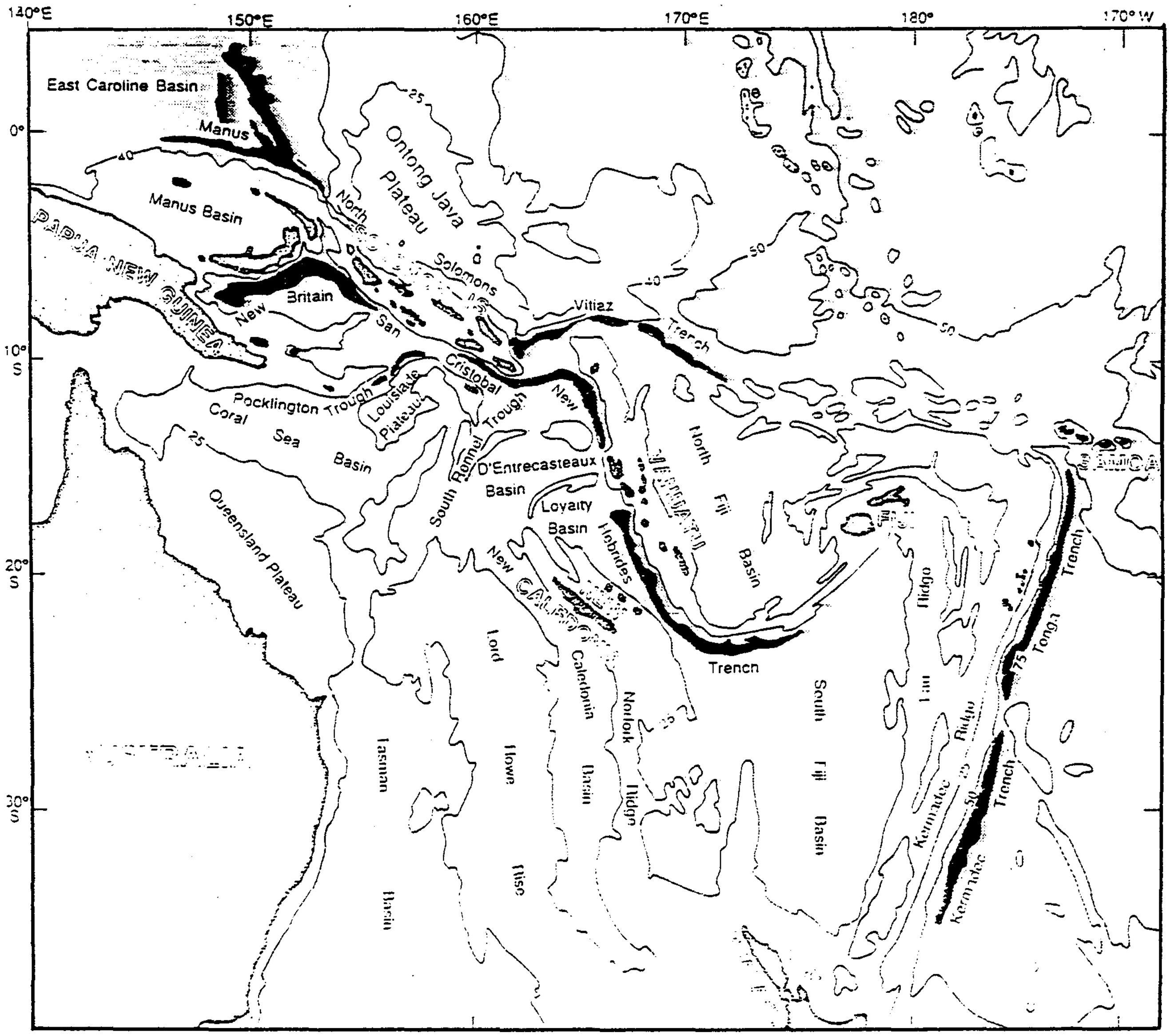


Fig. 2.1 - General map of the Southwest Pacific region

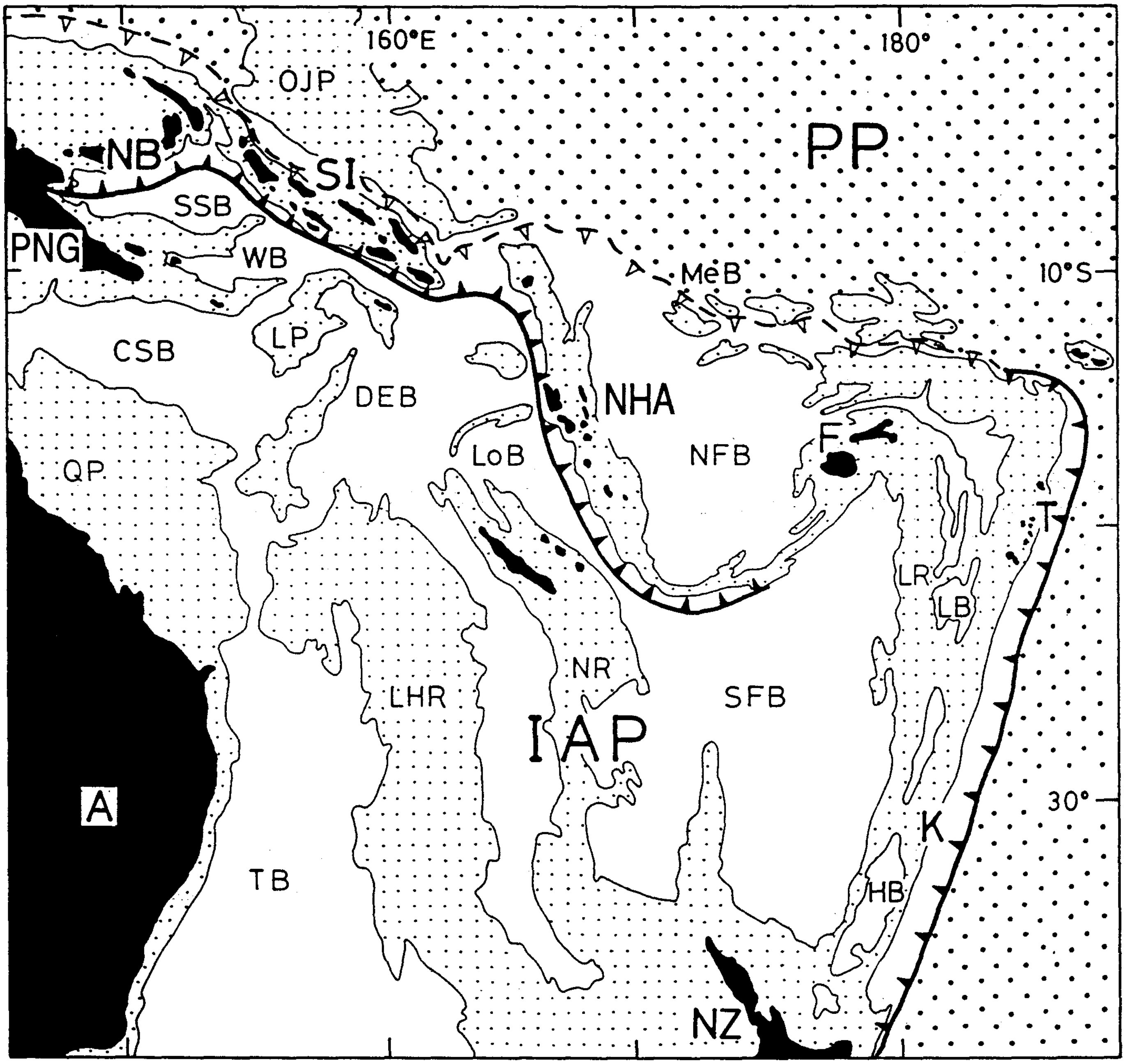


Fig. 2.2 - Morphotectonic map of the Southwest Pacific
(Bathymetric contour is the 2,500 m isobath)

Coarse dotted area*: oceanic crust of the Pacific Plate ;*
Fine dotted area: *arcs, ridges and plateaus ;* ***White area:*** *marginal basins.*

IAP: Indo-Australian Plate	PP: Pacific Plate	A: Australia
PNG: Papua New Guinea	NB: New Britain	SI: Solomon Islands
NHA: New Hebrides Arc	MeB: Melanesian Borderland	T: Tonga
K: Kermadec Island	NFB: North Fiji Basin	F: Fiji
SFB: South Fiji Basin	LR: Lau Ridge	LB: Lau Basin
HB: Havre Basin	NR: Norfolk Ridge	LoB: Loyalty Basin
LHR: Lord Howe Rise	TB: Tasman Basin	OJP: Ontong Java Plateau
DEB: D'Entrecasteaux Basin	LP: Louisiade Plateau	CSB: Coral Land Plateau
SSB: Solomon Sea Basin	WB: Woodlark Basin	QP: Queensland Plateau

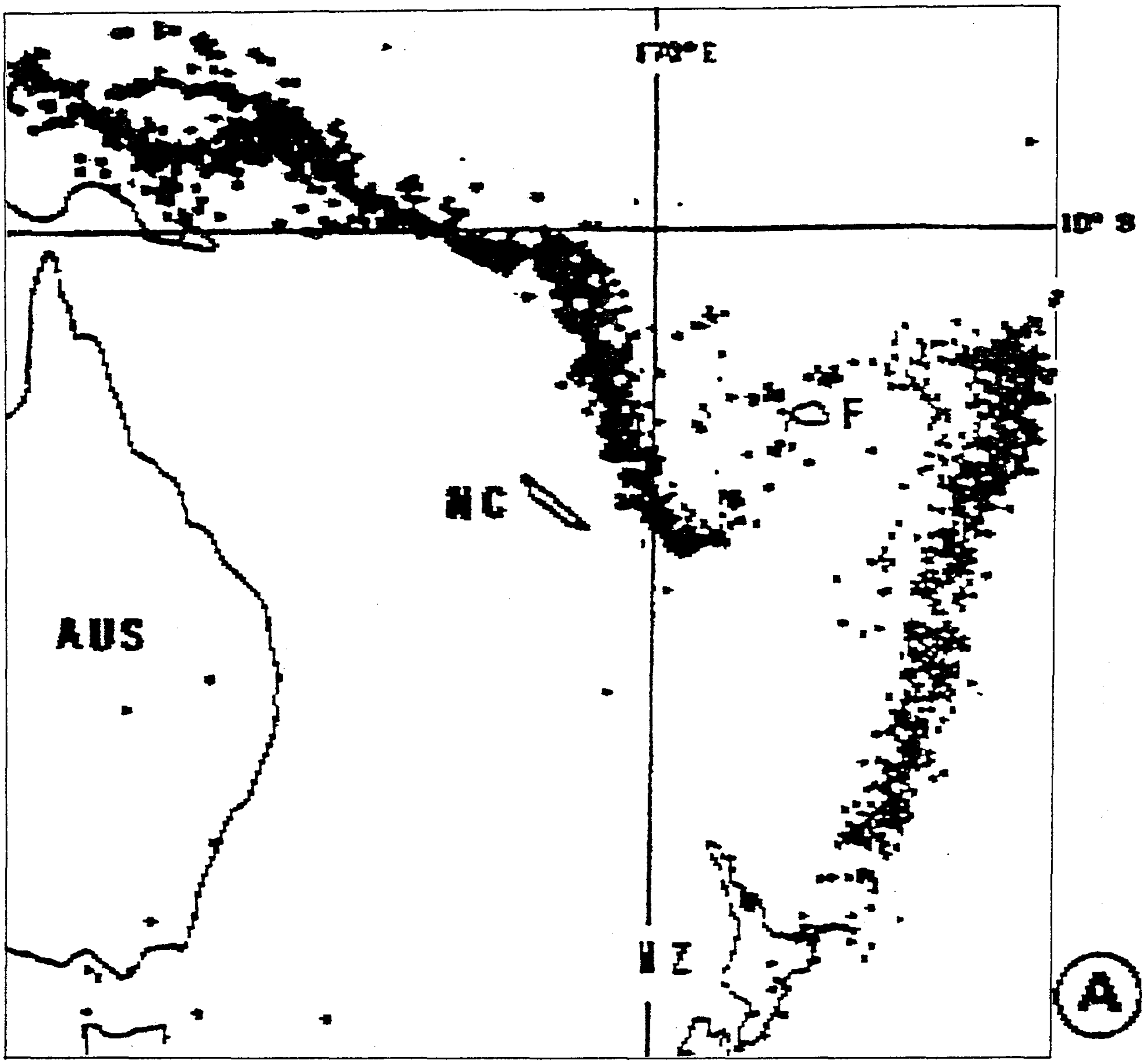


Fig. 2.3a - Shallow seismicity of the Southwest Pacific (0-100 km)

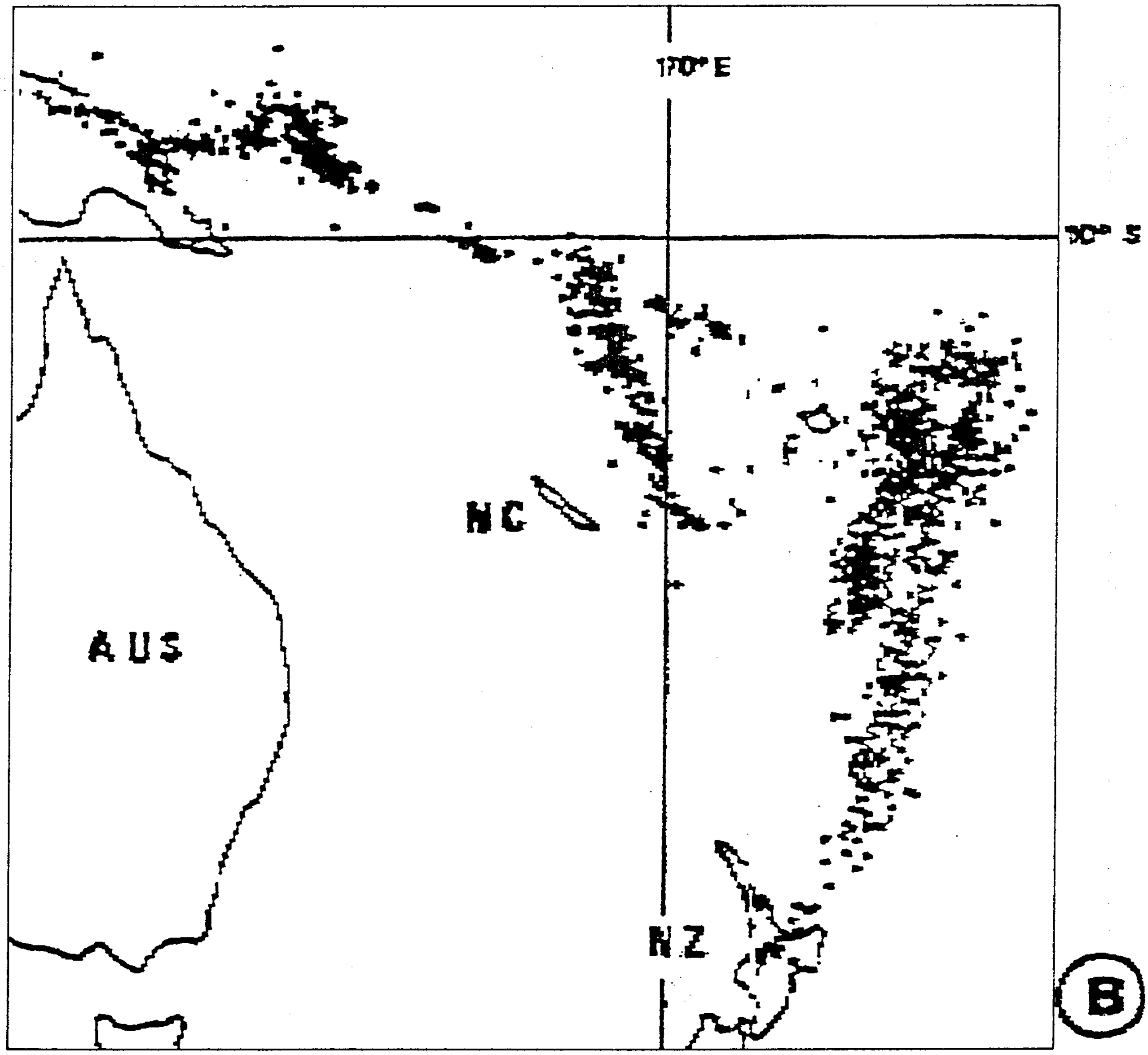


Fig. 2.3b - Intermediate and deep seismicity of the Southwest Pacific (100-700 km)

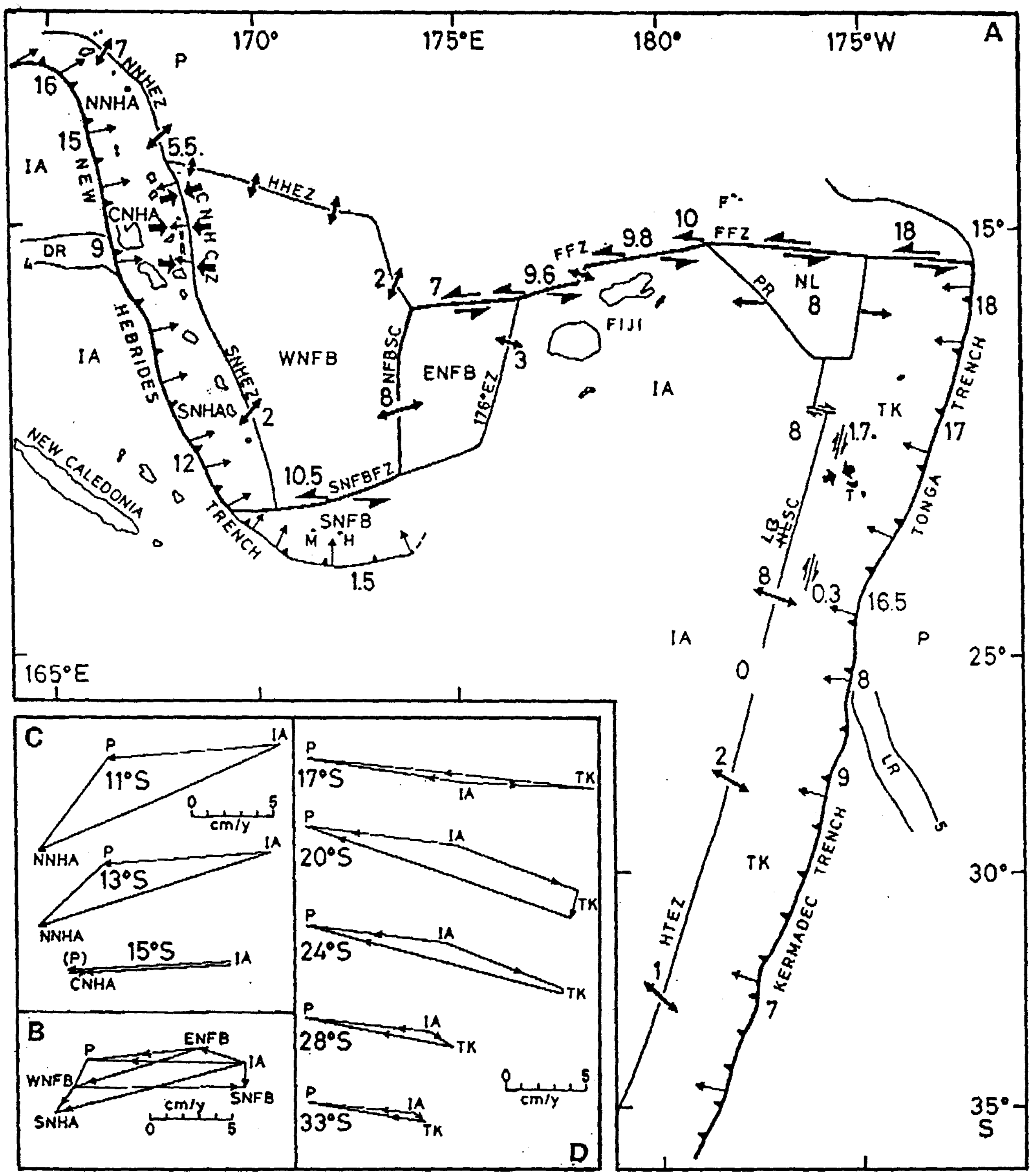


Fig. 2.4 - Proposed quantitative model for present-day relative motions in the Southwest Pacific

(Pelletier and Louat, 1989)

A : map showing the plate boundaries and the relative motions.
B : vectors diagrams for motions.

This subduction zone is generally considered to have been continuously active for the past 20 My. Pleistocene to Recent volcanism related to the Tonga-Kermadec subduction is evidenced by a discontinuous volcanic line, parallel to the trench, extending southwards into the continental North Island of New Zealand.

2.1.3 - Subduction of the Indo-Australian Plate

Subduction of the Indo-Australian Plate occurs along the New Britain, Solomon Islands and New Hebrides arc systems.

New Guinea Island Arc

Although westwards the seismicity is diffuse, resulting from a complex left-lateral shear/collision motion, the subduction is evidenced in the eastern part of the main island of Papua New Guinea by the intermediate depth seismicity distributed along a plane dipping northwards to a depth of 200 km. The presence of Quaternary to Recent volcanic islands and submarine volcanoes, north of the coast of New Guinea, confirms this hypothesis.

New Britain Island Arc

New Britain Island is bounded southwards by a deep trench and is affected by intense seismic and volcanic activity. The trench axis marking the plate boundary between the South Bismarck Sea Plate and the Solomon Sea Plate trends roughly along the arc of a small circle centred on the pole of rotation of the Indo-Australian and Pacific plates. Relative plate motion should be transcurrent, but the distribution of the intermediate-depth earthquakes along a plane dipping northwards to a depth of 200 km suggests a true subduction, accounted for not only by the single relative motion vector of the two major plates but also by the existence of several small micro-plates with boundaries related to small marginal basins.

Solomon Island Arc

The Solomon Island subduction zone is a good example of oblique subduction where the downgoing plate is also subject to lateral slippage. In the northern and central parts of the arc, most focal mechanisms solutions show that the earthquakes result from stress affecting the lithosphere through dip and the maximum depth of the Benioff zone associated with that subduction reaches 200 km. In the southern part of the arc, the number of earthquakes resulting from a lateral slippage increases and the deepest are only at a depth of 100 km. The N74E trend of the slip is very close to the theoretical trend of the plate boundary as inferred from the Minster *et al.,* (1974). The Quaternary volcanic activity related to the subduction has created the western islands of the archipelago and is surimposed on some older islands resulting from a previous history. This region was surveyed during the Australia-New Zealand-United States Tripartite Project (1982-1986) and reported by Vedder *et al.,* (1986) and, Vedder and Bruns (1989).

New Hebrides Island Arc

The New Hebrides Island Arc extends for a distance of 1,700 km from the Santa Cruz Islands in the north to Matthew and Hunter Islands in the south. Continuous seismicity defines a plane dipping at 60° and with a maximum depth of about 350 km in the the northern part, but not exceeding 170 km in the far southern part. A high rate of subduction (up to 15 cm/year in the north) follows from the combination of the convergence of the two major plates in opposite subduction zones at trenches and the actively spreading marginal basin system of the North-Fiji Basin. The geology and offshore resources of Vanuatu were studied during the Tripartite Project (Greene and Wong, 1988).

2.1.4 - The active marginal basins

The marginal basins of the region vary in size but are very important in the general plate tectonic pattern of the region, accounting for the variations in trends and rates of the subduction as well for differences in the rate of motions with theoretical models.

The basins of the Bismarck Sea

Plate motions in the northwestern region of the Southwest Pacific are accommodated by two marginal basins: the active Manus Basin and the New Guinea Basin separated by the Willaumez-Manus Rise. These basins can be considered, with the fore-arc Woodlark Basin, as responsible for the subduction in the New Britain and New Guinea Trenches. The study of the New Ireland and Manus region was the subject of a volume (Marlow *et al.,* 1988) reporting the results of the Tripartite Project (1982-1986).

The Woodlark Basin

The Woodlark Basin is a good example of very oblique subduction of an active spreading center beneath an island arc (the Solomon Islands Arc), which was surveyed during the Tripartite Project (Taylor and Exon, 1987).

The North Fiji Basin

The North Fiji Basin is the largest in size and possibly the most complex of the active marginal basins of the region. Originally named North Fiji Plateau because of its relative shallow depth, which does not exceed 3,000 m, this basin is the key-feature accounting for the two opposite subductions of the New Hebrides and Tonga arcs. Its active spreading ridge system is now well-defined in most parts although some links have still to be mapped (Auzende *et al.,* 1988a; Louat and Pelletier, 1989; Pelletier and Louat, 1989). It is thought to have developed as a consequence of the clockwise migration of the New Hebrides Island Arc from a west-east trending position along the Vitias paleo-arc, a relict of a former Indo-Australian and Pacific plate boundary. A study of the northern part of that basin, known as the "Melanesian Borderland", is one of the purposes of the present work.

The Lau-Havre Basin

The Havre Basin is a narrow trough, broadening in its northern part to the Lau Basin, which depths range generally from 2,000 to 3,000 m. The spreading rates vary from 1 cm/year in the south up to no less than 8 cm/year in the Lau Basin (Pelletier and Louat, 1988), due to the distance to the pole of rotation of the plates and adjustments induced by second order features.

2.2 - THE NEW HEBRIDES ISLAND ARC

The New Hebrides Island Arc system extends from the northern Santa Cruz Islands to the Matthew and Hunter Islands in the south (Fig. 2.5). The arc is structurally segmented into three parts (Ravenne *et al.,* 1977). From west to east , the northern and southern parts consist of a deep trench, a summit platform basin especially extended in the northern area, an active volcanic chain, and a series of north-south troughs in the back arc area. In the central part, the arc has been significantly affected by two geodynamic events: the collision of the d'Entrecasteaux Zone which is resisting subduction in the New Hebrides Trench; and the opening of the North Fiji Basin, a marginal basin on the east side of the arc (Auzende *et al.,* 1986; 1988). The d'Entrecasteaux Zone is a ridge and basin system (Collot *et al.,* 1985; Collot and Fisher, 1991) on the eastward-subducting Indo-Australian Plate.

The summit basin on the northern arc platform is called the Torres-Santa Cruz or Vanikoro Basin (Fig. 2.6). Thick, probable mid-Miocene to Holocene sediments fill this basin and lap onto an eastern volcanic ridge and a western upbowed arch of older folded, faulted, and carbonate-capped sedimentary rocks. The western arch is deformed by horsts and grabens along a primary 100 km long, northwest-trending, fault zone. A secondary, 50 km long fault zone across the southern basin appears to truncate the primary fault zone. This latter fault seems to be recently active and could result from the impingement of the West Torres Massif, on the Indo-Australian Plate, against the New Hebrides Arc just north of Espiritu Santo (Greene *et al.,* 1988).

The central arc segment differs significantly from the north and south parts of the arc in that:

1) the trench is absent where the d'Entrecasteaux Zone collides with the arc;

2) unlike the other segments, no back-arc troughs are present (Récy *et al.,* 1990);

3) a deep basin, the Aoba Basin, is located between two older parts of the arc on the east and west in this central segment. The Aoba Basin is limited by a western volcanic belt of late Oligocene to middle Miocene age (Espiritu Santo and Malekula Islands), an eastern volcanic belt of late Miocene to Pliocene age (Maewo and Pentecost Islands) (Mitchell and Warden, 1971), and is divided into the North and South Aoba Basins by Aoba Island. Along with Aoba Island, the islands of Santa Maria on the south of the basin, and Ambrym on the north, are currently active volcanoes of the present volcanic arc which began in the Pliocene. These volcanoes are located on lineaments (fracture zones) which transect the arc (Greene *et al.,* 1988). The growth of Aoba volcano led to different evolutions of the North and South Aoba Basins since the Pliocene.

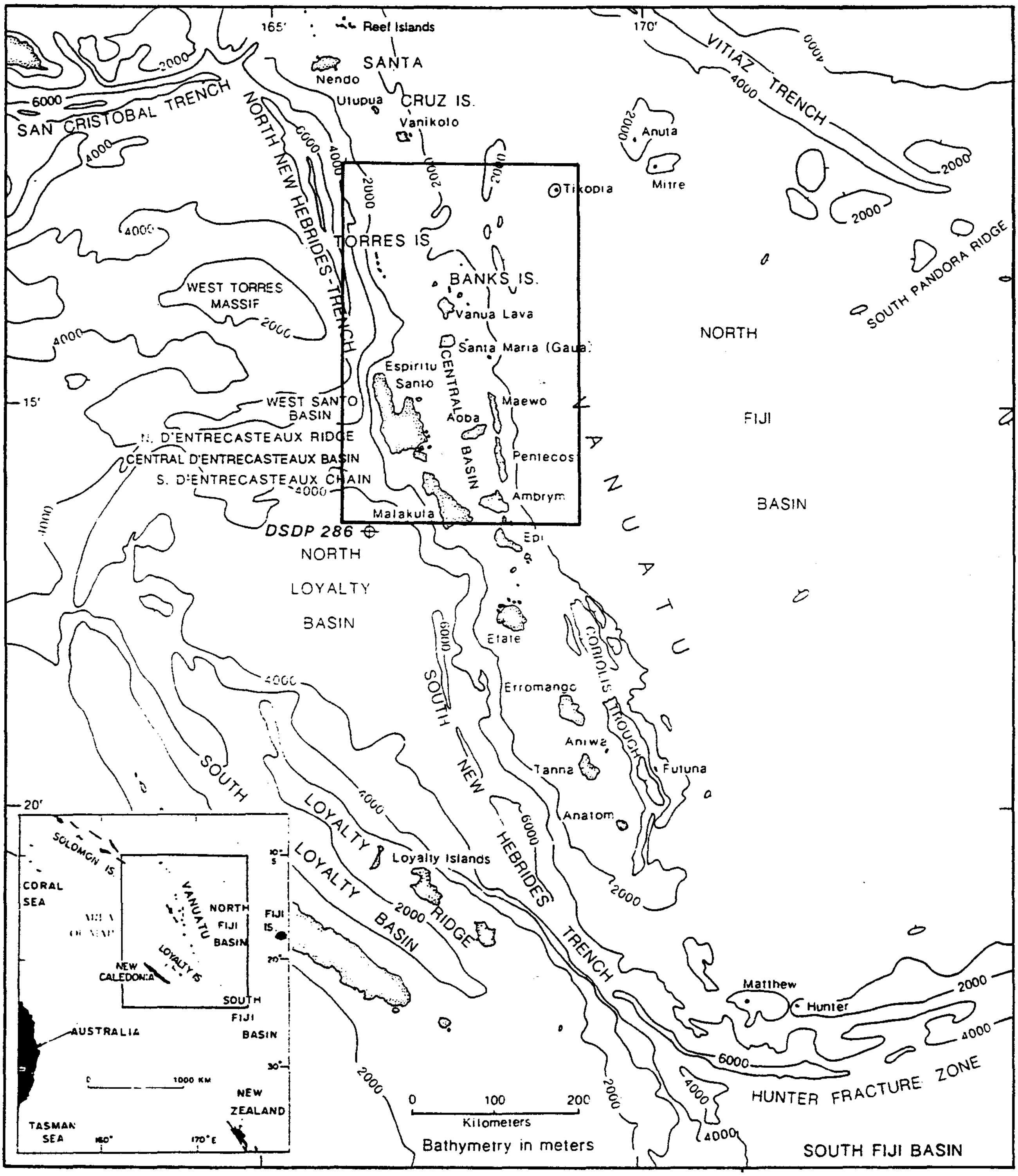


Fig. 2.5 - Bathymetric map of the New Hebrides Arc and location of the NHIAB sheet

(from Kroenke, Jouannic and Woodward, 1983)

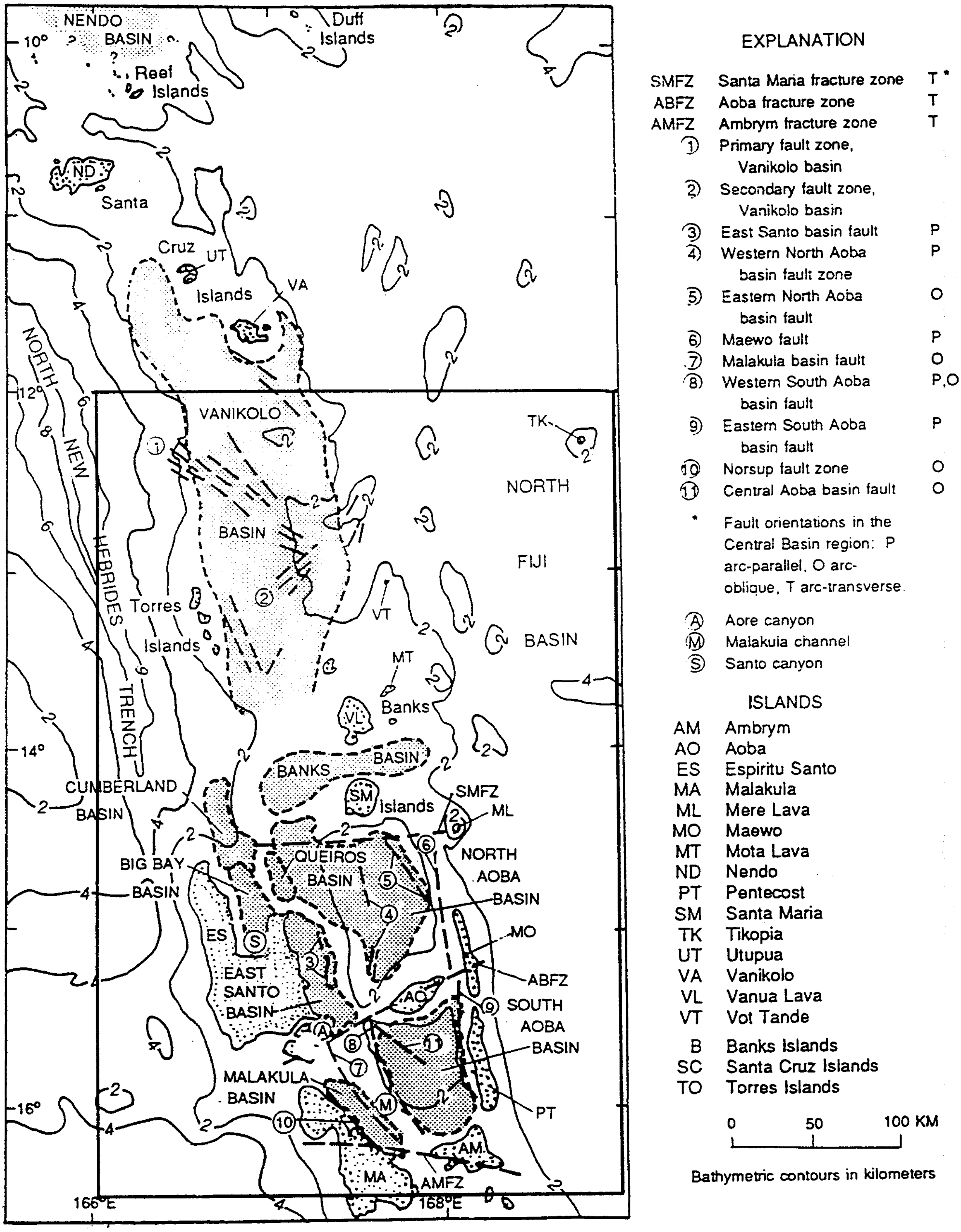


Fig. 2.6 - Sedimentary basins and faults in the central and northern New Hebrides Arc and location of the NHIAB sheet *(from Greene and Wong, 1988)*

The central part of the New Hebrides Island Arc has recorded a complex evolution of the arc. Geological and paleomagnetic evidence suggest that the initiation of the early arc system was linked to the late Eocene Vitias Arc (Carney and Macfarlane, 1978; Falvey, 1978). The Vitias paleo-arc (Outer Melanesian Arc) across the north end of the North Fiji Basin was at that time continuous from the Solomon to the Tonga Arcs and was associated with a west dipping subduction zone. A modification of plate boundaries and reversal of the subduction polarity induced the opening of the North Fiji marginal basin and the southwest migration of the volcanic arc (Chase, 1971; Carney and Macfarlane, 1978; Macfarlane *et al.*, 1988). The Vitias Arc ceased to be active.

However, another possible interpretation of the evolution of the arc is based on the hypothesis of continuous eastward subduction during Neogene time. The three volcanic chains of the New Hebrides Arc can then be associated with variations in inclination of the down-going slab, attributed to modifications of the rate of plate convergence (Luyendyk *et al.*, 1974; Carney and Macfarlane, 1977; Hanus and Vanek, 1983; Katz, 1988; Louat *et al.*, 1988).

Magnetic anomalies and seabeam bathymetric data confirm four stages of evolution since late Miocene (Auzende *et al.*, 1988b):

* During stage 1 (10 My), a continuous volcanic arc (Vitias Arc) formed the plate boundary between the Pacific and Indo-Australia plates.

* During stage 2 (10-8 to 3 My), the collision of the Ontong Java Plateau with the Vitias Arc induced the reversal of subduction to the east, accretion in the North Fiji Basin began, and the clockwise rotation of the New Hebrides Arc started.

* Recent stages 3 (3 My) and 4 (0.7 My) are characterized by development of a N-S spreading centre in the southern North Fiji Basin and, north of a triple junction, E-W spreading axes in the northern basin.

* During the last stage, modification of the axial spreading and the triple junction gave rise to the present day configuration of the marginal basin and the arc. The collision of the d'Entrecasteaux Zone, contemporaneous with the two last stages, was the other determining factor in the structural evolution of the area.

In this geodynamic context, the central arc displays an atypical pattern of subsiding basins, the North and South Aoba Basins, between two uplifted ridges. The basins are assymetric with a steep eastern flank along Maewo and Pentecost Islands. A shallow terrace on the western flank supports sedimentary basins parallel to the slopes of Espiritu Santo and Malekula Islands. These small island-shelf basins, in water depths of about 1,000 m along the eastern and northern coasts of Malekula and Espiritu Santo, are called Malekula Basin, East Santo Basin, and Big Bay Basin (a northward extension of Big Bay Basin is called Cumberland Basin). Big Bay Basin (Katz, 1981) is an offshore extension of a fluvial valley, filled with more than 2 km of marine silt, sand and conglomerate of late Pliocene-early Pleistocene age (Holmes, 1988). The floor of this basin is composed of late Oligocene to middle Miocene volcanic and volcaniclastic rocks (Greene and Johnson, 1988).

East Santo Basin (Katz, 1981) is bounded on the east by a sinuous, anticlinal, carbonate-capped ridge. To the southeast, the basin is truncated by faults or overlain by lava flows from Aoba volcano. The nearly 2 km of sediments in the basin appear to consist of Miocene to early Pleistocene biocalcarenite beds overlain by alternating calcarenite, calcilutite and foraminiferal mudstone (Greene and Johnson, 1988).

Structurally, Malakula Basin (Fisher *et al.,* 1988) is similar to East Santo Basin but its eastern structural ridge is broader, the anticline is better developed, and it is buried beneath a thin cover of Quaternary marine sediment. To the north and south, the ridge is truncated by fracture zones covered by submarine lava flows from Aoba and Ambrym volcanoes.

South Aoba Basin (Katz, 1981), bordered by eastern and western faults, consists of 2.5 km of lower to middle Miocene rocks, 1.4 km of possible upper Miocene to Pliocene calcareous rocks and a thin cover of Holocene ash and pelagic sediment.

More data are available for the North Aoba Basin, especially the results of ODP drilling at sites 832 and 833 (Leg 134 - Collot, Greene, Stokking *et al.,* 1992). The North Aoba Basin contains up to 5,000 m of sediment of early Miocene to Holocene age, with various seismic characteristics suggesting a wide range of lithologies and even volcanic intrusions (Gérard, 1993). Pleistocene deposits are mainly ash and volcaniclastic flows. A major unconformity at 700 m was dated as early Pleistocene. This discontinuity has been correlated with the time of collision of the d'Entrecasteaux Ridge.

The compressive tectonic pattern of the back-arc displays a recent strong surficial deformation of the eastern border of North Aoba Basin in the Pleistocene deposits (Daniel *et al.,* 1989; Gérard, 1993). This stress is maximum near Maewo Island with a N90E compressional trend, decreasing toward the north to a N60E compressional trend. This change in trend results from the collision/subduction of the d'Entrecasteaux Zone in the central arc which has uplifted the front and back of the arc and caused simultaneous subsidence of the Aoba Basin (Chung and Kanamori, 1978; Collot *et al.,* 1985). The central segment of the arc has overthrust the North Aoba Basin. Both parts of the thrust are characterized by similar oceanic crust. The North Aoba Basin is therefore a subsiding basin pinched (and overthrust) between two ancient volcanic arcs. It is classified as a piggy back basin (Gérard, 1993).

The Torres Santa-Cruz Basin is a large fore-arc basin below 1,500 m of water depth with a built up crust. As opposed to the Aoba Basin, it is not affected by collision of the d'Entrecasteaux Zone.

2.3 - GEOLOGICAL SETTING OF SOLOMON ISLANDS

2.3.1 - The Solomon Islands Arc

This chapter is mainly the result of the compilation of the different synthesis papers especially those published in:

- Vedder, Pound and Boundy, Eds., 1986, Geology and offshore resources of Pacific island arcs-central and western Solomon Islands: *Houston, Texas, Circum Pacific Council for Energy and Mineral Resources, Earth Sciences Series,* Vol. 4 , and

- Vedder and Bruns, Eds., 1989, Geology and offshore resources of Pacific island arcs-Solomon Islands and Bougainville, Papua New Guinea Regions: *Houston, Texas, Circum Pacific Council for Energy and Mineral Resources, Earth Sciences Series,* Vol. 12.

The other references are in the bibliographic enclosure.

2.3.1.1 - Plates Reconstruction and the Solomon Islands Arc

Reconstructions of the relative plate motion in the hot spot reference frame for the Cretaceous and Cenozoic times (Gordon and Jurdy, 1985; Engebretson *et al.,* 1985; Stock and Molnar, 1982, 1987; Wells, 1989) converge to the conclusion that the double island chain of the Solomon Islands can be interpreted as the result of the complex interactions between the Australian Plate and the Pacific Plate (Coleman and Packham, 1976; Wells, 1989).

The Australian Plate is moving northward at an absolute rate of 7 cm per year (Minster and Jordan, 1978) and is being consumed beneath the Pacific Plate along a series of trenches that flank the southern and western sides of the island arcs. The Pacific Plate has a northwestward absolute rate of motion of 10.7 cm per year (Minster and Jordan, 1978).

The Solomon Islands are on a northwest-trending segment of the leading edge of the Pacific Plate where the rate of oblique convergence may exceed 10 cm per year (Johnson and Molnar, 1972). Presumably a combination of subduction and sinistral shear accommodates the rapid convergence along this segment of the plate boundary.

In his study of the Solomon Islands basins, Katz (1980) divided the region into two geologic provinces separated by a major zone of tectonism: the Malaita province and the Main Solomon province. The area which separates the two island chains in the central and western Solomon Islands is called Central Solomon Trough (CST - called SLOT in the past). This structural trough is a part of the Solomon Basin of de Broin, Aubertin, and Ravenne (1977) and can be divided in four structural basins: the Shortland Basin, Russell Basin, Iron Bottom Basin, and Indispensable Basin (Fig. 2.7). The same names were used by Maung and Coulson (1983) with slight modification. An additional name, New Georgia Wedge, is applied by Cooper, Bruns, and Wood (1986) to a large lenticular body that underlies the southwest side of the Central Solomon Trough (Fig. 2.7).

Katz recognized internal structural complexities in the Central Solomon Trough, including possible fragmentation beneath Manning Strait by a fault zone that caused "en échelon" segmentation of the basin. The sediment thickness increases with water depth, and the axial part of the trough is underlain by 2.5 to 4.5 km of relatively undeformed strata. In their report Maung and Coulson (1983) proposed the term Central Solomon Basin for the entire area located between Bougainville and Malaita. Kroenke (1984), in his regional tectonic synthesis, attributed the development of the Central Solomon Trough to the reversal of arc polarity due to the collision of the Ontong-Java Plateau against the Solomon Islands Zone, which resulted in the transformation of the former back-arc basin into the present intra-arc basin.

2.3.1.2 - Morphology

Morphologically, the seafloor depression beneath New Georgia Sound is flat bottomed, steep sided, and narrow ended. It is slightly sinuous, and its floor is disrupted by Savo volcano near the southeast end and by a bathymetric saddle in the constriction between Kolombangara and Choiseul (Fig. 2.7). Water depths in the broad, nearly flat central part generally range from about 1,000 m to 1,800 m. The area between New Georgia and Santa Isabel is the deepest at slightly more than 1,800 m. The southwestern edge of the depression is bordered by islands with steep relief, the highest of which is Guadalcanal, where one mountain peak is 2,447 m above sea level (Hackman, 1980). The northeast side of the trough is bordered by islands of lower relief (Choiseul, Santa Isabel, and the Florida Islands group) ; the highest peak is about 1,220 m on Santa Isabel. Thus, the total structural relief is as much as 9 km.

2.3.1.3 - Seismicity

Intense seismicity characterizes the northwestern and southeastern parts of the Solomon Islands Arc where the trench system is well developed. Conversely, seismic activity is much reduced along the central part of the arc opposite the active Woodlark spreading ridge where the trench system is weakly expressed bathymetrically. Another relatively quiet zone between the main Solomon Islands group and the Santa Cruz Islands group is believed to be transform (de Broin, Aubertin, and Ravenne, 1977; Dunkley, 1983).

