Compressive Tectonism along the Eastern Margin of Malaita Island (Solomon Islands)

JEAN-MARIE AUZENDE[1]*, LOREN KROENKE[2], J.-Y. COLLOT[3]**, Y. LAFOY[4] and BERNARD PELLETIER[5]

[1] *IFREMER/CB, BP 70, 29280 Plouzané, France*
[2] *HIG, University of Hawaii, 2525 Correa Road, Honolulu, HI 96822, Hawaii, USA*
[3] *Centre ORSTOM de Villefranche/Mer, France*
[4] *Service de des Mines et de l'Energie, BP 465, 98845 Nouméa cedex, Nouvelle Calédonie*
[5] *Laboratoire de Géologie-Géophysique, Centre ORSTOM de Nouméa, BP A5, UR 14, 98848 Nouméa cedex, Nouvelle Calédonie*
* *Now at Laboratoire de Géologie-Géophysique, Centre ORSTOM de Nouméa, BP A5, UR14, 98848 Nouméa cedex, Nouvelle Calédonie*
** *Now at IGNS, PO Box 1320, Wellington, New Zealand*

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Abstract. New bathymetric and geophysical data were collected in the region east of the island of Malaita during the SOPACMAPS II cruise of the French research vessel L'ATALANTE. This region, part of the Malaita Anticlinorium was interpreted as a piece of oceanic crust from the Ontong Java Plateau obducted over the old Solomon Islands arc during collision between the Pacific and Australian plates. It has been generally accepted that convergent motion between the Australia and Pacific plates since the Late Miocene was absorbed exclusively along the San Cristobal trench, southwest of the Solomon Islands Arc.

Bathymetry, imagery, and geophysical data (magnetism, gravity, seismic) acquired during the SOPACMAPS II survey allow us to classify the successive parallel ridges mapped within the region as being recent volcanic, oceanic crust, or deformed sedimentary ridges.

Seismic profiling provides evidence of successive compressive events along the Malaita margin caused by the relative motion between the Solomon Islands and the Pacific plate. The main phase of convergence probably occurred during Oligocene-early Miocene time, but some relative motion between the two domains are still being absorbed along the East Malaita boundary. The existence of active faulting in the sedimentary cover throughout the region and the present-day deformation of the outer sedimentary ridge is a good illustration of this phenomenon.

1. Introduction

The origin of the Solomon Islands Arc is still enigmatic. Depending on the authors, it has been variously interpreted as an island arc (Coulson, 1985), a volcanic chain (Coleman and Packam, 1976) or a complex shear system at the boundary between the Pacific and Australian Plates (Wells, 1989). The island of Malaita, sandwiched between the Australian and Pacific plates in the Solomon Islands Arc region (Coulson and Vedder, 1986), is a major feature of this complex compressive boundary (Figures 1, 2). It is formed of pre-Miocene non-metamorphosed basaltic basement overlain by a layer of predominantly pelagic carbonate up to 1200 m-thick.

Both Malaita and the island of Ulawa are part of an oceanic sequence emplaced by the obduction of a portion of the Pacific Plate during Miocene time (Kroenke, 1972). Subsequent uplift has exposed a folded sequence of Cretaceous and Tertiary pelagites and ocean floor basalts on the islands of Malaita (Coleman, 1965; Hughes and Turner, 1977), Ulawa and Santa Isabel. Malaita and Ulawa are located at the junction of the Vitiaz and North Solomon paleo-subduction zones (Wells, 1989).

Malaita Island lies along the eastern side of Indispensable Basin, which, in turn, lies east of the Santa-Isabel Florida Islands platform. West of this platform lies the Central Solomons Trough (New Georgia Basin) including the Shortlands and Russell basins. The Solomons Trough has been variously interpreted as a backarc basin (Coleman and Packham, 1976; Cooper *et al.*, 1986) or a left-lateral strike-slip, pull-apart basin formed by the relative motion between the Australian and Pacific plates (Wells, 1989; Auzende *et al.*,1994). The eastern Malaita region is bounded at its eastern end by the morphologically and structurally complex Melanesian arc gap which includes the northwestern tip of the North Fiji Basin (Pelletier *et al.*, 1993; Auzende *et al.*, 1994).

The Island of Malaita was interpreted by Kroenke (1972), Hughes and Turner (1977), and Coleman and Kroenke (1981) as a piece of the oceanic crust of the Ontong Java Plateau folded and obducted during the collision phase between the Ontong Java Plateau and

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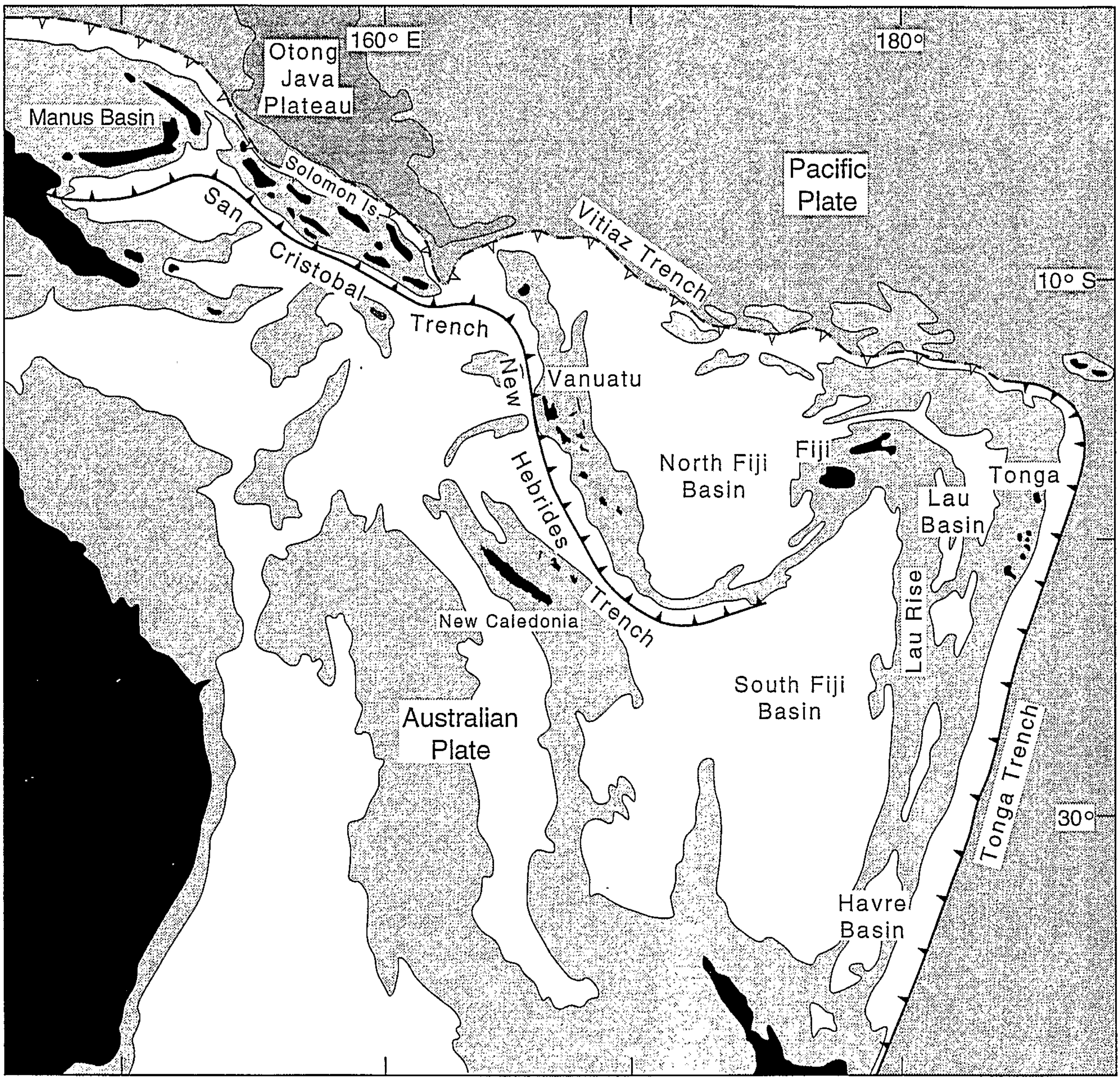


Fig. 1. Geodynamical setting of the boundary between Australian and Pacific plates in the SW Pacific domain. The fossil (discontinuous lines) and active (continuous lines) subduction zones are underlined.