Clearly defined Benioff zones dip steeply northeastward in the vicinity of Bougainville and the Santa Cruz Islands group. Near San Cristobal, the Benioff zone is not well defined and may be steeply inclined. Deep-seated earthquakes in the range of 500-700 km occur beneath Bougainville and the Santa Cruz Islands group. Halunen and Von Herzen (1973) and Kroenke (1972) suggested that these deep shocks may originate along a detached lithospheric slab derived from an old, southwest-directed episode of subduction. Early studies (Denham, 1969; 1971) indicated that most of the seismicity could be ascribed to the northward movement of the Australian Plate coupled with sinistral shear along its northern edge. Interpretation of focal mechanisms of large earthquakes for the period 1963 to 1967 showed that slip vectors were roughly orthogonal to both segments of the sharply curved New Britain Trench, a pattern that was not in accordance with simple underthrusting of the Australian Plate beneath the Pacific

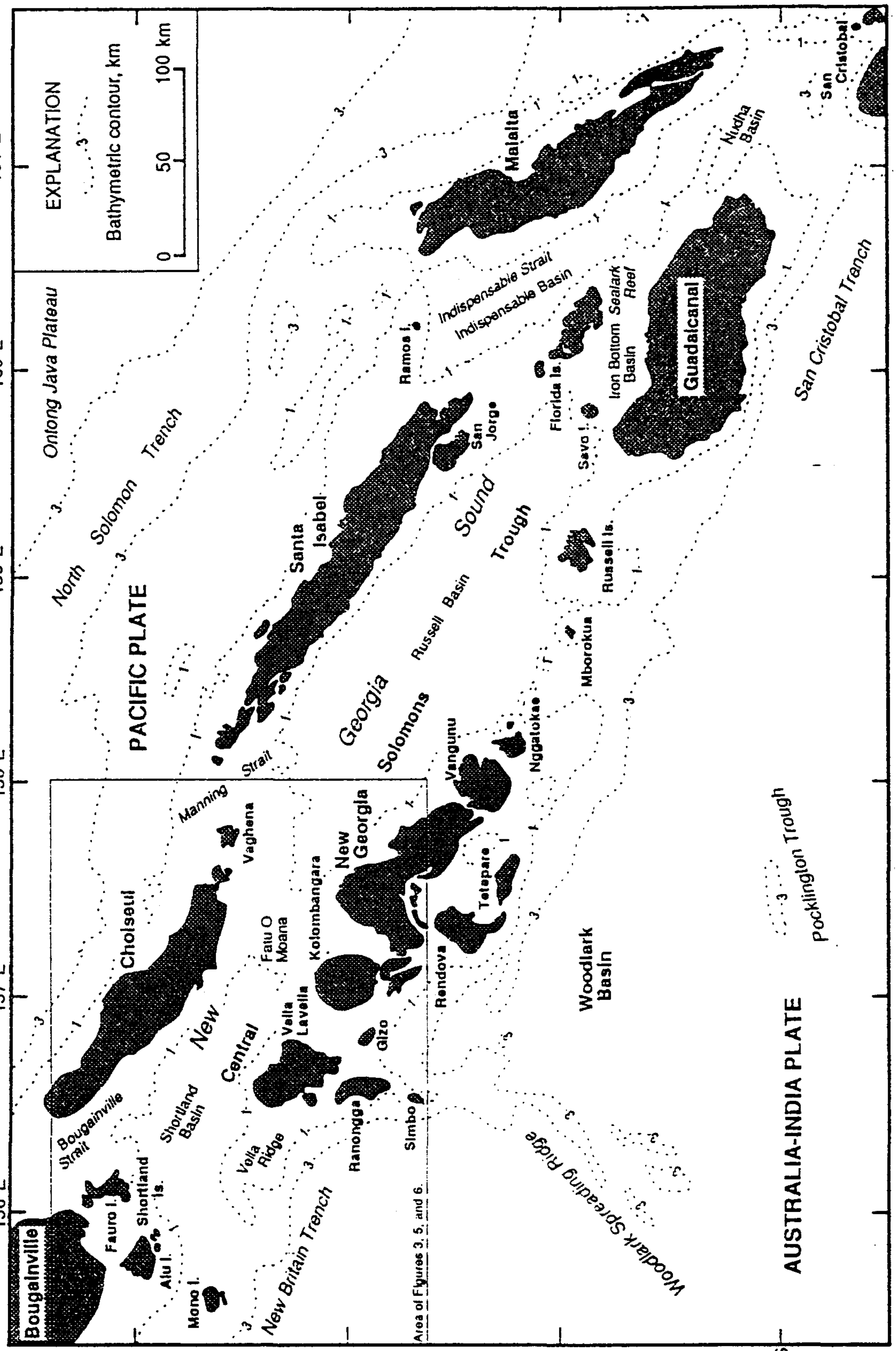


Fig. 2.7 - Place names, tectonic features and bathymetry of the central and western Solomon Islands area

Plate along their northwest-trending boundary (Ripper, 1970). In order to explain the pattern of hypocenters and the direction of slip vectors in terms of plate tectonics, minor plates were postulated along the boundary zone of the two major plates; and these minor plates derived their relative motion from the collision. A complex set of relations including active underthrusting of the Australian Plate beneath San Cristobal, the occurrence of deep remnants of lithospheric slabs beneath the central part of the island chain, and underthrusting of the Pacific Plate beneath Santa Isabel was proposed by Denham (1975) to account for the spatial distribution of earthquakes. Different authors identified various microplates. Their nomenclature is summarized below (Vedder *et al.*, 1986):

1) Solomon Sea Plate (Johnson and Molnar, 1972; Johnson, 1979; Curtis, 1973; Ramsay, 1982), or simply the Solomon Plate (Luyendyk, MacDonald, and Bryan, 1973; Weissel, Taylor, and Karner, 1982) lies between the Woodlark Spreading Ridge in the Solomon Sea and the New Britain Trench.

2) South Bismarck Plate (Johnson and Molnar, 1972; Connelly, 1976; Johnson, 1979; Taylor, 1979) is in the South Bismarck Sea between the New Britain Trench and the Bismarck Sea seismic lineament (Denham, 1969; Ripper, 1975a; 1975b; 1977; Connelly, 1976; Curtis, 1973; Krause, 1973) and thus includes the island of New Britain.

3) North Bismarck Plate (Johnson and Molnar, 1972) lies north of the Bismarck Sea seismic lineament and south of the Manus Trench.

4) New Britain Plate (Curtis, 1973) corresponding to the South Bismarck Plate.

5) Manus Plate (Curtis, 1973) includes the North Bismarck Plate as well as the Solomon Islands archipelago south of the Pacific Province of Coleman (1965a).

Shallow (< 80 km), diffuse earthquakes occur in the area of subduction of the active Woodlark spreading system and deep earthquakes that may originate in detached pieces of lithosphere occur in three zones (around 400, 500, and 535 km) (Cooper and Taylor, 1984). Recent seismic activity concentrated at the base of the Ontong Java Plateau suggest active obduction of the Pacific Plate in the vicinity of the plateau (Cooper *et al.*,1986). It is also the illustration of rapid uplift of the area.

2.3.1.4 - Crustal structure

In the Central Solomons, crustal thickness was estimated to vary from about 27 km under Indispensable Strait to 17 km southwest of Guadalcanal (Rose, Woollard, and Malahoff, 1968). From five other profiles across the entire Solomons/northern Vanuatu region, they estimated the crustal thickness to vary from 9 to 29 km. Thus, the Solomon Islands appear to have little or no "root", and crustal thickness seems to be similar to that of the oceanic region to the north. Seismic refraction studies by Furumoto *et al.*, (1970) suggested a linear, blocklike character for the Solomons and a crustal thickness that varies from 15 to 20 km. Later work by Furumoto *et al.*, (1976) showed that the crust is as much as 40 km thick beneath the Ontong Java Plateau but only 10 to 12 km in the Solomon Sea south of the arc.

Interpretations of crustal structure from sonobuoy, seismic, and gravity data (Cooper, Bruns, and Wood, 1986; Cooper, Marlow, and Bruns, 1986) indicate that the Central Solomons Trough is composed of three different basins in which as much as 6 km of Cenozoic sediment may have accumulated. The sedimentary sequence consists of low velocity (1.6-2.6 km/s) strata in the upper part and higher velocity (2.8-4.4 km/s) strata in the lower part. Volcanic rocks (5.0-5.5 km/s) and lower crustal rocks (6.2-7.0 km/s) underlie the basins (Vedder and Bruns, 1989).

On the basis of preliminary interpretations of seismic and gravity data, two different arc reconstructions are plausible (Cooper *et al.,* 1986). One implies a rootless arc in which, high-velocity upper mantle rocks 12 to 15 km beneath the intra-arc basin, are juxtaposed against deformed oceanic crust along the faulted northeast side of the arc. The other, suggests (1) low-density lithosphere under the Woodlark Basin, (2) a tongue of lithosphere subducted to a depth of 150 km beneath the modern arc, (3) shallow, possibly relict mantle beneath the intra-arc basin, and (4) a remnant of subducted Pacific lithosphere faulted against old arc rocks.

2.3.1.5 - Geodynamic evolution

As suggested by Coleman and Kroenke (1981), Kroenke (1984), and Kroenke, Resig, and Cooper (1986), the northeastern part of the Solomon Islands Arc is an obducted piece of the oceanic Ontong Java Plateau, and the central islands are the remnants of an early Tertiary northeast-facing arc that collided with the plateau about 20 My. On the contrary Ramsay (1982), demonstrated that the structure of Santa Isabel is not compatible with obduction processes. The modern southwest-facing arc is marked by late Cenozoic volcanic centers that extend from Bougainville to Guadalcanal. This hypothetised reversal in arc polarity (Karig and Mammerickx, 1972; Halunen and Von Herzen, 1973) was a direct result of the older arc-plateau collision. In the Woodlark Basin, seafloor spreading has been active for about 5 My, and the resulting separation of the Pocklington and Woodlark Rises is accompanied by subduction of the spreading system beneath the Solomon Islands Arc segment of the Pacific Plate at the rate of more than 10 cm/year (Weissel *et al.,* 1982; Taylor, 1984).

To explain the absence of volcanism east of Guadalcanal, Coleman and Kroenke (1981) invoke the effect of cool, thick, depleted oceanic lithosphere of the Ontong Java Plateau being juxtaposed against the downgoing Australian slab. Dunkley (1983), however, asserted that volcanism is not to be expected in the transform area directly east of San Cristobal, the descending slab probably is not in contact with the lithosphere of the Ontong Java Plateau at depth, and the absence of volcanism in eastern Guadalcanal and San Cristobal does not represent an unusual gap in spacing of volcanoes along the arc.

Geologically, the Central Solomons Trough is one of several island-arc-related basins such as Manus, Woodlark, North Fiji and Lau basins, that lie along the complex boundary between the Australian and Pacific plates in the Melanesian Borderlands region. In the vicinity of the Solomon Islands, interaction between these plates since early Tertiary time resulted in two episodes of subduction and arc magmatism that included reversal of arc polarity (Kroenke, 1984).

As suggested by different authors (Vedder *et al.,* 1986; Wells, 1989), the sequence of events leading to basin development seems to have been:

1) pre-Oligocene, southward-directed subduction of the Pacific Plate beneath the Solomons Islands region resulting in deformation and metamorphism of oceanic rocks;

2) Oligocene to early Miocene magmatism and emplacement of large volumes of island-arc tholeiitic volcanic rocks;

3) middle to late Miocene collision with the Ontong Java Plateau resulting in the end of subduction and reversal of arc polarity;

4) and, late Miocene to Holocene northward-trending subduction of the Australian Plate beneath the Solomon Islands region resulting in a second phase of volcanism together with uplift, extension and the inception of an intra-arc basin.

These late Cenozoic events have been complicated by the subduction of the Woodlark spreading system (Exon and Taylor, 1984). According to Dunkley (1983), active subduction of the Woodlark Basin Ridge caused eruption of the unusual magmas in the New Georgia group.

2.3.1.6 - Sedimentary deposition and vertical evolution

Rapid sedimentation in the Central Solomons Trough probably began in the late Oligocene, either as back-arc volcanoclastic aprons that coalesced southwest of the volcanic centers (Choiseul, Santa Isabel) or as forearc sheets of sediment that collected in now-dismembered basins along northeast side of the volcanic centers (Guadalcanal). The arc polarity reversal near the end of Miocene time resulted in the deposition of sediment wedges that were derived from the newly formed volcanic chain to the south of the old arc. These wedges probably spread northward in the incipient intra-arc basin and enlarged in volume as volcanism and uplift increased in the Pliocene. As noted by Katz (1980), the late Oligocene to Pliocene strata in the basin probably are not composed entirely of primary volcanoclastic detritus and probably were derived in part from uplifted older rocks. During episodes of volcanic quiescence, reef limestone and related shelf and slope carbonate beds formated around craters and insular basement highs.

Probable extension accompanied by downwarping and faulting during the Pliocene and Pleistocene resulted in a deepening of the basin. At the same time, rapid influx of sediment caused by uplift along the basin margins produced depositional sequences as thick as 3.5 km at places in the trough (Bruns *et al.*, 1986). Katz (1980) estimated about 2 km of downwarping in the trough during the last million years, and Chivas *et al.*, (1982) documented at least 2 km of Pleistocene uplift on Guadalcanal. Hughes and Varol (1984) reported Quaternary uplift rates of 500 to 3,700 m/My in the Rendova-Tetepare Islands area on the southwest side of New Georgia. Paleoecologic interpretations from Quaternary rocks dredged on near Vella Lavella indicate local uplift of as much as 700 m during a span of 0.5 My in early Pleistocene time (Resig, 1986). Continued uplift in the same area led to subaerial exposure followed by subsidence of at least 600 m in the late Quaternary (Coulson and Vedder, 1986). Rocks from other dredge sites along the southwest side of New Georgia Sound near the Russell Islands show evidence for uplift of as much as 900 m followed by subsidence of as much as 700 m during a comparable time span. Multichannel seismic-reflection data suggest that as much as 2 km of subsidence has occured along the southwestern side of the Central Solomons Trough during Pliocene and Quaternary time (Bruns *et al.,* 1986). On the northeast side at Choiseul, at least 600 m of uplift has elevated and tilted Pleistocene fringing-reef deposits (Strange, 1981).

Compressive stresses developed in the overriding plate in response to subduction of buoyant oceanic lithosphere (Dunkley, 1983) are responsible of the uplift along the southwest flank of the New Georgia. The estimated amounts of uplift attest to the exceptionally rapid rates of tectonism in the central and western Solomon Islands.

2.3.1.7 - Plio-Pleistocene volcanism

The Solomon volcanic province as defined by Coleman (1970) includes the reversed modern arc which is dominantly limited to the westernmost, south-facing islands. It incorporates from west towards east, the Shortland Islands, a small part of central Choiseul Island, the New Georgia Islands group, the Russell Islands, the north-western part of Guadalcanal Island and Savo Island. This volcanism results from the northeastward subduction of the Woodlark Basin, an active spreading system of the Australian Plate, beneath the overriding Pacific Plate. The following presentation is mainly based on the recent compilation by Coulson and Vedder (1986).

In Shortland Island, the horseshoe-shaped bay of north Fauro is believed to have been created by a caldera collapse of a large volcano. A minimum 1,500 m thick reworked tuff and lava flows sequence is overlain by a 600 m thick sequence (Togha pyroclastics) of volcanic brecchia, tuff and minor lava flows (Turner, 1975). Based on comparison with similar rocks elsewhere in the Solomon Islands, the later volcanics, possibly linked to the caldera formation, are assumed to be Plio-Pleistocene. On Alu Island, some possibly Pliocene andesites are present (Hughes, 1982).

In the central Choiseul Island, Mount Maetambe (1,060 m) is dominantly composed of andesitic pyroclastic deposits. They consist of tuff, ash and breccia with a minimum thickness of 500 m (Coleman, 1960). No interbedded lava flows was observed. Some interbedded turbidites however indicate that at least part of these deposits were emplaced below sea level. Activity possible began in middle Miocene times and may have been sporadically continuous into Pleistocene times (Hugues, 1982). Geothermal springs are present on Mount Maetambe.

The entire New Georgia Islands form a complex of emergent coalescent volcanoes encircled by fringing reefs. It represents also the most active and voluminous volcanic development from late Miocene to Holocene. Volcanic rocks consist of large volumes of porphyritic olivine basalts, picritic basalts, and subordinate hornblende basaltic andesite and andesite flows. Fined-grained aphyric Mg-rich basalts are less common but widespread. Typically, the volcano flanks display lateral facies changes from massive flows to volcanoclastics, showing an increasing degree of reworking as distance from the volcanic centers increases. Many lavas are chemically atypical of arc suites, this anomaly being attributed to the subduction of the active Woodlark spreading system (Johnson *et al.,* 1986). Among all the New Georgia Islands, Kolombangara is an almost circular Pliocene basaltic volcano, 1,770 m high, crowned by a 4 km wide, 1,000 m deep, very steep crater. On the southern slope, Ndughore Peak is an adventive cone that represents probably the most recent (Pleistocene) volcanic manisfestation. The western part of Vella Lavella Island consists of a Pleistocene (to Holocene ?) volcanic edifice that culminates at 790 m whereas the bottom of its crater floor is close to sealevel. It contains several sulfur steam vents and a few adventive cones surround the main one. A special mention is also made of the very active Kavachi submarine volcano (9°S-158°E). Since 1950, when its activity was noted for the first time, this shallow basalt-andesite volcano has built up seven times a short-lived small islet, up to 150 m long, that is rapidly destroyed after the end of the volcanic activity.

Russell Islands are the remnants of an emergent Pliocene volcano composed of basaltic breccia overlain by basalt lavas and is presently encircled by a large fringing reef.

On Guadalcanal, dissected Plio-Pleistocene volcanic cones are dominantly composed of hornblende andesite flows with sequence as much as 900 m thick called Gallego lavas (Thompson and Pudsey-Dawson, 1958). Pyroclastic aprons and coarse volcanoclastics flank the extrusive centers. Unstratified tuff breccia interfingers with poorly stratified lithic tuff near the volcanic centers progressively grades laterally into stratified volcanic wacke are deposit in narrow channels and basins (Wright, 1968). These deposists also contain air-fall ashes and material derived from the underlying andesite flows. These pyroclastics probably represent ignimbritic sequences linked to explosive activity of the volcanic centers. Volcanic mudflows (lahars) are also present.

Savo Island is a Pelean type volcano which most recent eruptions occured during a period from 1830-1840 (Coleman, 1965). The volcanic edifice consists largely of agglomerates and tuffaceous deposits (Proctor and Turner, 1977). Solfataras are active on the south and eastern slopes of the island.

2.3.2 - The Melanesian Arc Gap (MAG)

The Solomon Islands Arc ends abruptly northeast of San Cristobal Island. The far north of the New Hebrides Island Arc is also sharply interrupted northwards and westwards at the Reef Islands and Tinakula volcano. Between those two arcs, lies a basin with an average depth of 4,000 m, apparently unnamed, although its western part is occasionaly named Ulawa Deep, from the name of the Ulawa Island, north of San Cristobal. We propose naming this region the "Melanesian Arc Gap" (Fig. 2.8).

This rectangular-shaped basin is about 300 km long and 200 km wide and bounded by two deep trenches: the Cape Johnson Trench northwards and the over 8,000 m deep San Cristobal Trench southwards. The sea floor of the basin is uneven, riddled with submarines volcanoes with diameter ranging from 1-2 km to 20 km for the largest and depths which can be less than 2,000 m. In the center and on the eastern side of the basin, two huge features are observed: a very large (about 55 km) seamount occurs north of the San Cristobal Trench and a massive NNE-SSW feature is separated from the New Hebrides Island arc by a 4,500 m deep, narrow channel. Prior to the SOPACMAPS survey, only a few data were available on its morphology and origin. In the central part, a narrow (about 40 km width) zone, trending close to

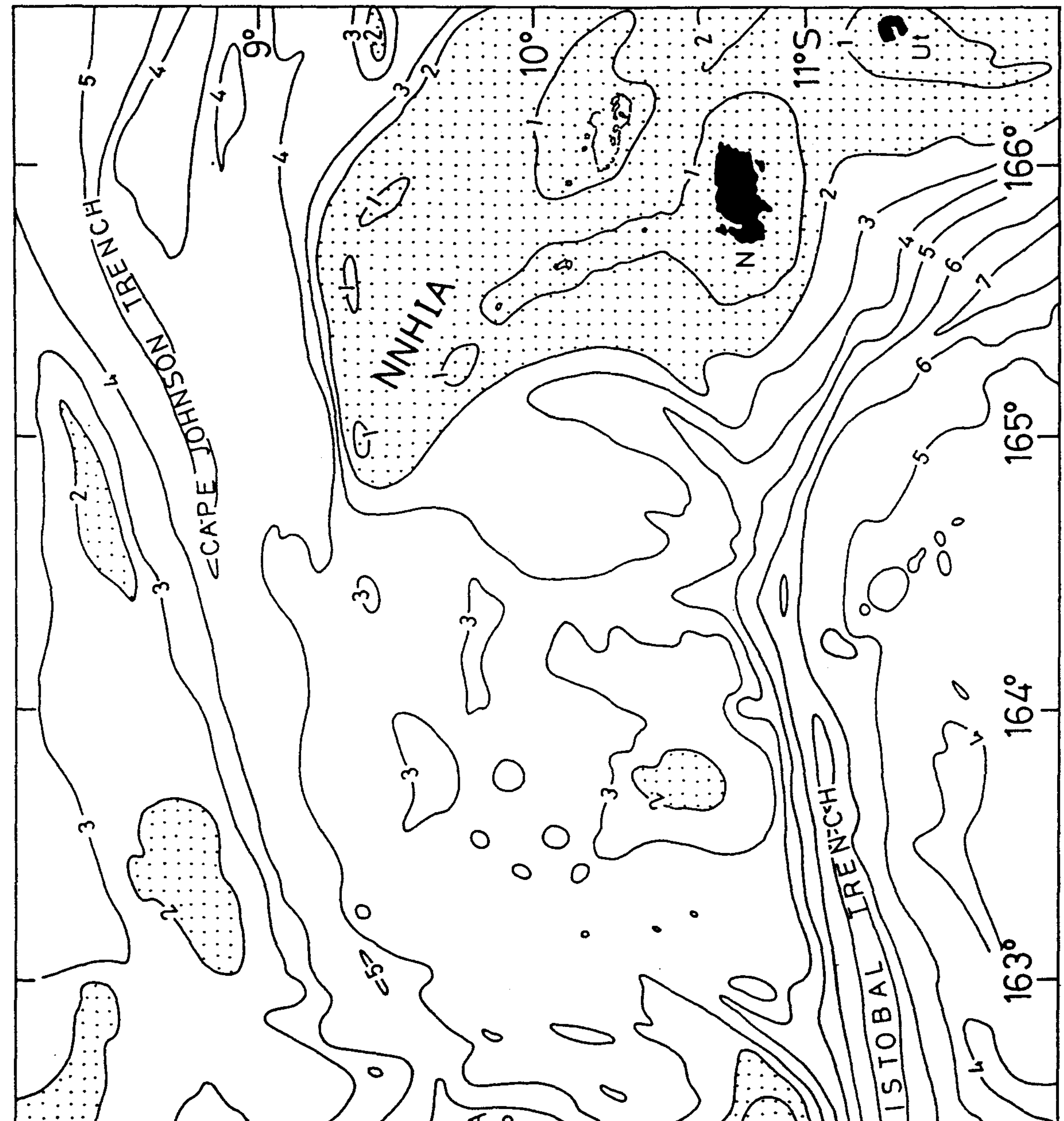


Fig. 2.8 - Bathymetry of the Melanesian Arc Gap as known before the present study

north-south, was surveyed by SSI (Seafloor Surveys International, Inc.), as a part of PacRimWest project (Telecommunications cable route survey). SSI used the Seamarc Sys09 and provided bathymetric, acoustic imagery and structural interpretation charts.

2.3.3 - The North New Hebrides Back Arc Area (NNHBAA)

2.3.3.1 - Regional Geography

The NNHBAA (or the Eastern Outer Islands Group, Province of the Solomon Islands, Fig. 2.9) rises steeply between a northwest extension of the North Fiji Basin, an extensive marginal basin with an average water depth of 3,600 m, and the South Solomon-New Hebrides (Torres) Trench systems which reach depths of about 7,000 m and form a western boundary to this region. The southeast trending Vitias Trench, reaching depths of more than 6,000 m, forms the northeast boundary of the region. This boundary feature also extends westwards as the Cape Johnson Trench, forming the northern boundary. Islands of the NNHBA extend from Vanikoro in the south to Anuta in the north. Nendo Island is only 95 km from the New Hebrides Trench axis, while Anuta lies 270 km south of the Vitias Trench (Fig. 2.10).

2.3.3.2 - Geological framework/Previous works

The NNHBAA includes a group of small scattered islands some 450 km east of the main Solomon Islands chain, and about 130 km north of the Islands of Vanuatu. Politically, they belong to the Solomon Islands but in geological and structural terms, they represent the northern extension of the New Hebrides Island Arc system.

Four islands, Tinakula, Nendo, Utupua and Vanikoro (Santa Cruz Group), form a well-defined chain in the west of the group, while the Duff Islands, Anuta and Fatutaka form a discontinuous chain to the east. Tikopia Island lies midway between the two groups. All the islands are volcanogenic with well preserved volcanic cones on Vanikoro, Utupua and Tikopia and an active volcano on Tinakula. The Reef Islands (NE of Nendo) are composed of coral and sand clays upon a probable volcanic basement (Hughes *et al.*, 1981; Coulson, 1985).

Seismicity defines a Wadati-Benioff zone reflecting the eastward subduction of the Autralo-Indian Plate along the northern New Hebrides Trench. The Vitias Trench is seismically inactive, and is thought to be a fossil trench representing a former south dipping subduction zone. In the northern NNHBA region, seismicity, focal mechanisms, and bathymetry allow identification of three zones (Louat and Pelletier, 1989):

1) Numerous events clustered along a N120E trending zone near 11°S, 166°30'E coincide with a depression separating islands of the Santa Cruz archipelago. Focal mechanisms indicate normal and strike-slip faulting. These solutions have a NE trending T-axis.

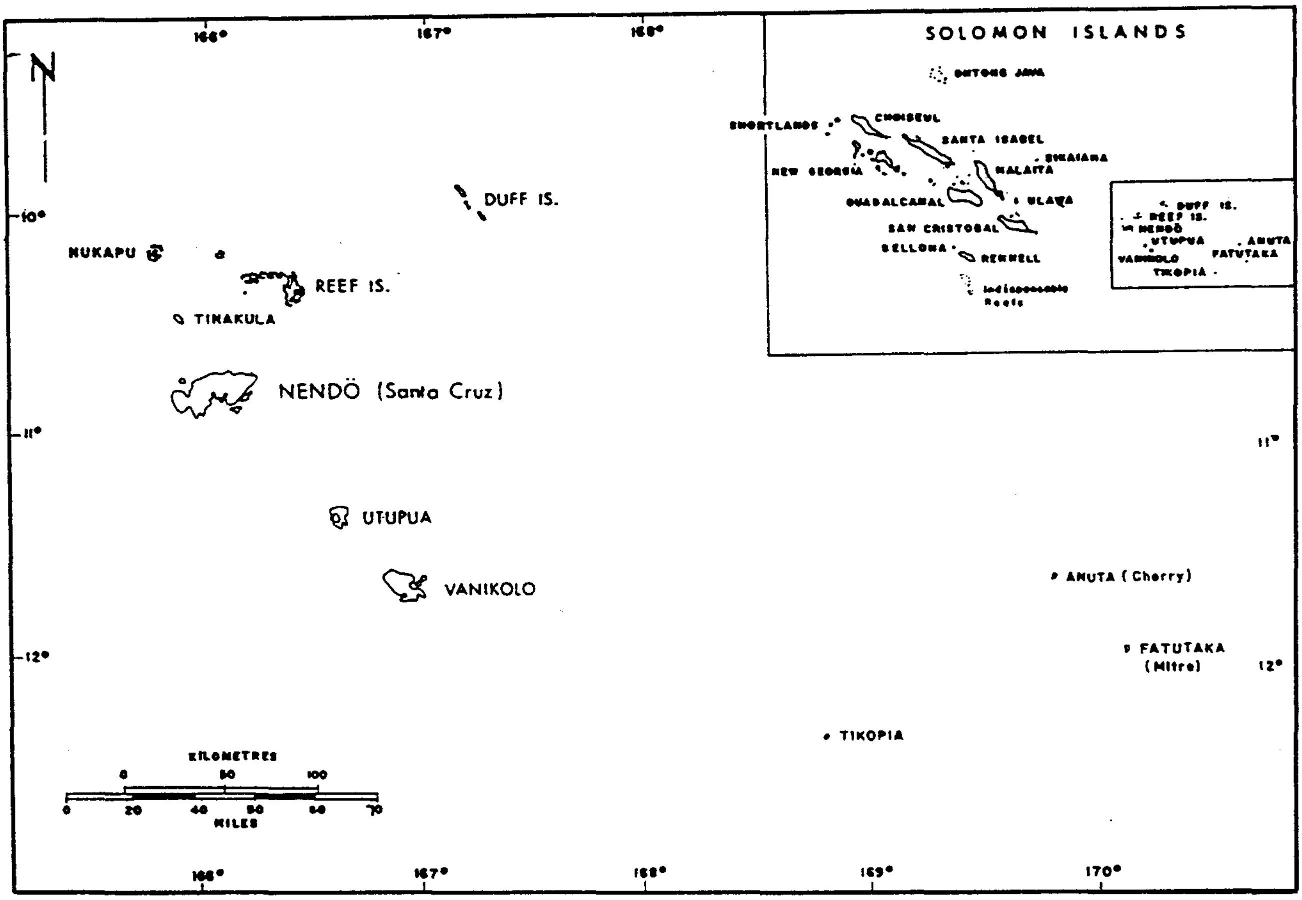


Fig. 2.9 - Islands forming the Eastern Outer Islands Group, Solomon Islands

(from Hughes et al., 1981)

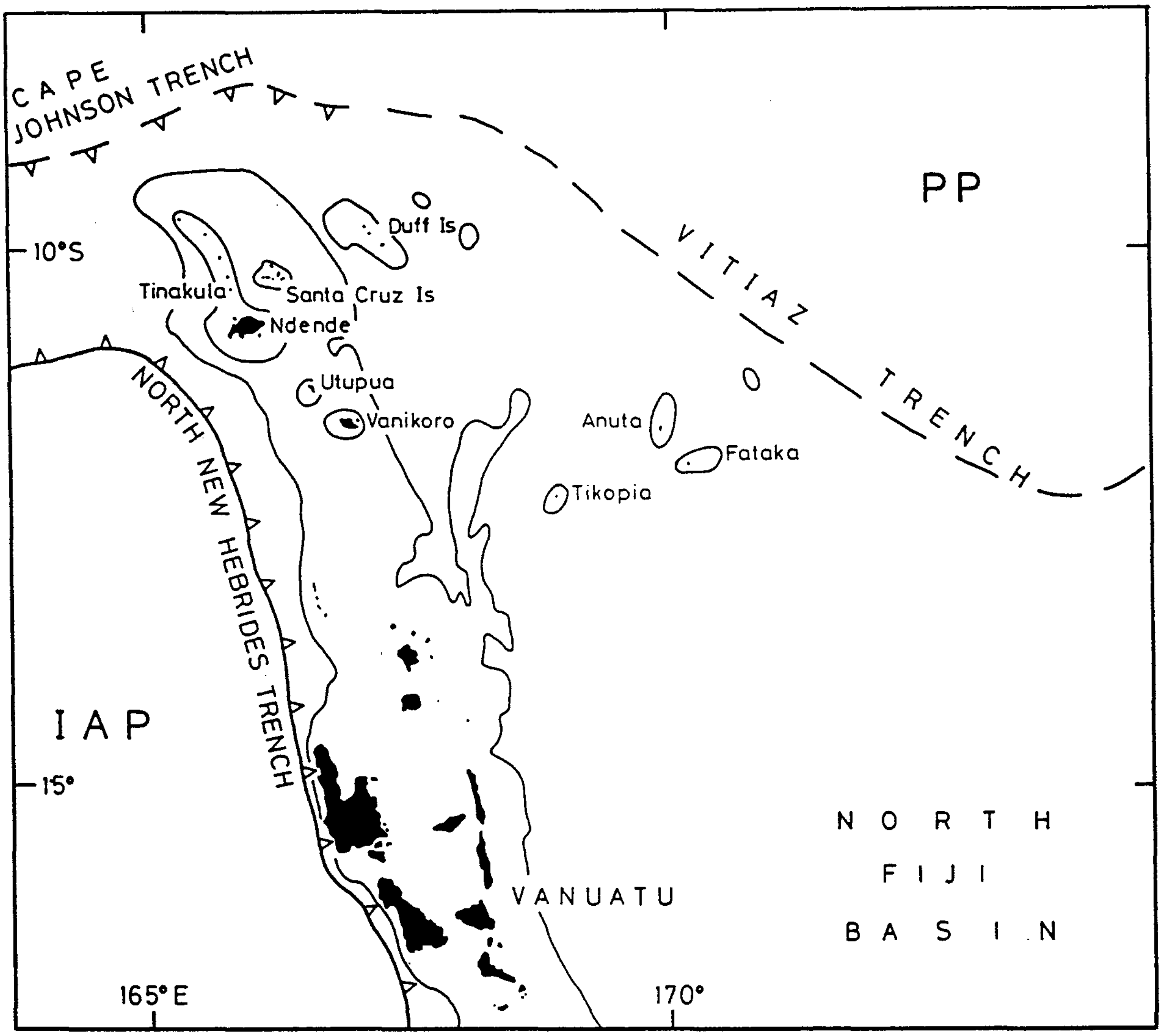


Fig. 2.10 - Sketch map of the Northern New Hebrides Back Arc Area

PP : Pacific Plate ; IAP : India-Australian Plate

2) At 10°20'S, 165°E, a N-S trend is indicated by normal and strike-slip solutions sharing a common T-axis orientated N10E.

3) A small group of events at 12°30'S, 167°30'E extend along a N170E trending zone. The zone is correlated with the northern New Hebrides back-arc troughs. Two events with normal fault solutions are located west of the troughs and they display a N125E T-axis.

2.3.3.3 - Petrology and age

The islands form distinct volcanic piles of submarine and subaerial lava flows and volcanic rocks ranging in age from Oligocene to Recent. Basalts predominate and include tholeiitic, high alumina, and alkaline types, together with high and low silica andesites and dacitic rocks. Analyses of rocks suggest that predominantly tholeiitic basalts are found in the western chain and in samples from the Vitias Trench. In the eastern chain and Tikopia, high alumina and alkali basalts are common, along with andesites and dacites (Hughes, 1978). A later petrological and geochemical study by Monjaret *et al.*, (1991) which includes the back-arc Jean Charcot and Coriolis Troughs, shows the northern zone basalts have geochemical characteristics intermediate between MORB and island-arc tholeiites and acid lavas near primitive island-arc lava. These results suggest that the volcanics were emplaced at the time of the initiation of the arc in this area, so the New Hebrides back-arc troughs must be considered as intra-arc troughs and are back-arc structures only because of their location at the rear of the active arc.

It is possible to explain the geology of the NNHBAA and the differentiation of the rocks there by a single subduction reversal model proposed for the Solomon and New Hebrides chain by Coulson (1985).

Previous data from the vicinity of the Eastern Outer Islands shows that no volcanic arc lies immediately south of the Vitias paleo-trench. The northwestern corner of the North Fiji Basin is created by oceanic style accretion along two successive spreading systems trending NW-SE and E-W respectively, as far north as 8°30'S and 9°S. The Tikopia Ridge could either correspond to, or be superimposed on, the youngest E-W spreading axis. The eastern part of the back-arc troughs domain, which in fact forms the western edge of the North Fiji Basin, is a continuous and 400 km long volcanic ridge called the Duff Ridge (Fig. 2.11). The western part of the back-arc troughs domain is the edge of the New Hebrides Arc, its northern end being an E-W intra-arc graben, the Santa Cruz Trough. The existence of the back-arc troughs is mainly due to the construction of the volcanic Duff Ridge which isolated a piece of the old North Fiji Basin oceanic crust to the west of it (Pelletier *et al.*, 1993a; 1993b).

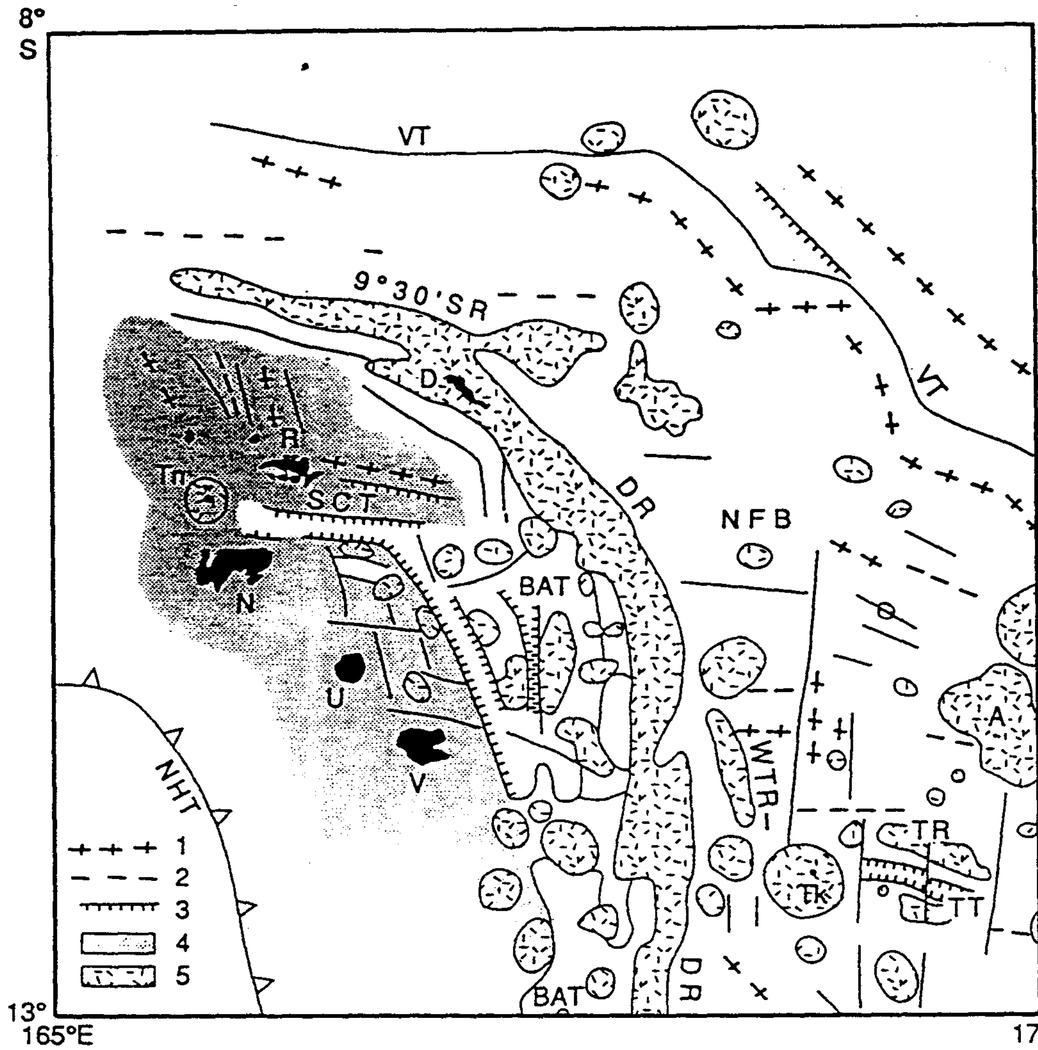


Fig. 2.11 - Structural sketch

(from Pelletier et al., 1993b)

1: structural high ; 2: structural low ; 3: normal fault scarp ; 4: arc platform ; 5: volcanic edifice.

NHT: New Hebrides Trench ; BAT: Back-Arc Troughs domain ; NFB: North Fiji Basin ; VT: Vitias Trench ; D: Duff Islands ; R: Reef Islands ; Tn: Tinakula Island ; N: Ndende Island ; U: Utupua Island ; V: Vanikoro Island ; Tk: Tikopia Island ; A: Anuta Island. 9°30 SR : 9°30'S ridge ; DR: Duff Ridge ; SCT: Santa Cruz Trough ; TR: Tikopia Ridge ; TT: Tikopia Trough ; WTR: West Tikopia Ridge.

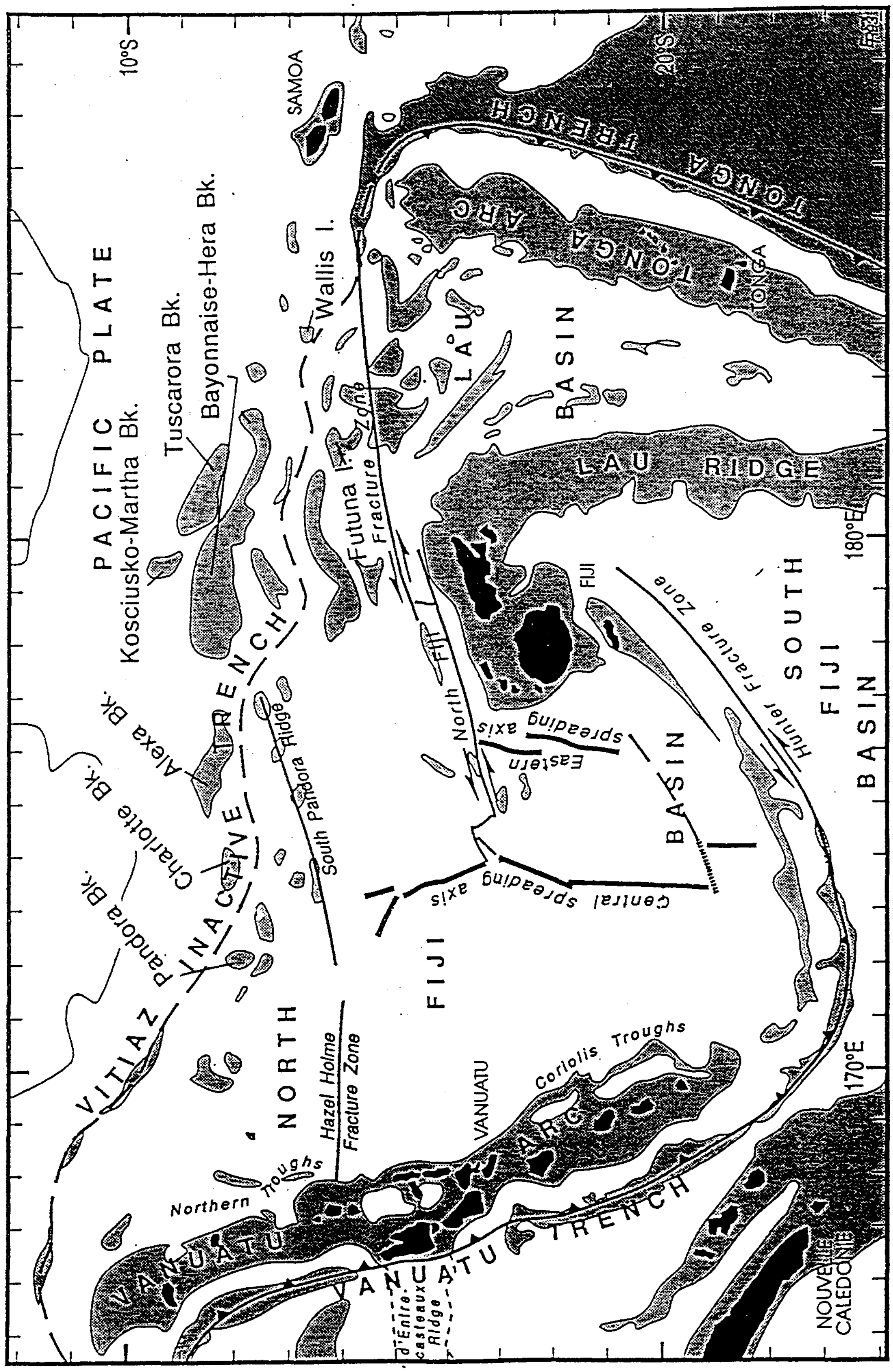


Fig. 2.12 - Tectonic setting of the South West Pacific

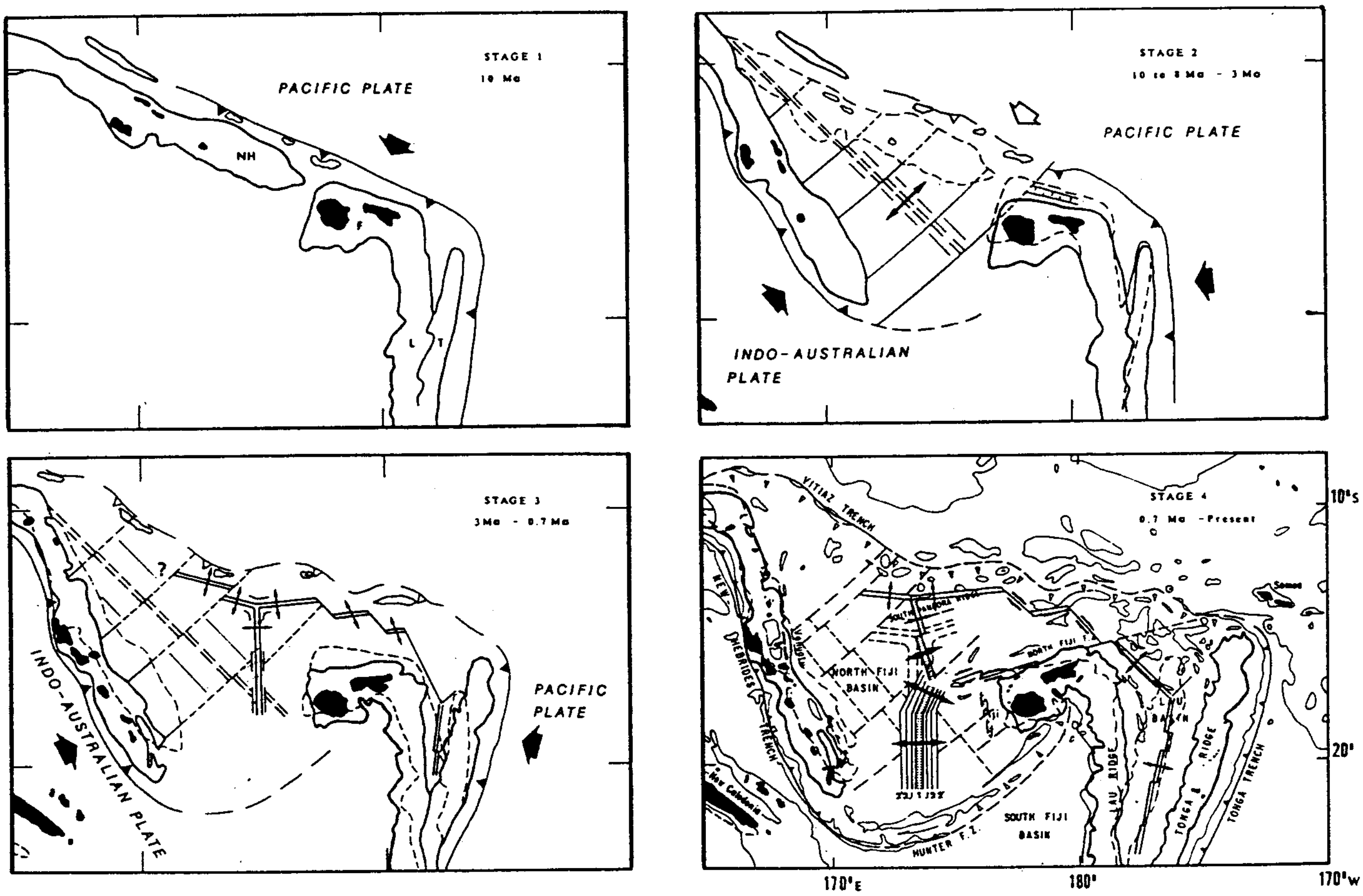


Fig. 2.13 - Evolution of the North Fiji Basin *(from Auzende et al., 1988).*

Stage 1: New Hebrides (NH), Vitias, Fiji (F), Lau (L) and Tonga (T) ridges constitute arc above subducting Pacific Plate.