the Paleo Solomon Islands Arc (Kroenke, 1972; Coleman and Kroenke, 1981; Kroenke, 1984). This area was named the Malaita Anticlinorium (Kroenke, 1972). Kroenke (1984) and Kroenke *et al.* (1986) concluded that subduction ended along the North Solomon Trench in the early Miocene (~22 Ma) and started along the New Britain-San Cristobal trenches in the late Miocene (~10 Ma). Yan and Kroenke (1994) suggested an age of 25 Ma for the end of North Solomon subduction and an age of ~12 Ma for the start of subduction along the New Britain-San Cristobal trenches. Yan and Kroenke (1994) also concluded that folding and obduction of the southern margin of the Ontong Java Plateau (i.e., formation of the Malaita Anticlinorium) began about 5 Ma, concomitant with collision of the Woodlark Basin with the Solomon Island Arc. Recently, Mahoney *et al.* (1993a and b), Saunders *et al.* (1993) and Tejada *et al.* (1995) confirmed from geochemical work, ^{40}Ar-^{39}Ar dating and field exploration, the interpretation that the exposed oceanic crust on Malaita is part of the Ontong Java Plateau. They demonstrate that the oceanic basalts of Malaita have been emplaced in deep water (close to 3 km) in similar fashion to the basalts encountered in the drilling of DSDP Site 289 (Andrews, Packham *et al.*, 1975) and ODP Site 807 (Kroenke, Berger, and Janecek, *et al.*, 1991) on the Ontong Java Plateau. Other authors (Bruns *et al.*, 1986) suggest that the former subduction zone between the Australian and Pacific plates was located along the Kia-Korigole-Kaipito fault zone, west of the North Solomon Trench (Figure 2). Ramsay (1982), proposed that the entire Solomon Islands Arc is underlain by the oceanic basement of the Ontong Java Plateau. Tejada *et al.* (1995) report that although Santa Isabel basement east of the Kia-Korigole-Kaipito fault is part of the Ontong Java Plateau, basement west of the fault is BABB (Back-Arc Basin Basalts) or MORB (Mid-Oceanic Ridge Basalts)-like in origin and not part of the Ontong Java Plateau.

During the SOPACMAPS II cruise (18th August–16th September 1993) complete bathymetric and image coverage of the seafloor has been made in the area between eastern Malaita and northern San Cristobal and the North Solomon and Cape Johnson Trenches, i.e. between 8° S and 10°30′ S and 160°30′ E and 162°30′ E. Gravimetric and magnetic data, as well as single channel seismic profiles, were also simultaneously acquired during the bathymetric data acquisition (Figure 3). This new data set provides the basis for a detailed structural study of the region and facilitates a new interpretation of the formerly and presently active compressive tectonic regime.

2. Data Acquisition

2.1. Bathymetry and Imagery: Data Acquisition and Processing

The bathymetric survey of leg II (Figures 3, 4) of the SOPACMAPS cruise was carried out with the SIMRAD, EM12 Dual swath-mapping system installed on the IFREMER research vessel L 'ATALANTE. The EM12 Dual system comprises two multibeam echosounders, one located port and one starboard, generating 81 stabilised beams to provide coverage up to seven times the water depth. The determination of energy and phase of the backscattered signal allows a detailed mapping of the swath and displays a geometrically and bathymetrically corrected sonar image of the seabed reflectivity. The acquired data were processed onboard in real time with interactive processing systems (e.g. TRISMUS = Multibeam; TRINAV = Navigation; TRIMEN = Geophysical measurements; IMAGEM = imagery) developed by IFREMER.

2.2. Magnetism: Data Acquisition and Reduction

The magnetic data (Figure 5) were acquired at a 6-sec sampling interval using a BARRINGER M-244 proton magnetometer, towed 280 m astern the ship. Because of the proximity of the magnetic equator (magnetic inclination of study area is less than 20), the amplitude of the total field is relatively low: less than 42000 nT.

The magnetic anomalies were computed by subtracting the IGRF 90 (Langel, 1992) from the measured total field, but they were 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, with an average equal to about 20 nT) are thus mainly due to diurnal variations. These errors were taken into account in the hand-contouring process of the different maps and do not affect our results.

2.3. Gravimetry: Data Acquisition and Processing

During the SOPACMAPS II cruise, gravity data were collected off the eastern side of Malaita and Ulawa islands (Figure 6), along lines 140 to 163, using the sea gravity meter BODENSEEWERK KSS30. This gravity meter consists of a GSS30 gravity sensor mounted on a KT30-two-axes gyro stabilised platform. The gravity sensor includes a non-astatized spring-mass assembly as the basic gravity detector. In calm seas, such as encountered during the SOPACMAPS II cruise, the theoretical accuracy of the gravity sensor can be 0.2 mGal.

Using the on-line-processing system, gravity values were obtained on board the ship, approximately 120 sec after each measurement. This system provides Eotvos corrections, free air and Bouguer anomalies in mGal. During the cruise, the gravity data were automatically corrected for spring tension, cross coupling, Eotvos and for latitude, according to the IGSN (International Gravity Standardisation Net) 1971 ellipsoid.