Stage 2: Reversing of polarity of subduction under New Hebrides, clockwise rotation of New Hebrides arc, and first counterclockwise rotation of Fiji Islands.
Large heavy black arrows indicate active subduction. White arrow indicates fossil subduction. Thin black arrows indicate active spreading.

Stage 3: End of New Hebrides and Fiji rotations. Beginning of north-south spreading in central north Fiji Basin and functioning of triple junction in northern part.

Stage 4: Recent rearrangements of axial spreading zone.
Large dashed lines = flow lines of New Hebrides rotation. Thin dashed lines = magnetic lineations. 1, J, 2 and 2' = identified magnetic anomalies. F. Z. = fracture zone.

(Auzende *et al.*, 1986 and 1990). Located around 173°30'-174°E, it includes four segments that trends N15-160E with different propagators and is active since 3 My (Auzende *et al.*, 1988b; and submitted, de Alteris *et al.*, 1993; Ruellan *et al.*, in press). The second spreading axis is located at 176°E between the main central spreading axis and the Fiji Platform in an area characterized by important shallow seismic activity. This axis, firstly postulated by Sclater and Menard (1967), Chase (1971), Brocher and Holmes (1985) and Louat and Pelletier (1989), trends N5-10E and is interpreted as a southward propagating rift (Auzende *et al.*, 1993). This axis is bounded to the north by the western part of the Fiji Fracture Zone which connects the main spreading axis in the 16°50'S triple junction (Lafoy *et al.*, 1987 and 1990).

Toward the north, the N160E trending segment of the main spreading axis is connected with the sub E-W trending Hazel Holme Ridge (Pelletier *et al.*, 1993) and the south Pandora Ridge interpreted as a slow spreading center (Price and Kroenke, 1991; Kroenke *et al.*, 1991). A possible triple junction occurs at the northern end the main axis (Auzende *et al.*, in press).

The northwestern part of the basin, located north of 14°S has been recently surveyed and is interpreted to be the result of accretion along two successive fossil spreading centers trending first NW-SE then E-W (Pelletier *et al.*, 1989 and 1993a and b).

The overall structure of the northeastern part of the North Fiji Basin, east of 174°E and north of the Fiji Fracture Zone, is largely unkown. On the basis of an aeromagnetic survey over the whole area, Cherkis (1980) reported E-W trending magnetic lineations and proposed an active spreading center located near 14-14°30'S. The only area explored by surface ship is located north of Viti Levu Island and comprised between 176°30'E and 178°E and 13°30'S and 16°40'S (Halunen, 1979; Brocher, 1985; von Stackelberg *et al.*, 1985; von Stackelberg and von Rad, 1990). On the basis of sedimentary thickness and WNW-ESE magnetic lineations and bathymetric trends, these authors proposed a WNW-ESE inactive spreading center at 14°30'S and 14°S.

The opening of the NFB can be divided into three major stages (Pelletier *et al.*, 1993; Auzende *et al.*, submitted): an opening in a NE-SW direction from 12 to 7 My, an opening in a N-S direction from 7 to 3 My and an opening in an E-W direction from 3 My to the present day. The triangular shape of the basin results from these three successive spreading phases. Since the beginning of the creation of the NFB, the location of the successive spreading centers migrates southward to accompany the migration of the New Hebrides Arc.

2.4.2 - The Fiji Platform, The Fiji Fracture Zone and the northern part of the Lau Basin

The Fiji Platform which supports the Fiji Islands corresponds to the northern end of the Lau Ridge. The crustal thickness in Fiji is about 15-20 km which is typical of island arcs (Hamburger *et al.*, 1990). The Fiji Islands are primarily composed of arc-related volcanic and intrusives rocks indicating a complex evolution in three periods (Rodda, 1967 and 1976, Gill, 1976 and 1984; Gill *et al.*, 1984; Rodda and Kroenke, 1984; Whelan *et al.*, 1985): a period of intraoceanic island arc in the late Eocene to midde Miocene; a period of arc fragmentation in the late Miocene to middle Pliocene, and a period of back-arc deformation since the late Pliocene.

The first period is marked by upper Eocene-lower Oligocene dacite tuffs and island arc tholeiites intruded by lower Oligocene tonalite. This island arc tholeiite volcanism, which may extend in the early Miocene, is considered to be part of the Vitias Arc that included the previously coalescent Lau-Tonga Arc, the Fiji Platform and the proto New Hebrides Arc before the late Miocene onset of opening of the North Fiji Basin and the Pliocene onset of opening of the Lau Basin. Island-arc tholeiitic eruptives and intrusives were emplaced in the midde-late Miocene from 13 My to 7 My (Whelan *et al.*, 1985) and were followed by calk-alcaline to shoshonitic series from 6 to 3 My. Late Pliocene-Pleistocene volcanism on Fiji was of two types and occurred in different tectonic settings. Shoshonitic and high-K calk-alcaline volcanism ranging in age from 3 to 1 My was erupted on the southern part of Fiji and on the Kandavu Ridge and is related to the subduction of the South Fiji Basin along the Hunter Fracture Zone. Alkalic volcanism in northern and eastern Fiji resulted from tensional rifting. This ocean island type of volcanism replaced the subduction related volcanism at 3 My (Gill *et al.*, 1984; Cole *et al.*, 1985).

The topography of the northern flank of the Fiji Platform is controlled by strike-slip and extensional deformation along the so-called Fiji Fracture Zone. This fault zone is underlined by an E-W trending broad seismic belt that extends westward from the northern end of the Tonga Trench to the central triple junction of the North Fiji Basin. Numerous strike-slip focal mechanisms along the entire length of the fault indicates E-W trending left-lateral strike-slip motion (Isacks *et al.*, 1969; Sykes *et al.*, 1969; Eguchi, 1984; Hamburger and Isacks, 1988; Hamburger *et al.*, 1988; Pelletier and Louat, 1989; Louat *et al.*, 1989; Hamburger *et al.*, 1990).

The northern flank of the Fiji Platform and the northern part of the Lau Basin have been recently imaged by GLORIA during a SOPAC Survey in 1989 (Tiffin *et al.*, 1990; Clarke *et al.*, 1991; Parson and Tiffin, 1992; Jarvis *et al.*, in press). Two opposing sense strike-slip plate boundaries have been identified.

The left-lateral Fiji Fracture Zone bounds the northwest flank of the platform. It mainly exhibits E-W structural trends and is offset by at least two N-S to N45E extensional relay zones. These pull-apart basins occur at 177°25'E and 178°40'E. In the former, previously reported by von Stackelberg *et al.*, (1985), fresh MORB and BABB lavas with hydrothermal sulfide mineralizations have been recovered (von Stakelberg and von Rad, 1990; Johnson and Sinton, 1990). The bathymetric highs located in the North Fiji Basin north of the Fiji Fracture Zone, like the Braemar Ridge and the Balmoral Ridge and Reef further west, are interpreted by Jarvis *et al.*, (in press) to be pieces of the Fiji Platform rifted away by successive spreading segments (pull-apart basins) during changes in the location of the North Fiji Fracture Zone.

One or possibly two dextral fracture zones bound the northeastern flank of the Fiji Platform. One is the NW-SE trending Peggy Ridge in the northwestern part of the Lau Basin. The Peggy Ridge is seismically very active and was interpreted either as an active NW-SE spreading center (Chase, 1971; Auzende *et al.*, 1988), or as a NW-SE right-lateral strike-slip fault (Sclater *et al.*, 1972; Weissel, 1977; Eguchi, 1984), or as a transtensional feature (NW-SE dextral strike-slip motion and E-W extension: Pelletier and Louat, 1989; Parson *et al.*, 1990) inducing a leaking aspect. Another dextral strike-slip fault zone runs west of the Peggy Ridge along the flank of the platform close to the Cikobia Island. The relationship between this fault zone and the Fiji Fracture Zone is unclear. A recent volcanic zone with NNW-SSE to NNE-

WSW trending series of trough and ridge has been identified in the junction area, north of the Cikobia Island (Clarke *et al.,* 1991). However the Fiji Fracture Zone has yet to be traced north of this structure and south of the Futuna Island.

2.4.3 - The Vitias Trench Lineament

The Vitias Trench lineament bounds northward the North Fiji Basin and the northern end of the Lau Basins and separates them from the Pacific oceanic crust which is Jurassic to Cretaceous in age. The lineament consists of the Vitias Trench and three discontinuous and elongated troughs, the Alexa, Rotuma and Horne Troughs, which connect the Vitias Trench to the northern termination of the Tonga Trench (Brocher, 1985). The exact location of this lineament in its eastern part is still unclear. The Vitias Trench lineament is believed to be the site of former subduction of the Pacific Plate below the Australian Plate from the Eocene to late Miocene. At that time, the Vitias Arc was a single continuous east-facing arc from Tonga to Solomon (Gill and Gorton, 1973; Falvey, 1975 and 1978; Coleman and Packham, 1976; Gill *et al.,* 1984). The cessation of the North Solomon and the Vitias subduction zone is explained by the arrival at the trench of the Ontong Java Plateau and the Melanesian Border Plateau which induced a reversal of arc polarity and the inception south of the arc of the South Solomon and New Hebrides trenches (Kroenke, 1972; Packham, 1973; Falvey, 1975). Although most of the authors agree with this model, the details of this arc reversal history is still unclear. An another possible explanation for the origin of the Vitias Trench lineament is that this lineament was the site of transform motion between the Pacific and the Australian plates (Fairbridge, 1961). The western (Vitias Trench) and eastern (Alexa, Rotuma and Horne Troughs) parts of the Vitias Trench lineament have been partly surveyed by Pelletier *et al.,* (1988 and 1993) and Brocher (1985) respectively.

The Vitias Trench is a more than 600 km long well marked depression from 8°30' at the northern tip of the North Fiji Basin to 12°S north of Pandora Bank. The depth, which is mainly more than 4,500 m, reaches a maximum of 5,600 m. The trench is composed of NW-SE segments left laterally offset by E-W features. The trench floor is flat and is underlain by 0.2 - 0.3 s thick sediments. The shape of the trench is almost symmetrical and the water depths on each side of the trench are quite similar. Between 167°E and 168°E, the trench like morphology disappears and a volcanic edifice obstructs the trench. The northern wall of the trench is characterized by sedimentary cover, by southwest facing scarps which strike parallel to the trench, and by a rise elongated NW-SE rising to 3,200 m. The southern flank of the trench is in general steeper than the northern one. A narrow and discontinuous ridge parallels the different segments of the trench to the south. However, no large structure which could be interpreted as a volcanic arc lies along its southern flank especially north of 11°S. South of 11°S, large volcanic edifices adjacent to the trench can be regarded as piece of the fragmented Vitias Arc.

Structures of Alexa, Rotuma and Horne Troughs lying along the eastern part of the Vitias Trench lineament, which extends from 174°E to 176°W, were mainly addressed by Brocher (1985). Alexa Trough (4,000 m deep) strikes WSW-ENE and lies south and west of the Alexa Bank and north of the Rotuma Island and Ridge. Rotuma Trough is a curved trough, composed of two parts. In its western part, it is narrow, 4,000 m deep and strikes NW-SE between Rotuma Island and Hat Puk Seamount to the west and the Alacrity and Eaglestone ridges to the east. In the eastern part, the trough is deeper (4,800 m deep), more asymmetric and trends NE-SW between the Alacrity and Hera Banks to the north and the high in the south called the Haut-fond Rotuma and Mont Arabis on the hydrographic map and Manatu Seamount by Brocher (1985). The Horne Trough (4,600 m deep) trends E-W and extends west of Wallis Island and north of Horne Islands (Futuna and Alofi). On the basis of different evidences, Brocher (1985) proposed that the Vitias Trench lineament was first an active site of subduction of the Pacific Plate and then subjected to post-subduction translational deformation due to collision of seamounts of the Western Samoan Chain. Where the segments of the trench lineament are less deformed and not narrowed or eliminated by collision with seamounts, the former subduction zone morphology and structure are preserved: the outer (northern) wall is sedimented and shows normal faulting, while the inner (southern) wall is steeper and is generally flanked to the south by a structural high. However the eastern part of the trench lineament is, as the Vitias Trough, characterized by lack of a well defined forearc and magmatic arc south of it. Brocher (1985) proposed a progressive reversal of Vitias subduction from west to east since the late Miocene and a cessation of the subduction around 3 My. This interpretation is based on oblique convergence between the Pacific Plate and the northern tip of Tonga Trench, westward thickening of post-collisional sequences filling the troughs, and post-Miocene island arc volcanism south of the lineament.

However, the geochemical affinity and age of volcanism lying immediately south of the Vitias Trench lineament are still not well known. Quaternary alkalic volcanism is present on Rotuma Island (Sinton *et al.*, 1985; Fig. 2.14; Woodhall, 1986) and is correlated with active extension along the South Pandora Ridge on the North Fiji Basin (Sinton *et al.*, 1985) or local extension along the Vitias suture zone during recent plate reorganization (Sinton *et al.*, 1985).

- Volcanics of possible island arc-affinity (Sinton *et al.*, 1985) have been recovered from the Manatu seamount and dated of latest Pliocene (1.8 My: Duncan, 1985).

- Earliest Pliocene (5.4 My: Duncan, 1985) tholeiites with island arc affinity (Sinton *et al.*, 1985) have been recovered from the northern flank of the Horne Islands and are interpreted as the reflect of subduction along the Lau-Vitias Trench (Sinton *et al.*, 1985). A petrological and geological study of the Horne Islands (Grzesczyk *et al.*, 1991) reported two Pliocene volcanic series capped by Quaternary reef limestones. The first volcanism corresponds to submarine tholeiite having an affinity close to that of the Lau Basin and of the orogenic volcanics from Fiji, Lau and Tonga. This volcanism is dated as early Pliocene by micropaleontologic dating of the sediments associated with the lavas. The second volcanism overlying the tholeiitic lavas is composed of alkali-enriched tholeiites and transitional basalts of late Pliocene in age. This change in volcanism type in Horne Islands coincides with the change at 3 My in Fiji and Lau volcanism from subduction island arc tholeiites to alkali basalts reported by Gill *et al.*, (1984) and Cole *et al.*, (1985), and is correlated with a main plate reorganization in the termination of the north Tonga Trench from convergence (Vitias-Tonga subduction) to transform motion (North Fiji Frature Zone) (Grzesczyk *et al.*, 1991).

2.4.4 - The Melanesian Border Plateau

The Melanesian Border Plateau (Fairbridge and Stewart, 1960), also called the New Hebrides-Samoan lineament (Hawkins, 1976) is a series of volcanic seamounts, ridges, banks and islands on the Pacific oceanic crust, which parallels northward the Vitias Trench lineament from 173°30'E to the Samoan Islands (172°W). The absence of magnetic anomalies lineations on the Pacific crust north of the Vitias lineament and the presence further north of magnetic lineations identified as lower Cretaceous anomalies M1 (115 My) to M114 (130 My) suggest that the seafloor around the Melanesian Border Plateau was formed during the upper Cretaceous magnetic quiet zone (110 to 80 My: Scheibner *et al.,* 1991). Abundant altered tholeiitic basalt and gabbro, as well as in minor proportion alkalic basalt and hyaloclatites have been recovered on a fault scarp, northeast of Niulakita Island in deep water (3,400-4,000 m) (Sinton *et al.,* 1985). A tholeiitic basalt sample yields a Ar/Ar age of 82 My which is in agreement with the inferred age of the oceanic crust in the region (Duncan, 1985).

The origin of the volcanic highs along the Melanesian Border Plateau, still not well understood, is likely not unique and could be related to various plate tectonic processes. These highs can be divided into different groups which are aligned in different directions and may correspond to different magmatic provinces:

1 - the Samoan Volcanic Chain in the east;
2 - the Wallis Islands;
3 - the Tuvalu Chain in the northwest;
4 - the Robbie Ridge in the northeast; and
5 - the Alexa-Charlotte Banks in the west.

These groups converge immediately north of the Vitias Trench lineament in the Southern Tuvalu Banks Area.

The Samoan Volcanic Chain extends WNW-ESE and includes, from west to east, the Samoan Islands, Field Bank, Lalla Rookh Bank and Combe Bank. Samoan Islands are composed of late Quaternary to historic post-erosional nephelinitic lavas which covers Pleistocene shield-building alkalic basalts and tholeiitic basalts (Stearns, 1944; Mac Donald, 1944; Hawkins and Natland, 1975; Natland, 1980; Natland and Turner, 1985). Rocks dredged from Field Bank, dated at 5.4 My by K-Ar and 4.2 by Ar/Ar methods (Duncan, 1985), are strongly undersaturated lavas similar to the Samoan post-erosional magmatism (Sinton *et al.,* 1985). Rocks from Lalla Rookh Bank are late Miocene (10 My: Duncan, 1985) alkalic basalts and ankaramites (Sinton *et al.,* 1985; Johnson *et al.,* 1986) and are related to the transition from shield-building to post-erosional Samoan volcanism. The dredged rocks from Combe Bank are tholeiitic and alkalic basalts similar to the Samoan shield-building lavas (Sinton *et al.,* 1985). A picritic tholeiite, dated at 14 My, possibly represents the early phase of the shield-building magmatism at Combe Bank (Duncan, 1985). The geochemical character of the Samoan Island volcanism appears to extend westward to Combe Banks. Increase of age of this volcanism along the chain with a rate of 7.7 ± 2.5 cm per year supports the idea that the Samoan Volcanic Chain has been generated by a hotspot (Hawkins and Natland, 1975; Natland, 1980) which is now 100 km east of Samoan

Islands (Duncan, 1985). However post-erosional undersaturated lavas on the Samoan Volcanic Chain are thought to be derived from peculiar deformation along the hinge fault at the northern Tonga Trench (Hawkins and Natland, 1975; Natland, 1980).

Wallis Islands, located on the western part of the Samoan Volcanic Chain, are composed of Quaternary (less than 0.5 My) tholeiitic and alkalic basaltic flows and pyroclastics (Sinton *et al.*, 1985; Duncan, 1985; Price and Kroenke, 1991). Although these basalts are similar to shield lavas of the Samoan Islands, they are too young to be related to the Samoan hotspot. This volcanism is related, like the post-erosional volcanism of Samoa, to deformation along the transform plate boundary at the northern Tonga subduction zone (Price and Kroenke, 1991)

The central seamounts of the Melanesian Border Plateau (Tuscarora, Hera, Bayonnaise, Kosiusko and Mac Caw Banks), although aligned along the Samoan Volcanic Chain, are also located in the southern prolongation of the NNW-ESE trending Marshall-Gilbert-Tuvalu volcanic chain, which is interpreted as a Cretaceous hotspot chain on the basis of its parallel direction with the Cretaceous segments of the Hawaiian-Emperor and Louisville Chains. Consequently these seamounts could be the southernmost extension of Cretaceous hotspot chain or the western extension of the Samoan hotspot chain.

The Robbie Ridge trends ENE-WSW and also joins the Melanesian Border Plateau in its central part. Origin of the Robbie Ridge is unknown. Only limestones have been recovered from the Robbie Bank (Sinton *et al.*, 1985). Because the Robbie Ridge parallels the Lower Cretaceous magnetic anomalies M1 to M14 identified further north, and the flexural response of the Pacific crust induced by the Robbie Bank requires a thin lithosphere, Watts *et al.*, (1980) proposed that the Robbie Ridge formed on or close a spreading center in the Cretaceous (Watts *et al.*, 1980). However on the basis on a more recent study of the flexural response of the Pacific crust around this bank, Robbie Bank is considered to be post-Cretaceous and to be possibly part of the Samoan Seamount Chain (Brocher, 1985).

The western part of the Melanesian Border Plateau is composed of the Alacrity and Eaglestone ridges and the Alexa/Charlotte Banks. The origin of these highs is unknown. Watt *et al.*, (1980) proposed that Eaglestone Ridge and Alexa Bank formed off-axis after the Cretaceous. Basalts dredged along the Alexa Bank have tholeiitic to transitional alkalic affinity and are broadly similar to shield lavas from the Samoan Islands (Sinton *et al.*, 1985). However the Ar/Ar age of 36.9 My of a basalt is too old to be related to the Samoan hotspot volcanism (Duncan, 1985). Alexa Bank may have been formed onto Cretaceous Pacific seafloor during an Eocene mid-plate volcanism.

DATA ANALYSIS

CHAPTER 3

DATA ANALYSIS

3.1 - PREVIOUS WORK

3.1.1 - East Malaita zone

The East Malaita zone is constituted by a NW trending system of structures prolongating the post-early Miocene "en échelon" fold belt of Malaita Island (Kroenke, 1972). At the northern and southern tips of Malaita Island, the folds are characterized by a reverse polarity compared with the main part of the island.

Steep submarine scarps observed on the East Malaita margin suggest the existence of significant faulting. To the north this folded system abuts against the North Solomon Trench which is interpreted by Kroenke (1984) as a structural hinge line or a regional syncline. A relatively shallow (3,000 m deep), poorly defined and sediment-infilled (Vedder and Coulson, 1986) trench separates Solomon Islands from the Ontong-Java Plateau. For Coleman and Kroenke (1981) it represents the late Eocene to early Miocene site of the subduction zone related to the motion of the Ontong-Java Plateau.

Multichannel profiles carried out during the R/V *S.P. Lee* cruise (1982) allow correlation between the Ontong-Java Plateau and the Malaita system. The deep troughs bounding the northeast of Malaita are filled with early Miocene deformed sediments.

3.1.2 - Indispensable Basin (Fig. 3.1)

The Indispensable Basin is a narrow, asymmetric basin separating the Santa Isabel-Florida- Guadalcanal Islands platform from Malaita. It is about 200 km long and 55 km wide at its maximum width. The geologic setting of the basin is different from that of the Central Solomon Trough, as noted by Bruns *et al.*, Vedder and Bruns, Vedder and Coulson, 1986 (in Vedder, Pound and Boundy, 1986).

Malaita and the northeastern side of Santa Isabel are part of the Pacific Province of Coleman (1965, 1970), whereas Guadalcanal, Florida and southwestern Santa Isabel are part of the Central Province. The Indispensable Basin lies in a structural depression between the broad Malaita anticlinorium and the Santa Isabel - Florida - Guadalcanal Islands platform. The basin form was controlled by the development of these features: the north flank of the basin shows uplifting and faulting due to the continuing development of the Malaita anticlinorium since late Miocene; the southwest flank is formed by a major southwest dipping thrust fault, alternatively

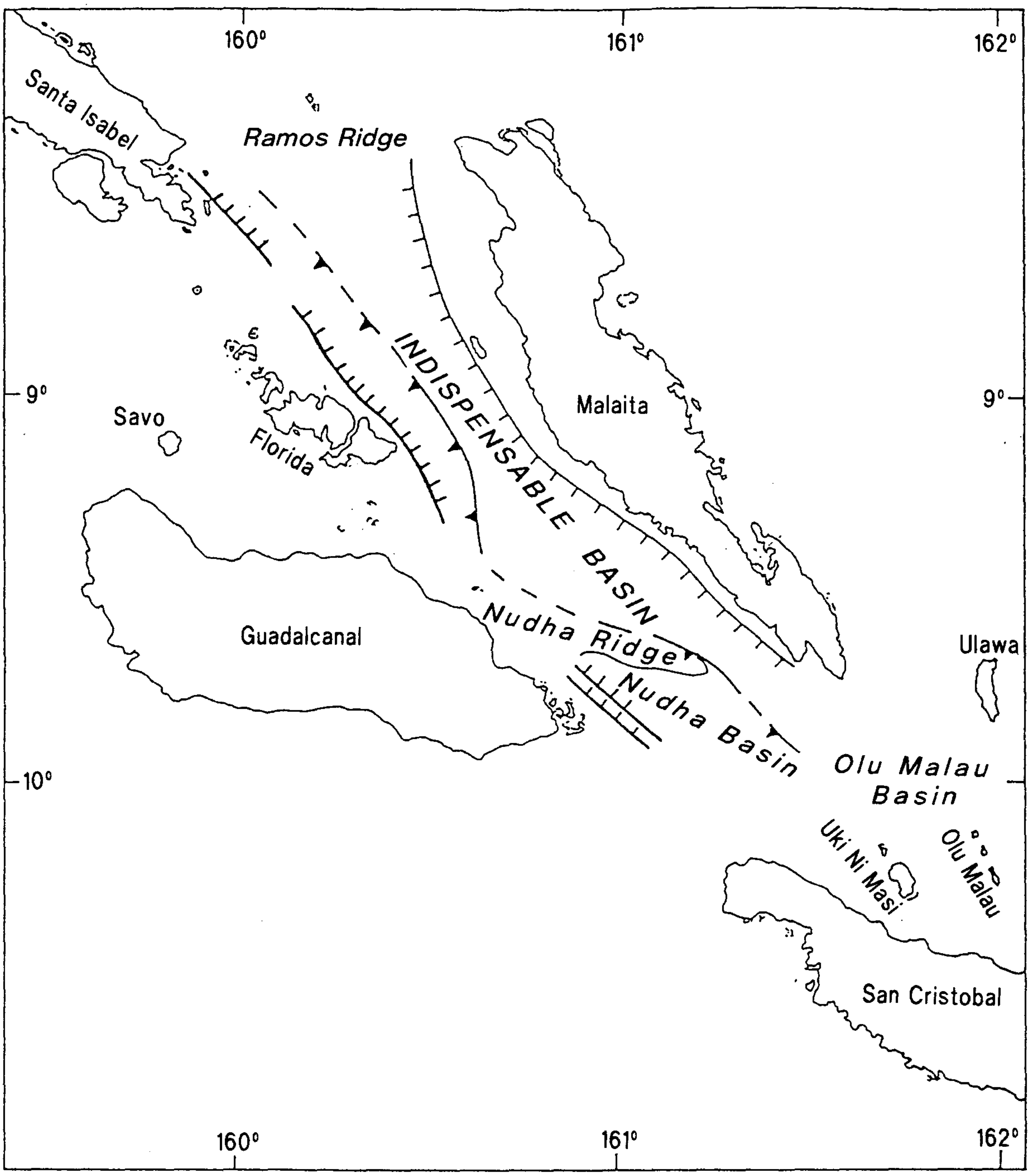


Fig. 3.1 - Location of the Indispensable Basin

changing into a strike-slip fault; however, in the south, the uplifting of the Nudha Ridge, during Quaternary time, produced the formation of a narrow, adjacent basin, the Nudha Basin, a probable extension of the onshore Mbokokimbo Basin on Guadalcanal Island.

3.2 - BATHYMETRY

3.2.1 - East Malaita

The surveyed area corresponds to the entire eastern side of Malaita and the Ulawa Islands. (Fig. 3.2). It can be divided in three main zones showing different structural characteristics.

The northern zone, north of 8°45'S, is the simplest one with a N160°E trending scarp bounding the Malaita Island. The scarp is constituted by a succession of parallel steps up to the North Solomon Trench. It is cut in two places by deep square depressions open toward the east. These depressions centered on 8°25'S and 8°45'S are limited to the east by steep scarps. At the foot of these scarps, the North Solomon Trench is a triangular shaped basin with a maximum depth reaching 4,250 m. The trench is bounded to the east by a regular, flat, southwest-dipping area trending N140°E.

The central zone is constituted by a tectonized zone reflecting the Malaita and the Ulawa Islands structural prolongation. It is mainly characterized by three successive parallel ridges separated by deep basins on the slope. The most proeminent ridge is the central one with a summit culminating at an average depth of 750 m. This ridge, like the other two and the intermediate basins, shows changes of trends limited by N120°E, N140°E and N160°E faults. The northern tip of this central ridge is formed by the 8°45'S, 2,500 m deep, square depression of the northern zone. The eastern ridge seems to be different in nature that the two other, and could be mainly a sedimentary deformation zone. This deformed zone abuts in a 4,000 m deep domain representing the extension toward the south of the North Solomon Trench. Here the trench is poorly expressed and is constituted by a succession of small elongated ridges and depressions suggesting compressive deformation oriented to the southwest . This area is flanked by the flat, southwest-dipping, N140°E trending oceanic bottom previously described in the northern zone.

The southern zone is marked at 9°15'S by a drastic change of the slope structural directions from NW-SE to NS trend. The eastern flank of the Ulawa Island is probably constituted by a major NS fault running from 9° to 10°30'S. To the east the slope is dissected by oblique alternation of spurs and depressions oriented N40°E to EW. The slope abuts in a deep trough more than 5,500 m deep guided by NS and NW-SE directions. The eastern side of the trough is characterized by NE-SW oblique ridges and depressions while the western side is a flat bottomed basin more than 6,000 m deep. This trough is supposed to be the southern end of the North Solomon Trench and the junction with the Cape Johnson Trench. To the south the whole area is limited by a major EW scarp flanking a less than 1,750 m high ridge separating the Solomon-Johnson Trench junction zone from the San Cristobal Trench.

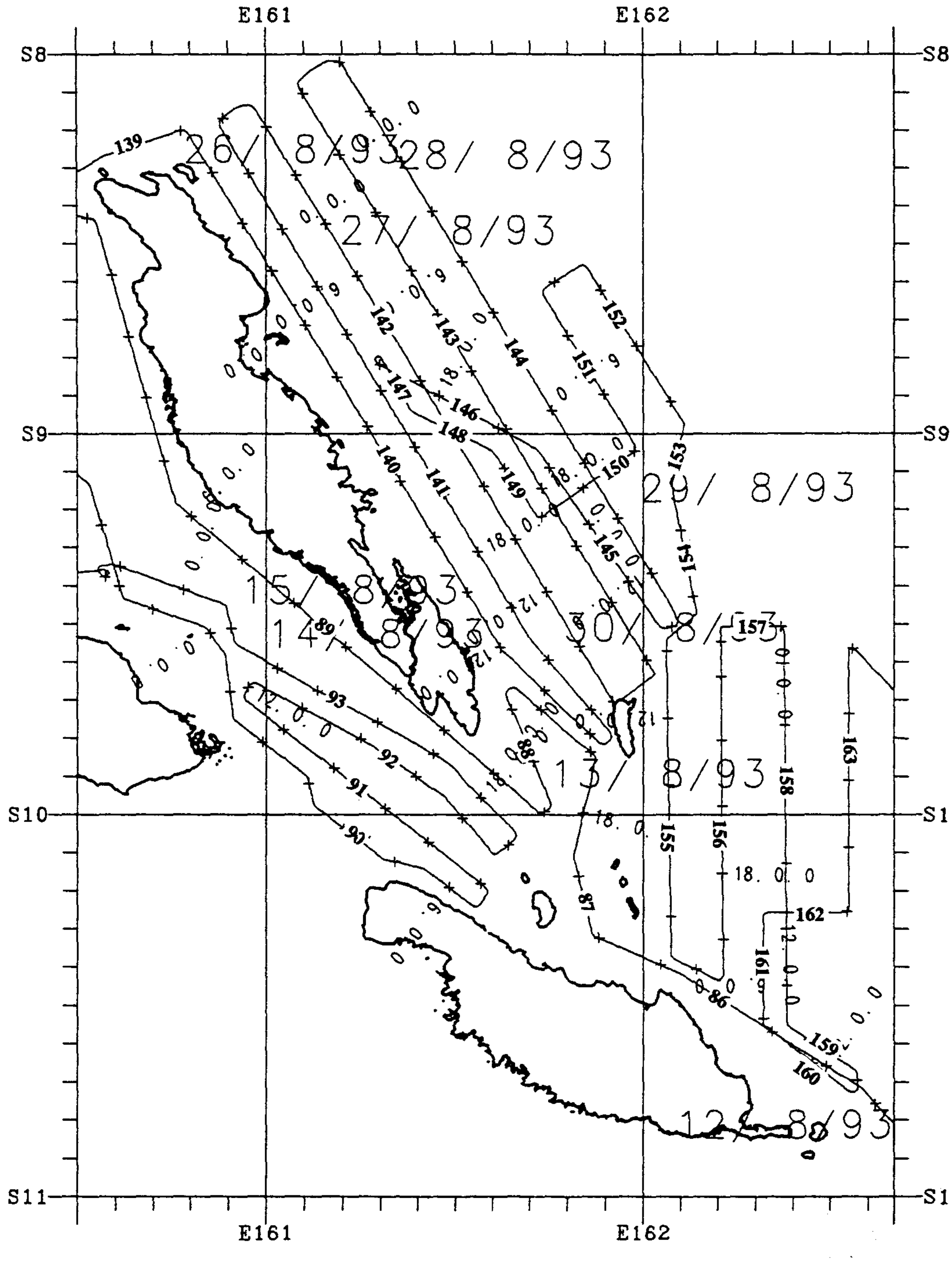


Fig. 3.2 - Survey location and profile identification

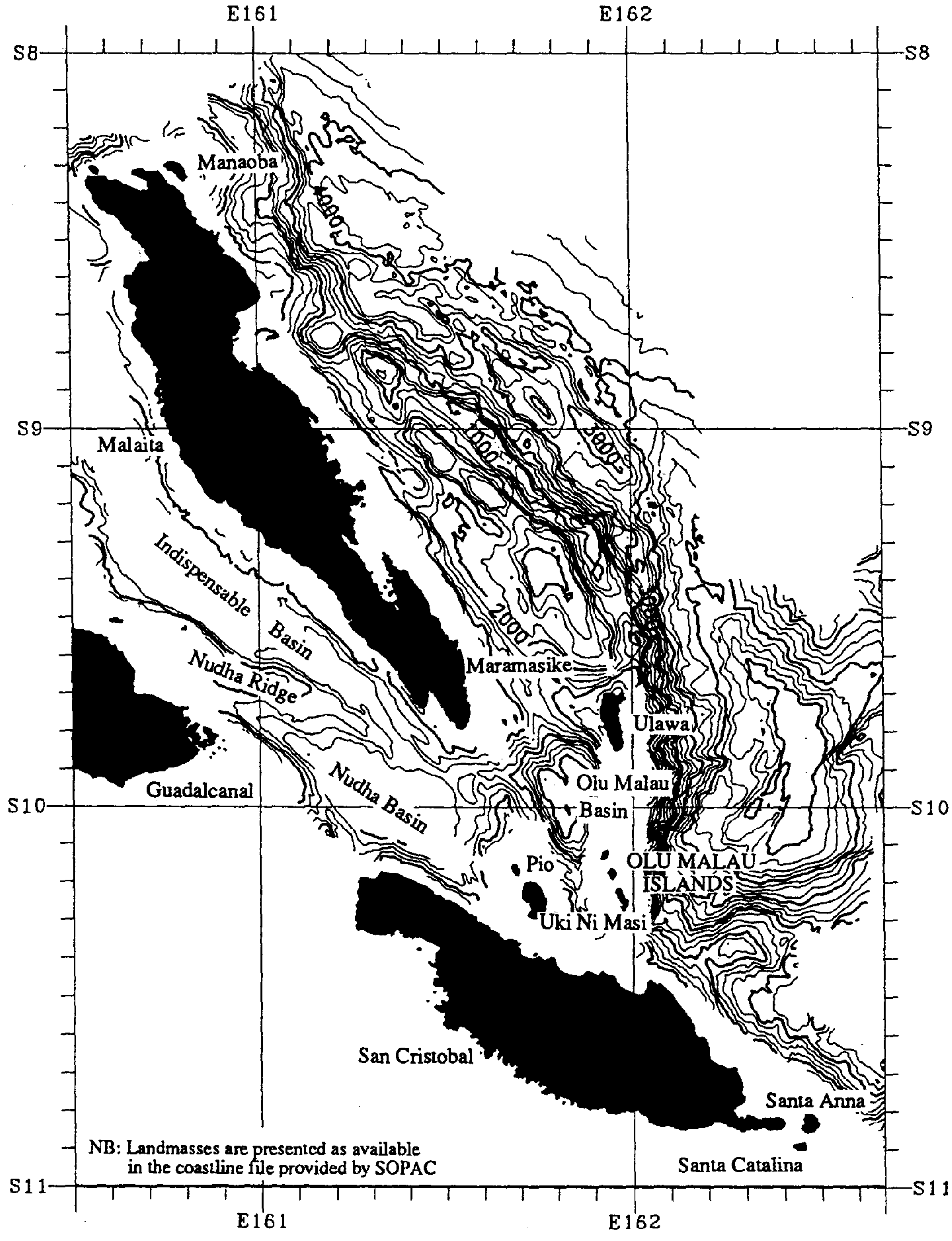


Fig. 3.3 - Bathymetry in the Malaita Area

3.2.2 - Indispensable Basin

The Indispensable Basin lies between Malaita on its northeastern side, San Cristobal to the southeast, the Santa Isabel-Florida-Guadalcanal islands platform to the west and northwest and the Ramos Ridge to the north. Due to the lack of time, during the SOPACMAPS cruise, it was not possible to get a full bathymetric coverage of the basin; nevertheless, in the southern part, between 9°30'S and 10°20'S, the coverage is fair, and clearly shows several basins.

a) A triangular basin southwest of Ulawa Island, bordered to the south by the Uki Ni Masi and the Olu Malau (Three Sisters islands) islands, will be described hereunder as " Olu Malau basin". The depth of more than 3,000 m in the center is fairly uniform except for a small ridge on the northwest side dividing the basin into two parts.

b) The Indispensable Basin (sensu stricto) is separated from the previous one by a saddle between the southern extension of Malaita and the Uki Ni Masi Ridge. We got only a few data on the slopes which seem to be eroded by numerous channels.

c) The Nudha Basin is separated from the Indispensable Basin by the Nudha Ridge. This ridge trending NW-SE joins the Guadalcanal Island platform at the level of Nudha Island. Its northeastern slope is steep and probably due to a fault. The Nudha Basin, with a length of approximately 80 km and a width of 25 km is more than 2,000 m deep, tapered to the northwest and the southeast. Its southwestern slope is steep and marks a normal fault uplifting the southeastern extension of Guadalcanal Island.

3.3 - IMAGERY

3.3.1 - East Malaita

The imagery data obtained on East Malaita allow identification of the same structural subdivisions.

The northern part of the survey is characterized by few reflective features except those associated with the N160°E scarp bounding Malaita Island to the east. Slumping zones can be identified at the foot of the slope and in the deep square depressions previously described.

The central area is more reflective, especially the central ridge which appears to have young or reactivated relief without significant sedimentary cover. To the east, at the foot of the ridge, the imagery illustrates the deformed aspect of the area linking the central basement ridge with the North Solomon Trench.

To the south, the Ulawa Island slope is also very reflective and bounded by slumped or deformed features. The deep basin constituting the junction between the North Solomon and Cape Johnson trenches is cut by NE-SW ridges and scarps parallel to the Cape Johnson Trench trends. In the southeastern part of the survey appear the complicated structures of the Melanesian Arc Gap.

3.3.2 - Indispensable Basin

The acoustic imagery allows confirmation of the existence of numerous channels eroding the slopes, especially on the southwestern slope of Malaita and the northern slope of Guadalcanal.

The basins show poorly reflective facies interpreted as homogeneous sediments. The Olu Malau Basin is, however, slightly more reflective than the Indispensable and Nudha basins. This fact, in addition to the greater depth, could suggest that the sedimentation is less active in the Olu Malau Basin, probably because of the distance and the size of the surrounding islands.

The Nudha Ridge and especially the eastern flank of the Nudha Basin are highly reflective, showing steep slopes and lack of sedimentary cover.

At the toe of the slopes, material with a medium degree of reflectivity is evident. This material can be interpreted as volcanic material which originated from the islands.

3.4 - SEISMIC REFLECTION PROFILES

3.4.1 - East Malaita

NW-SE (profiles 140 to 154, see plates 1 and 2) and NS-trending seismic reflection profiles (155 to 163, see plate 3) were carried out along the eastern part of the Solomon Islands arc, offshore Malaita and Ulawa, respectively. The interpretation of the seismic reflection profiles reveals:

- North of Ulawa, the extension of the island through a 15 km wide submarine ridge which trends N340°E south of 9°15'S and NW-SE north of this latitude. The submarine ridge is offset by a series of WNW-ESE left-lateral faults which are present at 9°25'S, 9°15'S and 8°55'S.

- immediately east of Ulawa a major 3,000 m high, N340E-trending eastward-facing normal fault. Ulawa and its northern extension, the submarine ridge, are bordered to the west by a series of sub-circular depressions (filled with 1 s.t.w.t. of sediments) that reach a maximum depth of 3,000 m. To the east, although the seismic profiles almost parallel the trench, the study area (profiles 143, 144 and 152) shows southward-dipping sedimentary series averaging 2 s.t.w.t. of thickness, cut by normal faults. North of Malaita, sediments within the North Solomon Trench are 1.0 to 1.5 km thick and essentially undeformed. North of 9°15'S, the eastern end of the North Solomon Trench trends N340°E up to 8°55'S, then changes direction to N130°E. Between the submarine ridge and the trench axis, a curvilinear structure, convex toward the east, is

Plate 1 - Interpreted seismic profiles in the Malaita Area (PR 140 to 143)

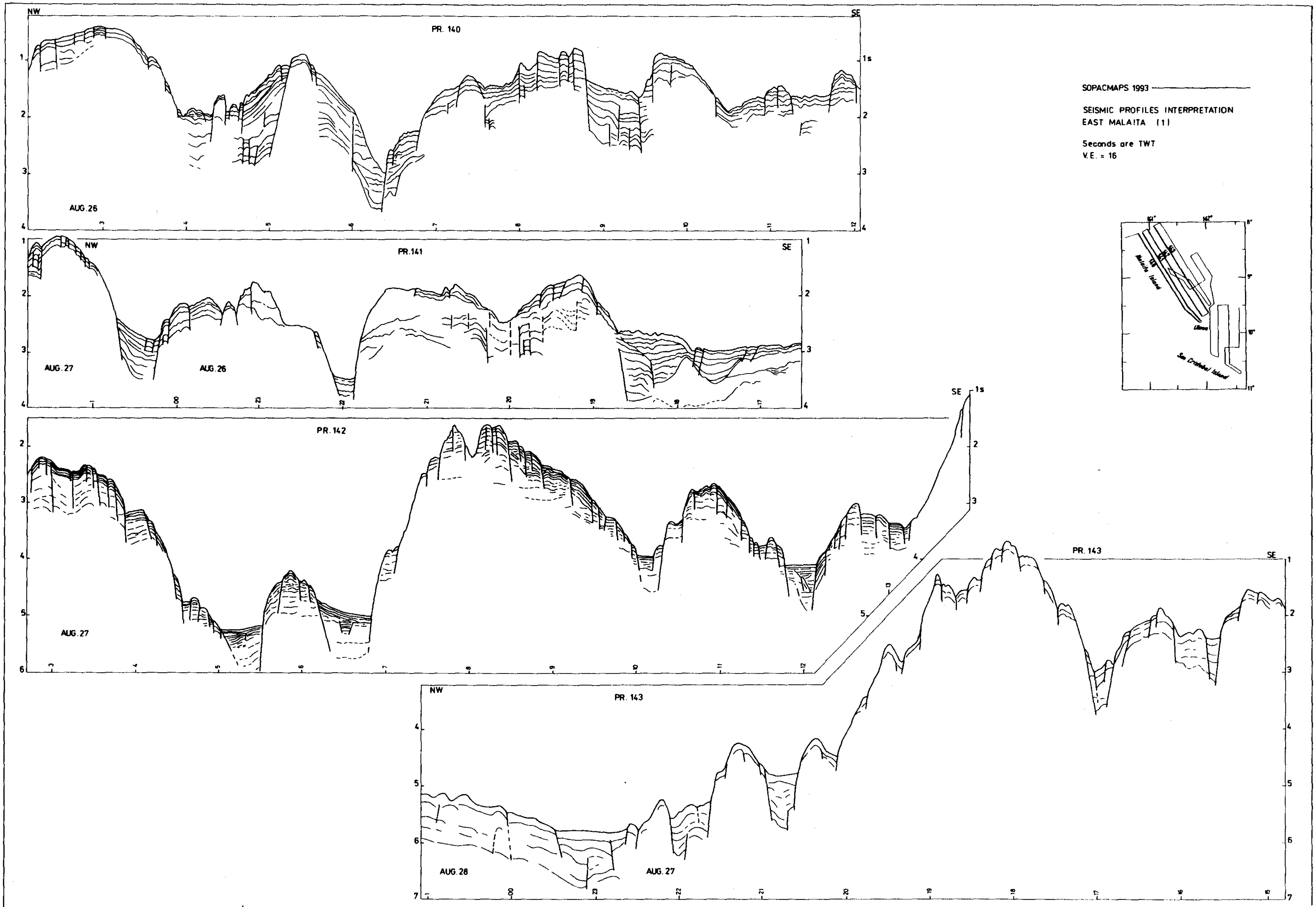
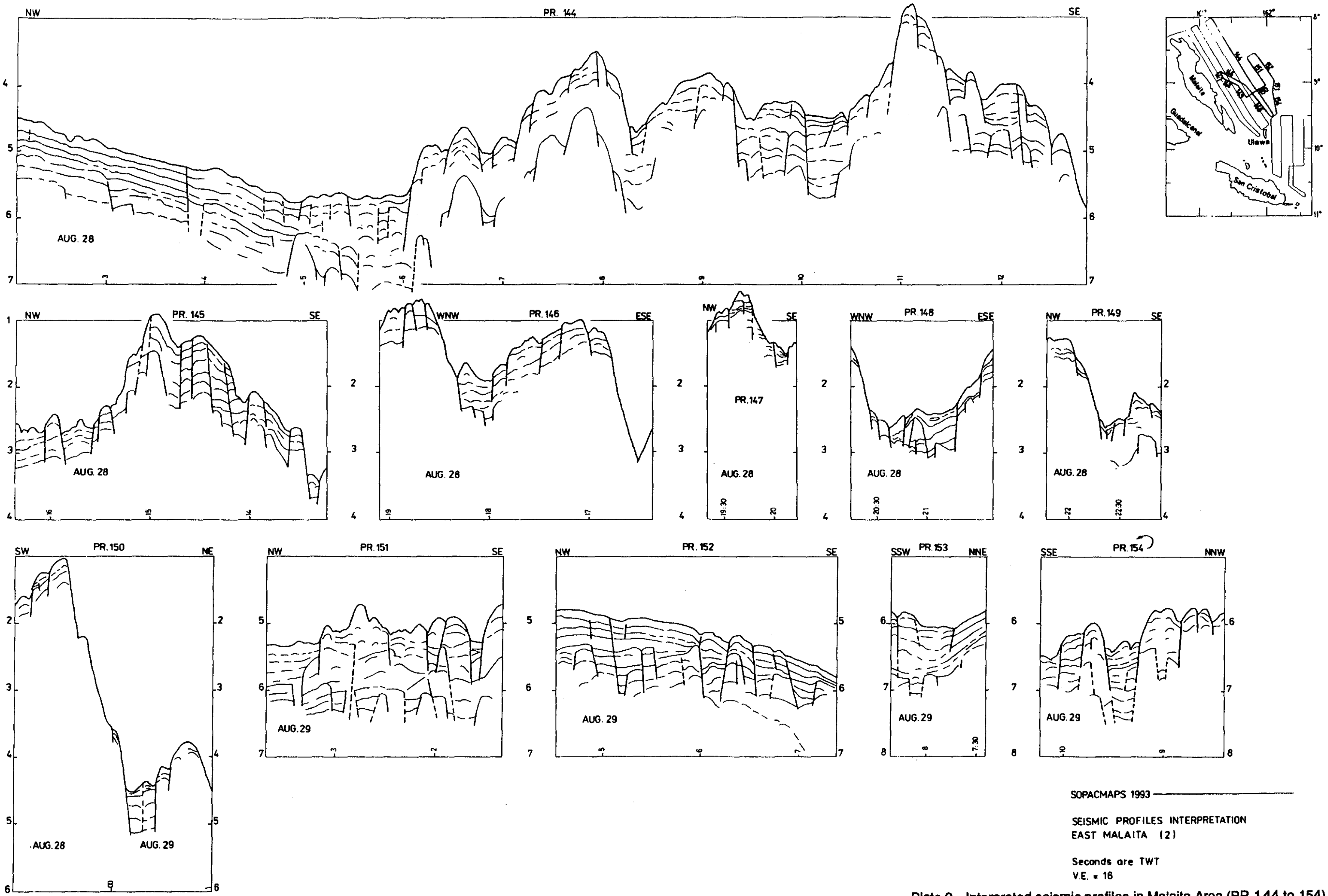


Plate 1 - Interpreted seismic profiles in Malaita Area (PR 140 to 143)

Plate 2 - Interpreted seismic profiles in the Malaita Area (PR 144 to 154)



SOPACMAPS 1993

SEISMIC PROFILES INTERPRETATION
EAST MALAITA (2)

Seconds are TWT
V.E. = 16

Plate 2 - Interpreted seismic profiles in Malaita Area (PR 144 to 154)

Plate 3 - Interpreted seismic profiles in the Malaita Area (PR 155 to 163)

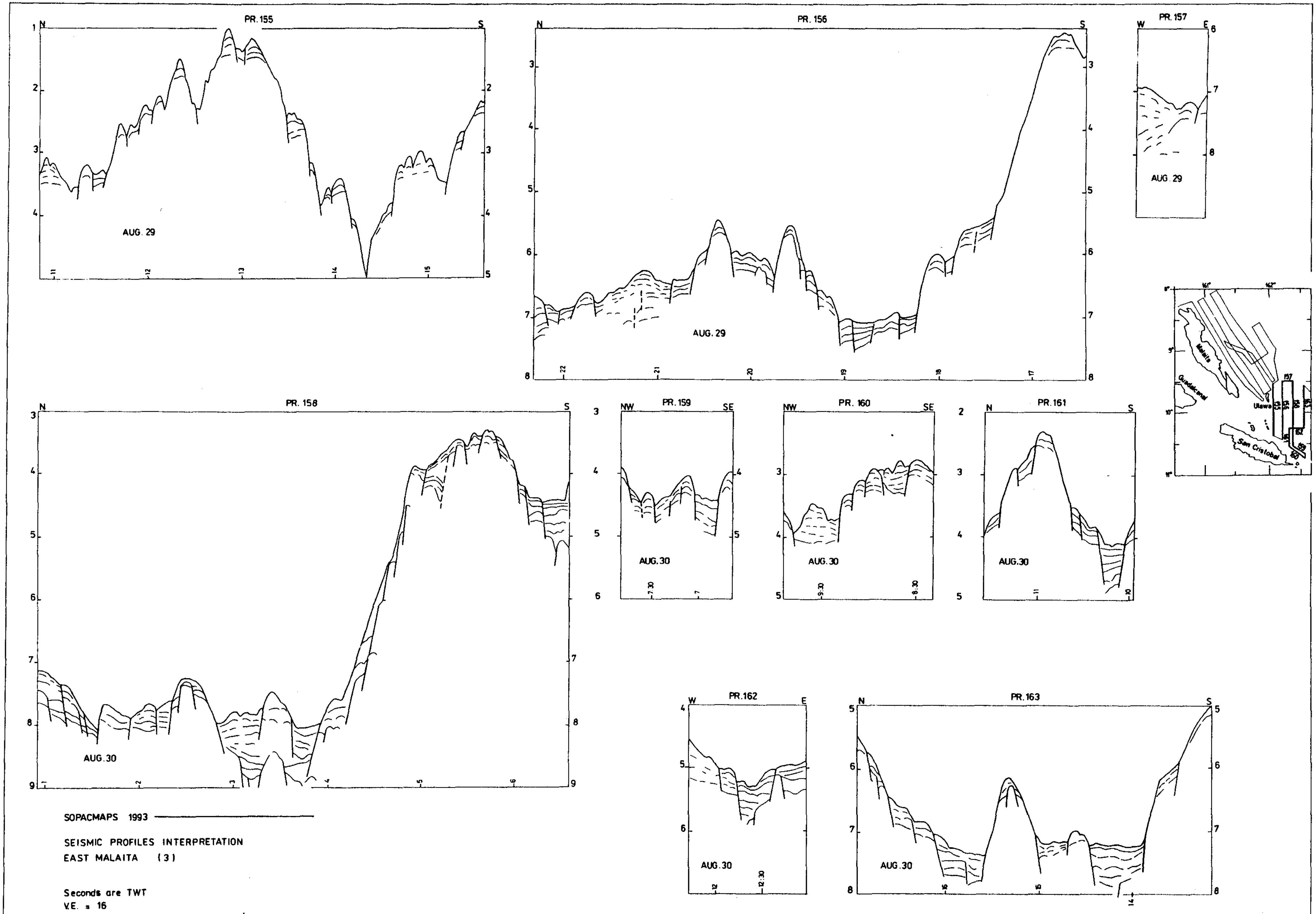


Plate 3 - Interpreted seismic profiles in Malaita Area (PR 155 to 163)

observed from about 8°30'S to 9°10'S. This 15 to 20 km wide structure is made up of a series of sediment-covered highs and depressions that reach average depths of 3,000 and 3,500 m, respectively. On the seismic reflection profiles, the curvilinear structure appears to correspond to an "accretionary zone" filled by the gently folded sedimentary series (1 s.t.w.t. thick) which dip toward the trench axis.

- between Ulawa and Malaita, a NE-SW-trending fault (with a clear magnetic signature) that lies at 9°40'S and left-laterally offset the islands;

- east of Ulawa, the presence of a V-shaped, 6,300 m deep "double-bottom" trench centred at 10°S-162°30'E and affected on its western and eastern sides by NE-SW-trending faults. The NE-SW trend parallels the Cape Johnson Trench, the eastern arm of the V-shaped trench. The trench abruptly stops at 10°10'S along an E-W-trending structure. The convergence of the western part of the North Solomon Trench and the eastern Cape Johnson Trench with a probable (southern limit of our survey) NW-SE-trending trough defines a Trench-Trench-Trench Triple Junction. This Triple junction feature is connected southward to another Triple Junction (San Cristobal - New Hebrides) through the probable NW-SE-trending trough.

On several profiles (143, 144 and 152), the reflectors cannot be traced beneath the gently folded sedimentary series which dip toward the North Solomon Trench axis but instead, into the accretionary zone, suggesting that the trench is probably a geomorphic feature developed during deformation of the Malaita anticlinorium rather than a "typical" subduction zone.

3.4.2 - Indispensable Basin

Three NW-SE profiles (91, 92 and 93, see plates 4 and 5) were shot over the Nudha Ridge and the Nudha Basin. Because of the necessity of running profiles parallel to the morphological features for the multibeam bathymetry, the seismic profiles are not easy to interpret. However, some indications are valuable for establishing the morphostructural map.

- Profile 91:
This profile crosses the Nudha Basin longitudinally from the northwest to the southeast. The sedimentation looks homogeneous, and shows a maximum thickness of 1.2 s.t.w.t. in the southeast portion of the profile.

- Profile 92:
This profile shows clearly two separate structural units: to the southeast, the Nudha Basin, crossed along only 25 km, instead of 60 km on the previous profile, ends abruptly on the southeast edge of the Nudha Ridge, which occurs on the nortwestern part of the profile. The correlation of the two maximums of sediment thickness in the basin, on both profiles 91 and 92, indicates a low axis trending SW-NE. The southeastern flank of the ridge is marked by normal faulting producing several steps. The northwestern part of the profile shows some erosional features on the top of the ridge.

Plate 4 - Interpreted seismic profiles in the Malaita Area (PR 91 and 92)

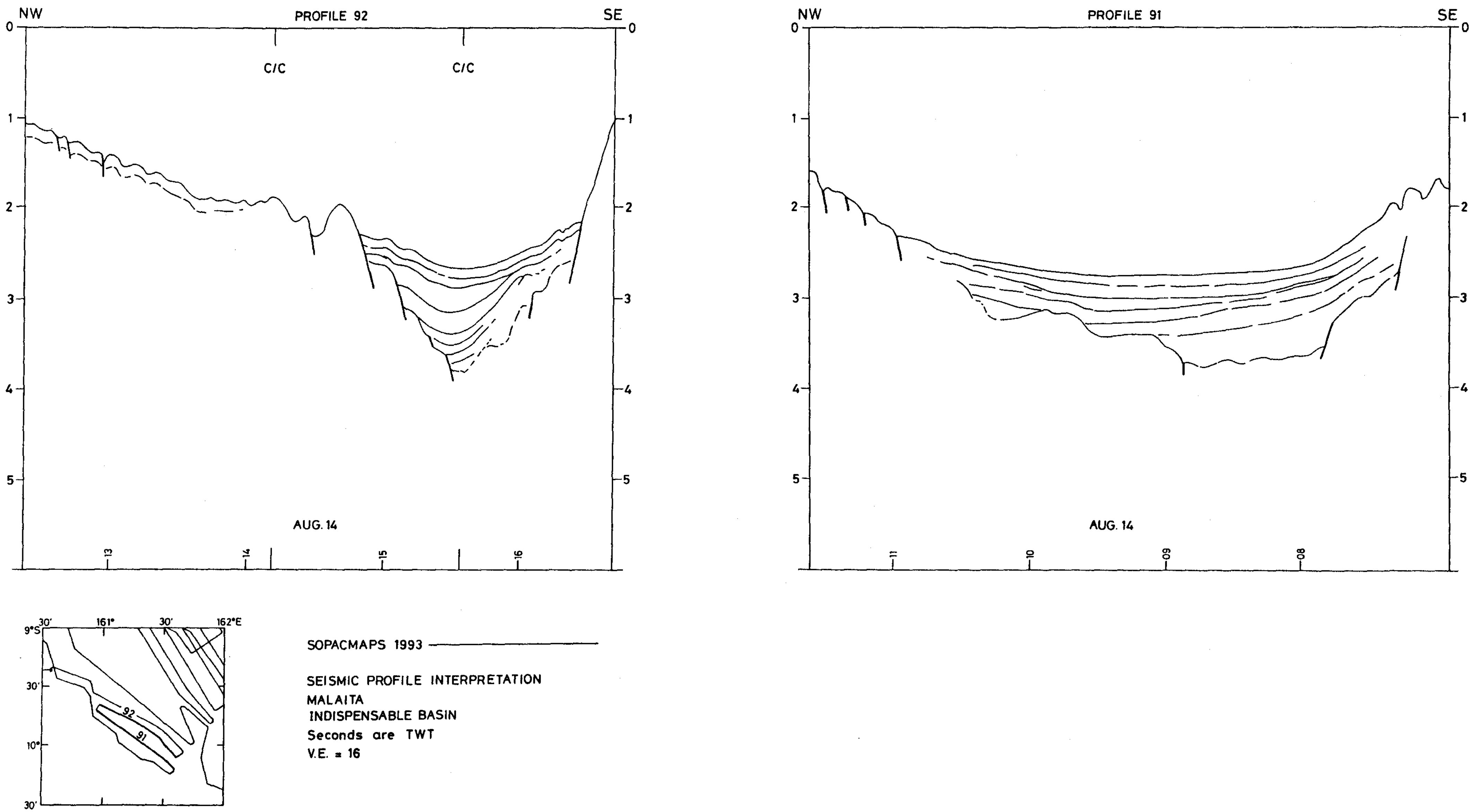
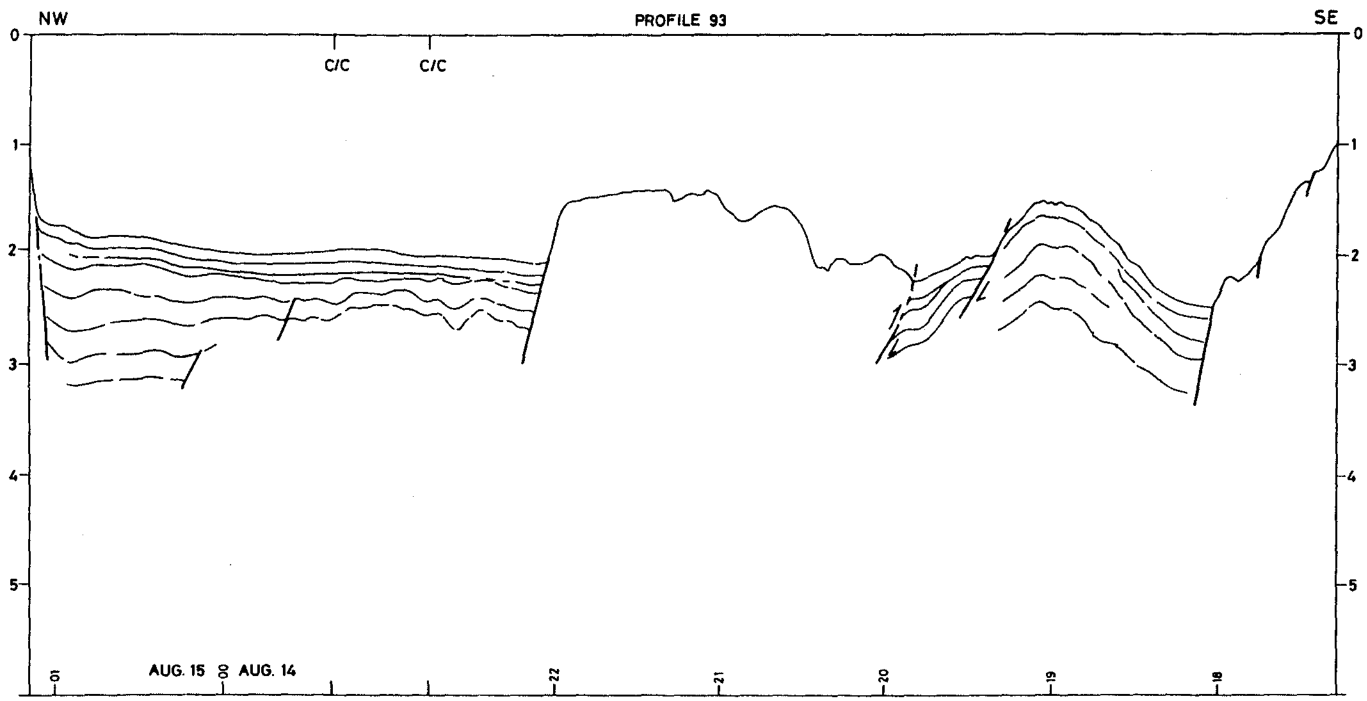
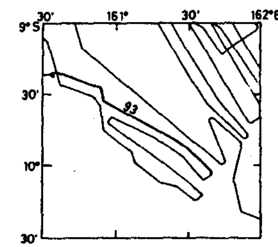


Plate 4 - Interpreted seismic profiles in Malaita Area (PR 91 and 92)

Plate 5 - Interpreted seismic profile in the Malaita Area (PR 93)





SOPACMAPS 1993

SEISMIC PROFILE INTERPRETATION
MALAITA
INDISPENSABLE BASIN
Seconds are TWT
V.E. = 16

Plate 5 - Interpreted seismic profile in Malaita Area (PR 93)

- **Profile 93:**
this profile can be divided into three parts:

1) to the northwest, the profile crosses the southwestern flank of the Indispensable Basin (s.s.); on the acoustic basement, two sedimentary units can be distinguished: a poorly defined internal bedded unit, with a variable thickness, is overlain by a well-bedded thinner sequence.

2) The Nudha Ridge, well-defined by normal faulting, is only 35 km long on our profile, but as the profile is tangential to the northeastern flank of the ridge, that length must not be considered as significant of the importance of the ridge. From both profiles 92 and 93, normal-faulting trends can be inferred, but the two profiles are very close, and possibly do not represent major structural trends.

3) the third part of the profile shows a sedimentary antiform, pinched between the Uki Ni Masi Ridge and the Nudha Ridge. The southeastern part of the Indispensable Basin seems to underthrust the Nudha Ridge, the contact being probably the major suture described by Bruns *et al.* (1986). The contact with the Uki Ni Masi Ridge is interpreted as normal faulting and connected to the same contact on the previous profiles with a NS trend.

3.5 - MAGNETISM

__Preliminary note__: the magnetic anomaly contouring presented in this report has been operated by computer. It does not take into account the main structural discontinuities and may consequently be locally doubtful or wrong. This contouring provides the general trends, but is not valid for formal scientific purposes.

3.5.1 - East Malaita

The seafloor topography east of Ulawa and the Three Sisters Island arc is dominated by the presence of a croissant shaped, 6,000 m deep trough which trends N-S, paralleling the coastline. This trough is bordered on the west by a fan shaped structure sitting on Ulawa Island and dipping eastwards, with very steep slopes. On the south, it is intercepted by an east-west trending structure associated with the San Cristobal slope break.

All over the area, average magnetic anomaly amplitudes (Fig. 3.4) range between 0 and 200 nT (only two lows of negative amplitude reaching -200 nT are observed near the coastline at 9°42'S and 9°56'S). Isocontours are smooth, showing a slight negative gradient, from 200 nT in the trough at the foot of the slope, to zero on the top of it (note that the gradient is more important westwards than southwards). Therefore we think that the magnetic anomaly pattern is merely associated with the sea-floor topography, and that it does not indicate the presence of magnetized body at shallow crustal levels. The prism that abuts against the Ulawa Island is assumed to be made of accreted sedimentary material.

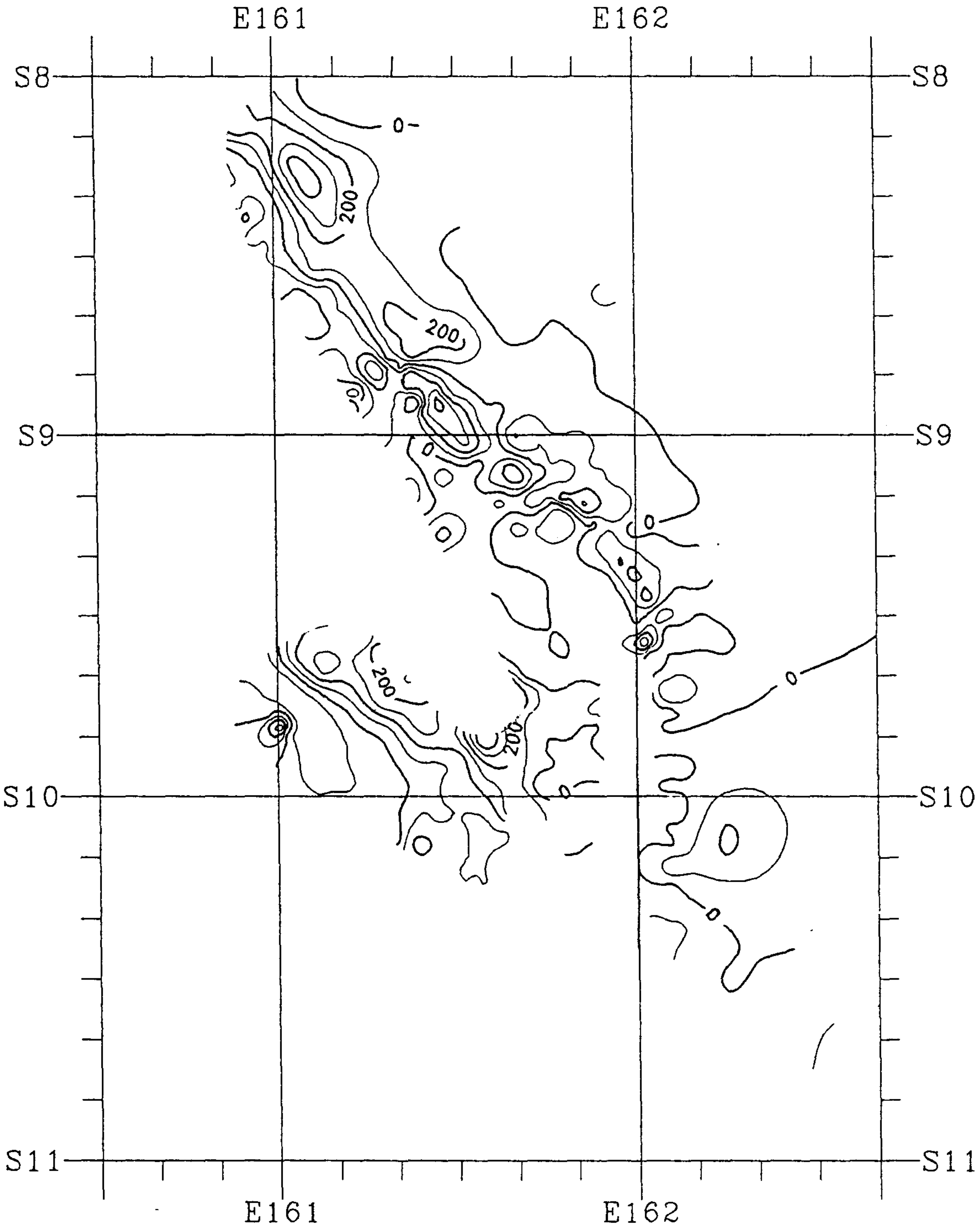


Fig. 3.4 - Magnetism in the Malaita Area (computer contouring) - Contour interval 100nT

Further north, off the east coast of Malaita, the sea-floor topography consists of a series of three, well defined ridges trending NNW, alternating with basins parallel or sub-parallel to the coast line of the island. The major feature is an arc shaped ridge which trends N-S in the south and bends N310° in the north, in the direction of the major left-lateral strike slip fault that affected the northern part of the Malaita Island. It is flanked by very steep slopes, and is as shallow as 750 meters in some places. Magnetic anomalies all over the area range between -500 nT and +500 nT. They generally trend N340°E to N310°E, and reflect sea-floor topography. Their high amplitudes indicate the presence of magnetized material of volcanic origin. This supports the conclusion of the structural interpretation, which considers that the ridges off Malaita are the underwater continuation of Eocene volcanic basement which is known to outcrop on the Ulawa Island.

3.5.2 - Indispensable Basin

Off the southwestern slope of Malaita, magnetic anomalies range between - 500 nT and +411 nT. Their trend cannot be defined, as only one profile was run. These high amplitudes indicate the presence of magnetized material of volcanic origin.

The southwestern flank of the Indispensable Basin shows a magnetic anomaly pattern roughly associated to the sea floor topography, the 0 nT contour being, for example, orientated NW-SE. However, the Nudha Ridge and the Nudha Basin are not evidenced by those anomalies.

Over the Olu Malau Basin, average magnetic anomaly amplitude is low in comparison with the high amplitudes (reaching 500 nT) observed along the profile 89, close to the southern coast of Malaita.

3.6 - GRAVIMETRY

__Preliminary note__: the gravity contouring presented in this report has been operated by computer and is valid for general description purposes. The processing is not highly sophisticated and that this contouring is not valid for accurate scientific use.

3.6.1- East Malaita

Gravity data were obtained along the eastern side of the Malaita and Ulawa Islands (Fig. 3.5) along profiles 140 to 163. The mean discrepancy in gravity measurements calculated at six trackline intersections is 1.2 mGals without considering a 17 mGals discrepancy obtained at one intersection. This mean discrepancy allows contouring of the Free Air Anomalies at 10 mGals intervals.

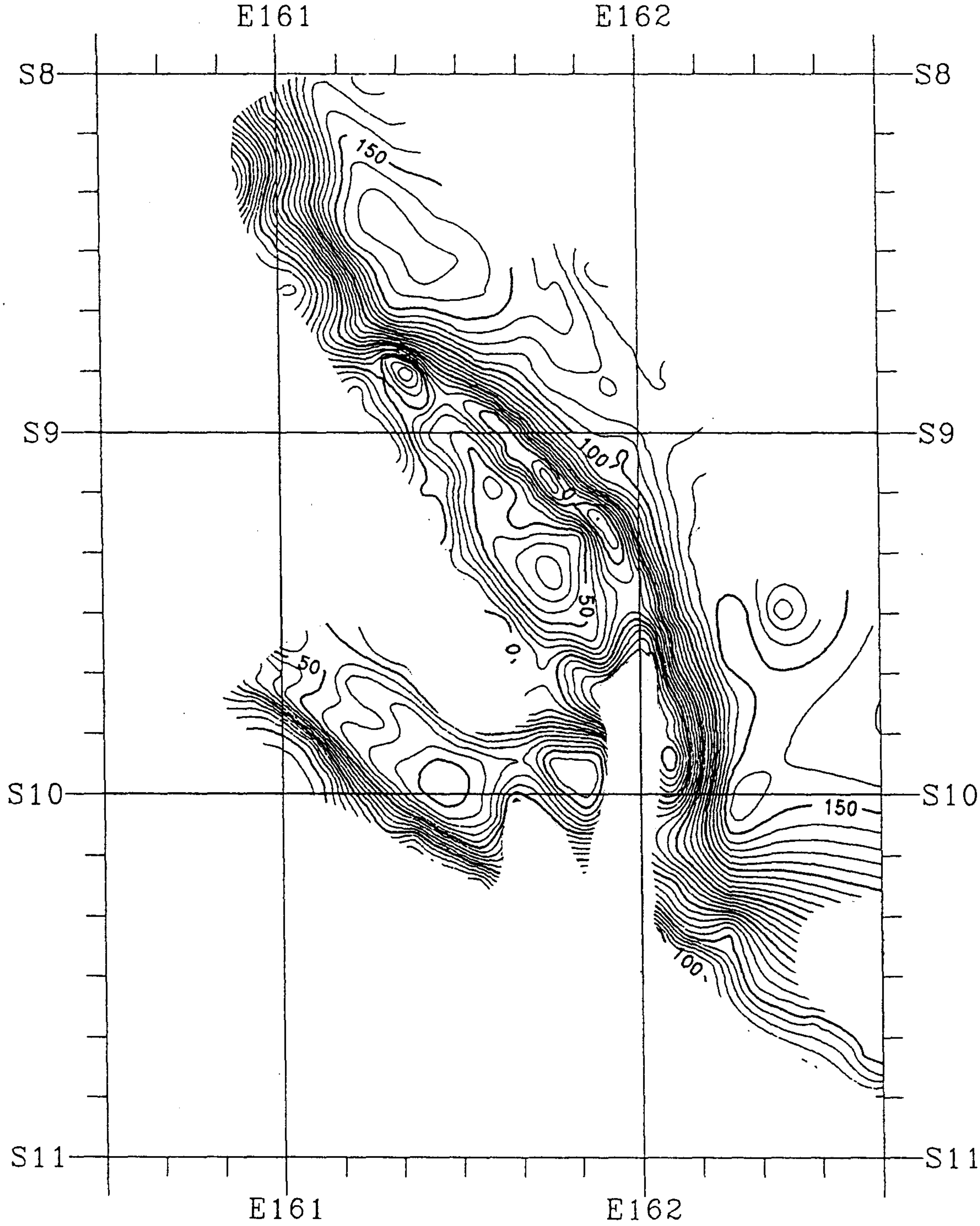


Fig. 3.5 - Gravity in the Malaita Area (computer contouring) - Contour interval 10 mGals

Free Air Anomalies obtained within the study area range from -167 mGal over the 6,000 m deep trench east of the Ulawa Island to +110 mGal over the shallow water sea floor off the eastern Malaita Island. From east to west, Free Air Anomalies can be separated into three groups corresponding to three arcuate structural domains trending roughly NNE-SSW: an east gravity low reaching -63 mGals, an arcuate gravity high reaching locally +60 mGals and a double western gravity as low as -167 mGals.

The western gravity low that reaches -63 mGal superimposes on a series of 2,500-3,000 m deep, bathymetric lows trending NE-SW.

The arcuate gravity high extends from the Ulawa Island obliquely toward the northeastern part of the Malaita Island. This high coincides with a major topographic ridge that culminates near 700 m and crosscut obliquely the deformation wedge; +50 to +60 mGals values of gravity anomalies suggest that the ridge does not consist only of accreted pelagic sediment, although gravity modelling would be necessary before concluding. From the geology of the Ulawa Island this ridge appears to be made of a volcanoclastic basement of Eocene-Oligocene age overlain by Miocene carbonate sediment and Pleistocene emerged reefs.

The eastern gravity low shows two minima centred over the trenches. One gravity low reaches -150 mGals and coincides with the 4,250 m deep flat-bottomed trough that separates the OJP from the Malaita deformation wedge. The second low (-167 mGals) coincide with the NS 6,000 m deep trench east of Ulawa Island. The eastern slope of the Ulawa Island is characterized by a gravity gradient of 12.1 mGal/km.

3.6.2 - Indispensable Basin

Free Air Anomalies obtained within the region range from -114 mGals over the 3,000 m deep Olu Malau Basin to +115 mGals over the northern edge of San Cristobal, south of Olu Malau Island. Free Air Anomalies can be separated into three groups, corresponding to the stuctures:

1) From the northeast, a positive gravity marks the western slope of Malaita, whereas towards the south the value decreases along profile 89, still remaining over -45 mGals. Isocontours are smooth and the negative gradient from northeast to southwest is very slight. The high axis of Malaita is separated from the Ulawa Island high axis only by a slightly negative anomaly.

2) The Indispensable Basin is characterized by an "en échelon" negative anomaly reaching a minimum of -106 mGals in the southern part, close to the minimum of the Olu Malau Basin. These two gravity low give an east-west trend to the contours.

3) Over the southwestern part, the anomaly value increases whith respect to the bathymetry. The Nudha Ridge is clearly marked by a broadening of the -50 to 0 mGal zone, south of 9°30'S, whereas the negative anomaly zone is restricted.

GEOLOGICAL SYNTHESIS

CHAPTER 4

GEOLOGICAL SYNTHESIS

The survey conducted in the Malaita Area allows refinement of the previous observations made in particular by Kroenke (1984).

The Malaita Area is a part of the Malaita anticlinorium resulting from the conjunction of shortening processes along the North Solomon and Cape Johnson trenches and strike-slip to subduction along the San Cristobal Trench.

The northern part of the area shows a quite direct contact between the Malaita Island margin and the "subducting" Pacific-Ontong Java plate. The NW-SE Malaita slope abuts against the 4,000 m deep sediment infilled North Solomon Trench flanked to the east by a N140°E trending dipping plate.

The central area is essentially represented by the submerged prolongation of the Ulawa-Malaita geologic features. The most remarkable feature of this area is the central ridge underlined by a strong magnetic and gravimetric anomaly. This magnetic anomaly suggests, at least for a part, a volcanic nature for the ridge. The central ridge, bounded by N140°E, N160°E and NS faults (see the morpho-strutural interpretation map at 1:500,000 scale) is separated from Malaita Island by an elongated 3,000 m deep graben with the same structural directions. East of this area, the North Solomon Trench disappears and is occupied by a deformed sedimentary cover forming a succession of elongated N140E ridges and depressions. The whole area can be interpreted as an old compression zone affected, in the present stage, by vertical movements.

On the 162°E longitude the whole Malaita domain is cut by a major NS fault up to the southern tip of the Ulawa margin. East of this fault a 6,000 deep square trough constitutes the "nodal" basin at the junction of the North Solomon and Cape Johnson trenches. Recently, this trough has been cut by N40E ridges parallel to the Cape Johnson Trench.

At the southern tip of the area, EW ridges and depressions correspond to the structures related to the San Cristobal strike-slip/subduction zone.

The Indispensable Basin development history was described by Bruns *et al.*, (1986) as different from that of the Central Solomon Trough. The formation of the basin may have occured during the early Pliocene by the subsidence of a shallow-water shelf. The basin now lies in a structural depression between the Malaita anticlinorium and the suture between the Solomon Islands Arc and the thickened portion of the Pacific Plate.

The Nudha Basin is an extension of the Indispensable Basin, separated from it by the uplift of the Nudha Ridge during Quaternary. Onland geology shows the same arrangement in the Mbokokimbo formation on Guadalcanal Island.

* *GEOLOGICAL HAZARDS*

In the Malaita Area, the central ridge culminating at less than 1,000 m deep is interpreted as a volcanic basement line. Active debris flows observed along the ridge slopes are probably of volcanic origin.

Around the Indispensable Basin, acoustic imagery shows debris flows in the channels eroding the slopes, especially on the southwestern slope of Malaita.

POTENTIAL RESOURCES

CHAPTER 5
POTENTIAL RESOURCES

5.1 - LIVING RESOURCES

5.1.1. - Preliminary considerations

Because of over exploitation of the shallow coastal areas, due to the steady increase of demographic pressure and the recent appearance of efficient equipment, all Pacific island countries and territories have attempted to identify new fisheries resources. For about 20 years, they have thus naturally moved towards off-shore fishing activities, especially devoted to outer reef slopes, seamounts and open sea resources. Distribution of species and fishing conditions are closely linked to topography and to the nature of the substrate. Morpho-bathymetric knowledge of ocean bottoms should therefore be the preliminary step to any fisheries operation.

Many species live on the outer reef slopes, between 100 and 500 m. They are mainly deep snapper *(Etelis spp., Pristipomoides spp., etc.)* belonging to the Lutjanidae family. Some very sedentary species are particularly fond of the lower part of sub-marine cliffs situated between 300-400 m depth, others prefer smoother floors, whereas some more mobile species are likely to go up along slopes till a 50-60 m depth. These species can also be found over seamounts shallower than 450 m. Fish poisoning free, they can be eaten safely. Their aesthetic quality (bright red), their delicious taste and their high food-value are many of their attractive qualities for exports. Tests carried out have proved that their preserving capacity on ice and by freezing are higher than those of tempered species due to the low fat content of their flesh. As their growth rate is low, intensive exploitation could be damaging. Maximum Sustainable Yields (MSY) - key values of any fisheries management - are between 1 and 3 kg/hectare/year depending on the areas, which for most the Pacific island countries represents an annual MSY not exceeding a few thousands tons a year. These species seem overexploited in some areas, whereas stocks remain almost virgin in other zones. Studies carried out should enable formulation of management rules for any development planning for local fishing and for any negotiation with foreign fishing fleets.

Deeper than 500 m, other fish species are likely to be found where geomorphological and hydrological conditions are favourable, especially the "alfonsino", *Beryx spendens*, which is subject to commercial exploitation by means of bottom lines and trawl in many Pacific areas. This species particularly likes the summits and flanks of some seamounts, where it can be fished between 500 and 900 m. Several research programmes have been devoted to this species. They have shown its growth rate is low, its reproduction occurs during summer, and that it migrates both vertically and horizontally. MSY have been defined as well as the management rules for its exploitation. In the Central and Western Tropical Pacific, as the seamounts are poorly known, further exploratory surveys have to be made to evaluate the resources. As no fishing has so far been made deeper than 900 m in the tropical SOPAC region, no information is therefore available on deeper resources.

Other demersal resources exist over outer reef slopes and seamounts, especially deep prawns living between 300 and 800 m *(Heterocarpus spp., Plesionika spp.)* and crabs *(Chaceon sp.)* living at a depth of 400-500 m. Studies carried out through exploratory trap fishing have demonstrated limited resources, exploitation of which is strongly conditioned by topography. The prawns have been subject to abundance estimations, preserving and marketing tests. They are well accepted fresh by the consumers, thanks to their bright red colour, but are difficult to preserve. The stocks are limited and can only sustain occasional artisanal fishing operations. Lastly, the nautilus *(Nautilus belauensis, N. macromphalus, N. pompilius, N. srobiculatus et N. stenomphalus)* are found between the surface and a depth of 600 m in many tropical Pacific Islands. Searched for their shells, they are caught with traps with maximum yields around 300-400 m.

For many years, bathyal zone exploration of several Pacific areas has revealed a fauna composed of organisms the hard part of which can be used in jewellery. These organisms are part of the Cnidaria sub-branch and belong to Gorgonacea and Antipatharia orders. Their commercial value depends upon their hardness, their colour and their lustre. *Corallium spp.* of which 36 species are known and 7 are at present fished, range in colour from white to red, whereas the Antipatharians produce black coral. Some species of the genus *Stylaster* (Order Stylasterina) with their pastel shades of white, yellow, pink and mauve might well be considered for use despite their comparative fragility. The living part of these bodies is made up of polyps whose tentacles catch particles in suspension. To develop, they require hard substrates where the colony can establish itself and fairly strong currents to carry their food to them. This is why they are particularly abundant on some seamounts. It is on these formations therefore that commercial exploitation has developed. Collection is difficult because of the rugged bottom and is carried out mainly by dredging and mopping. In Hawaii small manned-submersible are used. The most important fishing activity is carried out by Japan and Taiwan whose boats have operated for many years over the Emperor Chain seamounts (140 tons of *Corallium spp.* fished in 1983, representing 70% of world production). Since 1980, exploration surveys for potential resources of semi-precious corals have been carried out by SOPAC, mostly focused on Antipatharians, on *Corallium spp.* and on other species such as the so-called "gold coral" *(Gerardia spp., Parazaanthus spp., Primnoa spp.)* and the "bamboo coral" *(Lepidisis spp., Acanella spp.)*. The areas investigated have been the Cook Islands (28 dredgings operations), Kiribati (95), Vanuatu (66), Papua, New Guinea, Western Samoa (36), the Solomon Islands (168) and Tonga (55). The results of these surveys have been very promissing in some places, the richest bathymetric layers being in the 100 to 300 m depth range. Nearly 800 dredging operations have been carried out in New Caledonia during the exploration programme on the bathyal fauna. All these operations depend on a good knowledge of the sea floor topography.

The tunas (yellowfin tuna, *Thunnus albacores;* bigeye tuna, *Thunnus obesus;* albacore tuna, *Thunnus alalunga;* skipjack, *Katsuwonus pelamis)* and associated species (Mahi mahi, *Coryphaena spp.;* swordfish and marlins) are found all over the tropical Pacific where they are fished according to their species and their growth stage, either at the surface (trolling, pole and line, seine), or in midwater (longline and vertical lines down to 300 m water depth). Yellowfin tunas and skipjack are usually found in the near off-shore where they are easily caught by local artisanal fisheries. Several Fish Aggregating Devices (FAD) have been deployed to improve the catch rates and to reduce the exploitation costs. Life duration and efficiency of the FADs depend upon the mooring location (coast outline, distance to the coast, depth, seafloor topography) and the main prevailing hydrological conditions. Their deployment is difficult but can be eased by a good knowlegde of morpho-bathymetry of the seafloors. Furthermore, seamounts act as FADs if their summit is not too deep.

Vanuatu

Etelis spp. fishing is common on the outer reef slopes of almost all the islands of the archipelago, object of the Village Fisheries Development Project (VFDP). The fishing technique is the bottom line and hand wooden reel. Many documents have been produced on this subject. MMrss Clillaurren, David and Grandperrin are currently completing a synthesis. Mr. David's PhD. (1991) widely refers to this fishery.

R/V *Le Vauban* and R/V *Alis* have carried out some exploratory fishing cruises using bottom longline on outer reef slopes and over two or three seamounts, down to a 400-500 m depth. Fishing showed the presence of deep snapper, but was not deep enough to show whether *Beryx splendens* occurs or not. Reports on these cruises are available.

Many trap fishing operations have led to the capture of Nautilus, deep prawns and deep crabs (see corresponding reports).

Several FADS aiming at artisanal troll fishing for tunas were set particularly off Santo, Port-Vila and Pentecost (see Cillaurren's PhD. and David's PhD.).

Several deep dredging operations have been carried out by SOPAC and ORSTOM.

Tuvalu

Deep snapper fishing with handreel and tuna fishing are very active. Information regarding resources on seamounts is not available.

Solomon Islands

(see Tuvalu and deep dredgings).

5.1.2 - SOPACMAPS results

The evaluation of living resources are important requirement in the SOPAC region. The SOPACMAPS survey, owing to the use of the most modern survey equipment, has brought various areas to an accurate level of knowledge in term of water depths, sea-bottom morphology and sea-bottom nature. Even though the survey operations were mainly focused on deep and moderately-deep waters, large banks and shallow water zones were delineated and their asssociated slopes mapped. This first systematic work can be applied to a strategic planning approach, considering that the shallow waters zones delineated should constitute the targets for the further surveys focused on banks mapping, identification of the sea-bottom nature, various samplings and in-situ observations and experiments.

During SOPACMAPS survey, only depths over 500 meters were explored. So, the living resources of economic interest, such as precious corals, nautilus, which could be used in jewellery, or crabs (*Chaceon* sp.), shrimps (*Heterocarpus* spp., *Plesionika* sp.) and fishes like snappers (*Etelis* spp.) or jobfishes (*Pristipomoides* spp.), are not considered.

The major part of the summit of the central ridge being less than 1,000 m deep, it constitutes a fair possibility for concentration of deep species fishes, like alfonsinos (*Beryx splendens* sp.). Those fishes are caught on an industrial basis on longlines or bottom trawls in several places in the Pacific ocean, and a precise bathymetry is essential for prospecting.

Other fishing sites are the slopes of East Malaita and the Ulawa Islands where small mounds and seamounts are culminating at less than 1,000 m depth. The slopes around the Indispensable Basin, although uncompletely surveyed, show also good opportunities for deep fishing prospect.

5.2 - MINERAL RESOURCES

5.2.1 - Polymetallic nodules

5.2.1.1 - General setting conditions

Since their discovery in 1876 during the HMS *Challenger* expedition, manganese nodules have been studied extensively. The most important fields of nodules are reported in the North Pacific Ocean between the Clarion and Clipperton Fractures Zone (CCFZ) but they are also observed in many oceans where the conditions of formation are favourable. One of the main causes of nodules formation is the dramatic change in ocean circulation which occured near the Early-Middle Miocene boundary with a major interruption of the circumequatorial circulation due to the uplift of Central America and the closure of Thetys. Since that time, the Antarctic Bottom Water circulation increased, causing deep-sea erosion and modifications in silica deposition processes from the Atlantic to the Pacific, hence bringing to more favourable conditions for nodules formation.

Several processes must be considered in nodule formation:

- primary supply of terrigeneous, biogenic and hydrogenetic material to sediment and nodules;
- deposition, erosion, reworking of this material as a function of seafloor morphology and changes in the composition and movement of the bottom waters;
- effect of bioturbation on sediments and nodules.

The importance of the Carbonate Compensation Depth (CCD) must also be mentioned:

Near the equator and at a shallow depth, the local or regional relationship between the CCD and seafloor results in domination of sedimentation over nodule formation, and nodules are reported as of rather low economic interest;

Nodules with the greatest economic potential (that is with a 2.4 to 2.6% Ni+ Cu content) are observed in abyssal hills regions located under the CCD, characterized by siliceous ooze and argilaceous deposits with a low average sedimentation rate.

As a general rule, polymetallic nodules are not observed in regions where the sedimentation rate is high, or when pelagic sedimentation is interrupted by catastrophic turbidite deposits (proximal and distal) with inputs of terrigeneous and/or bioclastic material.

5.2.1.2 - Potential resources

The Malaita Area is characterized by a rapid increase of the water depth to the north-east and the east. The vicinity of islands such as Malaita, San Cristobal and Ulawa and the associated detritic and gravity sedimentary processes are not favourable to polymetallic nodule formation.

The only sedimentary basin observed in the area is located south east of the Guadalcanal termination, with a water depth of about 2,000 m, but as it is probably subject to terrigeneous sedimentation, it does not constitute a good environment for polymetallic nodules.

5.2.2 - Polymetallic crusts

5.2.2.1 - General setting conditions

Polymetallic crusts are observed in various oceanic environments, always associated with a hard substrate, where bottom currents circulation prevents any sediment deposition. These environments are numerous: spreading centers, midplate seamounts, continental margins, rocky outcrops in deep basins, etc.

Growth rates of polymetallic crusts vary with the geodynamic conditions and the nature of the substrate: an hydrothermal crust may be characterized by a 10 mm/My growth rate, while a crust located on an isolated seamount may grow at a 1 mm/My rate or less; this last growth rate is particularly characteristic of crusts of thalassic origin.

Mid-plate seamounts are often covered by Fe Mn crusts with a high cobalt content (> 1%, that is 4 to 6 times the Co content reported in abyssal nodules). The economic interest of these deposits has been increased since the discovery of platinoïds at concentrations of 0.2 to 1 g/ton.

In the SOPAC region, several cruises have been conducted by IFREMER in the French Polynesia EEZ (NODCO project) in several parts of the Tuamotu archipelago. Several Cobalt and platinium bearing sites have been identified and surveyed in detail. These studies confirm the existence of a "cobalt province" and suggest the idea of a possible "platinium province" in the region.

5.2.2.2 - Potential resources

The central zone of East Malaita Area is constituted by a tectonized zone reflecting the Malaita and the Ulawa Islands structural prolongation. It is mainly characterized by three successive parallel ridges separated by deep basins on the slope. The most proeminent ridge is the central one with a summit culminating at an average depth of 750 m. This central ridge, probably volcanic in origin, is a good candidate for polymetallic crusts formation.

5.2.3 - Hydrothermal sulfides

5.2.3.1 - General setting conditions

The discovery in 1979 of high temperature hydrothermal events at EPR axis has been followed by many investigations focused on accretion axis at the first time, and more recently by studies conducted on hydrothermal processes in back-arc environments. This second tectonic setting corresponds to that of major sulfide deposits on land, where such ores are commonly associated with felsic volcanic rocks. These onshore deposits are believed to have formed in island-arc setting or marginal basins. The ore-forming processes in these fossil environments are similar to those described at sea-floor spreading centers; the character of the resulting deposits is, however, widely controlled by source-rock lithology which reflects the tectonic setting.