2.4. Seismic Reflection Profiling

During SOPACMAPS II cruise L'ATALANTE was equiped with two 75 cubic-inches GI air guns towed at the speed of 10 knots with a 10 sec shooting cadency. The signal was received on a seismic pipe composed of 6 active traces (16 hydrophones KC201), then

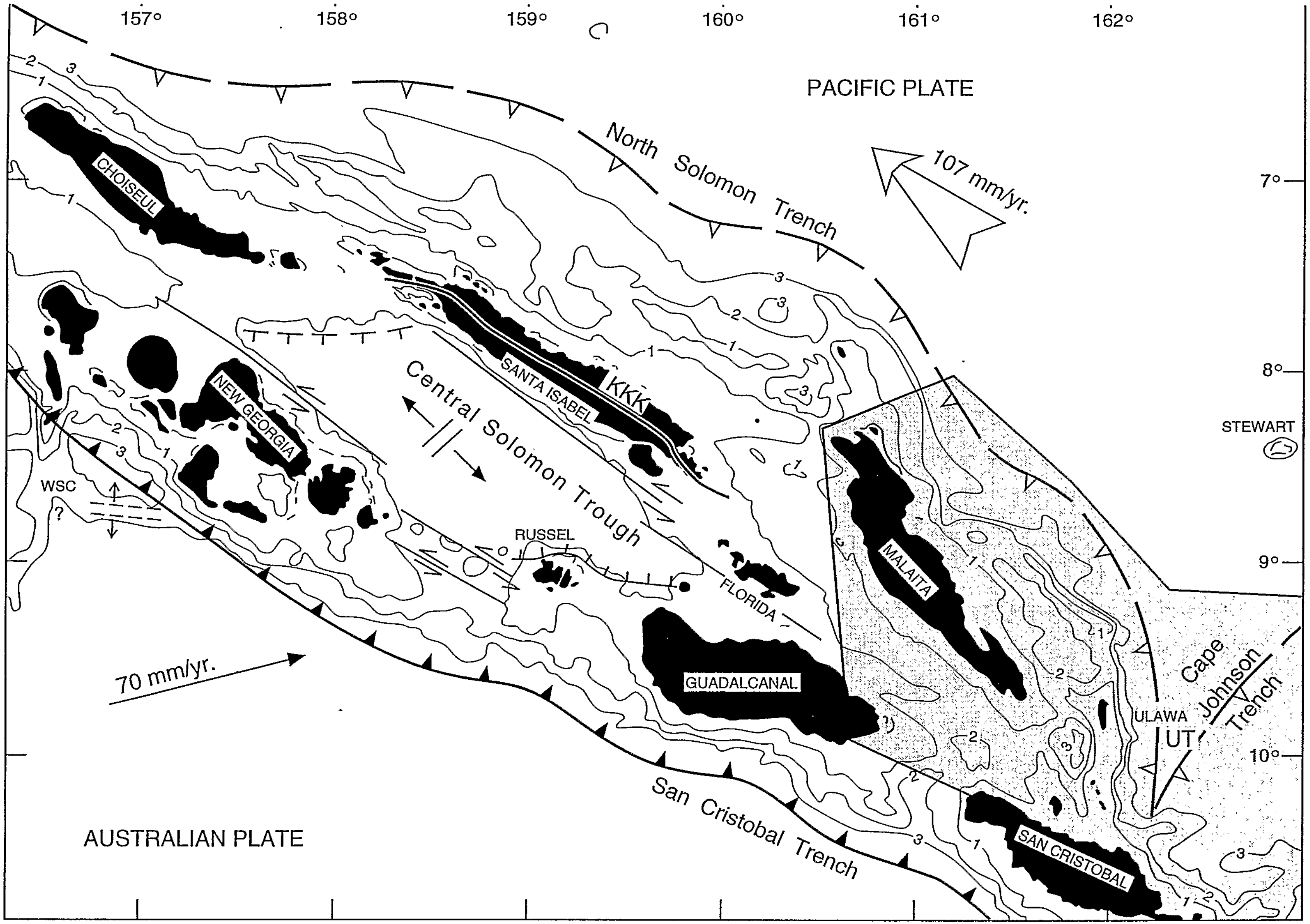


Fig. 2. Simplified geodynamical setting of the Solomon Islands arc after Wells (1989) and Auzende *et al.* (1994). The inferred extensional zones are represented with arrows showing the direction of extension. Left-lateral strike-slip faults are shown in Mborokua Basin and Central Solomon Trough. The vector of the relative motion of the Australian plate wrt Pacific plate is from Wells (1989). The white arrow corresponds to the absolute motion of the Pacific plate. Fossil (white triangles) and active (black triangles) subduction zones are indicated. WSC = Woodlark Basin spreading center, KKK = Kia-Korigole-Kaipito fault, UT = Ulawa Trough. The grayed box corresponds to the bathymetric and geophysical survey carried out east of Malaita Island during SOPACMAPS I and II cruises of the R/V L'ATALANTE.

preamplified, filtered and amplified on a SEDASIS system. Recordings were made continuously on board the ship, on digital recorders (magnetic tape, exabyte cartridge and DOWTY graphic recorder).