In the SOPAC region, one of the most recent studies have been conducted on the Lau Back-Arc Basin where hydrothermal fields have been discovered along the Valu Fa Ridge, near the active Tofua Island Arc. Nine occurrences have been reported along a remnant island arc (Lau Ridge), an island arc (Tonga Ridge), an active back arc spreading, and in Lau Basin. The ore occurrences consist of Ba-Zn deposits, Ba-Zn-Cu-Fe deposits, and Fe-Cu sulfides under Fe-Mn crusts.

5.2.3.2 - Potential resources

The regional geology clearly indicates that CST Area is not favourable in term of hydrothermal activity. Nevertheless as for any volcanic rocks, there may be a scattering of sulfide assemblages occurring as trace elements, but it does not constitute a potential resource.

5.3 - OIL POTENTIAL

Offshore seismic petroleum exploration around Solomon Islands has been carried out from 1969 to 1984 as outlined in the review of petroleum potential published by the Australian BMR (P. J. Coleman, 1989). Some targets were identified and recommendations for more multichannel seismic lines to be run were given. The present work, focused on bathymetry, can only give more information for future work.

5.3.1 - East Malaita area

East Malaita Area shows three distinct areas: the first one is the 4,000 m deep NW-SE depression related to the North Solomon Trench. The second one is the "nodal" basin resulting from the junction between the Cape Johnson and North Solomon trenches. The third one is the east Malaita domain which probably represents the submerged junction between Ulawa Island and the northern part of Malaita which is a large scale anticlinorium resulting from folding during a previous phase of deformation. This area is considered to be a compression zone between Solomon Islands and the Ontong Java-Pacific plate. The seismic profiles carried out during SOPACMAPS cruise do not provide evidences of present-day compression but evidence of vertical motions.

The 3,000 m deep graben located immediately east of the Malaita Island between the central ridge and the Malaita slope, could be a potential site of oil exploration but requires further investigation such as by multichannel seismic.

5.3.2 - Indispensable Basin

Because of the orientation of the profiles, more designed for bathymetric survey than for geophysical work, little information can be used for studying for the oil potential. Nevertheless, it must be noted that a oil potential has been previously reported in the Indispensable Basin (Vedder and Bruns, 1986; Coleman, 1989).

Considering the existence of 4.5 km of Cretaceous and early Tertiary strata above acoustic basement, the Indispensable Basin and its extensions onshore (Mbokokimbo Basin) and offshore (Nudha Basin), are considered by those authors as selected targets having good prospects. New bathymetric data should permit to better location of future multichannel seismic profiles.

CONCLUSIONS

CHAPTER 6

CONCLUSIONS

The SOPACMAPS cruise obtained accurate and extensive data in the Solomon Islands economic zone. Over the so-called Malaita Area, located on the ancient boundary of the Australian and Pacific Plates. There is now a fair bathymetric map of the east coast of Malaita. The Indispensable Basin, on the west side is not fully covered but the slopes from 1,000 m to 1,500 m in depth are well documented.

The Malaita Area is interpreted by Coleman and Kroenke (1981) as a piece of the oceanic crust of the Ontong Java Plateau folded and obducted 8 My ago during the collision phase between the Ontong Java Plateau and the old Solomon Arc. The result of this collision was the end of the functioning of the North Solomon Trench and the reversal of the polarity of the subduction from NE-SW along the North Solomon Trench to SW-NE along the late Miocene to present-day active San Cristobal Trench (Kroenke, 1984). The obducted and folded Malaita Area was named Malaita Anticlinorium (Kroenke, 1977). This overthrusting phase was accompanied by the emission of basaltic volcanism through the old Pacific crust of Malaita (Hughes and Turner, 1977).

The SOPACMAPS cruise seismic profiles indicate that the North Solomon Trench is infilled by a 1 to 2 s.t.w.t thick sedimentary cover dipping to the south. This dipping could be interpreted as a small amplitude present-day deformation within the southwestward dipping North Solomon Trench. Some indications of gentle folding have been observed at the foot of Malaita margin.

The major part of the Malaita margin is constituted by a deformed alternation of highs and lows joining northern Malaita Island with the Ulawa zone. This deformed zone is cut by an important N-S Fault at 162°E. This fault separates the Malaita Anticlinorium from the 6,000 m deep nodal trough created by the junction between the North Solomon and the Cape Johnson trenches.

The two flanks of the Malaita Anticlinorium are different, for example, the Indispensable Basin and adjacent basins contain a greater amount of sediments than in the eastward basins.

The SOPACMAPS cruise was mainly designed for bathymetric purpose and the profiles were run for the maximum of efficiency of the multibeam EM12 echosounder of the R/V L'Atalante. Nevertheless, seismic reflection profiles recorded continuously, in conjunction with magnetism and gravity, give valuable information allowing to discuss the deep structure of the area in term of potentialities. All those information should be an essential basis for further explorations using various techniques as multi-channel seismic reflection on selected areas and sampling by dredging, coring or drilling.

In the field of living ressources, it is clear that he major part of the summit of the central ridge (less than 1,000 m deep) constitutes a fair possibility for concentration of deep species fishes, like alfonsinos (*Beryx splendens* sp.). Those fishes are caught on an industrial basis on longlines or bottom trawls in several places in the Pacific ocean, and a precise bathymetry is essential for prospecting.

Other fishing sites are the slopes of East Malaita and the Ulawa Islands where small mounds and seamounts are culminating at less than 1,000 m depth. The slopes around the Indispensable Basin, although uncompletely surveyed, show also good opportunities for deep fishing prospect.

The only sedimentary basin observed in the area is located south east of the Guadalcanal termination, with a water depth of about 2,000 m, but as it is probably submitted to terrigeneous sedimentation, it does not constitute a good situation for polymetallic nodules.

The central zone of East Malaita Area is constituted by a tectonized zone reflecting the Malaita and the Ulawa Islands structural prolongation. It is mainly characterized by three successive parallel ridges separated by deep basins on the slope. The most proeminent ridge is the central one with a summit culminating at an average depth of 750 m. This central ridge, probably volcanic in origin, constitutes a good candidate for polymetallic crusts formation.

The regional geology clearly indicates that CST Area is not favourable in term of hydrothermal activity. Nevertheless as for any volcanic rocks, there may be a scattering of sulfides assemblages occurring as trace elements, but in no case it can constitute a potential resource.

Geological hazards are important in Malaita Area; they are related to the central volcanic ridge and the slides triggered by volcanic activity and associated earthquakes.

A scarce shallow seismicity is present in the region, but quite less intensive than on the southwest Guadalcanal and south San Cristobal coasts in association with the present subduction.

SURVEY EQUIPMENT

CHAPTER 7

SURVEY EQUIPMENT

7.1 - DATA PROCESSING ON BOARD R/V L'ATALANTE

Before describing the different measurement equipment, a presentation of the computer systems which purpose is data acquisition on board the R/V L'Atalante must be completed.

*** CINNA** is the software dedicated to the navigation parameters acquisition coming from the satellite navigation system (GPS) and the dead reckoning sensors.Those data are then transmitted to the ARCHIV station which stores them on an optical digital disk.

CINNA's second function is to calculate a real-time navigation. The data are transmitted by the computer network to the other systems, such as the route control CAPS and the gravimeter.

*** HIPPI 120** is the vertical sensor from DATAWELL. It provides the multibeam echosounder with the vessel attitude (roll, pitch). It consists of a gyroscoper and inclinometer system.

*** CAPS** is a route control system in which beginning and end of profile coordinates are introduced as well as a great set of control parameters. The system keeps the ship on the profile with a few meters transversal accuracy. This system depends on the navigation quality received.

*** TERMES** is a scientific measurement acquisition station, excepted the multibeam echosounder and the RDI current profiler. This station receives the data from the sensors (geophysic and oceanographic). It proceeds by an elementary checking of their quality, stores them locally and transmits them to the ARCHIV station.

*** CITE** is a management and storage system of technical parameters coming from the vessel sensors like winches, vessel propulsion, angle drawer ...

*** ARCHIV** is one of the main system of on board computer network. Its function is the storage of multibeam echosounder data. Through this system, all the parameters relative to bathymetry, imagery, navigation, etc., are stored on an optical digital disk (8 Gigabytes), either in real time, or in postpone time. The collected data come from CINNA, TERMES, EM12 Dual, RDI.

*** VIDOSC** is the scientific data visual display system. It displays in real-time all measurements concerning the ship, obtained by TERMES, CITE, CINNA and EM12 (geophysic and physic parameters, navigation data, technical data, bathymetry). Located in the scientific control room, it offers several types of graphs/charts:

. on a color double screen (19"):
the bathymetric data contouring and navigation plots in real-time with different possibilities (zoom, scale adjustment, contour interval modification, etc.) and all the geophysic and oceanologic data on graphs as a function of time.

. on a A0 plotting table:
the global bathymetric chart with no processed navigation is plotted in real time. A control in real-time can then be made on the mapping quality and the swath width rate (lack of data between two profiles for instance).

*** SDVI** (Video Information Diffusion System) is dedicated to the distribution, throughout the ship, of various information such as bathymetry (longitudinal and vertical profiles), meteorological conditions, ship's speed and position, drift, etc.

7.2 - BATHYMETRY AND IMAGERY PROCESSING

7.2.1 - BATHYMETRY

R/V L'Atalante is equipped with the SIMRAD EM12 Dual system. This system is a low frequency (13 khz) multibeam echo sounder which provides precision swath mapping capability to full ocean depths (11,000 m). Its typical accuracy is 0.25 % of water depth or 60 cm (whichever is greater).

The coverage sector of the EM12D (Dual) version is 150° with 162 beams, covering a swath width at most 7.4 times the water depth. Compared to the EM12S (Single), this brings to an increase in swath width of approximatly 10 km in the 3,000 m to 6,000 m depth range. In fact, the background noise depends on the sea state (sea state 4 gives an approximatly 45 db noise level).

In addition to the sounding data, the EM12D measures the level of the backscattered signal from the seabed within the swath corridor.

The EM12D operates with five different sectors (all with 162 beams) : 150°,140°, 128°, 114°, 98°. These will be used as shown in the table below. Note that the coverage will not be roll dependent but depth capability may vary with different bottom conditions.

Angular Sector	Maximum Coverage	Depth Range	Horizontal Spacing
150°	7.4 x Depth	50 m - 3,000 m	0.047 x D
140°	5.5 x Depth	2,500 m - 4,200 m	0.035 x D
128°	4.1 x Depth	3,500 m - 6,000 m	0.086 x D
114°	2.9 x Depth	5,000 m - 8,000 m	0.019 x D
98°	2.3 x Depth	7,000 m - 10,000 m	0.015 x D

In order to keep accurate control of the sound velocity in sea water, temperature probes are used. The probe (Sippican) transmits the temperature profile to the operator. After the measurements, the sound velocity profiles may be computed by TRISMUS software using the salinity database Levitus, and loaded into the operating unit.

The probes generally used have a 2,000 m depth maximum capability. For deeper water, the variation in sound velocity with position and period of year is very small, and the temperature and salinity database Levitus are used.

The real time quality assurance unit is mounted on the R/V L'Atalante. Data processed in real time are displayed on a colour graphic monitor and printed on an Benson printer for hard copy documentation.

The whole processing is realized with specific softwares created by IFREMER and its subsidiary GENAVIR.

7.2.2 - POST-PROCESSING NAVIGATION

The purpose of the interactive TRINAV software is to create a computer file with the data, the time, the GPS position, the gyroscopic heading and the longitidinal and transversal speeds (Doppler and electromagnetic loch).

7.2.3 - POST-PROCESSING EM 12 DUAL BATHYMETRIC DATA

The software use for this processing is called TRISMUS. It enables to generate bathymetric contour chart.

In input, TRISMUS receives:

* the navigation file processed by TRINAV.
* the file with the "x, y ,z" of each beam.

The main processing stages are:

* Merging of the 2 files resulting to "x,y" files (coordinates of the sounding points).

* Creation of a digital elevation model (DEL) which corresponds to a regular grid with a regular mesh (generally square). The software converts an elementary average of the soundings in the range of the mesh. An interpolation generally follows this operation.

* Filtering of the soundings by comparison between a DEL dedicated to this purpose and the sounding "x, y" file.

* Display and edition of the contouring bathymetric chart.

* Validation of this one by a visual mapping control.

7.2.4 - EM12 DUAL IMAGE PROCESSING

The Simrad dual echosounder provides the acoustic imagery simultaneously with the bathymetry. The imagery data are consistent with bathymetry (geometry, swath path, number of beams, resolution, ...) and are contained in the set of signals resulting from sounding.

The imagery data output is based on the different signal levels (in term of reflectivity) provided by the various types of sea-bottom.

The acoustic imagery data are on one hand displayed in real time on a wide Dowty analogic recorder and on the other hand stored in the computers systems for further specific processing. The data displayed in real time are not corrected by the navigation. The navigation corrections are introduced during the navigation processing. Then, the final processing of the imagery (mosaïcking, interpolation) is made possible with the **IMAGEM** software developped by IFREMER.

Even if the acoustic energy generated by the sea bottom is still being experienced (IFREMER is working on a R&D program on the subject), it can be assumed that the acoustic and energy response of the bottom is mainly related to its nature: so, indurated rocks (volcanic or sedimentary) are characterized by a high level of energy (which correspond to the dark areas on the analogic record) while soft sediments appear with different levels of grey.

These levels of grey are not yet very well documented, because of the numerous physical characteristics which must be considered in the signal interpretation: sediments grain size, surface texture, water content, etc., that is why the acoustic imagery interpretation presented in this report is generaly conducted with the sub-bottom profiler data and in agreement with the rules of marine geology and more particularly sedimentology.

7.2.5 - SETTING UP OF THE CELERITY FILES

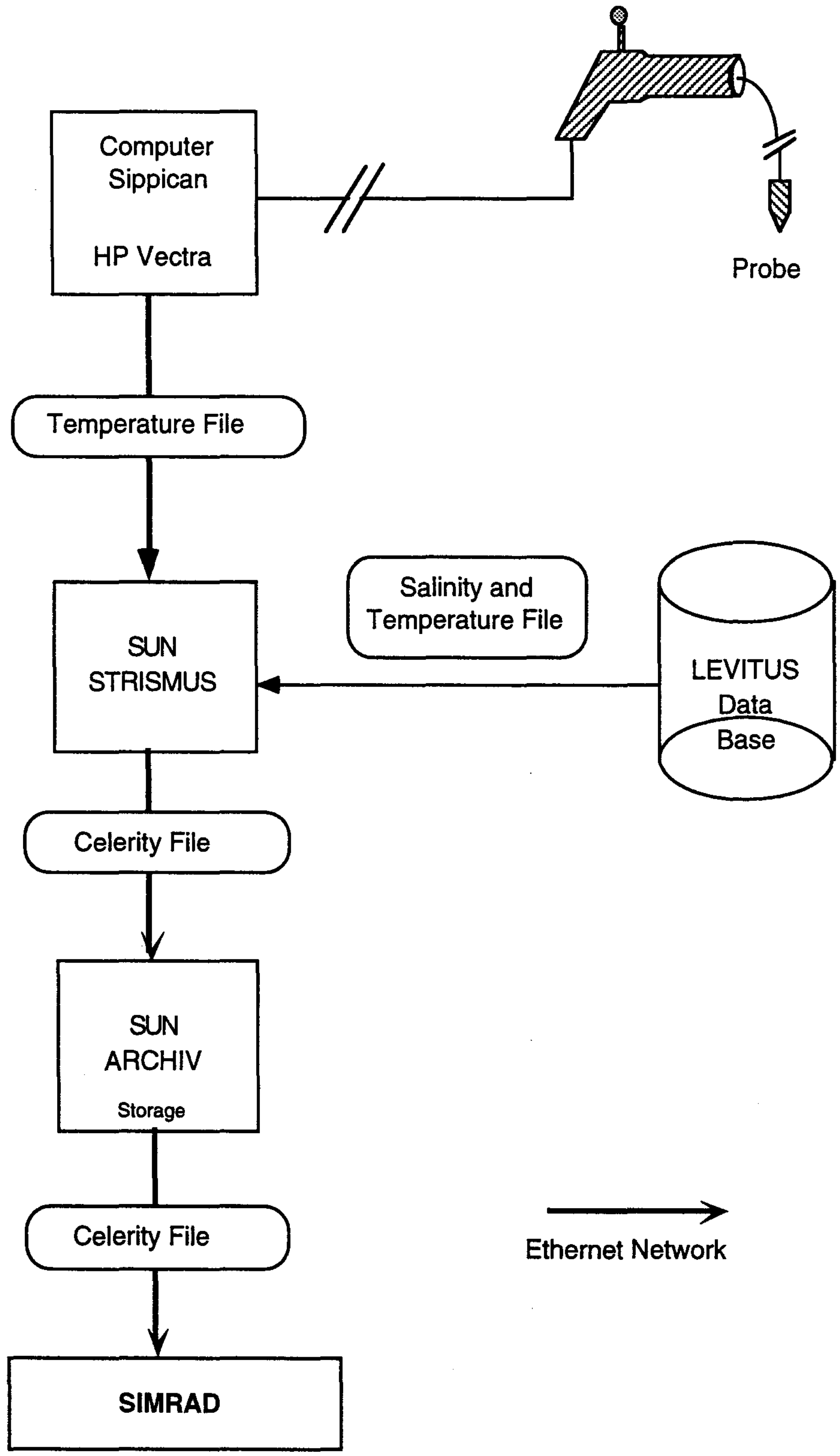
The EM12 DUAL running regularly makes necessary the integration of sound speed data through all the considered water sections. To obtain these data, SIPPICAN probes are operated. They provide temperature measurements. According to the bathymetry, 4 probe models (200 m/460 m/760 m/1830 m) can be selected.

* Temperature measurements are received by the Sippican calculator which transforms the binary format into ASCII format.

* This "**temperature**" file is sent on a SUN station which is connected to the international data base LEVITUS that holds, among others, salinity and temperature data, in order to create a "**celerity**" file. The illogical values are eliminated and the superior values to 1830 m are interpolated owing to LEVITUS datas.

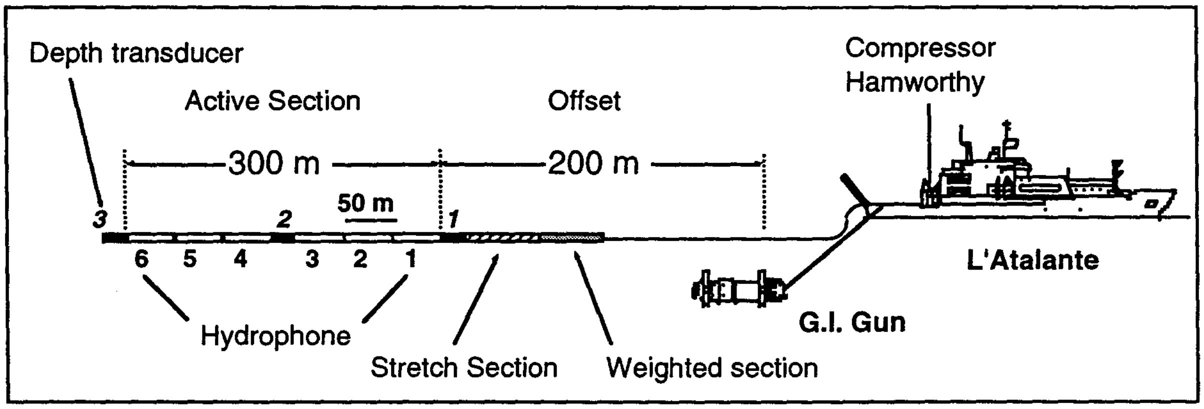
* Once obtained the "**celerity**" file, this one is sent on the SUN/ARCHIV on one hand to be stored with the other survey data and on the other hand to be transferred in the SIMRAD echo-sounder via Ethernet network.

SETTING UP OF THE CELERITY FILES



7.3 - Seismic reflection

7.3.1 - SEISMIC REFLECTION ON R/V L'ATALANTE

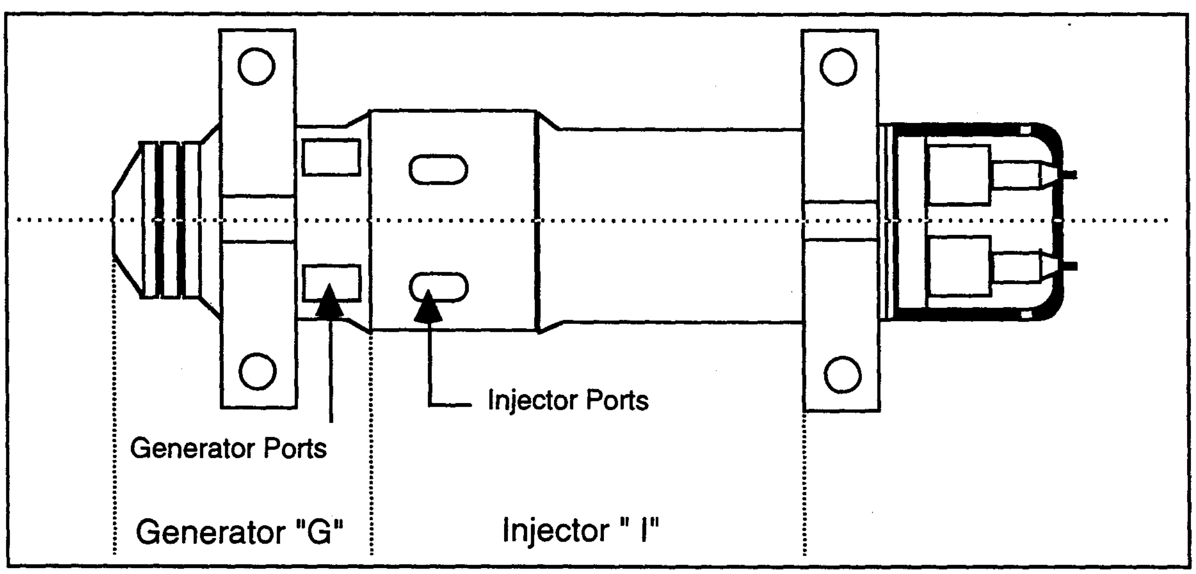


It is a seismic reflection system in a simplified version. This system is equipped with two air guns (SODERA - Type G.I.) and a streamer of reduced dimensions towed at a speed of 10 knots. One of the 6 channels is printed on a Dowty graphic recorder.

The 6 channels recorded on a magnetic tape recorder (Kennedy - 1,600 bpi) in an internal non-standard format (SISRAP). Then, a transcribing is realized to obtain files with a standard SEG Y format.

The whole SEG Y files are transferred on an Exabyte (8 mm) with 2.5 Go capacity.

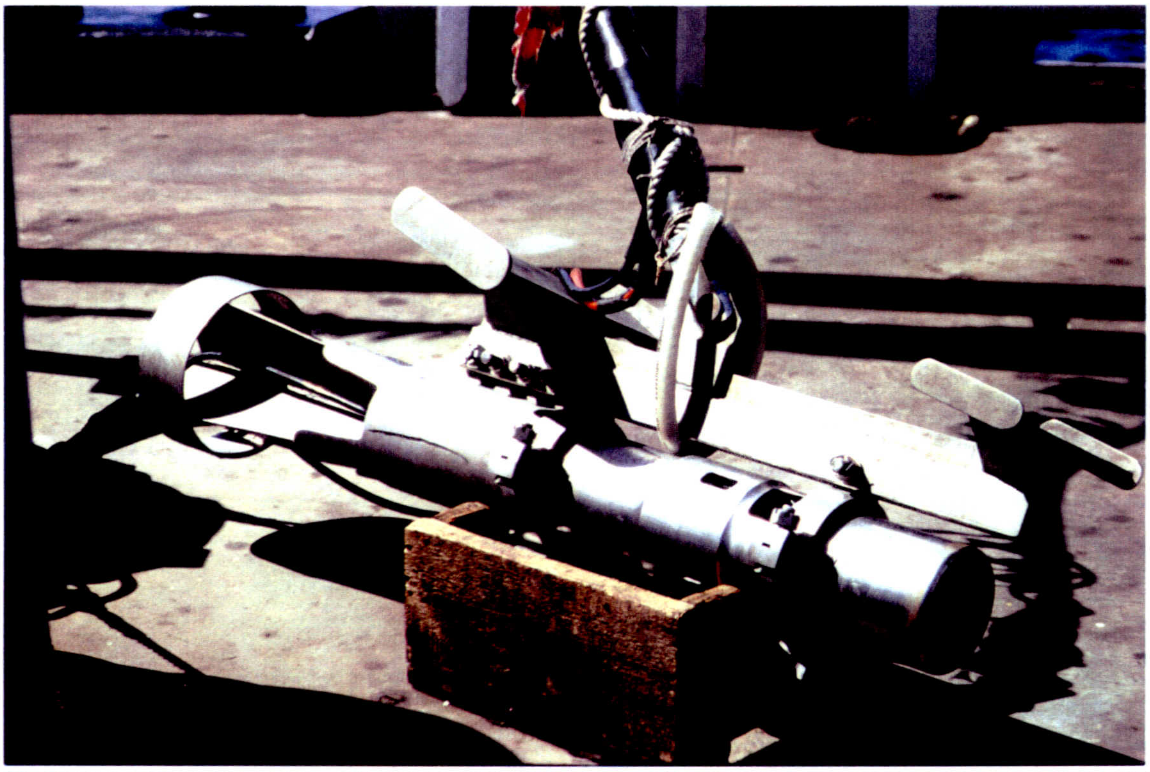
7.3.2 - G.I. GUN - MODEL 150



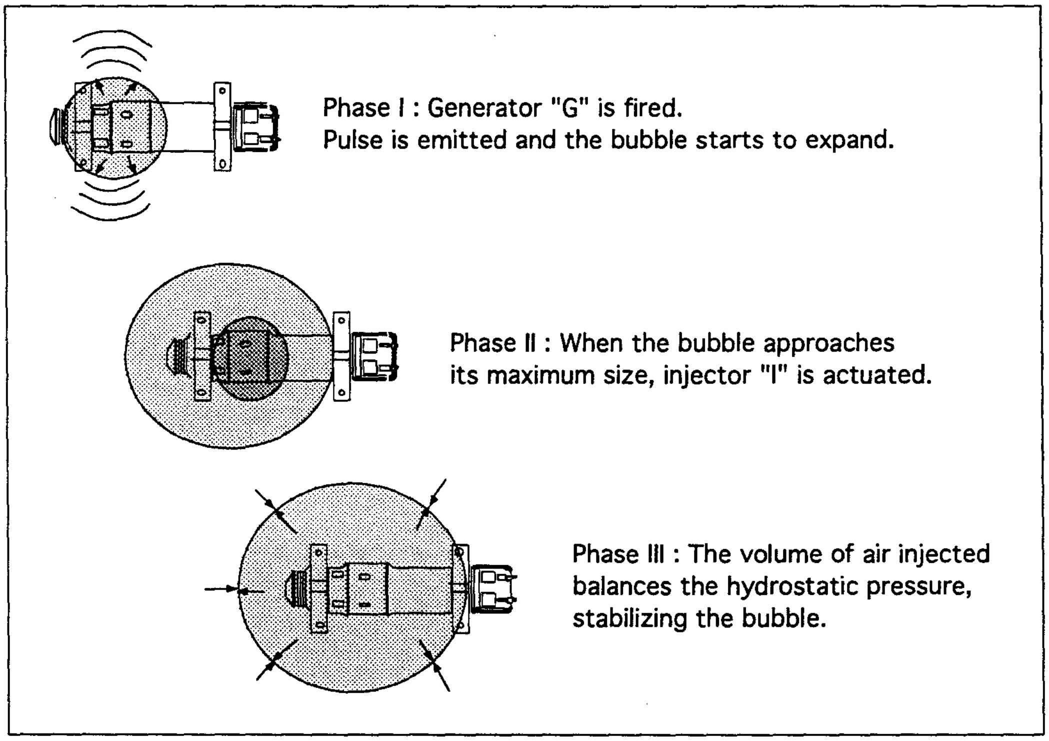
G.I. GUN - MODEL 150

- SPECIFICATIONS -

* Type	:	Sodéra - type "GI"
* Air pressure	:	1,000 to 3,000 psi (70 to 210 bars)
* Minimum firing interval	:	4 seconds
* Total air requirement	:	13 std. ft^3/shot (370 NL/shot) at 2,000 psi (140 bars)

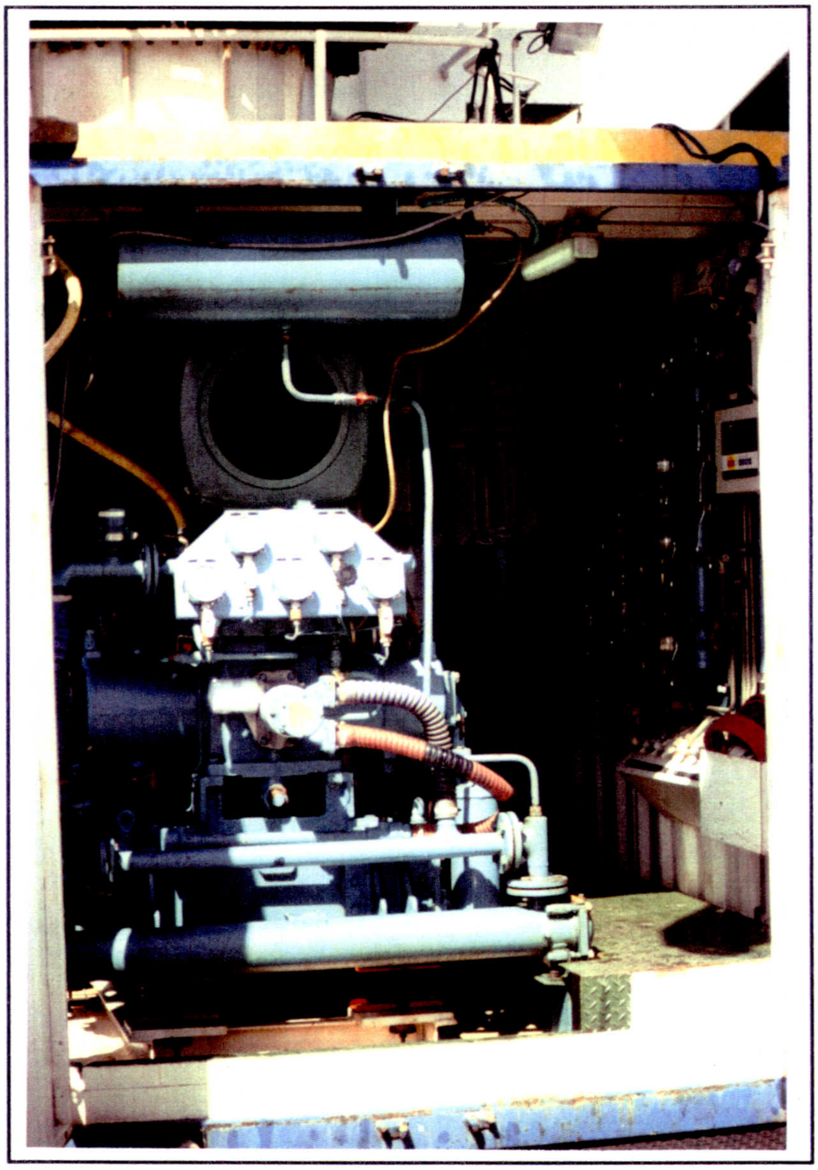


7.3.3 - AIR GUN PRINCIPLE



7.3.4 - COMPRESSOR

* Type	:	Hamworthy - 4 TH190W70
* Air capacity	:	300 m^3/h
* Pression	:	200 bars
* Engine power	:	94 KW
* Speed	:	1 475 rpm.



7.3.5 - STREAMER SPECIFICATIONS

*** Streamer :**

Type	:	AMG 37-43
Diameter	:	1 3/4"

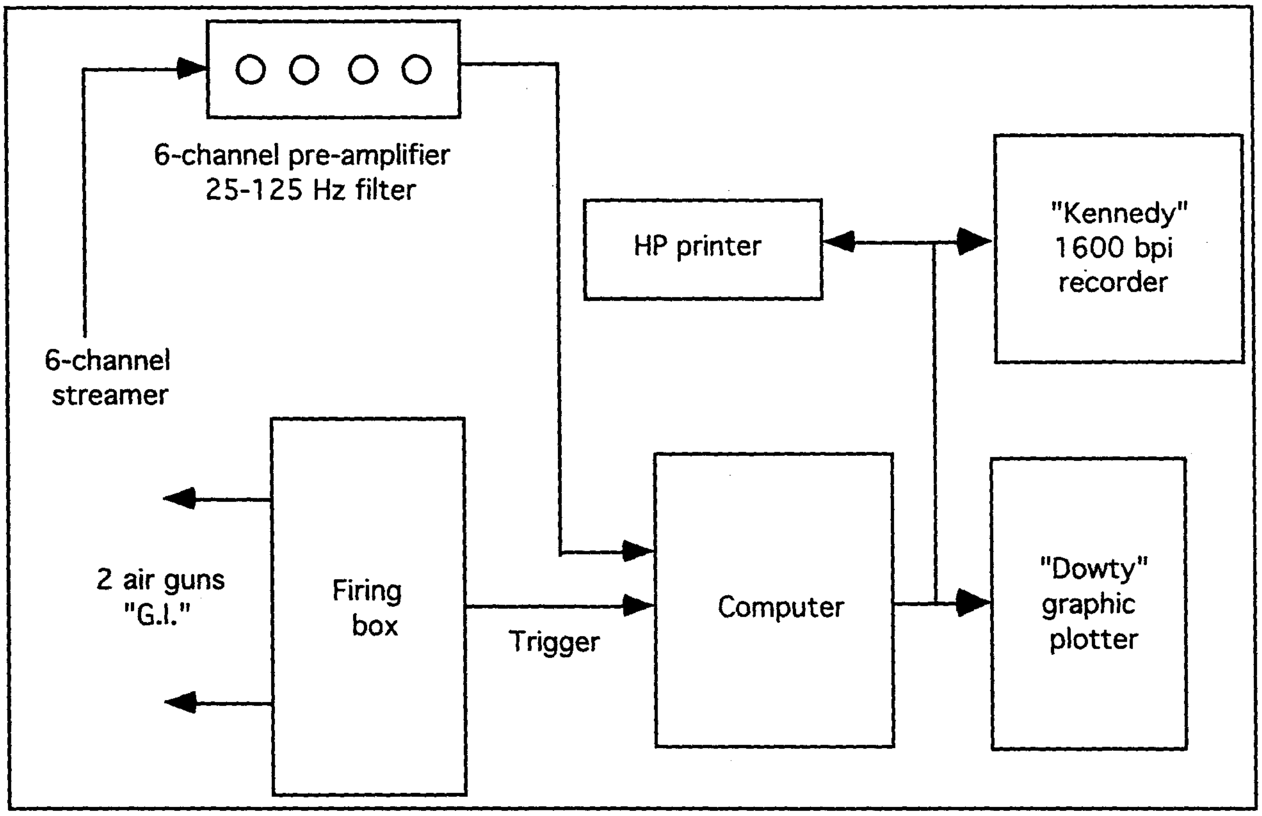
*** Hydrophone :**

- Sensitivity	:	-92 dB re 1 V/µbar
- Capacity	:	0.014 µF
- Sensitivity variations versus depth	:	± 0.5 dB up to 100 m
- Acceleration noise immunity	:	-100 dB re 1 bar/g

*** Active section :**

- 6 hydrophons		
- Capacity	:	0.075 µF
- Transformer ratio	:	10/1
- Primary self inductance	:	15,000 H
- Trace sensitivity	:	8 V/bar
- Frequency response	:	3 to 1,000 Hz

7.3.6 - RECORDING DATA



7.4 - Instrumentation

A - Barringer magnetometer
B- Bodenseewerk seagravimeter system KSS 30
C - 3.5 kHz hull mounted sub-bottom profiler
D- Oceano-meteorology station
E- Acoustic Doppler current profiler VM-ADCP
F- Thermo-salinometer - CTD+100

A - BARRINGER MAGNETOMETER

The magnetic data are acquired at a 6-second sampling interval using a BARRINGER M-244 proton magnetometer, towed 280 meters astern the ship. The magnetic anomalies are computed by subtracting the IGRF 90 from the measured total field, but not corrected for diurnal variations. The accuracy of the instrument being equal to about 0.5 nT, cross-over errors (which are less than about 50 nT) are thus mainly due to diurnal variations which are about 40 nT at the latitude of the cruise.

The magnetic anomalies provided by the on-line processing system are automatically contoured (the contour interval is 50 or 100 nT) using the GMT public software and the **TRIMEN** software developed by IFREMER.

- SPECIFICATIONS -

SENSITIVITY	:	0.1 gamma sample interval 2.0 sec. or greater 0.2 gamma sample interval 1.1 to 1.9 sec. 0.5 gamma sample interval 0.5 to 1 sec.
ACCURACY	:	0.5 gamma
RANGE	:	20,000 to 90,000 gammas
TUNING	:	Automatic throughout range. Manual selection of ambient field starting value through menu.
CYCLE RATES	:	
Continuous Cycling	:	0.5 sec. to 600.0 sec. Selectable in 0.1 sec. increments throughout the entire range
Manual Cycling	:	Pushbutton on front panel
External Cycling	:	Activated externally
DISPLAY	:	Lower power, large area Liquid Crystal Display showing six digit magnetic field reading, supply voltage, depth, signal strength, input values (in menu mode) and real-time one or two trace analog representation of every reading. The display provides a means of viewing the current data instantaneously.
CONTROLS	:	A 16-digit tactile membrane keyboard provides control of all operating and variable parameters. An audio transducer indicates each keyboard entry. The keyboard also features a disable to lock front panel controls while the unit is in operation.

B - BODENSEEWERK SEAGRAVIMETER SYSTEM KSS 30

The gravity data are collected using the sea gravity meter BODENSEEWERK KSS30. This gravimeter consists of a GSS30 gravity sensor mounted on a KT30-two-axes gyro stabilized platform. The gravity sensor includes a non-astatized spring-mass assembly as basic gravity detector. In calm sea, the theoretical accuracy of the gravity sensor can be ±0.2 mGal.

Using the on-line-processing system, real gravity is obtained on board the ship, approximately 120 s after the measurement. This system provides values of gravity, Eotvos corrections, Free-Air and Bouguer anomalies in mGal. Bouguer anomalies calculated with a density contrast between the earth crust and the sea water of 1.64 g/cm^3. Gravity data are automatically corrected for spring tension, cross coupling, Eotvos and for latitude, according to the IGSN (International Gravity Standardisation Net) 1971 ellipsoid.

The gravity value measured in Suva (Fiji) Kings Wharf station 814 at the beginning of the cruise is 97,8609.49 mgals. The ending base station at Noumea is 97,8864.62 mgals.
(meas. gra. = -1,741.30).

The free-air gravity anomaly is contoured by computer using the GMT public software and the **TRIMEN** software.

1 - GSS 30 GRAVITY SENSOR

The measuring system, based on a translatory sensor, consists of a tube-shaped mass guided by 5 threads in frictionless manner.

The motion of the gravimeter mass is thus limited to one degree of freedom. While the constant portion of gravity acceleration "g" is compensated by mechanical spring, gravity changes are detected by an electromagnetic system.

An appropriate electronic system suppressing the interference accelerations caused by heavy seas is located in the sub-system control electronics.

2 - CONTROL ELECTRONICS

The control electronics for sensor and platform have been designed with special regard to high reliability and good maintainability. Failure sources can be located by means of a built-in-test-equipment, allowing a quick trouble shooting without interruption. The control electronics are split into five parts :

* Control electronics of the gravity sensor.

* Central processor with multipurpose key-board and display panel for :

  - System operation,
  - Continuous system selftest,
  - Gyro ship compass interface programming,
  - Run up/down and emergency stop logic,
  - Gyro erection control and optimal compensation during turn manoeuvre,
  - and data logging of: gravity, time, heading, velocity, X and Y acceleration, navigation data, etc.

* Control electronics of the platform.

* Central power supply with buffered battery to overcome short main failures perturbations of maximum 2 min. duration.

* Two-channel-monitor recorder where the channel selection can be performed by means of the key-board at the central processor-unit.

3 - KT 30 PLATFORM

The KT 30 platform has been specially designed by Bodenseewerk Geosystem for seagravimetrical applications.

Important simulation and analytical work has preceeded the final layout of the platform and associated servo-control.

As vertical gyro, the proven ANSCHÜTZ electrically erected gyro, specially manufactured for naval applications and designed for a continuous service life time of more than 10 000 hours, is used.

4 - DATA ACQUISITION SYSTEM

The BCD - coded digital output of the seagravimeter system KSS 30 can be interfaced with the data logger, part of the central processing unit.

By using furthermore a teletype or magnetic tape (option) the data can be registered.

A parallel output will be provided for interfacing an integrated satellite/radio navigation system with data logging and preprocessing (INDAS).

5 - KSS 30 SYSTEM SPECIFICATION

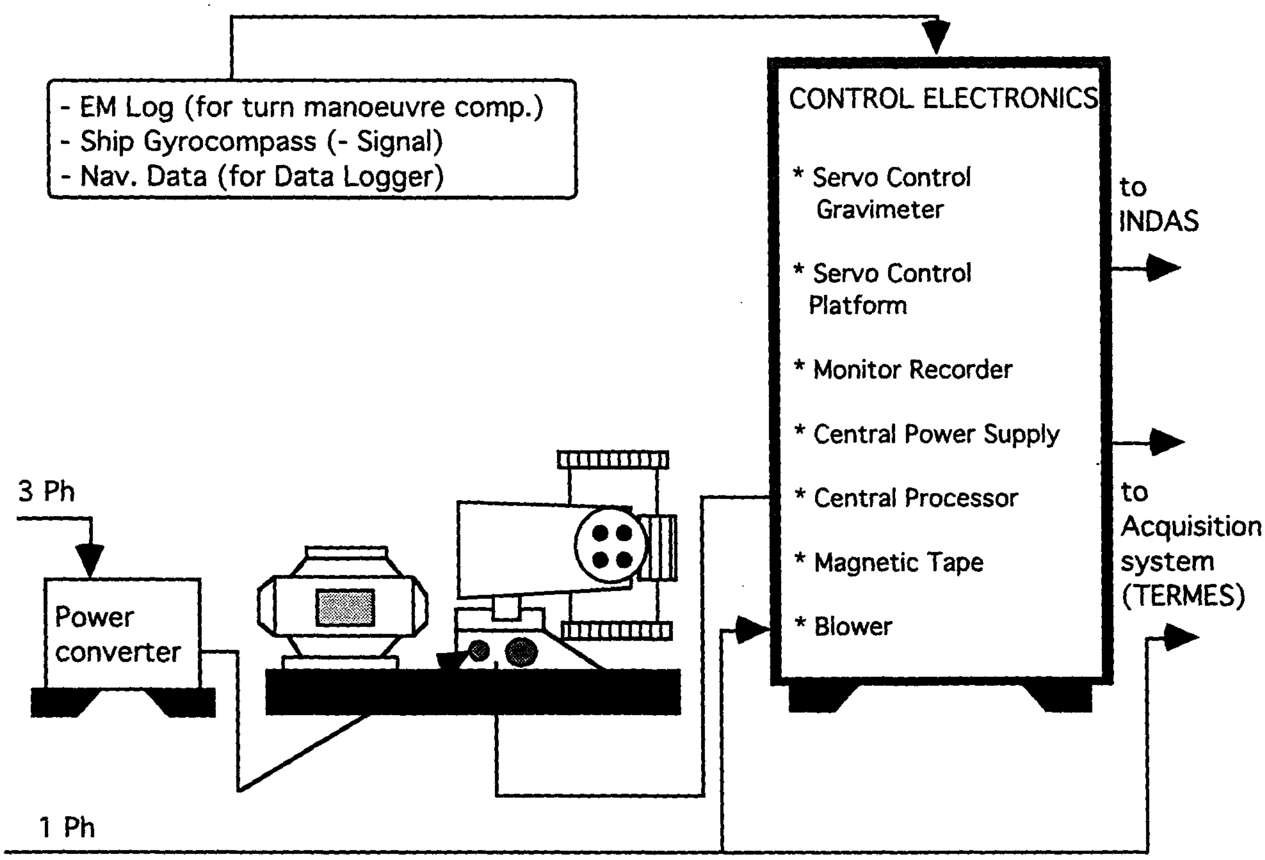
	Sea status I (calm sea)	Sea status II (rough sea)	Sea status III (very rough sea)
Vertical Acceleration Horizontal Acceleration	< 15,000 mgal < 2,500 mgal	15,000 - 80,000 mgal 2,500 - 25,000 mgal	> 80,000 mgal > 25,000 mgal
Dynamic Accuracy* Effective Accuracy**	0.5 mgal RMS ± 0.2 mgal RMS	1 mgal RMS ± 0.4 mgal RMS	2 mgal RMS ± 0.8 mgal RMS

* *"Dynamic accuracy" is defined as accuracy without applying data reduction.*
** *"Effective accuracy" is defined as accuracy obtained in conditions with many crossings applying data reduction procedures.*

The sensor is operative up to 800 000 $mgal_{pp}$ and linearized within 400 000 $mgal_{pp}$.

Temperature and Pressure effect	< 0.1 mgal
Scale factor calibration	< 0.5 %
Turn manoeuvre	± 1 mgal
Platform Accuracy (dynamic)	± 0.5'
Time constant sensor	66 sec.
Drift	< 3 mgal/month
Measuring Range	10,000 mgal
Data Output :	
*Analogue (for strip chart monitor recorder)	± 10 V
*Digital (for "on-line" data logging and preprocessing) interface	V 24 serial
Angular Range of Stabilized Platform :	
* Roll	± 36°
* Pitch	± 27°
Environmental Conditions :	
* Temperature (thermostating better than ± 2°C/h)	between + 18°C and + 27°C
* Humidity (relative)	less than 90 %

Power supply:	
* Voltage	220 V / 3 Ph
* Frequency	50 Hz ± 20 %
Power Consumption	
(excluding data acquisition system):	
* Maximum (gyro run-up)	1 KVA
* Normal operation	0.5 KVA
Weight and Dimensions:	
* Gyrotable KT 30	138 kg
(with sensor GSS 30 & vertical gyro)	90 x 43 x 52 (cm^3)
* Control electronics GE 30	170 kg
(with 19" rack)	55 x 65 x 127 (cm^3)
* Power converter (rotating) 55 x 65 x 60 (cm^3)	82 kg



BODENSEE WERK SEAGRAVIMETER SYSTEM KSS 30

C - 3.5 kHz HULL MOUNTED SUB-BOTTOM PROFILER

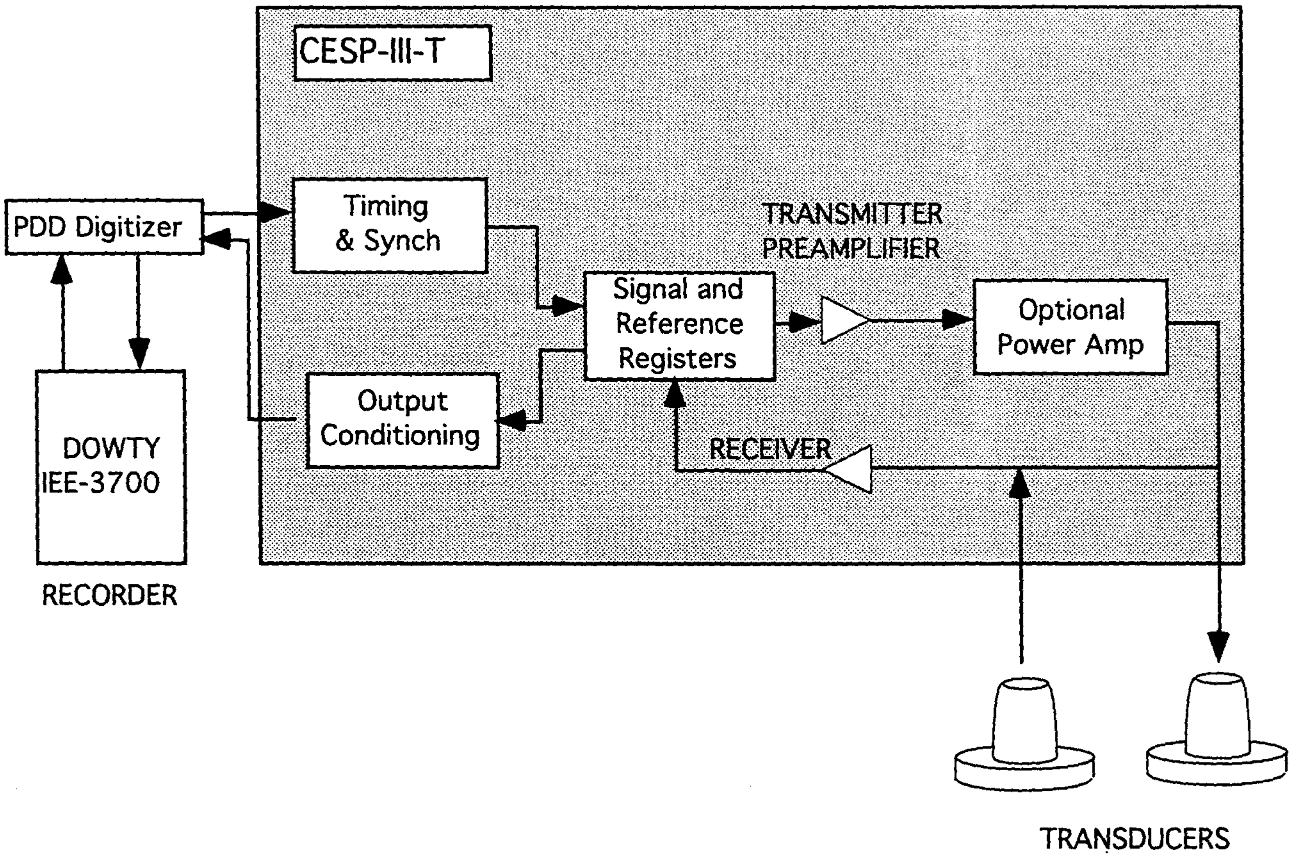
R/V L'Atalante is equipped with a 3.5 kHz hull mounted sub-bottom profiler which characteristics are as follows:

- **Receiver** : RAYTHEON correlator CESP-III-T (Correlation Echo Sounder Processor), improvement of signal/noise radio through modulation and binary correlation, 1024 bits.
- **Transceiver** : RAYTHEON PTR-105B is a complete 2 KW sonar transmitter, combined with a highly sensitive receiver.
- **Recorder** : DOWTY IEEE-3700, thermal linescan recorder.

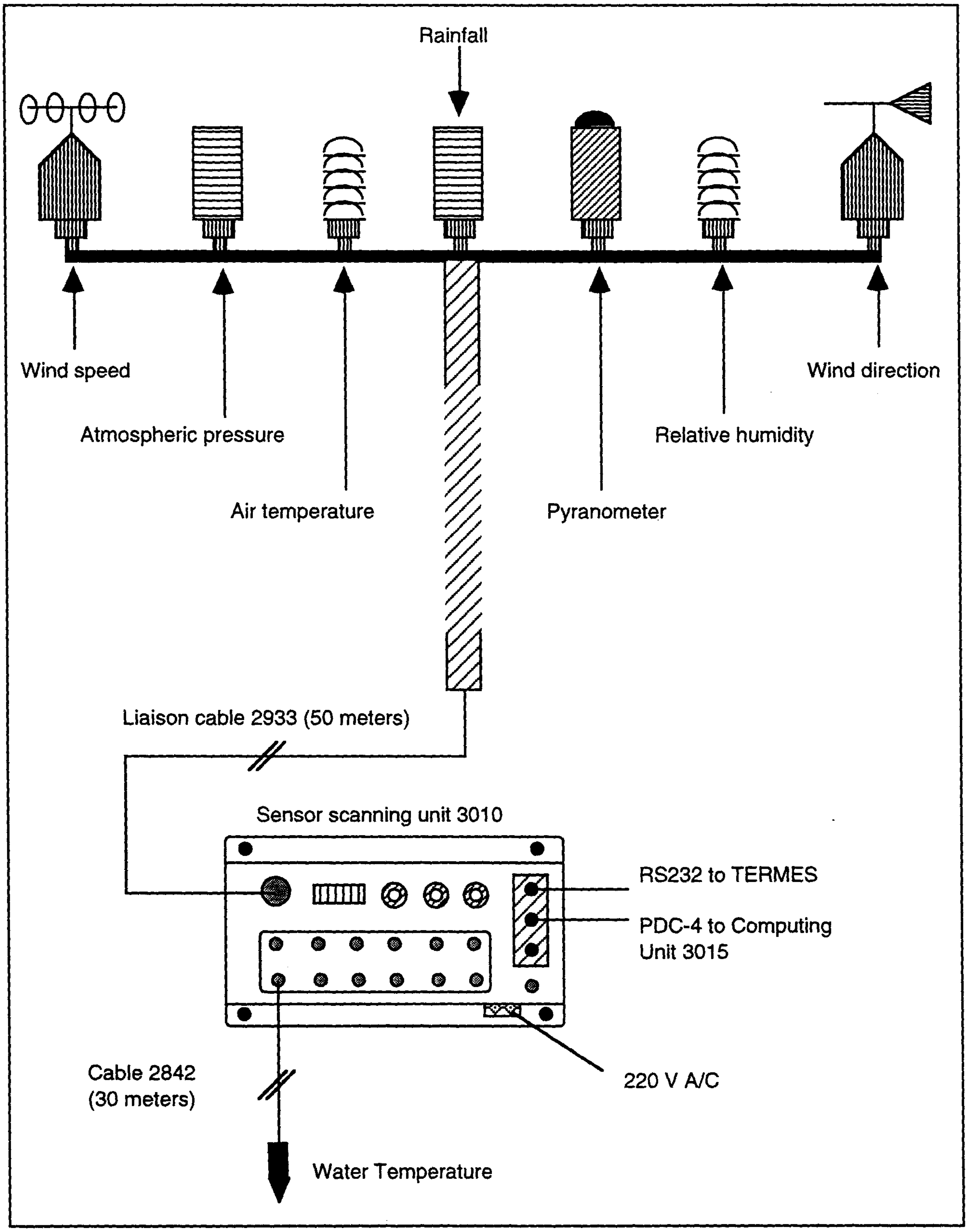
3.5 kHz data is provided within a wide beam; It is faded by bad weather conditions, steep slopes and close reliefs (side echoes).

*** DATA PROCESSING**

The data is recorded in real time on an Dowty IEEE 3700. The watch leader informs time marks every 30 minutes and ensures a first draft interpretation according to a reference guide.



D - OCEANO-METEOROLOGY STATION



1 - SENSOR SCANNING UNIT - AANDERAA 3010

The Sensor Scanning Unit 3010 is a module for automatic scanning/reading of Aanderaa sensors and converting their output into PDC-4 and RS 232 ASCII code.

The 3010 contains a 12 channel multiplexer, an R-2R network for analog to digital conversion and a digital control system which includes a microprocessor.

A built-in, quartz clock generates the trigger pulse for the unit. When triggered, the unit scans the preset number of input channels in sequence. The R-2R network converts the sensor signal by successive approximation into raw data words in 10-bit binary code, which are fed to the PDC-4 and RS 232C output receptacles.

After the last sensor has been read, a sync pulse denotes the end of a complete measurement cycle. The RS 232C output is for direct connection to a computer.

A liquid crystal display shows raw data after each sensor reading, and elapsed time after each measurement cycle.

Sampling intervals can be selected by means of the rotary switch.

* Measuring principle	:	Successively balanced bridge.
* Bridge Voltage	:	10 pulses for each channel. Duration of each pulse: 1/36 second.
* Measuring Range	:	1/22 of bridge voltage symmetrically around bridge midpoint.
* Output Signals	:	a) Aanderaa 10-bit binary word. b) RS-232, ASCII-coded decimals at 300 baud, 8 data bits, no parity and 2 stop bits.
* Resolution	:	10 bits.
* Accuracy	:	± 1 bit.
* Measuring Speed	:	4 seconds each channel.
* Number of Channels	:	Selectable from 1 to 12.

2 - COMPUTING UNIT - AANDERAA 3015

The Computing Unit receives and displays data in real time. The unit converts sensor information from the Aanderaa Automatic Weather Station to readings in engineering units and presents one sensor channel at a time on a built-in liquid crystal display.

Each channel may be examined giving the last data entry together with statistical values such as maximum, minimum and average.

* Input Signal	:	Aanderra PDC-4 code. Interval set by transmitting station.
* Internal Clock	:	100 year clock, drift 0.5 sec/day.
* Storage Capacity	:	The last 144 data sets are stored together with time and date.
* Display	:	Alphanumeric 40 x 2 character LCD.
* PDC-4 Output	:	Delayed copy of input signal.
* RS-232	:	ASCII-coded 1,200 baud, 8 data bits, 1 stop bit, no parity.

3 - TEMPERATURE SENSOR - AANDERAA 3145

The temperature sensor is a platinum sensor for air and water measurements;

The sensor is based on the ohmic half-bridge principle (VR-22) with a 2,000 ohm film-type platinum resistor as the sensing element.

The sensor used for air temperature measurements is equipped with a radiation screen 2922, which protects the sensor from heating caused by solar radiation in wind velocities as low as 0.5 m/s.

* Resistor - R_1	:	4,000Ω
* Resistor - R_2	:	2,000Ω + Pt 2,000Ω
* Measuring Range	:	-44 to +49°C
* Resolution	:	0.1°C
* Time Constant	:	# 6 minutes.

4 - AIR PRESSURE SENSOR - AANDERAA 2810

Air pressure sensor 2810 utilizes a small silicon chip of 4x4 mm as sensing element. In the central area of this chip is a thin membrane that is exposed to atmospheric pressure on one side and to a vacuum on the other.

The membrane is furnished with four diffused resistors that form a Wheatstone bridge. The output signal is proportional to the atmospheric pressure. The chip thus acts as an absolute pressure-sensing device.

Four heating resistors and a temperature resistor are also diffused onto the chip. In conjunction with an external control circuit, these resistors allow the chip to be held at a constant temperature of 35°C during measurement.

* Measuring Range	:	920 - 1,080 mb.
* Accuracy	:	± 0.2 mb.
* Resolution	:	0.2 mb.
* Operation Temperature Range	:	- 20°C to + 35°C.
* Output Impedance	:	45Ω.
* Sensor Output	:	Aanderaa half-bridge.

5 - SOLAR RADIATION SENSOR (PYRANOMETER) - AANDERAA 2770

Solar Radiation Sensor 2770 has been developed to measure solar and sky radiation under all weather conditions. The sensor employs a high sensitivity thermistor bridge which measures the temperature rise of a black surface under a borosilicate glass dome.

* Wavelength	:	0.3 to 2.5 micron.
* Resolution	:	0.4 mW/cm^2.
* Output	:	Aanderaa half-bridge.
* Output Impedance	:	2.5Ω at 20°C.
* Accuracy	:	Better than ± 2mW/cm^2.
* Linearity	:	> ± 1 %.
* Response Time	:	63 % of final value in 60 seconds.
* Range	:	0 - 200 mW/cm^2.

6 - RELATIVE HUMIDITY SENSOR - AANDERAA 2820

The 2820 sensor consists of an RH probe with a receptacle for a watertight plug and a radiation screen to protect it from solar radiation and rain.

It utilizes a bundle of hygroscopic hair and a silican beam which detects the variations in length of the hair as humidity changes. The hair bundle is tensioned by a spring which transfers the deflection to the beam.

Two resistors diffused onto each side of the beam are parts of a temperature controlled half-bridge. In this way the variation in length of the hair is converted to an electrical signal.

* Range	:	5 to 100 % Relative Humidity (RH).
* Accuracy	:	± 3 % RH.
* Resolution	:	0.3 % RH.
* Output Impedance	:	5,000Ω.
* Sensor Output	:	Aanderaa half-bridge

7 - RAINFALL SENSOR - AANDERAA 3064

Rainfall is collected in a funnel and a special designed filter forms the water into equally sized droplets. These droplets fall an a drop detector providing an electrical pulse for each drop.

These pulse are counted by a pulse counter embedded in the sensor base. The sensor will give the total amount of precipitation during the sampling interval.

The housing is made of anodized aluminium and the base will fit on a 25 mm aluminium tube, in which case a watertight connecting cable is available to connect the sensor with the Sensor Scanning Unit.

* Resolution	:	0.08 mm.
* Range	:	45.0 mm/interval.
		8 mm max/minute.
* Operating Temperature	:	0 to + 60°C.

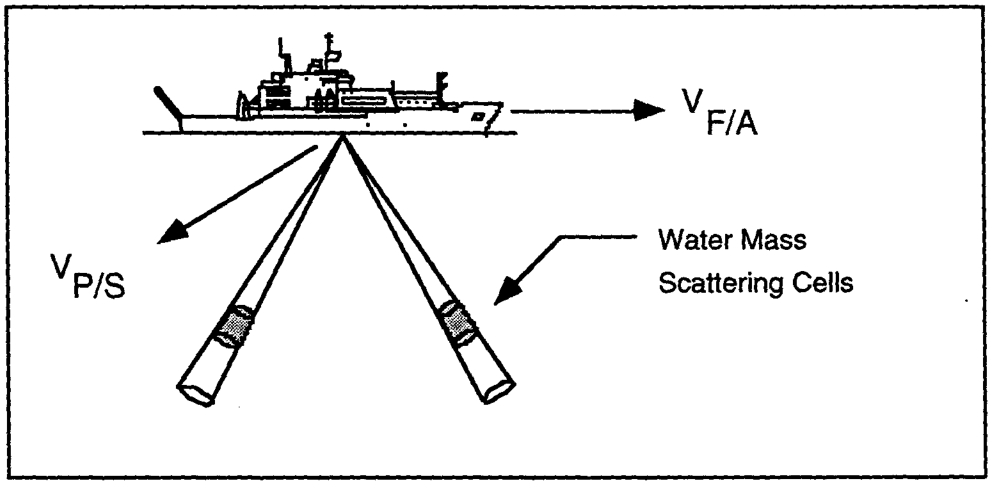
E - ACOUSTIC DOPPLER CURRENT PROFILER (VM-ADCP)

The Vessel Mounted Acoustic Doppler Current Profiler (VM-ADCP) is manufactured by R.D. Instruments (San Diego, USA). This system is routinely used to describe the ocean currents of the 0 - 800 meters upper layer.

The ADCP transmits acoustic pulses (75 kHz or 300 kHz) from a transducer assembly. The transducer receives backscattered sound from plankton and small particles riding the water currents. Using the doppler effect and some basic trigonometry, the ADCP converts the backscattered sound into components of water current velocity.

The 75 kHz system permits the ADCP to process the data of 128 layers of 16 meters thickness between the surface and 800 meters.

A graph of the mean EW and NS velocity profiles processed obtained during the period of sampling (usually 2 to 5 minutes i.e. 0.3 to 0.8 miles at a speed of 10 knots) appears on the screen during the cruise. The navigation recorded is essential to substract the ship velocity to the velocity profiles provided by ADCP. These data are recorded on-board, and then processed later when necessary.



- Geometry for a two-beam doppler current profiler system -

- Real time paper output -

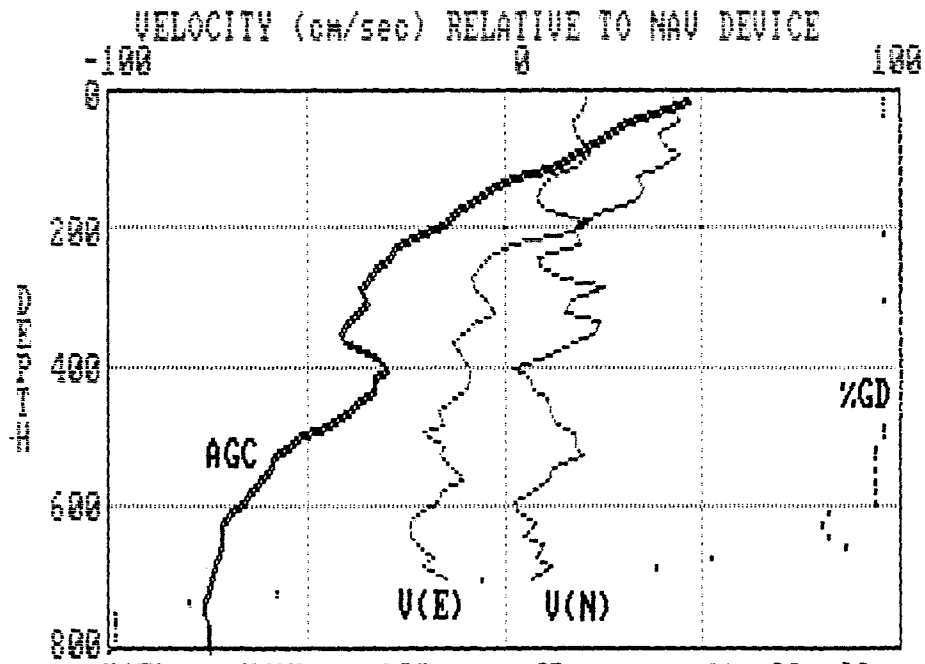
DISK FILE: -------- ENSEMBLE: 1 JUL 12, 1993
CRUISE ID: 75KHZ,2MN,WT,ZONEC 10:42:46

HEADING: 335.8 DEG
PITCH: 7.0 DEG
ROLL: -26.3 DEG
TEMP: 22.1 (C)

BOTTOM (cm/sec)
SHIP VEL N
SHIP VEL E
DPTH M

NAV DEVICE G: SE
LAT -25.4644
LON 169.0000
DIR 338.1923
VEL 10.7773 kts

REF LYR (cm/sec)
VEL N -475.98
VEL E 222.66



V(E)— V(N)— AGC▬ %GD...... dt: 29, 29
PINGS: 10 ENS. TIME LEFT: 0:01:05 BIT OK

V(E) = Velocity East
V(N) = Velocity North

AGC = Gain control
%GD = % good data

F - THERMO-SALINOMETER - CTD+100

SENSOREN·INSTRUMENTE·SYSTEME

SIS

CTDplus 100 , 500 AND 1000
A NEW GENERATION OF CTD INSTRUMENTS

Features:

- High resolution and accuracy
- New sensor concept, conductivity and temperature in the same sample volume
- Autonomous battery powered system
- LC display
- User programable by cursor keybuttons
- Internal calculation of salinity, density and sound speed according to UNESCO tables and standards
- Autocalibration functions for simple recalibration of sensors
- Time series sampling for moorings
- Spatial series sampling for profiling
- Light weight, small size, easy handling
- Several optional upgrade modules (e.g. formatted output on printer)

The CTD plus 100, 500 and 1000 is a family of CTD "hang alone" systems for use in water depths of 100 meters, 500 meters and 1000 meters respectivly.

For simple use they are activated by three cursor keybuttons to take samples and store them in solid state CMOS RAMS, to read out samples on display, to continosly sample, calculate and display parameters.

For advanced use there are options available as

— serial RS 232 interface with data output in scientific units (sail protocol on request) for direct formatted drive of printers or communication with computers and controllers
— single conductor cable interface module for real time data acquisition
— ac power module for stationary use in laboratory as salinometer or flow through instrument
— several battery modules
— DC acquisition module with 14 bit resolution for optional sensors such as 0_2, pH etc.

For field analysis and processing there is a handheld computer with printer/plotter and SIS fieldsoft program package available.

CTDplus 100 · 500 · 1000

Modes of Operation

Program selection
Three magnetic cursor switches for complete stepping through user menu allows the choice of operational modes.

Main menu

```
SAMPLE   READ OUT   CONTINUOUS
```

Sampling mode submenu
Setting of parameters for time series sampling (delay time, sampling time increment) and spatial series sampling (initial pressure, sampling pressure increment, maximum pressure according to memory capacity and depth capability of instrument).

```
tdelay=0.30hrs.min  tincr=0.05hrs.min
Pinit=080dbar Pincr=0.1dbar Pend=090dbar
```

Sampling initialization

```
SAMPLING ACTIVATED BY TIMING-PARAMETER
SAMPLING ACTIVATED BY DEPTHS-PARAMETER
```

Read out
Selection of displayed parameters (measured and/or calculated). Up and down scrolling through data. Optional ASCII data output over serial interface.

```
p=072.55dbar   T=10.251°C  C=40.255mS/cm
S=36.934‰.   σ=28.749kg/m³   v=1494.3m/s
```

Continuous operation
Real time acquisition and calculation of selected parameters (measured and/or calculated).

Specifications

Parameter	Range	Resolution	Accuracy	Stability	Response time
conductivity	1-65 mS/cm	1 µS/cm	10 µS/cm	2 µS/cm month	20 ms
temperature	-2 °C — +40 °C	0.001 °C	0.005 °C	0.001 °C/month	20 ms
pressure	0 — 100 dbar 0 — 500 dbar 0 — 999 dbar	0.01 dbar	0.05% fs	0.01%/month	10 ms
salinity	2‰ — 42‰	0.001‰	0.019‰	0.004‰/month	—
density	0 — 65 kgm⁻³	0.001 kgm⁻³	0.016 kgm⁻³	0.003 kgm⁻³/month	—
sound speed	1392-1724 msc⁻¹	0.1 msec⁻¹	0.02 msec⁻¹	0.004 msec⁻¹/month	—

Sampling Rate: spatial mode user selectable ≧ 0.1 dbar
time mode user selectable 0:01 h:min ≦ ts ≦ 9:59 h:min respectivly
real time data acquisition 3 msec for a complete CTP cycle of 17 bit resolution

Memory: CMOS solidstate with 100, 500, 1000 datasets. Upgrade as option.

Power Supply: 2 Alkaline D cells: 10 hours continous operation
up to 40 days time sampling
Power module with lithium batteries available for longer uninterrupted supply.
External supply 1.4 V — 7.5 V, 1.5 W

Available option: Standard serial interface, ac power module. On request single conductor cable interface, field computer, deck unit, SIS fieldsoft program package, solid state CMOS ram upgrade.

Outer dimensions: 420 mm (pressure case) 180 mm (battery module) length, 60 mm diameter

Weight: 3 kg in air with battery module and batteries.

SIS reserves the right to change specifications without prior notice

Represented by:

SIS

SiS Sensoren Instrumente Systeme GmbH
Projensdorfer Straße 324, D-2300 Kiel 1
Telefon (0431) 30972 · Telefax (0431) 338691
Telex 292226 sis d

ENCLOSURES

CHAPTER 8

ENCLOSURES

ENCLOSURE 1

STAFF

R/V L'ATALANTE
- LEG 1 -

(July, 18th to August, 15th, 1993)

STAFF	NAME	COMPANY
Representatives	DALOMAE John TIFFIN Donald	S.I. Hydrographic Office SOPAC Technical Secretariat
Chief Scientist	**DANIEL Jacques**	**ORSTOM Noumea**
Watch	GERARD Martine GABALDA Germinal LE MOIGN José DUPONT Jacques DUPERRET Anne MOLLARD Lucien COUTELLE Alain SAHABI Mohamed *DALOMAE John*	ORSTOM Bondy ORSTOM Bondy UBO Brest ORSTOM Brest UBO Brest ORSTOM Nouméa UBO Brest UBO Brest
EM12 multibeam		
Acquisition	LE DOARE Jacques LOUSSOUARN Claude SERVE Henry	GENAVIR Brest GENAVIR Brest GENAVIR Brest
Processing Bathymetry Acoustic imagery	 GUEGUEN Bernard SATRA Catherine	 GENAVIR Brest IFREMER Brest
Cartography	BUTSCHER John	ORSTOM Nouméa
Secretary	MISSEGUE François	ORSTOM Nouméa

R/V L'ATALANTE
- LEG 2 -

(August, 19th to September, 16th, 1993)

STAFF	NAME	COMPANY
Representatives	OLISUKULU Clifford LARUE Michel	Solomon Island SOPAC Fiji
Chief Scientist	**AUZENDE Jean-Marie**	**ORSTOM Nouméa**
Watch: 0h00-4h00	LAFOY Yves GRACIA Eulalia *OLISUKULU Clifford*	SME Nouméa UBO Brest
4h00-8h00	EISSEN Jean-Philippe ONDREAS Helene CAMBON Pierre	ORSTOM Brest IFREMER Brest IFREMER Brest
8h00-12h00	GELI Louis COLLOT Jean-Yves LEBELLEGARD Pierre	IFREMER Brest ORSTOM Villefranche ORSTOM Nouméa
EM12 multibeam		
Acquisition	COQUET Stephane SERVE Henry	GENAVIR Brest GENAVIR Brest
Processing		
Bathymetry	NORMAND Alain	IFREMER Brest
Acoustic imagery	PELLEAU Pascal	IFREMER Brest
Cartography	CARRE Daniel	IFREMER Brest
Secretary	PERRIER Julien	ORSTOM Nouméa

R/V L'ATALANTE
- LEG 3 -

(September, 22nd to October, 20th, 1993)

STAFF	NAME	COMPANY
Representatives	HANUAGI Tony	S.I.Hydrographic Solomon Islands
	PATALO Fanoanoagu	Lands &Survey Dpt, Tuvalu
	CATAKI Viliame	Fiji Hydrographic Service
	SICHOIX Lydie	Pacific French University
Chief Scientist	**PELLETIER Bernard**	**ORSTOM Nouméa**
Watch: 0h00-4h00	SAGET Philippe	IFREMER Brest
	LEAU Hélène	UBO Brest
	LE ROY Pascal	UBO Brest
	PATALO Fanoanoagu	
4h00-8h00	ASLANIAN Daniel	UBO Brest
	FLEUTELOT Corinne	UBO Brest
	CATAKI Viliame	
	RIGAUT Frédéric	UBO Brest
8h00-12h00	LE SUAVÉ Raymond	IFREMER Brest
	HANUAGI Tony	
	SICHOIX Lydie	
	TOUSSAINT Bertrand	ORSTOM Villefranche
EM12 multibeam		
Acquisition	JANNEZ Michel	GENAVIR
	LE DOARE Jacques	GENAVIR
	LOUSSOUARN Claude	GENAVIR
Processing		
Bathymetry	GUEGUEN Bernard	GENAVIR
Acoustic imagery	LEBELLEGARD Pierre	ORSTOM Nouméa
Seismic reflexion		
Acquisition	LE PHILIPPE Jean-Luc	GENAVIR
	QUEINNEC Yvon	GENAVIR
Cartography	PERRIER Julien	ORSTOM Nouméa
Secretary	CORNEC Jacques	IFREMER Brest

ENCLOSURE 2

CRUISE CHRONOLOGY

LEG 1

18 July 1993

Departure from Noumea (New Caledonia) at 15:30 local time. Start of transit profiles T1A at 08:31. Good sea conditions.
T1A to T1B

19 July 1993

Transit profiles T1B to T1F.
Launching the seismic equipment at 14:23 and the magnetometer at 14:45. Start of profiling in the New Hebrides Intra-Arc (NHIAB) (Aoba Basins) at 16:52. Good sea conditions.
PR 1A to PR 1B.

20 July 1993

Continuation of the survey on the Aoba Basins zone. Good sea conditions.
PR 1B to PR 2G.

21 July 1993

Continuation of the survey on the Aoba Basins zone. Good sea conditions.
PR 3A to PR 5C.

22 July 1993

Continuation of the survey on the Aoba Basins zone. Rough sea conditions.
PR 6A to PR 8C.

23 July 1993

Continuation of the survey on the Aoba Basins zone. Rough sea conditions.
PR 9A to PR 16.

24 July 1993

Continuation of the survey on the Aoba Basins zone. Good sea conditions.
PR 16 to PR 27B

25 July 1993

End of the survey on the Aoba Basins zone at 17:08. Beginning of the survey on Banks Basin at 17:47 (PR 31A). Good sea conditions.
PR 27B to PR 31A

26 July 1993

Continuation of the survey on the Banks Basin zone. Very rough sea conditions.
PR 31B to PR 34A

27 July 1993

Very rough sea conditions.
End of the survey on the Banks Basin zone at 02:00 and beginning of surveying on Big Bay zone at 02:40. 20:34, stop of seismic profiles for short repairing on the air-gun.
21:17, end of profiling in the Big Bay zone. 21:17, start of seismic profiles.
PR 34A to PR 39C

28 July 1993

Beginning of surveying on Banks Basin zone at 21:18. Rough sea conditions.
PR 39D to PR 41B

29 July 1993

Continuation of surveying on the Banks Basin zone. Good sea conditions. 01h26, short repairing on the air-gun. 03:30, start of seismic profiles. 21:06, short repairing on the air-gun.
22:22, start of seismic profiles.
PR 41B to PR 49

30 July 1993

Good sea conditions. Continuation of the survey on the Banks Basin zone. 20:47, problem with the compressor and the air-gun. 22:35, start of seismic profiles.
PR 49 to PR 54

End of the survey on New Hebrides Intra-Arc Basins zone at 17:00. 17:08, beginning of the survey in the North New Hebrides Back-Arc area (NNHBA).
PR 55A to PR 55C

31 July 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Good sea conditions.
22:11, repairing the air-gun. Start the seismic profiles at 23h50.
PR 55C to PR 60

1 August 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Rough sea conditions.
PR 60 to PR 62D

2 August 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Rough sea conditions.
PR 62D to PR 64A

3 August 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Rough sea conditions.
PR 64B to PR 66A

4 August 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Rough sea conditions.
21:14, stop of seismic profiles for short repairing on the air-gun. 22:00, start the seismic profiles.
PR 66A to PR 67F

5 August 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Good sea conditions.
PR 67F to PR 69

6 August 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Good sea conditions.
PR 69 to PR 73C

7 August 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Very good sea conditions.
PR 73C to PR 77

8 August 1993

Rough sea conditions.
End of the survey on North New Hebrides Intra-Arc Basins zone at 10:27.
PR 77 to PR78. Beginning the survey on the Melanesian Arc Gap (MAG) at 10:33.
PR 79

9 August 1993

Continuation of the survey on the Melanesian Arc Gap zone. Good sea conditions.
Trouble on the Kennedy recorder but the "10 seconds" record goes on.
PR 80A to PR 81C

10 August 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Good sea conditions.
PR 81C to PR 83B

11 August 1993

Continuation of the survey on North New Hebrides Intra-Arc Basins zone. Very rough sea conditions.
PR 83B to PR 85A

12 August 1993

Very rough sea conditions. End of the survey on North New Hebrides Intra-Arc Basins zone at 16:06. PR 85A to PR86C
Beginning the survey on the Indispensable Basin at 16:06.
PR 87A to PR 89A

13 August 1993

Continuation of the survey on the Indispensable Basin. Good sea conditions.
PR 89A to PR 90E

14 August 1993

Continuation of the survey on the Indispensable Basin. Good sea conditions.
PR 90E to PR 93C

15 August 1993

End of the survey on the Indispensable Basin at 01:09.
PR 93C. Good sea conditions.
Equipment (seismic and magnetometer) taken on board at 01:15.
Anchored in Honiara harbour at 05:00 (16:00 local time).

LEG 2

19 August 1993

Departure Honiara 19 August at 03:20 TU. Start of profiling in the Iron Bottom Sound at 04:32.
End of the Iron Bottom Sound box at 22:00.
Beginning of the profile to the Mborokua Basin.
PR94 to 103.

20 August

Transit profiles PR104 and 105 between Iron Bottom Sound and Mborokua boxes. 02:48, beginning of the survey of Mborokua Basin. Good sea conditions in the morning becoming rough in the evening.
Note : From GPS and Radar measurements it seems that the Mborokua Island position on the Hydrographic map nr. 3996 must be shifted by about 0,5 miles to the South.
PR104 to 110.

21 August

Continuation of the Mborokua box. Rough sea with a wind reaching 30 knots speed.
PR 111 to 116.

22 August

End of Mborokua box at 01:38. Beginning of New Georgia Sound box.
PR117 to 122.

23 August

Continuation of the New Georgia Sound box. Good weather conditions. 09:30, stop of seismic and magnetic profiles for short repairing on the streamer.
PR123 to 130

24 August

Continuation of profiles on New Georgia Sound box.
PR131 to 135.

25 August

End of the New Georgia Sound box at 00:28. Good weather conditions.
Transit to East Malaita zone. 2-hour stop for Simrad calibration
PR136, 137 and 138.

26 August

Start of the East Malaita box : 02:40. PR140. Good weather conditions.
PR139 to 140.

27 August

East Malaita box, continuation. Good weather conditions.
PR141 to 143.

28 August

Continuation of East Malaita box. Good weather conditions.
PR143 to 150.

29 August

Continuation of East Malaita box. Good weather conditions.
PR150 to 157.

30 August

Continuation of East Malaita box. Good weather conditions.
PR158 to 164.

31 August

Start of the Melanesian Arc Gap box. Wind 25-30 knots, Sea 4.
PR165 to 166.

1 September

Continuation of surveying on the Melanesian Arc Gap. Same weather conditions as 31 August.
PR166 to 167.

2 September

Continuation of surveying on the Melanesian Arc Gap. Wind 25 knots, Sea 3.
PR168 to 170.

3 September

Continuation of surveying on the Melanesian Arc Gap. Wind 25 knots, Sea 3.
PR170 to 171.

4 September

Continuation of surveying on the Melanesian Arc Gap. Beginning of the North New Hebrides Back-Arc area survey. Wind 25 knots, Sea 3.
PR171 to 172.

5 September

Continuation of the North New Hebrides Back-Arc area survey.
PR173 to 174.

6 September

Continuation of the North New Hebrides Back-Arc area survey.
PR174 to 176.

7 September

Continuation of the North New Hebrides Back-Arc area survey.
PR176 to 177.

8 September

Continuation of the North New Hebrides Back-Arc area survey.
PR177 to 178.

9 September

End of the North New Hebrides Back-Arc area box. Start of the NW Pandora Bank box.
Rough sea. PR178 to 181.

10 September

Surveying on Pandora Bank box. Rough Sea. Wind 25-30 knots.
PR181 to 183

11 September

Surveying on Pandora Bank box. Rough Sea.
PR183 to 185.

12 September

Surveying on Pandora Bank box. Rough sea. Engine problems around 19:00.
PR 185 to 187.

13 September

Pandora Bank box. Rough sea. New problems on the engine around 01:00. 03:20 decision to stop the profile PR187, only one engine is working. Heading to Suva. Maximum speed 8 knots.
PR 187 to 188, T2.

14 September

Transit to Suva.
T2, T3.

15-16 September

Transit to Suva through the North Fiji Basin.

LEG 3

21 September 1993

Departure from Suva at 21:00 UT. Start of profiling (EM12, gravimetry and magnetism) off Suva Harbour, in order to complete the map obtained at the end of Leg 2.
Profiles PR193 and PR194.
Very good sea conditions.

22 September

The ship stops between 00:00 and 01:55 UT due to engine problems. End of profiling of Suva Harbour (profile PR195) and beginning of transit toward the Tuvalu Bank.
Profiles T6 to T9 between the Fiji Islands.
Very good sea conditions.

23 September

Continuing the transit. Profiles T10 and T11. Beginning of seismic profiling at 14:50 UT on profile T11. Beginning of mapping the South Tuvalu Banks Area around Hera Bank at 19:20.
Profiles PR196 and PR197.
Moderate sea conditions.

24 September

Continuing the mapping of South Tuvalu Banks Area:
PR197 to PR202 around Hera-Bayonnaise Bank. The peaks with water depths of 31 m located west of Hera-Bayonnaise Banks and reported on the hydrographic chart have not been found.
Moderate sea conditions.

25 September

Mapping around Kosciusko-Martha Banks:
Profiles PR203 to PR210. The bank of 24 m reported in 1880, south of Rose Bank, has not been found. In contrast a shallow bank, east of Martha Bank, was found.
Good sea conditions.

26 September

Mapping the area east and southeast of Kosciusko-Martha Banks. The banks at 25 m (1889), 18 m (1963) and 20 m (1977), east of the Martha Bank, have not been found.
Profiles PR210 to PR215.
Good sea conditions.

27 September

Continuing the profiles in the northeastern area of the South Tuvalu Banks. High bank is located near 10°13'S - 179°42W.
Profiles PR215 to PR219.

28 September

Stop of seismic reflexion acquisition from 2:30 to 17:00 UT and beginning of profiling in order to map the gaps between previous tracks, especially on the eastern banks and south of Rose Bank.
End of mapping of the northeastern sector of the South Tuvalu Banks Area and beginning of mapping the western part of Hera-Bayonnaise Bank.
Profiles PR219 to PR231.
Good sea conditions in the morning beginning moderate in the afternoon.

29 September

Continuing of profiling west of the Hera-Bayonnaise Banks. The banks at 26 m, 40 m and 22 m reported on the hydrographic map, west of the Hera-Bayonnaise Banks, have not been found.
Profiles PR231 - PR232. Bad sea conditions. Trade winds more than 30 knots.

30 September

Continuing profiles west of the Hera-Bayonnaise Banks.
Profiles PR232 to PR234. Bad sea conditions, wind 30 knots and abundant rain.

1 October

Continuing mapping the volcanic edifices west of Hera-Bayonnaise Banks. Interprofiles in order to cover the gaps between previous profiles.
Profiles PR234 to PR248.
Bad sea conditions continuing, wind 30 knots and abundant rain.

2 October

Profiling west of Hera-Bayonnaise Banks.
Profiles PR 249 to PR252.
Bad sea conditions. Wind 25-30 knots and rain.

3 October

Continuation of the South Tuvalu Banks survey, west of Hera-Bayonnaise Banks in the area of Alcarity and Eaglestone Ridges.
Profiles PR2. Moderate sea conditions.

4 October

Continuation of the South Tuvalu Banks Area survey, in the Eaglestone Ridge zone.
Profiles PR255 - PR256.
Moderate sea conditions, beginning bad at the end of the day.

5 October

Profiling on Eaglestone Ridge. Bad sea conditions, wind 25-30 knots.
Profiles PR256 - PR257.

6 October

Continuation of survey around Eaglestone Ridge. Sea conditions around wind 20-25 knots.
Profiles PR258 - PR259.

7 October

Profiling on Eaglestone Ridge to fill the gap between the previous profiles.
Moderate sea conditions.
Profiles PR259 to PR265.

8 October

Finishing the South Tuvalu Banks Area survey.
Transit to Alexa Bank.

9 October

Delimiting and mapping the flank of Alexa Bank. Beginning of Alexa Bank box at 02:00.
Seismic and magnetic records stop at 03:00 UT.
Profiles PR269 to PR273.
Good sea conditions.

10 October

Finishing to delimit Alexa Bank. Seismic and magnetic records start at 13:00 UT.
Good sea conditions. Profiles PR273 to PR278.

11 October

Transit to Charlotte Bank and delimiting and mapping the contour of Charlotte Bank. Seismic and magnetic records stop between 05:00 and 22:00 UT.
Profiles PR278 to PR280. Good sea conditions.

12 October

Mapping the area between Charlotte and Alexa Banks.
Profiles PR280 to PR284.
Good sea conditions.

13 October

Mapping the area North of Charlotte Bank.
Profiles PR284 to PR287.
Moderate sea conditions at the beginning. Wind increases at the end of the day.

14 October

Finishing to map the area west of Charlotte Bank and mapping the area south of Charlotte Bank.
Profiles PR287 to PR290.
Rough sea conditions, wind 25 knots.

15 October

Mapping the area east of Pandora Bank.
Profiles PR290 to PR292.
Moderate sea conditions, wind 25 knots.

16 October

Continuing to map the area east of Pandora Bank.
Profiles PR292 to PR295

17 October

Finishing the area east of Pandora Bank and beginning at 12:00 UT the transit to Noumea.
Profiles PR295 to PR297 and T12

18 to 20 October

Transit to Noumea trough the North Fiji Basin and the New Hebrides Trench.
Profiles T13 to T16.
Arrival in Noumea at 21:00 local time.

ENCLOSURE 3

LOGBOOK

Leg 1	NHIAB	New Hebrides Intra-Arc Basin
	NNHBAA	North New Hebrides Back Arc Area
	MAG	Melanesian Arc Gap
Leg 2	CST : IBS	Iron Bottom Sound
	MB	Mborokua Basin
	NGS	New Georgia Sound
	MALAITA	Malaita
	PBA	Pandora Bank Area
Leg 3	STBA	South Tuvalu Banks Area
	ACBA	Alexa/Charlotte Banks Area

- Leg 1 -

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
18/07/93	**Transit T1**	T1A	08:31	14:29	05:58	S 22° 17.166	E 167° 09.739	S 21° 12.000	E 167° 43.000
		T1B	14:29	08:04	17:35	S 21° 12.000	E 167° 43.000	S 17° 32.948	E 168° 07.230
19/07/93		T1C	08:05	09:40	01:35	S 17° 32.948	E 168° 07.023	S 17° 15.032	E 168° 16.643
		T1D	09:42	13:03	03:21	S 17° 15.032	E 168° 16.643	S 16° 35.800	E 168° 02.740
		T1E	13:04	14:18	01:14	S 16° 35.800	E 168° 02.740	S 16° 27.080	E 167° 53.070
		T1F	14:21	16:52	02:31	S 16° 27.080	E 167° 53.070	S 16° 13.700	E 167° 43.560
	NHIAB	PR1A	16:52	20:54	04:02	S 16° 13.700	E 167° 43.560	S 15° 54.541	E 167° 22.047
	Aoba Basins	PR1B	20:56	08:28	11:32	S 15° 54.541	E 167° 22.047	S 14° 32.811	E 167° 15.478
20/07/93		PR2A	09:53	12:47	02:54	S 14° 30.000	E 167° 24.000	S 15° 00.216	E 167° 20.410
		PR2B	12:49	13:14	00:25	S 15° 00.216	E 167° 20.410	S 15° 04.010	E 167° 18.480
		PR2C	13:14	15:40	02:26	S 15° 04.010	E 167° 18.480	S 15° 28.240	E 167° 20.490
		PR2D	15:40	16:13	00:33	S 15° 28.240	E 167° 20.490	S 15° 32.500	E 167° 23.000
		PR2E	16:13	18:30	02:17	S 15° 32.500	E 167° 23.000	S 15° 53.454	E 167° 25.251
		PR2F	18:33	21:26	02:53	S 15° 53.913	E 167° 25.517	S 16° 13.671	E 167° 47.410
		PR2G	21:31	23:45	02:14	S 16° 14.141	E 167° 48.207	S 16° 24.894	E 168° 07.731
21/07/93		PR3A	00:50	05:43	04:53	S 16° 27.681	E 168° 03.378	S 15° 51.767	E 167° 29.480
		PR3B	05:45	07:39	01:54	S 15° 51.481	E 167° 29.437	S 15° 34.855	E 167° 28.445
		PR3C	07:44	08:29	00:45	S 15° 34.183	E 167° 28.042	S 15° 28.924	E 167° 22.622
		PR3D	08:33	11:09	02:36	S 15° 28.376	E 167° 22.410	S 15° 03.103	E 167° 20.432
		PR4	12:05	14:57	02:52	S 15° 01.956	E 167° 22.499	S 15° 28.730	E 167° 24.940
		PR5A	15:55	18:35	02:40	S 15° 31.730	E 167° 28.440	S 15° 05.333	E 167° 26.444
		PR5B	18:36	21:16	02:40	S 15° 05.083	E 167° 26.501	S 14° 39.630	E 167° 33.449
		PR5C	21:19	22:44	01:25	S 14° 33.330	E 167° 33.440	S 14° 26.008	E 167° 33.448
22/07/93		PR6A	00:12	01:42	01:30	S 14° 24.875	E 167° 42.459	S 14° 39.730	E 167° 43.440
		PR6B	01:42	04:16	02:34	S 14° 39.730	E 167° 43.440	S 15° 04.730	E 167° 34.440
		PR6C	04:16	06:42	02:26	S 15° 04.730	E 167° 34.440	S 15° 29.308	E 167° 33.476
		PR6D	06:42	08:52	02:10	S 15° 29.308	E 167° 33.476	S 15° 50.879	E 167° 33.953
		PR6E	08:56	11:38	02:42	S 15° 51.292	E 167° 34.301	S 16° 11.420	E 167° 54.970
		PR7A	11:41	12:35	00:54	S 16° 11.420	E 167° 54.970	S 16° 09.713	E 168° 03.399
		PR7B	12:38	13:39	01:01	S 16° 09.892	E 168° 03.640	S 15° 59.730	E 168° 07.440
		PR8A	13:39	15:43	02:04	S 15° 59.730	E 168° 07.440	S 15° 39.830	E 168° 00.460
		PR8B	15:43	17:31	01:48	S 15° 39.830	E 168° 00.460	S 15° 21.876	E 168° 03.911
		PR8C	17:34	23:09	05:35	S 15° 21.466	E 168° 03.899	S 14° 29.630	E 167° 54.428
23/07/93		PR9A	00:10	02:23	02:13	S 14° 29.730	E 168° 00.484	S 14° 49.750	E 168° 00.460
		PR9B	02:23	06;28	04:05	S 14° 49.750	E 168° 00.460	S 15° 23.358	E 168° 05.912
		PR9C	06:29	08:04	01:35	S 15° 23.847	E 168° 05.945	S 15° 39.536	E 168° 04.958
		PR9D	08:06	09:03	00:57	S 15° 39.806	E 168° 05.000	S 15° 48.775	E 168° 07.962
		PR9E	09:04	10:28	01:24	S 15° 48.775	E 168° 07.962	S 16° 02.788	E 168° 10.454
		PR10	11:05	12:50	01:45	S 16° 04.130	E 168° 05.154	S 15° 49.041	E 167° 53.367

Leg 1 (continued)

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
		PR11	13:41	15:28	01:27	S 15° 51.831	E 167° 52.021	S 16° 07.276	E 168° 01.476
		PR12	16:06	18:27	02:21	S 16° 07.716	E 167° 56.418	S 15° 47.549	E 167° 42.952
		PR13	18:37	19:26	00:49	S 15° 46.050	E 167° 43.240	S 15° 40.345	E 167° 49.754
		PR14	19:35	20:57	01:22	S 15° 38.967	E 167° 49.638	S 15° 30.672	E 167° 38.365
		PR15	21:45	23:16	01:31	S 15° 30.747	E 167° 38.578	S 15° 33.540	E 167° 52.521
		PR16	23:24	01:07	01:43	S 15° 33.342	E 167° 53.703	S 15° 18.634	E 168° 03.018
24/07/93		PR17	01:51	03:25	01:34	S 15° 17.944	E 168° 00.401	S 15° 28.835	E 167° 51.488
		PR18	03:25	04:59	01:34	S 15° 28.835	E 167° 54.488	S 15° 26.372	E 167° 39.352
		PR19	04:59	08:29	03:30	S 15° 26.372	E 167° 39.352	S 15° 13.600	E 168° 01.800
		PR20	09:17	10:04	00:47	S 15° 11.880	E 167° 58.920	S 15° 06.673	E 167° 52.162
		PR21	10:10	12:14	02:04	S 15° 06.659	E 167° 51.236	S 15° 21.840	E 167° 36.839
		PR22	13:11	14:47	01:36	S 15° 21.653	E 167° 37.050	S 15° 12.981	E 167° 51.047
		PR23	16:26	17:28	01:02	S 15° 08.710	E 167° 42.500	S 15° 02.555	E 167° 51.953
		PR24	17:36	18:16	00:40	S 15° 01.404	E 167° 52.532	S 14° 54.673	E 167° 51.562
		PR25	18:25	19:18	00:53	S 14° 53.461	E 167° 52.425	S 14° 50.711	E 168° 00.550
		PR26	20:01	20:50	00:49	S 14° 50.880	E 168° 01.596	S 14° 49.849	E 167° 53.313
		PR27A	20:57	23:09	02:12	S 14° 49.243	E 167° 52.412	S 14° 29.639	E 167° 50.414
		PR27B	23:10	00:34	01:24	S 14° 29.553	E 167° 50.399	S 14° 16.721	E 167° 45.634
25/07/93		PR28A	00:43	01:59	01:16	S 14° 16.375	E 167° 44.391	S 14° 23.744	E 167° 34.368
		PR28B	01:59	03:23	01:24	S 14° 23.744	E 167° 34.368	S 14° 23.531	E 167° 19.625
		PR29	03:23	07:51	04:28	S 14° 23.531	E 167° 19.625	S 13° 38.750	E 167° 19.436
		PR30A	08:27	13:20	04:53	S 13° 38.650	E 167° 13.960	S 14° 26.790	E 167° 13.800
		PR30B	13:20	13:51	00:31	S 14° 26.790	E 167° 13.800	S 14° 30.000	E 167° 09.000
		PR30C	13:51	17:08	03:18	S 14° 30.000	E 167° 09.000	S 15° 01.800	E 167° 15.442
	Banks Basin	PR31A	17:47	21:20	03:33	S 15° 02.841	E 167° 15.842	S 14° 29.794	E 167° 03.960
		PR31B	21:21	00:35	03:14	S 14° 29.580	E 167° 03.962	S 13° 59.770	E 167° 06.929
26/07/93		PR31C	00:36	02:49	02:13	S 13° 59.543	E 167° 06.939	S 13° 37.708	E 167° 06.440
		PR32A	03:38	09:15	05:37	S 13° 37.790	E 167° 01.431	S 14° 29.665	E 166° 59.496
		PR32B	09:16	11:39	02:23	S 14° 29.801	E 166° 59.496	S 14° 51.803	E 167° 05.484
		PR33A	12:22	14:42	02:20	S 14° 51.627	E 167° 03.901	S 14° 29.720	E 166° 54.448
		PR33B	14:42	19:49	05:07	S 14° 29.720	E 166° 54.448	S 13° 37.626	E 166° 54.446
		PR34A	20:49	02:40	05:51	S 13° 35.841	E 166° 47.335	S 14° 29.737	E 166° 49.468
27/07/93	Big Bay	PR34B	02:40	05:36	02:56	S 14° 29.737	E 166° 49.468	S 14° 55.710	E 167° 03.396
		PR35	06:14	08:29	02:15	S 14° 54.688	E 167° 00.664	S 14° 35.662	E 166° 48.385
		PR36	09:19	11:29	02:10	S 14° 36.780	E 166° 45.990	S 14° 55.307	E 166° 57.506
		PR37	12:56	14:37	01:41	S 15° 03.686	E 166° 52.415	S 14° 46.708	E 166° 49.423
		PR38	15:25	17:01	01:36	S 14° 46.735	E 166° 49.448	S 15° 01.722	E 166° 56.937
		PR39A	17:36	19:09	01:33	S 15° 02.701	E 166° 54.930	S 14° 47.887	E 166° 48.507
		PR39B	19:10	20:29	01:19	S 14° 47.669	E 166° 48.395	S 14° 36.710	E 166° 40.922
		PR39C	20:33	21:17	00:44	S 14° 36.131	E 166° 41.082	S 14° 29.851	E 166° 42.422

Leg 1 (continued)

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
27/07/93	Banks Basin	PR39D	21:18	02:46	05:28	S 14° 29.535	E 166° 42.438	S 13° 37.371	E 166° 39.484
28/07/93		PR39E	02:46	04:25	01:39	S 13° 37.371	E 166° 39.484	S 13° 23.216	E 166° 47.015
		PR39F	04:25	07:36	03:11	S 13° 23.216	E 166° 47.015	S 12° 52.922	E 166° 34.510
		PR39G	07:39	14:06	06:27	S 12° 52.443	E 166° 34.448	S 11° 48.400	E 166° 35.060
		PR40	14:06	18:49	04:43	S 11° 48.400	E 166° 35.060	S 12° 03.559	E 167° 19.696
		PR41A	19:01	21:05	02:04	S 12° 04.839	E 167° 20.819	S 12° 26.144	E 167° 16.118
		PR41B	21:07	00:10	03:03	S 12° 26.156	E 167° 16.120	S 12° 51.434	E 167° 28.958
29/07/93		PR41C	00:12	03:29	03:17	S 12° 51.794	E 167° 28.938	S 13° 22.987	E 167° 22.956
		PR41D	03:29	04:19	00:50	S 13° 22.987	E 167° 22.956	S 13° 26.823	E 167° 15.488
		PR41E	04:19	04:55	00:36	S 13° 26.823	E 167° 15.488	S 13° 32.835	E 167° 14.717
		PR42	04:55	07:30	02:35	S 13° 32.835	E 167° 14.717	S 13° 32.734	E 166° 46.789
		PR43A	07:39	08:39	01:00	S 13° 31.589	E 166° 46.017	S 13° 22.930	E 166° 50.445
		PR43B	08:44	12:00	03:16	S 13° 22.171	E 166° 50.118	S 12° 51.780	E 166° 37.653
		PR44A	12:00	16:14	04:14	S 12° 51.780	E 166° 37.653	S 13° 22.715	E 166° 55.894
		PR44B	16:14	16:46	00:32	S 13° 22.715	E 166° 55.894	S 13° 27.767	E 166° 54.066
		PR45	16:46	18:27	01:41	S 13° 27.767	E 166° 54.066	S 13° 27.759	E 167° 11.417
		PR46	18:31	19:37	01:06	S 13° 27.619	E 167° 12.063	S 13° 20.668	E 167° 20.527
		PR47	20:00	21:20	01:20	S 13° 29.310	E 167° 22.070	S 13° 23.765	E 167° 08.326
		PR48	22:20	23:34	01:14	S 13° 23.652	E 167° 08.553	S 13° 16.482	E 167° 16.532
		PR49A	23:39	01:00	01:21	S 13° 15.750	E 167° 16.926	S 13° 02.300	E 167° 16.700
30/07/93		PR49B	01:00	02:00	01:00	S 13° 02.300	E 167° 16.700	S 12° 54.200	E 167° 23.200
		PR49C	02:00	05:01	03:01	S 12° 54.200	E 167° 23.200	S 12° 26.466	E 167° 12.011
		PR49D	05:01	06:40	01:39	S 12° 26.466	E 167° 12.011	S 12° 08.764	E 167° 14.283
		PR50	06:49	09:08	02:19	S 12° 08.764	E 167° 14.283	S 11° 59.213	E 166° 51.615
		PR51	09:14	10:06	00:52	S 11° 58.423	E 166° 51.253	S 11° 50.471	E 166° 51.253
		PR52	10:11	13:32	03:21	S 11° 50.120	E 166° 55.135	S 11° 55.678	E 167° 27.720
		PR53	13:32	15:04	01:32	S 11° 55.678	E 167° 27.720	S 11° 40.687	E 167° 24.177
		PR54	15:04	17:00	01:56	S 11° 40.687	E 167° 24.177	S 11° 42.420	E 167° 03.906
	NNHBAA	PR55A	17:08	17:45	00:37	S 11° 41.493	E 167° 03.425	S 11° 35.727	E 167° 05.720
		PR55B	17:52	19:29	01:37	S 11° 34.635	E 167° 05.551	S 11° 23.913	E 166° 52.894
		PR55C	19:29	01:38	06:09	S 11° 23.913	E 166° 52.894	S 10° 36.000	E 166° 18.500
31/07/93		PR55D	01:38	04:08	02:30	S 10° 36.000	E 166° 18.500	S 10° 35.995	E 165° 51.868
		PR55E	04:14	05:56	01:42	S 10° 35.522	E 165° 51.005	S 10° 17.585	E 165° 50.993
		PR55F	05:56	07:43	01:47	S 10° 17.585	E 165° 50.993	S 09° 59.890	E 165° 46.969
		PR56A	08:21	10:17	01:56	S 09° 58.395	E 165° 49.559	S 10° 17.000	E 165° 54.000
		PR56B	10:17	11:47	01:30	S 10° 17.000	E 165° 54.000	S 10° 32.300	E 165° 54.044
		PR57A	12:39	14:07	01:28	S 10° 31.054	E 165° 58.956	S 10° 16.000	E 165° 57.500
		PR57B	14:07	15:43	01:36	S 10° 16.000	E 165° 57.500	S 10° 00.000	E 165° 53.500
		PR58	16:16	18:17	02:01	S 10° 00.000	E 165° 56.500	S 10° 20.107	E 166° 01.908
		PR59	18:22	21:30	03:08	S 10° 20.544	E 166° 02.489	S 10° 25.102	E 166° 32.619

Leg 1 (continued)

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
01/08/93	**NNHBAA**	PR60	20:49	01:43	04:54	S 10° 27.890	E 166° 31.033	S 10° 24.490	E 166° 02.413
	(cont'd)	PR61A	02:33	04:20	01:47	S 10° 29.519	E 166° 03.067	S 10° 31.550	E 166° 20.476
		PR61B	04:20	06:10	01:50	S 10° 31.550	E 166° 20.476	S 10° 45.055	E 166° 32.271
		PR61C	06:10	10:08	03:58	S 10° 45.055	E 166° 32.271	S 11° 13.488	E 166° 59.995
		PR61D	10:08	11:59	01:51	S 11° 13.488	E 166° 59.995	S 11° 30.028	E 167° 08.013
		PR62A	13:09	15:23	02:14	S 11° 29.871	E 167° 14.974	S 11° 07.360	E 167° 10.848
		PR62B	15:23	19:12	03:49	S 11° 07.360	E 167° 10.848	S 10° 37.938	E 166° 44.450
		PR62C	19:12	21:26	02:14	S 10° 37.933	E 166° 44.450	S 10° 17.547	E 166° 34.999
02/08/93		PR62D	21:26	02:04	04:38	S 10° 17.547	E 166° 34.999	S 09° 42.921	E 166° 01.886
		PR63A	03:36	07:46	04:10	S 09° 43.094	E 166° 15.611	S 10° 13.054	E 166° 44.028
		PR63B	07:46	09:59	02:13	S 10° 13.054	E 166° 44.028	S 10° 32.915	E 166° 52.966
		PR63C	09:59	14:25	04:26	S 10° 32.915	E 166° 52.966	S 11° 03.554	E 167° 20.492
		PR63D	14:25	17:11	02:46	S 11° 03.554	E 167° 20.492	S 11° 30.088	E 167° 25.013
		PR64A	18:32	22:06	03:34	S 11° 31.114	E 167° 35.730	S 10° 59.537	E 167° 30.621
		PR64B	22:06	02:17	04:11	S 10° 59.537	E 167° 30.621	S 10° 27.380	E 167° 01.736
03/08/93		PR64C	02:17	04:22	02:05	S 10° 27.380	E 167° 01.736	S 10° 07.778	E 166° 52.405
		PR64D	04:22	07:39	03:17	S 10° 07.778	E 166° 52.405	S 09° 42.892	E 166° 29.390
		PR65A	09:24	12:05	02:41	S 09° 43.017	E 166° 42.423	S 10° 02.496	E 167° 01.482
		PR65B	12:06	14:12	02:06	S 10° 02.605	E 167° 01.542	S 10° 21.929	E 167° 09.949
		PR65C	14:12	18:42	04:30	S 10° 21.929	E 167° 09.949	S 10° 55.301	E 167° 40.234
		PR65D	18:42	22:18	03:36	S 10° 55.301	E 167° 40.234	S 11° 30.050	E 167° 45.620
		PR66A	23:49	03:14	03:25	S 11° 29.863	E 167° 55.971	S 10° 54.985	E 167° 50.950
04/08/93		PR66B	03:14	07:42	04:28	S 10° 54.985	E 167° 50.980	S 10° 20.949	E 167° 19.950
		PR66C	07:42	09:08	01:26	S 10° 20.949	E 167° 19.950	S 10° 08.012	E 167° 12.997
		PR66D	09:08	12:16	03:08	S 10° 08.012	E 167° 12.997	S 09° 42.990	E 166° 53.180
		PR67A	12:53	14:48	01:55	S 09° 43.007	E 166° 56.007	S 09° 56.543	E 167° 10.060
		PR67B	14:48	16:23	01:35	S 09° 56.543	E 167° 10.060	S 10° 06.053	E 167° 23.028
		PR67C	16:23	18:05	01:42	S 10° 06.053	E 167° 23.028	S 10° 21.048	E 167° 30.571
		PR67D	18:05	20:39	02:34	S 10° 21.048	E 167° 30.571	S 10° 38.477	E 167° 48.873
		PR67E	20:39	23:08	02:29	S 10° 38.477	E 167° 48.873	S 10° 55.012	E 168° 01.524
05/08/93		PR67F	23:08	08:02	08:54	S 10° 55.012	E 168° 01.524	S 12° 12.108	E 168° 48.595
		PR68	08:58	17:13	08:15	S 12° 13.716	E 168° 39.499	S 10° 59.896	E 167° 57.942
		PR69	19:15	01:30	06:15	S 11° 18.338	E 167° 57.920	S 12° 19.900	E 168° 28.464
06/08/93		PR70	02:36	06:09	03:33	S 12° 11.961	E 168° 18.462	S 11° 39.911	E 167° 59.924
		PR71	07:23	11:10	03:47	S 11° 39.146	E 167° 49.512	S 12° 12.100	E 168° 08.560
		PR72A	11:43	12:45	01:02	S 12° 13.600	E 168° 04.233	S 12° 05.121	E 167° 57.582
		PR72B	12:45	15:31	02:46	S 12° 05.121	E 167° 57.582	S 12° 03.014	E 167° 27.973
		PR72C	15:31	18:20	02:39	S 12° 03.014	E 167° 27.973	S 11° 53.978	E 166° 59.901
		PR73A	19:12	22:25	03:13	S 11° 46.397	E 167° 00.276	S 11° 48.502	E 167° 32.751
		PR73B	22:27	23:21	00:54	S 11° 48.798	E 167° 33.107	S 11° 55.721	E 167° 35.905
		PR73C	23:25	00:33	01:08	S 11° 56.000	E 167° 36.266	S 11° 56.908	E 167° 47.927

Leg 1 (continued)

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
07/08/93	**NNHBAA**	PR74A	00:40	02:20	01:40	S 11° 55.925	E 167° 48.388	S 11° 40.990	E 167° 39.881
	(cont'd)	PR74B	02:20	04:18	01:58	S 11° 40.990	E 167° 39.881	S 11° 34.004	E 167° 20.844
		PR74C	04:18	05:09	00:51	S 11° 34.004	E 167° 20.844	S 11° 34.013	E 167° 12.441
		PR75A	05:16	07:25	02:09	S 11° 33.236	E 167° 11.717	S 11° 12.234	E 167° 04.424
		PR75B	07:25	12:07	04:42	S 11° 12.234	E 167° 04.424	S 10° 35.460	E 166° 32.904
		PR75C	12:12	13:36	01:24	S 10° 34.667	E 166° 32.936	S 10° 25.916	E 166° 43.750
		PR75D	13:43	14:34	00:51	S 10° 24.516	E 166° 43.334	S 10° 16.640	E 166° 39.930
		PR75E	14:34	18:31	03:57	S 10° 16.640	E 166° 39.930	S 09° 46.954	E 166° 11.944
		PR76	20:15	23:21	03:06	S 09° 45.641	E 165° 55.830	S 10° 05.507	E 166° 14.004
		PR77	23:56	03:39	03:43	S 10° 07.104	E 166° 09.458	S 09° 37.944	E 165° 42.939
08/08/93		PR78	04:44	10:27	05:43	S 09° 38.051	E 165° 35.011	S 10° 32.394	E 165° 46.316
	MAG	PR79	10:33	23:43	13:10	S 10° 33.106	E 165° 45.911	S 11° 00.006	E 163° 31.001
09/08/93		PR80A	00:53	05:12	04:19	S 10° 51.612	E 163° 26.845	S 10° 43.000	E 164° 10.046
		PR80B	05:12	06:24	01:12	S 10° 43.000	E 164° 10.046	S 10° 38.004	E 164° 21.064
		PR80C	06:24	10:51	04:27	S 10° 38.004	E 164° 21.064	S 10° 32.491	E 165° 07.103
		PR80D	10:51	14:03	03:12	S 10° 32.491	E 165° 07.103	S 10° 29.996	E 165° 40.107
		PR81A	14:52	17:44	02:52	S 10° 24.003	E 165° 39.884	S 10° 24.002	E 165° 09.901
		PR81B	17:44	22:07	04:23	S 10° 24.002	E 165° 09.901	S 10° 26.140	E 164° 26.470
10/08/93		PR81C	22:07	04:02	05:55	S 10° 26.140	E 164° 26.470	S 10° 40.990	E 163° 27.902
		PR82A	05:16	06:53	01:37	S 10° 31.073	E 163° 26.049	S 10° 30.032	E 163° 41.386
		PR82B	06:53	08:10	01:17	S 10° 30.032	E 163° 41.386	S 10° 22.227	E 163° 51.782
		PR82C	08:10	09:09	00:59	S 10° 22.227	E 163° 51.782	S 10° 26.000	E 164° 00.000
		PR82D	09:09	10:56	01:47	S 10° 26.000	E 164° 00.000	S 10° 19.060	E 164° 15.001
		PR82E	10:56	12:17	02:21	S 10° 19.060	E 164° 15.001	S 10° 16.000	E 164° 27.000
		PR82F	12:17	16:53	04:36	S 10° 16.000	E 164° 27.000	S 10° 16.022	E 165° 10.081
		PR82G	16:53	19:29	02:36	S 10° 16.022	E 165° 10.081	S 10° 20.005	E 165° 35.094
		PR83A	20:07	22:50	02:43	S 10° 14.347	E 165° 35.032	S 10° 09.997	E 165° 09.990
		PR83B	22:50	00:47	01:57	S 10° 09.997	E 165° 09.990	S 10° 05.013	E 164° 49.987
11/08/93		PR83C	00:47	03:41	02:54	S 10° 05.013	E 164° 49.987	S 10° 07.072	E 164° 19.853
		PR83D	03:41	05:52	02:11	S 10° 07.072	E 164° 19.853	S 10° 18.044	E 163° 59.888
		PR83E	05:52	07:12	01:20	S 10° 18.044	E 163° 59.888	S 10° 29.889	E 163° 54.030
		PR83F	07:12	08:21	01:09	S 10° 29.889	E 163° 54.030	S 10° 34.019	E 163° 42.892
		PR83G	08:21	12:31	04:10	S 10° 34.019	E 163° 42.892	S 10° 36.955	E 162° 59.596
		PR84	12:36	19:38	07:02	S 10° 36.524	E 162° 58.935	S 09° 24.913	E 162° 50.989
		PR85A	20:58	04:57	07:59	S 09° 23.716	E 162° 40.824	S 10° 37.033	E 162° 49.013
12/08/93		PR85B	04:57	05:34	00:37	S 10° 37.033	E 162° 49.013	S 10° 42.929	E 162° 49.990
		PR85C	05:34	07:36	02:02	S 10° 42.929	E 162° 49.990	S 11° 00.094	E 163° 00.070
		PR86A	09:02	11:19	02:17	S 11° 01.126	E 162° 50.930	S 10° 43.077	E 162° 35.078
		PR86B	11:20	14:39	03:19	S 10° 42.970	E 162° 34.924	S 10° 24.981	E 162° 05.928
		PR86C	14:39	16:06	01:27	S 10° 24.981	E 162° 05.928	S 10° 18.906	E 161° 51.962

Leg 1 (continued)

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
	MAG	PR87A	16:06	17:18	01:12	S 10° 18.906	E 161° 51.962	S 10° 06.570	E 161° 49.015
	(cont'd)	PR87B	17:18	18:51	01:33	S 10° 06.570	E 161° 49.015	S 09° 51.066	E 161° 52.382
		PR87C	18:51	20:03	01:12	S 09° 51.066	E 161° 52.382	S 09° 42.960	E 161° 43.426
		PR88	20:47	22:51	02:04	S 09° 41.422	E 161° 38.377	S 09° 55.000	E 161° 44.000
13/08/93		PR89A	23:08	06:18	07:10	S 09° 59.160	E 161° 42.860	S 09° 10.932	E 160° 45.609
		PR89B	06:18	10:51	04:33	S 09° 10.932	E 160° 45.605	S 08° 26.338	E 160° 33.006
		PR89C	10:53	14:14	03:21	S 08° 26.132	E 160° 32.722	S 08° 18.171	E 159° 59.726
		PR90A	14:46	18:46	04:00	S 08° 21.302	E 159° 59.181	S 08° 57.399	E 160° 19.367
		PR90B	18:46	20:20	01:34	S 08° 57.399	E 160° 19.367	S 09° 07.967	E 160° 31.980
		PR90C	20:20	22:11	01:51	S 09° 07.967	E 160° 31.980	S 09° 25.790	E 160° 37.160
		PR90D	22:13	23:51	01:38	S 09° 26.000	E 160° 37.470	S 09° 30.500	E 160° 50.350
14/08/93		PR90E	23:53	01:26	01:33	S 09° 30.500	E 160° 50.400	S 09° 45.046	E 160° 54.882
		PR90F	01:26	06:15	04:49	S 09° 45.046	E 160° 54.882	S 10° 13.053	E 161° 31.094
		PR91	06:54	11:36	04:42	S 10° 11.391	E 161° 34.806	S 09° 42.987	E 160° 57.980
		PR92A	12:21	14:10	01:49	S 09° 40.245	E 161° 00.008	S 09° 49.078	E 161° 16.650
		PR92B	14:10	15:33	01:23	S 09° 49.078	E 161° 16.650	S 09° 54.204	E 161° 28.205
		PR92C	15:33	16:42	01:09	S 09° 54.204	E 161° 28.205	S 10° 06.156	E 161° 36.196
		PR93A1	17:15	18:36	01:21	S 10° 02.672	E 161° 39.585	S 09° 52.959	E 161° 29.419
		PR93A2	18:36	22:45	04:09	S 09° 52.952	E 161° 29.419	S 09° 33.035	E 160° 55.090
		PR93B	22:47	23:20	00:33	S 09° 32.824	E 160° 54.954	S 09° 27.057	E 160° 53.457
15/08/93		PR93C	23:20	01:09	01:49	S 09° 27.057	E 160° 53.457	S 09° 20.530	E 160° 35.350

- Leg 2 -

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
19/08/93	IBS (in CST)	PR94	5:20	7:40	0 02:20	S 09° 23.68	E 159° 55.81	S 09° 05.64	E 159° 44.05
		PR95	7:44	9:45	0 02:01	S 09° 05.94	E 159° 44.44	S 09° 21.23	E 159° 57.39
		PR96	10:13	11:20	0 01:07	S 09° 19.19	E 159° 59.00	S 09° 10.20	E 159° 51.67
		PR97	11:20	11:45	0 00:25	S 09° 10.20	E 159° 51.67	S 09° 06.25	E 159° 52.19
		PR98	12:16	13:42	0 01:26	S 09° 07.30	E 159° 52.70	S 09° 17.93	E 160° 00.35
		PR99	14:03	15:58	0 01:55	S 09° 17.03	E 160° 03.60	S 09° 01.19	E 159° 50.41
		PR100	16:24	18:39	0 02:15	S 08° 59.83	E 159° 52.00	S 09° 17.32	E 160° 06.95
		PR101	19:03	20:46	0 01:43	S 09° 15.96	E 160° 08.96	S 09° 02.31	E 159° 57.61
		PR102	20:47	21:42	0 00:55	S 09° 02.31	E 159° 57.61	S 09° 03.99	E 159° 47.70
		PR103	21:43	22:26	0 00:43	S 09° 04.57	E 159° 47.05	S 09° 10.10	E 159° 42.22
19/08/93	Transit	PR104	22:30	1:09	0 02:39	S 09° 10.23	E 159° 41.83	S 08° 56.61	E 159° 18.01
20/08/93	(in CST)	PR105	1:09	2:48	0 01:39	S 08° 56.61	E 159° 18.10	S 08° 53.91	E 159° 00.08
20/08/93	MB (in CST)	PR106	2:48	4:15	0 01:27	S 08° 53.92	E 159° 00.05	S 09° 05.46	E 158° 52.60
		PR107	4:15	5:58	0 01:43	S 09° 05.57	E 158° 52.60	S 09° 16.54	E 158° 54.41
		PR108	6:08	9:30	0 03:22	S 09° 21.48	E 158° 53.61	S 09° 08.88	E 158° 23.96
		PR109	10:24	13:58	0 03:34	S 09° 03.78	E 158° 22.26	S 09° 16.66	E 158° 52.42
		PR110	14:42	18:59	0 04:17	S 09° 11.78	E 158° 51.54	S 08° 55.41	E 158° 12.79
		PR111	19:42	23:59	0 04:17	S 08° 51.74	E 158° 14.62	S 09° 07.38	E 158° 51.25
21/08/93		PR112	0:41	4:05	0 03:24	S 09° 03.27	E 158° 51.71	S 08° 49.69	E 158° 14.84
		PR113	4:38	8:14	0 03:36	S 08° 46.60	E 158° 21.50	S 08° 59.48	E 158° 53.07
		PR114	8:54	13:14	0 04:20	S 08° 55.72	E 158° 54.86	S 08° 39.71	E 158° 15.02
		PR115	13:50	18:47	0 04:57	S 08° 36.44	E 158° 14.12	S 08° 52.78	E 158° 58.53
		PR116	19:30	2:48	0 07:18	S 08° 49.20	E 159° 00.53	S 08° 22.03	E 157° 54.58
22/08/93	NGS (in CST)	PR116.1	2:51	3:58	0 01:07	S 08° 21.69	E 157° 54.20	S 08° 11.42	E 157° 50.32
		PR116.2	3:59	4:50	0 00:51	S 08° 11.23	E 157° 50.23	S 08° 08.51	E 157° 41.98
		PR116.3	4:53	5:44	0 00:51	S 08° 08.24	E 157° 41.58	S 08° 00.24	E 157° 38.97
		PR117.1	6:11	6:52	0 00:41	S 07° 59.74	E 157° 41.37	S 08° 06.38	E 157° 43.79
		PR117.2	6:54	7:50	0 00:56	S 08° 06.54	E 157° 44.11	S 08° 09.65	E 157° 52.32
		PR117.3	7:52	8:53	0 01:01	S 08° 09.88	E 157° 52.44	S 08° 19.58	E 157° 55.88
		PR117.4	8:56	11:00	0 02:04	S 08° 19.95	E 157° 56.27	S 08° 28.17	E 158° 15.96
		PR117.5	11:00	12:04	0 01:04	S 08° 28.17	E 158° 15.96	S 08° 30.54	E 158° 26.63
		PR118.1	12:45	13:37	0 00:52	S 08° 26.39	E 158° 26.74	S 08° 24.41	E 158° 17.51
		PR118.2	13:37	15:27	0 01:50	S 08° 24.41	E 158° 17.51	S 08° 16.84	E 157° 59.27
		PR118.3	15:29	16:32	0 01:03	S 08° 16.62	E 157° 59.02	S 08° 06.75	E 157° 55.45
		PR118.4	16:35	17:22	0 00:47	S 08° 06.43	E 157° 55.25	S 08° 03.66	E 157° 47.22
		PR118.5	17:25	17:56	0 00:31	S 08° 03.26	E 157° 46.90	S 08° 07.58	E 157° 45.13
		PR119	18:00	20:00	0 02:00	S 07° 59.86	E 157° 44.64	S 07° 55.18	E 157° 24.50
		PR120	20:04	21:15	0 01:11	S 07° 55.31	E 157° 23.82	S 08° 03.99	E 157° 14.84
		PR121	21:30	23:01	0 01:31	S 08° 03.59	E 157° 15.24	S 07° 51.39	E 157° 13.61
		PR122	23:34	0:25	0 00:51	S 07° 52.87	E 157° 14.02	S 08° 00.80	E 157° 16.28

Leg 2 (continued)

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
23/08/93	NGS *(cont'd)*	PR123	0:56	2:01	0 01:05	S 08° 00.05	E 157° 16.11	S 07° 52.19	E 157° 23.90
		PR124	2:24	4:49	0 02:25	S 07° 52.20	E 157° 23.30	S 07° 49.55	E 156° 58.22
		PR125	4:52	5:58	0 01:06	S 07° 49.62	E 156° 57.73	S 07° 58.83	E 156° 51.16
		PR126	6:16	8:07	0 01:51	S 07° 58.98	E 156° 52.43	S 07° 40.32	E 156° 48.00
		PR127	8:27	10:15	0 01:48	S 07° 40.24	E 156° 50.36	S 07° 53.17	E 156° 53.11
		PR128	11:00	12:18	0 01:18	S 07° 50.13	E 156° 55.10	S 07° 45.03	E 156° 58.55
		PR129	12:21	16:55	0 04:34	S 07° 44.03	E 156° 58.88	S 07° 52.92	E 157° 45.57
		PR130	17:30	23:33	0 06:03	S 07° 48.22	E 157° 46.07	S 07° 34.30	E 156° 45.00
24/08/93		PR131	0:15	6:26	0 06:11	S 07° 29.47	E 156° 45.21	S 07° 45.23	E 157° 46.16
		PR132	6:49	13:14	0 06:25	S 07° 42.50	E 157° 46.42	S 07° 24.36	E 156° 44.92
		PR133	13:51	18:41	0 04:50	S 07° 22.07	E 156° 44.31	S 07° 37.83	E 157° 31.14
		PR134	19:06	21:32	0 02:26	S 07° 35.14	E 157° 31.52	S 07° 32.30	E 157° 07.34
		PR 135	22:06	0:28	0 02:22	S 07° 29.46	E 157° 09.02	S 07° 32.49	E 157° 32.72
25/08/93	**Transit**	PR136a	0:31	6:30	0 05:59	S 07° 32.64	E 157° 32.97	S 08° 00.93	E 158° 25.11
		PR136b	9:13	17:30	0 08:17	S 08° 01.27	E 158° 26.44	S 08° 39.53	E 159° 37.85
		PR137	18:18	20:30	0 02:12	S 08° 40.36	E 159° 40.87	S 08° 34.84	E 160° 02.81
		PR138	20:54	0:30	0 03:36	S 08° 34.37	E 160° 04.58	S 08° 16.52	E 160° 33.37
26/08/93		PR139	0:36	2:00	0 01:24	S 08° 16.00	E 160° 34.45	S 08° 12.65	E 160° 46.53
26/08/93	**MALAITA**	PR140	2:04	14:09	0 12:05	S 08° 12.03	E 160° 47.18	S 09° 48.29	E 161° 52.65
		PR141	14:38	1:46	0 11:08	S 09° 43.45	E 161° 51.70	S 08° 11.90	E 160° 53.03
27/08/93		PR142	2:41	13:58	0 11:17	S 08° 09.07	E 160° 58.56	S 09° 42.05	E 161° 55.09
		PR143	14:46	1:05	0 10:19	S 09° 37.64	E 162° 01.78	S 08° 05.35	E 161° 05.30
28/08/93		PR144	2:06	12:51	0 10:45	S 08° 01.95	E 161° 12.26	S 09° 29.64	E 162° 05.56
		PR145	13:11	16:20	0 03:09	S 09° 32.32	E 162° 02.56	S 09° 02.38	E 161° 43.10
		PR146	16:20	19:02	0 02:42	S 09° 02.38	E 161° 43.10	S 08° 49.08	E 161° 17.98
		PR147	19:17	20:12	0 00:55	S 08° 48.90	E 161° 18.70	S 08° 56.21	E 161° 22.87
		PR148	20:15	21:39	0 01:24	S 08° 56.43	E 161° 23.05	S 09° 02.67	E 161° 35.97
		PR149	21:45	22:55	0 01:10	S 09° 03.15	E 161° 36.53	S 09° 13.08	E 161° 43.30
		PR150	23:00	1:00	0 02:00	S 09° 13.04	E 161° 44.00	S 09° 02.64	E 161° 58.69
29/08/93		PR151	1:06	3:40	0 02:34	S 09° 01.88	E 161° 58.73	S 08° 38.24	E 161° 44.26
		PR152	4:31	7:22	0 02:51	S 08° 33.31	E 161° 50.65	S 08° 58.21	E 162° 06.46
		PR153	7:24	8:20	0 00:56	S 08° 58.61	E 162° 06.53	S 09° 08.32	E 162° 04.60
		PR154	8:22	10:13	0 01:51	S 09° 08.69	E 162° 04.63	S 09° 28.34	E 162° 08.50
29/08/93		PR155	10:50	15:34	0 04:44	S 09° 33.08	E 162° 03.69	S 10° 22.27	E 162° 04.51
		PR156	16:28	22:15	0 05:47	S 10° 25.35	E 162° 12.85	S 09° 30.41	E 162° 17.84
		PR157	22:30	0:00	0 01:30	S 09° 30.42	E 162° 13.38	S 09° 30.42	E 162° 22.06
30/08/93		PR158	0:08	6:35	0 06:27	S 09° 30.99	E 162° 22.55	S 10° 32.98	E 162° 23.16
		PR159	6:38	7:49	0 01:11	S 10° 33.29	E 162° 23.50	S 10° 40.05	E 162° 33.81
		PR160	8:18	9:54	0 01:36	S 10° 43.39	E 162° 32.84	S 10° 32.90	E 162° 19.30
		PR161	9:56	11:33	0 01:37	S 10° 32.50	E 162° 19.26	S 10° 15.80	E 162° 19.30
		PR162	11:38	12:39	0 01:01	S 10° 15.42	E 162° 19.86	S 10° 15.41	E 162° 29.64
		PR163	13:04	16:54	0 03:50	S 10° 14.56	E 162° 32.80	S 09° 34.13	E 162° 32.87

Leg 2 (continued)

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
30/08/93	**Transit**	PR164	17:01	1:14	0 08:13	S 09° 33.96	E 162° 32.79	S 10° 27.44	E 163° 24.11
31/08/93	**MAG**	PR165	1:22	15:02	0 13:40	S 10° 27.96	E 163° 25.19	S 10° 05.85	E 165° 31.04
		PR166	15:54	4:10	0 12:16	S 09° 57.72	E 165° 30.79	S 10° 19.03	E 163° 24.44
01/09/93		PR167	5:15	22:05	0 16:50	S 10° 08.69	E 163° 23.24	S 09° 50.91	E 165° 46.47
		PR168	22:09	23:36	0 01:27	S 09° 50.59	E 165° 47.00	S 09° 37.27	E 165° 53.90
		PR169	23:41	7:00	0 07:19	S 09° 37.02	E 165° 54.60	S 09° 34.33	E 166° 57.02
02/09/93		PR170	7:29	3:20	0 19:51	S 09° 29.97	E 166° 55.60	S 09° 58.05	E 163° 21.88
03/09/93		PR171	4:31	3:34	0 23:03	S 09° 47.69	E 163° 21.06	S 09° 20.35	E 166° 50.52
04/09/93	**NNHBAA**	PR172	3:34	23:55	0 20:21	S 09° 20.35	E 166° 50.52	S 11° 44.35	E 168° 43.27
05/09/93		PR173	0:53	14:27	0 13:34	S 11° 39.65	E 168° 48.67	S 09° 38.95	E 167° 19.35
		PR174	15:21	6:51	0 15:30	S 09° 34.24	E 167° 25.91	S 11° 34.14	E 168° 57.20
06/09/93		PR175	8:09	21:58	0 13:49	S 11° 28.13	E 169° 04.96	S 09° 27.07	E 167° 34.76
		PR176	23:15	14:15	0 15:00	S 09° 21.78	E 167° 43.40	S 11° 22.32	E 169° 13.05
07/09/93		PR177	15:18	4:59	0 13:41	S 11° 16.75	E 169° 20.94	S 09° 16.51	E 167° 50.20
08/09/93		PR178	6:00	21:18	0 15:18	S 09° 10.96	E 167° 57.50	S 11° 11.00	E 169° 28.80
08/09/93	**PBA**	PR179	21:30	17:40	0 20:10	S 11° 11.34	E 169° 30.50	S 11° 46.61	E 172° 25.02
09/09/93		PR180	17:50	21:13	0 03:23	S 11° 47.92	E 172° 25.70	S 12° 19.85	E 172° 18.85
		PR181	21:51	16:28	0 18:37	S 12° 19.69	E 172° 18.65	S 11° 36.78	E 168° 58.45
10/09/93		PR182	16:35	18:39	0 02:04	S 11° 35.77	E 168° 58.39	S 11° 24.09	E 169° 14.46
		PR183	18:41	14:18	0 19:37	S 11° 24.09	E 169° 14.81	S 11° 55.73	E 171° 46.80
11/09/93		PR184	14:25	15:23	0 00:58	S 11° 56.47	E 171° 47.33	S 12° 05.77	E 171° 44.68
		PR185	15:27	5:17	0 13:50	S 12° 06.31	E 171° 44.09	S 11° 32.29	E 169° 15.52
12/09/93		PR186	5:28	6:57	0 01:29	S 11° 30.98	E 169° 14.91	S 11° 18.38	E 169° 23.73
		PR187	7:03	3:30	0 20:27	S 11° 18.12	E 169° 24.55	S 11° 41.90	E 171° 28.26
13/09/93		PR188	3:32	12:54	0 09:22	S 11° 42.00	E 171° 30.00	S 12° 30.07	E 171° 49.58
13/09/93	**Transit**	TR2	12:54	5:15	0 16:21	S 12° 30.07	E 171° 49.58	S 14° 25.06	E 173° 08.02
14/09/93		TR3	5:15	4:27	0 23:12	S 14° 25.06	E 173° 08.02	S 16° 36.15	E 173° 07.18
15/09/93		TR4	4:30	14:16	0 09:46	S 16° 36.56	E 176° 07.44	S 17° 59.83	E 176° 59.83
		TR5	14:16	23:25	0 09:09	S 18° 00.00	E 177° 00.00	S 18° 24.40	E 178° 14.50

- Leg 3 -

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
22/09/93	Transit	TR6	04:17	07:35	0 03:18	S 18° 16.76	E 178° 40.68	S 18° 20.20	E 179° 18.67
		TR7	07:40	15:27	0 07:47	S 18° 20.00	E 179° 19.50	S 17° 09.90	W 179° 46.43
		TR8	15:27	19:51	0 04:24	S 17° 09.90	W 179° 45.61	S 16° 34.98	W 179° 06.65
		TR9	19:53	22:58	0 03:05	S 16° 34.98	W 179° 06.65	S 15° 59.85	W 179° 03.20
		TR10	23:00	00:47	0 01:47	S 15° 59.55	W 179° 03.61	S 15° 45.26	W 179° 20.70
23/09/93		TR11	00:47	19:15	0 18:28	S 15° 45.26	W 179° 20.70	S 12° 25.00	W 179° 25.00
23/09/93	STBA	PR196	19:17	21:27	0 02:10	S 12° 24.50	W 179° 24.27	S 12° 14.43	W 179° 06.85
		PR197	21:54	01:45	0 03:51	S 12° 14.39	W 179° 07.20	S 11° 45.52	W 179° 33.05
24/09/93		PR198	02:23	06:57	0 04:34	S 11° 42.12	W 179° 29.51	S 12° 14.33	W 179° 01.23
		PR199	07:07	09:49	0 02:42	S 12° 15.67	W 179° 01.31	S 12° 29.82	W 179° 24.75
		PR200	10:14	13:12	0 02:58	S 12° 27.00	W 179° 28.04	S 12° 05.78	W 179° 49.28
		PR201	13:16	13:47	0 00:31	S 12° 05.15	W 179° 49.36	S 12° 00.43	W 179° 48.11
		PR202	13:53	23:12	0 09:19	S 11° 59.58	W 179° 48.46	S 10° 46.91	E 179° 14.00
25/09/93		PR203	00:11	07:36	0 07:25	S 10° 41.90	E 179° 19.45	S 11° 34.35	W 179° 35.56
		PR204	08:33	13:24	0 04:51	S 11° 28.72	W 179° 50.13	S 10° 51.35	E 179° 36.73
		PR205	13:24	15:15	0 01:51	S 10° 51.35	E 179° 36.73	S 10° 52.64	E 179° 18.31
		PR206	15:39	17:04	0 01:25	S 10° 53.35	E 179° 19.94	S 10° 41.20	E 179° 27.54
		PR207	17:10	18:38	0 01:28	S 10° 40.22	E 179° 27.53	S 10° 28.54	E 179° 24.41
		PR208	18:45	20:35	0 01:50	S 10° 25.65	E 179° 24.56	S 10° 18.80	E 179° 41.31
		PR209	20:42	22:55	0 02:13	S 10° 19.43	E 179° 42.03	S 10° 40.51	E 179° 44.12
		PR210	23:00	00:54	0 01:54	S 10° 40.48	E 179° 44.74	S 10° 51.42	E 179° 48.82
26/09/93		PR211	00:54	05:13	0 04:19	S 10° 51.42	E 179° 48.82	S 11° 24.56	W 179° 41.92
		PR212	06:07	10:10	0 04:03	S 11° 18.92	W 179° 36.34	S 10° 48.17	E 179° 56.58
		PR213	10:12	12:16	0 02:04	S 10° 47.91	E 179° 56.41	S 10° 26.44	E 179° 48.37
		PR214	12:48	18:50	0 06:02	S 10° 26.25	E 179° 48.24	S 11° 15.16	W 179° 30.43
		PR215	19:41	02:20	0 06:39	S 11° 09.61	W 179° 24.21	S 10° 14.32	E 179° 49.42
27/01/00		PR216	03:06	09:41	0 06:35	S 10° 10.82	E 179° 56.83	S 11° 03.37	W 179° 18.72
		PR217	10:34	16:45	0 06:11	S 10° 58.07	W 179° 12.62	S 10° 06.99	W 179° 55.33
		PR218	17:24	21:44	0 04:20	S 10° 04.50	W 179° 55.33	S 10° 36.10	W 179° 20.88
		PR219	22:38	02:30	0 03:52	S 10° 30.74	W 179° 15.08	S 10° 03.39	W 179° 43.02
28/09/93		PR220	02:46	05:27	0 02:41	S 10° 10.15	W 179° 42.42	S 10° 18.13	W 179° 40.81
		PR221	05:38	06:53	0 01:15	S 10° 19.56	W 179° 41.94	S 10° 28.74	W 179° 51.59
		PR222	07:00	07:56	0 00:56	S 10° 29.83	W 179° 51.34	S 10° 37.82	W 179° 46.11
		PR223	07:56	08:37	0 00:41	S 10° 37.81	W 179° 46.11	S 10° 43.45	W 179° 50.63
		PR224	08:39	10:01	0 01:22	S 10° 43.81	W 179° 50.55	S 10° 54.89	W 179° 42.59
		PR225	10:07	12:24	0 02:17	S 10° 55.91	W 179° 42.77	S 11° 02.67	E 179° 53.69

Leg 3 (continued)

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
28/09/93	**STBA**	PR226	12:27	13:16	0 00:49	S 11° 02.48	E 179° 53.24	S 10° 56.65	E 179° 46.48
	(cont'd)	PR227	13:17	14:47	0 01:30	S 10° 56.65	E 179° 46.48	S 11° 05.95	E 179° 34.07
		PR228	14:52	15:37	0 00:45	S 11° 06.65	E 179° 34.10	S 11° 12.30	E 179° 38.89
		PR229	15:42	16:46	0 01:04	S 11° 13.19	E 179° 38.96	S 11° 21.93	E 179° 35.65
		PR230	17:06	21:21	0 04:15	S 11° 21.58	E 179° 34.82	S 10° 50.74	E 179° 08.43
		PR231	22:20	14:17	0 15:57	S 10° 55.66	E 179° 02.20	S 12° 32.74	W 179° 26.10
29/09/93		PR232	15:39	02:00	0 10:21	S 12° 39.52	W 179° 36.52	S 11° 17.44	E 179° 13.92
30/09/93		PR233	02:53	15:12	0 12:19	S 11° 22.07	E 179° 08.37	S 12° 43.67	W 179° 43.23
		PR234	16:00	05:12	0 13:12	S 12° 47.10	W 179° 49.45	S 11° 01.41	E 178° 41.39
01/10/93		PR235	06:15	09:42	0 03:27	S 11° 55.51	E 178° 48.05	S 11° 19.80	E 179° 09.84
		PR236	09:45	10:43	0 00:58	S 11° 19.89	E 179° 10.37	S 11° 17.59	E 179° 19.72
		PR237	10:48	12:26	0 01:38	S 11° 17.90	E 179° 20.27	S 11° 28.47	E 179° 28.36
		PR238	12:34	13:08	0 00:34	S 11° 28.26	E 179° 29.30	S 11° 24.03	E 179° 32.63
		PR239	13:11	14:00	0 00:49	S 11° 23.10	E 179° 32.59	S 11° 16.57	E 179° 26.94
		PR240	14:08	15:57	0 01:49	S 11° 16.76	E 179° 25.84	S 11° 31.07	E 179° 20.72
		PR241	15:57	16:44	0 00:47	S 11° 31.07	E 179° 20.72	S 11° 36.16	E 179° 16.08
		PR242	16:45	18:42	0 01:57	S 11° 36.16	E 179° 16.08	S 11° 48.61	E 179° 24.86
		PR243	18:42	20:35	0 01:53	S 11° 48.61	E 179° 24.86	S 11° 58.15	E 179° 35.38
		PR244	20:38	21:17	0 00:39	S 11° 58.19	E 179° 35.85	S 11° 56.44	E 179° 41.67
		PR245	21:19	21:57	0 00:38	S 11° 56.28	E 179° 41.93	S 11° 51.33	E 179° 46.31
		PR246	22:01	22:34	0 00:33	S 11° 51.52	E 179° 46.91	S 11° 54.67	E 179° 49.67
		PR247	22:38	23:13	0 00:35	S 11° 55.30	E 179° 49.52	S 11° 58.95	E 179° 45.01
		PR248	23:17	23:38	0 00:21	S 11° 59.62	E 179° 45.01	S 12° 04.50	E 179° 48.06
02/10/93		PR249	00:04	02:18	0 02:14	S 12° 04.86	E 179° 48.79	S 12° 11.20	W 179° 54.80
		PR250	02:08	07:03	0 04:55	S 12° 11.20	W 179° 11.20	S 12° 41.23	W 179° 26.24
		PR251	07:00	09:52	0 02:52	S 12° 41.23	W 179° 26.24	S 12° 58.97	W 179° 50.02
		PR252	09:55	01:13	0 15:18	S 12° 58.92	W 179° 50.53	S 10° 58.45	E 178° 28.35
03/10/93		PR253	02:07	19:03	0 16:56	S 11° 03.42	E 178° 22.00	S 12° 57.39	E 179° 57.42
		PR254	19:05	19:44	0 00:39	S 12° 57.89	E 179° 57.03	S 13° 01.72	E 179° 57.42
		PR255	19:45	10:30	0 14:45	S 13° 01.69	E 179° 50.61	S 10° 59.35	E 178° 07.67
04/10/93		PR256	11:22	02:57	0 15:35	S 11° 04.80	E 179° 01.93	S 12° 42.87	E 179° 23.53
05/10/93		PR256B	02:43	06:46	0 04:03	S 12° 42.87	E 179° 23.53	S 13° 06.97	E 179° 44.00
		PR257	07:21	23:07	0 15:46	S 12° 09.97	E 179° 38.82	S 11° 02.43	E 177° 51.53
		PR258	23:48	18:43	0 18:55	S 11° 07.02	E 177° 56.66	S 13° 13.44	E 179° 32.68
06/10/93		PR259	19:27	09:35	0 14:08	S 13° 19.70	E 179° 48.04	S 11° 23.00	E 178° 15.91
07/10/93		PR260	09:59	13:00	0 03:01	S 11° 22.08	E 177° 46.00	S 11° 39.12	E 178° 00.92
		PR261	13:27	18:37	0 05:10	S 11° 36.75	E 178° 06.71	S 12° 13.20	E 178° 38.27
		PR262	18:42	19:12	0 00:30	S 12° 13.10	E 178° 39.02	S 12° 09.74	E 178° 38.27
		PR263	19:19	22:26	0 03:07	S 12° 08.67	E 178° 42.63	S 11° 42.36	E 178° 20.34
		PR264	23:18	02:34	0 03:16	S 11° 38.69	E 178° 25.52	S 12° 02.98	E 178° 46.08
08/10/93		PR265	03:22	08:49	0 05:27	S 11° 58.46	E 178° 51.23	S 11° 13.94	E 178° 13.75
		PR266	08:55	12:46	0 03:51	S 11° 13.08	E 178° 14.05	S 11° 02.13	E 178° 46.36
		PR267	13:03	18:52	0 05:49	S 11° 03.85	E 178° 49.20	S 11° 26.38	E 177° 58.55
		PR268	18:57	19:51	0 00:54	S 11° 27.14	E 177° 58.59	S 11° 33.63	E 178° 04.01

Leg 3 (continued)

Date	Area	Profile number	Time			Beginning of profile		End of profile	
			Start	End	Total	Latitude	Longitude	Latitude	Longitude
08/10/93	ACBA	PR269	19:56	06:52	0 10:56	S 11° 34.17	E 178° 03.51	S 11° 57.13	E 176° 13.20
09/10/93		PR270	06:52	10:16	0 03:24	S 11° 57.13	E 176° 13.20	S 11° 40.90	E 175° 41.22
		PR271	11:06	14:14	0 03:08	S 11° 45.48	E 175° 35.50	S 11° 58.53	E 176° 01.10
		PR272	15:11	21:08	0 05:57	S 12° 00.95	E 175° 51.50	S 11° 38.88	E 175° 04.62
		PR273	21:27	01:30	0 04:03	S 11° 34.34	E 175° 05.12	S 11° 18.80	E 175° 35.73
10/10/93		PR274	01:30	02:43	0 01:13	S 11° 18.80	E 175° 35.73	S 11° 18.83	E 175° 47.39
		PR275	02:43	06:45	0 04:02	S 11° 18.83	E 175° 47.39	S 11° 42.00	E 176° 09.72
		PR276	06:45	11:41	0 04:56	S 11° 42.00	E 176° 09.72	S 11° 43.70	E 176° 51.11
		PR277	13:13	19:35	0 06:22	S 11° 55.19	E 176° 50.26	S 12° 08.41	E 175° 49.94
		PR278	19:35	05:05	0 09:30	S 12° 08.41	E 175° 49.94	S 12° 08.40	E 174° 11.82
11/10/93		PR279	08:45	21:55	0 13:10	S 12° 08.58	E 174° 09.50	S 11° 59.99	E 174° 23.22
		PR280	21:55	05:30	0 07:35	S 11° 59.99	E 174° 23.22	S 12° 00.01	E 175° 34.80
12/10/93		PR281	05:38	06:27	0 00:49	S 11° 58.92	E 175° 34.78	S 11° 52.33	E 175° 28.61
		PR282	06:35	12:04	0 05:29	S 11° 52.00	E 175° 27.16	S 11° 51.99	E 174° 26.87
		PR283	13:02	17:50	0 04:48	S 11° 44.04	E 174° 23.18	S 11° 43.99	E 175° 09.07
		PR284	18:55	02:44	0 07:49	S 11° 36.98	E 174° 59.78	S 11° 33.98	E 173° 35.77
13/10/93		PR285	03:36	12:39	0 09:03	S 11° 29.02	E 173° 39.24	S 11° 32.24	E 174° 58.05
		PR286	13:39	21:40	0 08:01	S 11° 28.07	E 175° 04.88	S 11° 22.52	E 173° 37.88
		PR287	21:43	01:03	0 03:20	S 11° 22.79	E 173° 37.53	S 11° 52.50	E 173° 20.14
14/10/93		PR288	01:09	05:44	0 04:35	S 11° 52.69	E 173° 19.24	S 11° 41.92	E 172° 32.08
		PR289	06:49	18:25	0 11:36	S 11° 49.48	E 172° 29.66	S 12° 13.46	E 174° 13.82
		PR290	19:24	04:45	0 09:21	S 12° 20.00	E 172° 05.90	S 11° 57.45	E 172° 27.18
15/10/93		PR291	05:44	16:30	0 10:46	S 12° 05.52	E 172° 25.76	S 12° 26.25	E 173° 57.34
		PR292	17:16	01:32	0 08:16	S 12° 32.30	E 173° 51.39	S 12° 12.51	E 172° 24.58
16/10/93		PR293	02:21	12:37	0 10:16	S 12° 19.25	E 172° 23.59	S 12° 38.05	E 173° 43.46
		PR294	13:37	19:16	0 05:39	S 12° 43.92	E 173° 36.67	S 12° 38.32	E 172° 43.46
		PR295	19:37	01:02	0 05:25	S 12° 39.21	E 172° 44.91	S 12° 49.33	E 173° 29.40
17/10/93		PR296	01:57	06:20	0 04:23	S 12° 55.13	E 173° 23.14	S 12° 44.34	E 172° 35.56
		PR297	08:07	12:11	0 04:04	S 12° 52.93	E 172° 40.97	S 13° 00.89	E 173° 16.85
18/10/93	Transit	TR12	12:18	21:59	0 09:41	S 13° 01.87	E 173° 17.14	S 14° 35.28	E 172° 39.80
		TR13	21:59	04:45	1 06:46	S 14° 35.28	E 172° 39.80	S 19° 10.00	E 169° 45.50
19/10/93		TR14	05:19	07:49	0 02:30	S 19° 12.54	E 169° 45.20	S 19° 39.70	E 169° 49.98
		TR15	07:49	21:00	0 13:11	S 19° 39.70	E 169° 49.98	S 21° 12.90	E 167° 48.98
		TR16	21:24	04:30	0 07:06	S 21° 12.90	E 167° 48.98	S 22° 18.76	E 167° 07.86

ENCLOSURE 4

ENVIRONMENTAL CONDITIONS

Weather observations

*** Weather codifications**

SEA (Douglas Scale)	SWELL (Douglas Scale)	WIND (Beaufort Scale)
0 - calm	0 - no swell	0 - calm
1 - smooth	1 - low swell, short or average length	1 - light air
2 - slight	2 - low swell, long	2 - light breeze
3 - moderate	3 - moderate swell, short	3 - gentle breeze
4 - rough	4 - moderate swell, average length	4 - moderate breeze
5 - very rough	5 - moderate swell, long	5 - fresh breeze
6 - high	6 - heavy swell, short	6 - strong breeze
7 - very high	7 - heavy swell, average length	7 - near gale
8 - precipitous	8 - heavy swell, long	8 - gale
9 - confused	9 - confused swell	9 - strong gale
		10 - storm
		11 - violent storm
		12 - hurricane

- Leg 1 -

Date	Wind* (Sector-Force)	Sea*	Swell*	Sky	Pressure (hPa)	Sea temp. (°C)	Air temp. (°C)
19/07/93	E-5	3	1	6	1,017.8	23.5	
20/07/93	E-2	1	0	3	1,016.9	26.4	25.5
21/07/93	ESE-6	3	1	2	1,017.6	26.1	25.1
22/07/93	ESE-6	4	2	5	1,015.1	26.7	25.8
23/07/93	ESE-6	4	2	7	1,014.6	26.7	24.8
24/07/93	ESE-5	3	1	8	1,015.0	25.9	25.8
25/07/93	ESE-5	3	1	3	1,015.9	26.7	25.7
26/07/93	ESE-6	6	1	7	1,016.3	26.5	23.7
27/07/93	ESE-6	5	1	2	1,014.8	26.5	25.6
28/07/93	ESE-4	4	1	2	1,013.3	26.4	25.4
29/07/93	E-4	3	2	3	1,011.5	26.8	25.4
30/07/93	E-4	4	2	2	1,010.8	26.8	27.1
31/07/93	ESE-4	3	1	7	1,010.2	27.4	26.4
01/08/93	ESE-5	5	2	4	1,011.3	27.9	27.7
02/08/93	ESE--4	4	0	3	1,011.1	27.9	27.8
03/08/93	ESE4	4	0	6	1,012.0	27.3	26.5
04/08/93	SE-4	4	0	5	1,012.8	27.2	27.3
05/08/93	SE-4	3	0	7	1,013.1	27.4	27.7
06/08/93	SE-5	3	0	8	1,013.5	27.3	26.1
07/08/93	ESE-1	1	1	7	1,013.1	27.3	26.4
08/08/93	S-4	4	0	8	1,014.5	27.1	26.9
09/08/93	SSE-3	3	1	3	1,015.5	26.5	27.0
10/08/93	SE-5	3	3	8	1,015.4	27.3	26.9
11/08/93	ESE-5	5	5	6	1,014.6	27.5	27.4
12/08/93	SSE-6	5	0	5	1,014.5	26.8	27.1
13/08/93	SSE-3	2	0	1	1,015.2	26.8	25.1
14/08/93	SE-6	3	0	3	1,013.9	26.8	26.9
15/08/93	SE-4	3	0	2	1,016.5	26.7	25.3

- Leg 2 -

Date	Wind* *(Sector- Force)*	Sea*	Swell*	Sky	Pressure *(hPa)*	Sea temp. *(°C)*	Air temp. *(°C)*
20/08/93	NE-1	0	1	6	1,015.3	26.8	27.0
21/08/93	ESE-5	4	3	8	1,014.7	26.3	25.3
22/08/93	SE-6	4	3	6	1,015.3	26.0	26.6
23/08/93	S-4	1	0	6	1,013.6	26.2	26.4
24/08/93	ESE-3	1	0	7	1,014.0	25.6	25.6
25/08/93	SE-3/4	2	1	8	1,014.0	24.3	25.5
26/08/93	SSE-2	2	1	7	1,013.4	26.3	25.5
27/08/93	SE-5	3	1	1	1,012.0	26.5	27.4
28/08/93	SSE-5	3	1	8	1,012.9	26.5	27.0
29/08/93	SE-4/5	2	3	6	1,013.4	26.7	27.2
30/08/93	E-2	0	1	7	1,015.5	26.6	25.8
31/08/93	E-3	1	3	8	1,016.0	26.2	26.3
01/09/93	SE-5	1	3	6	1,017.0	26.7	27.5
02/09/93	SE-6	3	3	5	1,015.2	26.9	27.0
03/09/93	SE-5/6	3	3	4	1,015.0	26.9	26.8
04/09/93	S-5	1	3	8	1,015.6	26.9	24.5
05/09/93	SE-4	1	3	6	1,015.1	26.6	26.8
06/09/93	ESE-5	1	3	5	1,015.2	27.0	26.6
07/09/93	ESE-2	1	1	5	1,013.3	27.3	27.9
08/09/93	E-1	0	1	3	1,012.1	27.5	27.2
09/09/93	SE-5	3	3	8	1,012.4	26.9	26.0
10/09/93	SE-6	3	3	7	1,016.0	26.4	25.9
11/09/93	SE-6	4	3	8	1,014.3	26.4	26.2
12/09/93	SE-4	1	3	6	1,013.7	26.4	26.3
13/09/93	SE-6	1	3	8	1,013.5	27.1	27.6
14/09/93	SE-5	1	3	5	1,016.4	26.1	25.4
15/09/93	SE-5	2	3	5	1,017.2	25.5	25.5

- Leg 3 -

Date	Wind* *(Sector - Force)*	Sea*	Swell*	Sky	Pressure *(hPa)*	Sea temp. *(°C)*	Air temp. *(°C)*
24/09/93	SE-5	3	0	5	1,012.9	27.5	27.8
25/09/93	SE-5	3	3	8	1,012.2	27.8	27.2
26/09/93	SE-2	1	1	5	1,011.5	27.8	29.2
27/09/93	SE-3	0	1	4	1,012.2	28.0	28.4
28/09/93	SE-3	1	1	1	1,011.4	28.5	28.4
29/09/93	SE-4	1	1	5	1,012.1	28.3	28.0
30/09/93	SSE-6	3	3	8	1,012.2	27.8	27.3
01/09/93	SSE-5	2	3	8	1,010.9	27.7	25.2
02/09/93	SEE-6	4	3	8	1,011.2	27.3	23.8
03/10/93	SE-5	1	3	8	1,011.9	27.4	23.2
04/10/93	ENE-4	2	3	8	1,011.1	27.0	25.6
05/10/93	SE-7	4	3	8	1,014.6	27.0	25.2
06/10/93	SE-6	3	3	4	1,015.7	27.5	27.8
07/10/93	SE-6	4	3	3	1,016.3	26.4	26.4
08/10/93	SE-6	3	3	2	1,014.3	27.6	26.2
09/10/93	SE-4	2	1	7	1,013.5	27.3	26.5
10/10/93	SE-5	1	1	2	1,012.8	27.1	25.8
11/10/93	SE-5	2	0	4	1,013.2	27.1	26.2
12/10/93	ESE-5	2	1	5	1,011.9	27.2	26.8
13/10/93	SE-5	2	1	5	1,011.1	27.3	26.8
14/10/93	SE-6	3	3	8	1,013.6	27.0	27.2
15/10/93	SE-5	2	3	8	1,014.7	26.7	27.3
16/10/93	SE-6	2	3	7	1,015.2	26.7	26.5
17/10/93	SE-6	3	3	4	1,013.8	26.6	26.2
18/10/93	SE-4	1	3	5	1,015.0	26.2	26.0
19/10/93	SE-4	1	1	3	1,017.2	24.1	23.8
20/10/93	E-3	0	1	2	1,018.0	22.7	22.4

Maritime traffic
and
Surface currents

- Leg 1 -

Date	Latitude South	Longitude East	Currents Force & Direction	Type of Ships / Remarks
19/07/93	19°07.50	167°56.70		none
20/07/93	15°34.00	167°20.00	1 knot - 180°	none
26/07/93	14°03.00	167°06.00	1 knot - 220°	none
27/07/93	14°00.00	166°48.00	1.2 knot - 300°	none
29/07/93	12°49.70	167°28.20	0.3 knot - 300°	none
30/07/93	12°09.00	167°14.00	0.3 knot - 214°	none
31/07/93	10°31.50	166°26.50	0.6 knot - 043°	none
01/08/93	10°30.00	166°20.00	1.0 knot - 290°	none
02/08/93	09°58.00	166°16.00	0.3 knot - 030°	none
03/08/93	10°45.00	167°18.00		none
04/08/93	11°28.00	167°59.60	0.2 knot - 190°	none
05/08/93	11°02.00	168°06.00	1.2 knot - 297°	none
06/08/93	11°59.00	168°21.00	0.4 knot - 287°	none
07/08/93	11°56.50	167°42.30	0.3 knot - 336°	none
08/08/93	11°06.50	166°09.00	0.8 knot - 008°	none
09/08/93	10°58.00	163°28.00	0.9 knot - 211°	none
10/08/93	10°31.00	164°08.00	no recorded	none
11/08/93	10°07.50	164°58.00	0.4 knot - 312°	1 unidentified ship
12/08/93	09°47.00	162°44.00	1.2 knot - 308°	5 unidentified ships +1 fishing ship +1 container ship
13/08/93	09°52.80	161°35.90	0.6 knot - 264°	none
14/08/93	09°31.00	160°51.00	no recorded	none
15/08/93	09°24.50	160°47.00	0.2 knot - 254°	none

- Leg 2 -

Date	Latitude South	Longitude East	Currents Force & Direction	Type of Ships / Remarks
20/08/93	09°02.3	159°27.9	2.1 knot - 220°	None
21/08/93	09°06.8	158°51.0	1.5 knot - 180°	A sea-mammal has been seen
22/08/93	08°32.0	158°20.0	1.3 knot - 250°	None
23/08/93	07°56.3	157°15.2	1.0 knot - 310°	None
24/08/93	07°30.0	156°43.2	1.2 knot - 330°	None
25/08/93	07°31.8	157°27.9	0.7 knot - 080°	a sword fish jumping out has been seen
26/08/93	08°19.2	160°29.3	1.4 knot - 200°	None
27/08/93	08°27.7	161°02.7	0.4 knot - 320°	None
28/08/93	08°16.7	161°12.2	0.5 knot - 314°	None
29/08/93	09°08.2	161°51.0	0.7 knot - 250°	None
30/08/93	09°30.4	162°22.0	0.6 knot - 280°	None
31/08/93	10°19.5	163°16.6	2.0 knot - 290°	None
01/09/93	09°57.3	164°05.3	0.2 knot - 180°	None
02/09/93	09°37.0	165°57.1	not recorded	None
03/09/93	09°40.2	163°55.3	0.4 knot - 350°	None
04/09/93	09°20.2	164°14.6	1.2 knot - 280°	None
05/09/93	11°44.3	168°43.2	2.0 knot - 280°	None
06/09/93	10°41.0	168°17.5	1.4 knot - 280°	None
08/09/93	10°00.6	168°23.7	0.4 knot - 000°	None
09/09/93	11°15.6	169°51.2	2.0 knot - 300°	None
10/09/93	12°14.7	171°55.9	0.4 knot - 160°	None
11/09/93	11°32.9	169°57.0	2.5 knot - 306°	None
12/09/93	11°45.0	172°13.1	0.8 knot - 170°	None
14/09/93	13°45.2	172°40.7	1.0 knot - 310°	None
15/09/93	16°09.7	175°31.0	0.4 knot - 210°	None

- Leg 3 -

Date	Latitude South	Longitude East/West	Currents Force & Direction	Type of Ships* / Remarks
23/09/93	15°51.8	W 179°12.9	0.4 knot - 340°	
24/09/93	11°58.6	W 179°21.2	0.1 knot - 230°	
25/09/93	10°41.7	E 179°17.9	1.2 knot - 220°	
26/09/93	10°43.0	E 179°50.1	0.6 knot - 310°	
27/09/93	10°34.1	E 179°54.0	0.3 knot - 290°	
28/09/93	10°20.2	W 179°24.8	0.4 knot - 180°	
29/09/93	11°06.7	E 179°14.4	0.3 knot - 330°	
30/09/93	11°33.5	E 179°26.7	1.2 knot - 230°	
01/10/93	11°45.2	E 179°18.0	1.1 knot - 170°	
02/10/93	12°04.5	E 179°48.2	2.0 knot - 310°	
03/10/93	11°07.9	E 178°36.3	0.4 knot - 190°	Sea bird (noddie) on board,19:15
04/10/93	12°26.7	E 179°21.2	*0.0 knot - 00°*	
05/10/93	12°28.0	E 179°11.4	2.0 knot - 300°	Sea birds (noddies & boobies) fishing
06/10/93	11°08.5	E 177°47.9	0.8 knot - 310°	
07/10/93	12°38.8	E 177°54.3	0.7 knot - 270°	
08/10/93	11°43.0	E 178°29.7	1.3 knot - 280°	
09/10/93	11°42.2	E 177°19.2	0.2 knot - 300°	Dolphinfish (Coryphaena) fished, 20:00
10/10/93	11°24.0	E 175°24.7	0.1 knot - 260°	
11/10/93	12°08.4	E 175°04.2	*0.0 knot - 00°*	Sea birds (noddies & boobies) fishing
12/10/93	12°00.0	E 174°43.9	0.7 knot - 300°	
13/10/93	11°36.0	E 174°05.2	0.3 knot - 220°	
14/10/93	11°49.2	E 173°25.7	1.0 knot - 350°	
15/10/93	12°08.9	E 173°17.2	0.4 knot - 100°	
16/10/93	12°16.3	E 172°41.3	0.1 knot - 280°	
17/10/93	12°47.4	E 173°21.2	1.5 knot - 280°	
18/10/93	14°53.4	E 172°28.4	0.3 knot - 300°	
19/10/93	18°26.2	E 170°13.0	0.3 knot - 340°	
20/10/93	21°42.0	E 167°35.2	0.8 knot - 190°	

* No maritime traffic has been encountered during this cruise.

ENCLOSURE 5

DOCUMENT TABLE

Codes used in the following table:

Documents	
Acoustic imagery	**ACI**
Seismic Reflection Profile	**SRP**
Sippican Probe	**SIP**
Sub-bottom Profiler	**SBP**

- Leg 1 -

ROLLS Type & Number	START Date	START Hour	END Date	END Hour	INCLUDED PROFILES
SRP (wide record) 10 seconds					
1	19/07/93	16:52	20/07/93	23:45	PR1-PR2
2	21/07/93	00:51	22/07/93	11:42	PR3-PR4-PR5-PR6
3	22/07/93	11:43	23/07/93	10:32	PR7-PR8-PR9
4	23/07/93	11:05	24/07/93	01:07	PR10-PR11-PR12-PR13-PR14-PR15-PR16
	24/07/93	01:51	24/07/93	14:48	PR17-PR18-PR19-PR20-PR21-PR22
5	24/07/93	16:26	25/07/93	17:11	PR23-PR24-PR26-PR27-PR28-PR29-PR30
6	25/07/93	17:47	26/07/93	11:40	PR31-PR32
7	26/07/93	12:21	27/07/93	11:30	PR33-PR34-PR35-PR36
8	27/07/93	12:58	28/07/93	14:05	PR36-PR37-PR38-PR39
9	28/07/93	14:06	29/07/93	16:46	PR40-PR41-PR42-PR43-PR44
10	29/07/93	16:47	30/07/93	10:06	PR45-PR46-PR47-PR48-PR49-PR50-PR51
	30/07/93	10:11	30/07/93	17:01	PR52-PR53-PR54
11	30/07/93	17:09	31/07/93	15:42	PR55-PR56-PR57
12	31/07/93	16:36	01/08/93	12:00	PR58-PR59-PR60-PR61
13	01/08/93	13:10	02/08/93	10:00	PR62-PR63
14	02/08/93	10:01	03/08/93	07:39	PR63-PR64
15	03/08/93	09:24	04/08/93	12:17	PR65-PR66
16	04/08/93	12:53	05/08/93	17:16	PR67-PR68
17	05/08/93	19:06	06/08/93	11:10	PR69-PR70-PR71
18	06/08/93	11:42	07/08/93	18:31	PR72-PR73-PR74-PR75
19	07/08/93	20:15	08/08/93	10:27	PR76-PR77-PR78
20	08/08/93	10:33	09/08/93	14:05	PR79-PR80
21	09/08/93	14:52	10/08/93	19:29	PR81-PR82
22	10/08/93	20:08	11/08/93	19:39	PR83-PR84
23	11/08/93	20:58	12/08/93	16:07	PR85-PR86
24	12/08/93	16:07	13/08/93	14:15	PR87-PR88-PR89
25	13/08/93	14:53	14/08/93	16:45	PR90A-B-C-D-E-F-PR91-PR92A-B-C
26	14/08/93	17:16	15/08/93	01:10	PR93A1-PR93A2-PR93B-PR93C
SRP (narrow rec.)					
1	19/07/93	16:52	22/07/93	23:09	PR1 to PR8C included
2	23/07/93	00:10	02/08/93	17:11	PR9 to PR63D included
3	02/08/93	18:32	13/08/93	18:46	PR64A to PR90B included
4	13/08/93	19:02	15/08/93	01:10	PR90A to PR93C

Leg 1 (continued)

ROLLS Type & Number		START		END		INCLUDED PROFILES
		Date	Hour	Date	Hour	
SBP 3.5khz						
	1	18/07/93	08:31	24/07/93	05:03	T1A to PR18 included
	2	24/07/93	05:05	27/07/93	20:29	PR19 to PR39B included
	3	27/07/93	20:29	03/08/93	22:31	PR39C to PR65D included
	4	03/08/93	22:31	11/08/93	19:38	PR66A to PR84 included
	5	11/08/93	19:50	15/08/93	01:10	PR85A to PR93C included
ACI						
	1	19/07/93	16:50	15/08/93	01:01	T1A to PR93C

- Leg 2 -

ROLLS Type & Number	BEGINNING		END		INCLUDED PROFILES
	Date	Hour	Date	Hour	
SRP (wide record) 10 seconds					
1	19/08/93	05:20	19/08/93	22:26	PR94 to PR103
2	19/08/93	22:30	21/08/93	18:47	PR104 to PR115
3	21/08/93	19:30	23/08/93	16:55	PR116 to PR129
4	23/08/93	17:30	25/08/93	00:28	PR130 to PR135
5	25/08/93	00:31	26/08/93	02:00	PR136 to PR139
6	26/08/93	02:04	29/08/93	10:13	PR140 to PR154
7	29/08/93	10:50	31/08/93	01:04	PR155 to PR164
8	31/08/93	01:23	04/09/93	03:35	PR165 to PR 171
9	04/09/93	03:36	08/09/93	21:19	PR172 to PR178
10	08/09/93	21:20	12/09/93	19:30	PR179 to PR187
SRP (narrow rec.)					
1	19/08/93	05:20	19/08/93	22:26	PR94 to PR103
2	19/08/93	22:30	21/08/93	18:47	PR104 to PR115
3	21/08/93	19:30	23/08/93	16:55	PR116 to PR129
4	23/08/93	17:30	25/08/93	00:28	PR130 to PR135
5	25/08/93	00:31	27/08/93	01:42	PR136 to PR141
6	27/08/93	02:41	29/08/93	10:13	PR142 to PR154
7	29/08/93	10:50	31/08/93	01:04	PR155 to PR164
8	31/08/93	01:23	04/09/93	03:35	PR165 to PR171
9	04/09/93	03:36	06/09/93	21:58	PR172 to PR175
10	06/09/93	23:15	12/09/93	19:30	PR176 to PR187
SPB 3.5 kHz					
1	19/08/93	05:20	24/08/93	18:30	PR94 to PR133
2	24/08/93	19:06	26/08/93	12:48	PR134 to PR140
3	26/08/93	13:00	29/08/93	14:11	PR140 to PR155
4	29/08/93	14:30	08/09/93	20:30	PR155 to PR178
5	08/09/93	20:50	16/09/93	03:35	PR178 to PR192
ACI					
1	19/08/93	05:20	08/09/93	21:40	PR94 to PR178
2	08/09/93	21:55	16/09/93	03:35	PR179 to PR192

- Leg 3 -

ROLLS Type & Number	BEGINNING Date	BEGINNING Hour	END Date	END Hour	INCLUDED PROFILES
SRP (wide record) 10 seconds					
1	23/09/93	14:44	24/09/93	01:54	TR11 to PR197
2	24/09/93	02:47	24/09/93	13:14	PR198 to PR200
3	24/09/93	13:16	26/09/93	05:13	PR201 to PR211
4	26/09/93	06:55	28/09/93	02:31	PR212 to PR219
5	28/09/93	17:30	29/09/93	00:23	PR230 to PR231
6	29/09/93	00:37	30/09/93	15:12	PR231 to PR233
7	30/09/93	16:02	02/10/93	09:53	PR234 to PR251
8	02/10/93	09:56	05/10/93	06:44	PR252 to PR256B
9	05/10/93	07:21	07/10/93	12:44	PR257 to PR260
10	07/10/93	13:38	09/10/93	03:20	PR261 to PR269
11	10/10/93	13:14	13/10/93	12:39	PR277 to PR285
12	13/10/93	13:39	16/10/93	01:32	PR286 to PR292
13	16/10/93	02:33	17/10/93	12:11	PR293 to PR297
14	17/10/93	12:21	19/10/93	04:42	TR12 - TR13
SRP (narrow rec.)					
1	23/09/93	14:50	29/09/93	15:30	PR198 to PR231
2	29/09/93	15:49	12/10/93	17:50	PR232 to PR283
3	12/10/93	18:56	12/10/93	20:30	PR284
4	12/10/93	20:30	19/10/93	04:45	PR284 to TR13
SBP 3.5 khz					
1	21/09/93	21:40	22/09/93	15:04	PR193 to TR7
2	22/09/93	15:05	02/10/93	03:35	TR8 to PR249
3	02/10/93	03:40	02/10/93	18:00	PR250 to PR252
4	02/10/93	17:45	13/10/93	02:44	PR252 to PR284
5	13/10/93	03:00	20/10/93	04:33	PR285 to TR16
ACI					
1	21/09/93	21:40	20/10/93	04:45	PR193 to TR16

ENCLOSURE 6

PROFILE TABLE

- Leg 1 -

Area	Profile nr.	ACI roll nr.	SBP 3.5 kHz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	(wide-10 sec) roll nr.
NHIAB	PR1	1	1	1	1
	PR2	1	1	1	1
	PR3	1	1	1	2
	PR4	1	1	1	2
	PR5	1	1	1	2
	PR6	1	1	1	2
	PR7	1	1	1	3
	PR8	1	1	1	3
	PR9	1	1	2	3
	PR10	1	1	2	4
	PR11	1	1	2	4
	PR12	1	1	2	4
	PR13	1	1	2	4
	PR14	1	1	2	4
	PR15	1	1	2	4
	PR16	1	1	2	4
	PR17	1	1	2	4
	PR18	1	1	2	4
	PR19	1	2	2	4
	PR20	1	2	2	4
	PR21	1	2	2	4
	PR22	1	2	2	4
	PR23	1	2	2	5
	PR24	1	2	2	5
	PR25	1	2	2	not recorded
	PR26	1	2	2	5
	PR27	1	2	2	5
	PR28	1	2	2	5
	PR29	1	2	2	5
	PR30	1	2	2	5
	PR31	1	2	2	6
	PR32	1	2	2	6
	PR33	1	2	2	7
	PR34	1	2	2	7
	PR35	1	2	2	7
	PR36	1	2	2	7
	PR37	1	2	2	8
	PR38	1	2	2	8
	PR39	1	2 & 3	2	8
	PR40	1	3	2	9
	PR41	1	3	2	9
	PR42	1	3	2	9
	PR43	1	3	2	9

Leg 1 (continued)

Area	Profile nr.	ACI roll nr.	SBP 3.5 kHz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	(wide-10 sec) roll nr.
NHIAB *(cont'd)*	PR44	1	3	2	9
	PR45	1	3	2	10
	PR46	1	3	2	10
	PR47	1	3	2	10
	PR48	1	3	2	10
	PR49	1	3	2	10
	PR50	1	3	2	10
	PR51	1	3	2	10
	PR52	1	3	2	10
	PR53	1	3	2	10
	PR54	1	3	2	10
NNHBAA	PR55A	1	3	2	11
	PR55B	1	3	2	11
	PR55C	1	3	2	11
	PR55D	1	3	2	11
	PR55E	1	3	2	11
	PR55F	1	3	2	11
	PR56	1	3	2	11
	PR57A	1	3	2	11
	PR57B	1	3	2	11
	PR58	1	3	2	12
	PR59	1	3	2	12
	PR60	1	3	2	12
	PR61A	1	3	2	12
	PR61B	1	3	2	12
	PR61C	1	3	2	12
	PR61D	1	3	2	12
	PR62A	1	3	2	13
	PR62B	1	3	2	13
	PR62C	1	3	2	13
	PR62D	1	3	2	13
	PR63A	1	3	2	13
	PR63B	1	3	2	13
	PR63C	1	3	2	14
	PR63D	1	3	2	14
	PR64A	1	3	2	14
	PR64B	1	3	3	14
	PR64C	1	3	3	14
	PR64D	1	3	3	14
	PR65A	1	3	3	15
	PR65B	1	3	3	15
	PR65C	1	3	3	15

Leg 1 (continued)

Area	Profile nr.	ACI roll nr.	SBP 3.5 kHz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	(wide-10 sec) roll nr.
NNHBAA *(cont'd)*	PR65D	1	3	3	15
	PR66A	1	4	3	15
	PR66B	1	4	3	15
	PR66C	1	4	3	15
	PR66D	1	4	3	15
	PR67A	1	4	3	16
	PR67B	1	4	3	16
	PR67C	1	4	3	16
	PR67D	1	4	3	16
	PR67E	1	4	3	16
	PR67F	1	4	3	16
	PR68	1	4	3	16
	PR69	1	4	3	17
	PR70	1	4	3	17
	PR71	1	4	3	17
	PR72A	1	4	3	18
	PR72B	1	4	3	18
	PR72C	1	4	3	18
	PR73A	1	4	3	18
	PR73B	1	4	3	18
	PR73C	1	4	3	18
	PR74A	1	4	3	18
	PR74B	1	4	3	18
	PR74C	1	4	3	18
	PR75A	1	4	3	18
	PR75B	1	4	3	18
	PR75C	1	4	3	18
	PR75D	1	4	3	18
	PR75E	1	4	3	18
	PR76	1	4	3	19
	PR77	1	4	3	19
	PR78	1	4	3	19
MAG	PR79	1	4	3	20
	PR80A	1	4	3	20
	PR80B	1	4	3	20
	PR80C	1	4	3	20
	PR80D	1	4	3	20
	PR81A	1	4	3	21
	PR81B	1	4	3	21
	PR81C	1	4	3	21
	PR82A	1	4	3	21
	PR82B	1	4	3	21

Leg 1 (continued)

Area	Profile nr.	ACI roll nr.	SBP 3.5 kHz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	(wide-10 sec) roll nr.
MAG *(cont'd)*	PR82C	1	4	3	21
	PR82D	1	4	3	21
	PR82E	1	4	3	21
	PR82F	1	4	3	21
	PR82G	1	4	3	21
	PR83A	1	4	3	22
	PR83B	1	4	3	22
	PR83C	1	4	3	22
	PR83D	1	4	3	22
	PR83E	1	4	3	22
	PR83F	1	4	3	22
	PR83G	1	4	3	22
	PR84	1	4	3	22
	PR85A	1	5	3	23
	PR85B	1	5	3	23
	PR85C	1	5	3	23
	PR86A	1	5	3	23
	PR86B	1	5	3	23
	PR86C	1	5	3	23
Indispensable Basin (in MAG)	PR87A	1	5	3	24
	PR87B	1	5	3	24
	PR87C	1	5	3	24
	PR88	1	5	3	24
	PR89A	1	5	3	24
	PR89B	1	5	3	24
	PR89C	1	5	3	24
	PR90A	1	5	4	25
	PR90B	1	5	4	25
	PR90C	1	5	4	25
	PR90D	1	5	4	25
	PR90E	1	5	4	25
	PR90F	1	5	4	25
	PR91	1	5	4	25
	PR92A	1	5	4	25
	PR92B	1	5	4	25
	PR92C	1	5	4	25
	PR93A1	1	5	4	26
	PR93A2	1	5	4	26
	PR93B	1	5	4	26
	PR93C	1	5	4	26

- Leg 2 -

Area	Profile nr.	ACI roll nr.	SBP 3,5 KHz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	SEISMIC SRP (wide-10 sec) roll nr.
IBS (in CST)	PR94	1	1	1	1
	PR95	1	1	1	1
	PR96	1	1	1	1
	PR97	1	1	1	1
	PR98	1	1	1	1
	PR99	1	1	1	1
	PR100	1	1	1	1
	PR101	1	1	1	1
	PR102	1	1	1	1
	PR103	1	1	1	1
Transit (in CST)	PR104	1	1	2	2
	PR105	1	1	2	2
MB (in CST)	PR106	1	1	2	2
	PR107	1	1	2	2
	PR108	1	1	2	2
	PR109	1	1	2	2
	PR110	1	1	2	2
	PR111	1	1	2	2
	PR112	1	1	2	2
	PR113	1	1	2	2
	PR114	1	1	2	2
	PR115	1	1	2	2
	PR116	1	1	3	3
NGS (in CST)	PR116.1	1	1	3	3
	PR116.2	1	1	3	3
	PR116.3	1	1	3	3
	PR117.1	1	1	3	3
	PR117.2	1	1	3	3
	PR117.3	1	1	3	3
	PR117.4	1	1	3	3
	PR117.5	1	1	3	3
	PR118.1	1	1	3	3
	PR118.2	1	1	3	3
	PR118.3	1	1	3	3
	PR118.4	1	1	3	3
	PR118.5	1	1	3	3
	PR119	1	1	3	3

Leg 2 (continued)

Area	Profile nr.	ACI roll nr.	SBP 3,5 KHz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	(wide-10 sec) roll nr.
NGS *(cont'd)*	PR120	1	1	3	3
	PR121	1	1	3	3
	PR122	1	1	3	3
	PR123	1	1	3	3
	PR124	1	1	3	3
	PR125	1	1	3	3
	PR126	1	1	3	3
	PR127	1	1	3	3
	PR128	1	1	3	3
	PR129	1	1	3	3
	PR130	1	1	4	4
	PR131	1	1	4	4
	PR132	1	1	4	4
	PR133	1	1	4	4
	PR134	1	2	4	4
	PR135	1	2	4	4
Transit	PR136a	1	2	5	5
	PR136b	1	2	5	5
	PR137	1	2	5	5
	PR138	1	2	5	5
	PR139	1	2	5	5
MALAITA	PR140	1	2 & 3	5	6
	PR141	1	3	5	6
	PR142	1	3	6	6
	PR143	1	3	6	6
	PR144	1	3	6	6
	PR145	1	3	6	6
	PR146	1	3	6	6
	PR147	1	3	6	6
	PR148	1	3	6	6
	PR149	1	3	6	6
	PR150	1	3	6	6
	PR151	1	3	6	6
	PR152	1	3	6	6
	PR153	1	3	6	6
	PR154	1	3	6	6
	PR155	1	3 & 4	7	7
	PR156	1	4	7	7
	PR157	1	4	7	7
	PR158	1	4	7	7
	PR159	1	4	7	7

Leg 2 (continued)

Area	Profile nr.	ACI roll nr.	SBP 3,5 KHz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	(wide-10 sec) roll nr.
MALAITA *(cont'd)*	PR160	1	4	7	7
	PR161	1	4	7	7
	PR162	1	4	7	7
	PR163	1	4	7	7
Transit	PR164	1	4	7	7
MAG	PR165	1	4	8	8
	PR166	1	4	8	8
	PR167	1	4	8	8
	PR168	1	4	8	8
	PR169	1	4	8	8
	PR170	1	4	8	8
	PR171	1	4	8	8
NNHBAA	PR172	1	4	8	8
	PR173	1	4	8	8
	PR174	1	4	8	8
	PR175	1	4	8	8
	PR176	1	4	8	8
	PR177	1	4	8	8
	PR178	1	4	8	8
PBA	PR179	1	4	8	8
	PR180	1	4	8	8
	PR181	1	4	8	8
	PR182	1	4	8	8
	PR183	1	4	8	8
	PR184	1	4	8	8
	PR185	1	4	8	8
	PR186	1	4	8	8
	PR187	2	5	10	10
	PR188	2	5	-	-
Transit	TR2	2	5	-	-
	TR3	2	5	-	-
	TR4	2	5	-	-
	TR5	2	5	-	-

- Leg 3 -

Area	Profile nr.	ACI roll nr.	SBP 3,5 khz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	SEISMIC SRP (wide-10 sec) roll nr.
Transit	TR6	1	1	-	-
	TR7	1	1	-	-
	TR8	1	2	-	-
	TR9	1	2	-	-
	TR10	1	2	-	-
	TR11	1	2	-	1
STBA	PR196	1	2	-	1
	PR197	1	2	-	1
	PR198	1	2	1	2
	PR199	1	2	1	2
	PR200	1	2	1	2
	PR201	1	2	1	3
	PR202	1	2	1	3
	PR203	1	2	1	3
	PR204	1	2	1	3
	PR205	1	2	1	3
	PR206	1	2	1	3
	PR207	1	2	1	3
	PR208	1	2	1	3
	PR209	1	2	1	3
	PR210	1	2	1	3
	PR211	1	2	1	3
	PR212	1	2	1	4
	PR213	1	2	1	4
	PR214	1	2	1	4
	PR215	1	2	1	4
	PR216	1	2	1	4
	PR217	1	2	1	4
	PR218	1	2	1	4
	PR219	1	2	1	4
	PR220	1	2	1	-
	PR221	1	2	1	-

Leg 3 (continued)

Area	Profile nr.	ACI roll nr.	SBP 3,5 khz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	(wide-10 sec) roll nr.
STBA *(cont'd)*	PR222	1	2	1	-
	PR223	1	2	1	-
	PR224	1	2	1	-
	PR225	1	2	1	-
	PR226	1	2	1	-
	PR227	1	2	1	-
	PR228	1	2	1	-
	PR229	1	2	1	-
	PR230	1	2	1	5
	PR231	1	2	1	5 and 6
	PR232	1	2	2	6
	PR233	1	2	2	6
	PR234	1	2	2	7
	PR235	1	2	2	7
	PR236	1	2	2	7
	PR237	1	2	2	7
	PR238	1	2	2	7
	PR239	1	2	2	7
	PR240	1	2	2	7
	PR241	1	2	2	7
	PR242	1	2	2	7
	PR243	1	2	2	7
	PR244	1	2	2	7
	PR245	1	2	2	7
	PR246	1	2	2	7
	PR247	1	2	2	7
	PR248	1	2	2	7
	PR249	1	2	2	7
	PR250	1	3	2	7
	PR251	1	3	2	7
	PR252	1	3 & 4	2	8
	PR253	1	4	2	8
	PR254	1	4	2	8
	PR255	1	4	2	8
	PR256	1	4	2	8
	PR256B	1	4	2	8
	PR257	1	4	2	9
	PR258	1	4	2	9
	PR259	1	4	2	9

Leg 3 (continued)

Area	Profile nr.	ACI roll nr.	SBP 3,5 khz roll nr.	SEISMIC SRP (narrow-4 sec) roll nr.	SEISMIC SRP (wide-10 sec) roll nr.
STBA *(cont'd)*	PR260	1	4	2	9
	PR261	1	4	2	10
	PR262	1	4	2	10
	PR263	1	4	2	10
	PR264	1	4	2	10
	PR265	1	4	2	10
	PR266	1	4	2	10
	PR267	1	4	2	10
	PR268	1	4	2	10
ACBA	PR269	1	4	2	10
	PR270	1	4	2	-
	PR271	1	4	2	-
	PR272	1	4	2	-
	PR273	1	4	2	-
	PR274	1	4	2	-
	PR275	1	4	2	-
	PR276	1	4	2	-
	PR277	1	4	2	11
	PR278	1	4	2	11
	PR279	1	4	2	-
	PR280	1	4	2	11
	PR281	1	4	2	11
	PR282	1	4	2	11
	PR283	1	4	2	11
	PR284	1	4	3	11
	PR285	1	5	4	11
	PR286	1	5	4	12
	PR287	1	5	4	12
	PR288	1	5	4	12
	PR289	1	5	4	12
	PR290	1	5	4	12
	PR291	1	5	4	12
	PR292	1	5	4	12
	PR293	1	5	4	13
	PR294	1	5	4	13
	PR295	1	5	4	13
	PR296	1	5	4	13
	PR297	1	5	4	13

Leg 3 (continued)

Area	**Profile**	**ACI**	**SBP 3,5 khz**	**SEISMIC SRP**	
				(narrow-4 sec)	(wide-10 sec)
	nr.	roll nr.	roll nr.	roll nr.	roll nr.
Transit	TR12	1	5	4	14
	TR13	1	5	4	14
	TR14	1	5	-	-
	TR15	1	5	-	-
	TR16	1	5	-	-

ENCLOSURE 7

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