3. Results of SOPACMAPS II Cruise

3.1. Bathymetry and Imagery

The surveyed region includes the eastern offshore flanks of Malaita, Marmasike, Ulawa, and Olu Malau islands as well as the floor and lower outer slope of the North Solomon Trench (Figures 2 and 3). The region adjoining the eastern side of the islands can be divided, on the basis of the bathymetry and imagery, into northern, central and southern areas, each showing different morphological and structural characteristics (Figure 4).

The area north of 8°45′ S is the least complex, consisting of a series of N 160° E trending scarps along the northeast flank of the island of Malaita. The scarps form the headwalls of deep, square depressions that progressively step down into the North Solomon Trench. These depressions, which are open toward the east, are centered at 8°45′ S and 8°25′ S and reach depths of 2000 m and 2500 m, respectively. Based on their morphology, the depressions are believed to be associated with the tops of large slump blocks, which form valleys or basins bounded by the headwall and the two flanking scarps. Except for the N 160° E scarps flanking Malaita the imagery reveals few reflective features. Slump structure also can be identified at the base of the slopes and within the square depressions. Below the depressions, a triangular-shaped basin, reaching a maximum depth of 4250 m, forms the floor of the North Solomon Trench. The trench floor is bounded to the east by the smooth trench outer slope, which dips to the southwest and strikes N 140° E.

The central area (between 8°45′ S and 9°20′ S) is composed of three successive parallel ridges separated by deep basins (Figure 4); these ridges parallel the structural trend of the Malaita and Ulawa islands. These ridges and intervening basins all show successive changes of trends from N 120° E, to N 140° E, and then to N 160° E. The western ridge (WR) is the seaward extension of the eastern margin of the Malaita and is formed by a basement high rising to less than 1000 meters below sea level and extending to the south as far as 9°45′ S. The most prominent ridge is the central one (CR), rising to an average depth of 750 m. The northern tip of this central ridge abuts against the aforementioned 2500 m-deep square depression in the northern area, centered at 8°45′ S. The eastern ridge (ER) in the central area is the deepest one, rising to approximately 3000 m below sea level. This ridge is also more discontinuous than the two other ridges. The imagery reveals the central area to be considerably more reflective than the northern area, especially in the vicinity of the central ridge, which appears to be a young or recently reactivated feature lacking any significant sedimentary cover. This lack of sedimentary cover could also be due to the current regime preventing deposition and/or favoring erosion.

To the east, at the foot of the eastern ridge, lies a 4000 m-deep trough, which represents the southeastward extension of the North Solomon Trench. Here, the trench floor is not continuous, but is characterized by a succession of small elongated ridges and depressions suggestive of downslope gravitational movement, i.e. sliding or slumping from both sides of the trench. As in the northern area, the trench is flanked to the east by a south–west dipping and N 140° E striking outer slope. The imagery emphasizes the deformed aspect of this area, as well as the slumping that characterizes the base of the trench lower slope.

The southern area (between 9°20′ S and 11° S) is marked at 9°20′ S by a dramatic change in structural trends from NW–SE to NS (Figure 4). The slope along the eastern flanks of Ulawa and Olu Malau islands is probably controlled by a major N–S aligned fault, extending from 9° S to 10°30′ S. This slope is deeply dissected by alternating spurs and furrows which probably are the scars of intense downslope movement i.e. submarine landslides, slumps and large sediment chutes. The seafloor here descends steeply into a deep crescent-shaped trough, the Ulawa Trough (Figure 2), reaching a depth of more than 6000 m below sea level. This trough lies at the junction between the eastern end of the North Solomon and the western end of the Cape Johnson trenches. The western side of the trough is characterized by a series of NE–SW trending ridges and depressions, whereas the eastern side is characterized by a flat-floored basin (Figure 4). The imagery reveals the Ulawa Island slope also to be very reflective, particularly within the landslide/slump scars. This emphasizes the deformed aspect of the area between the North Solomon and Cape Johnson trenches, highlighting the NE–SW ridges and scarps that parallel the trend of the Cape Johnson Trench. South of the Ulawa Trough, a major EW aligned ridge, extending eastward from the island of San Cristobal and rising to less than 1750 m below sea level, separates the North Solomon–Cape Johnson Trench junction from the San Cristobal Trench.

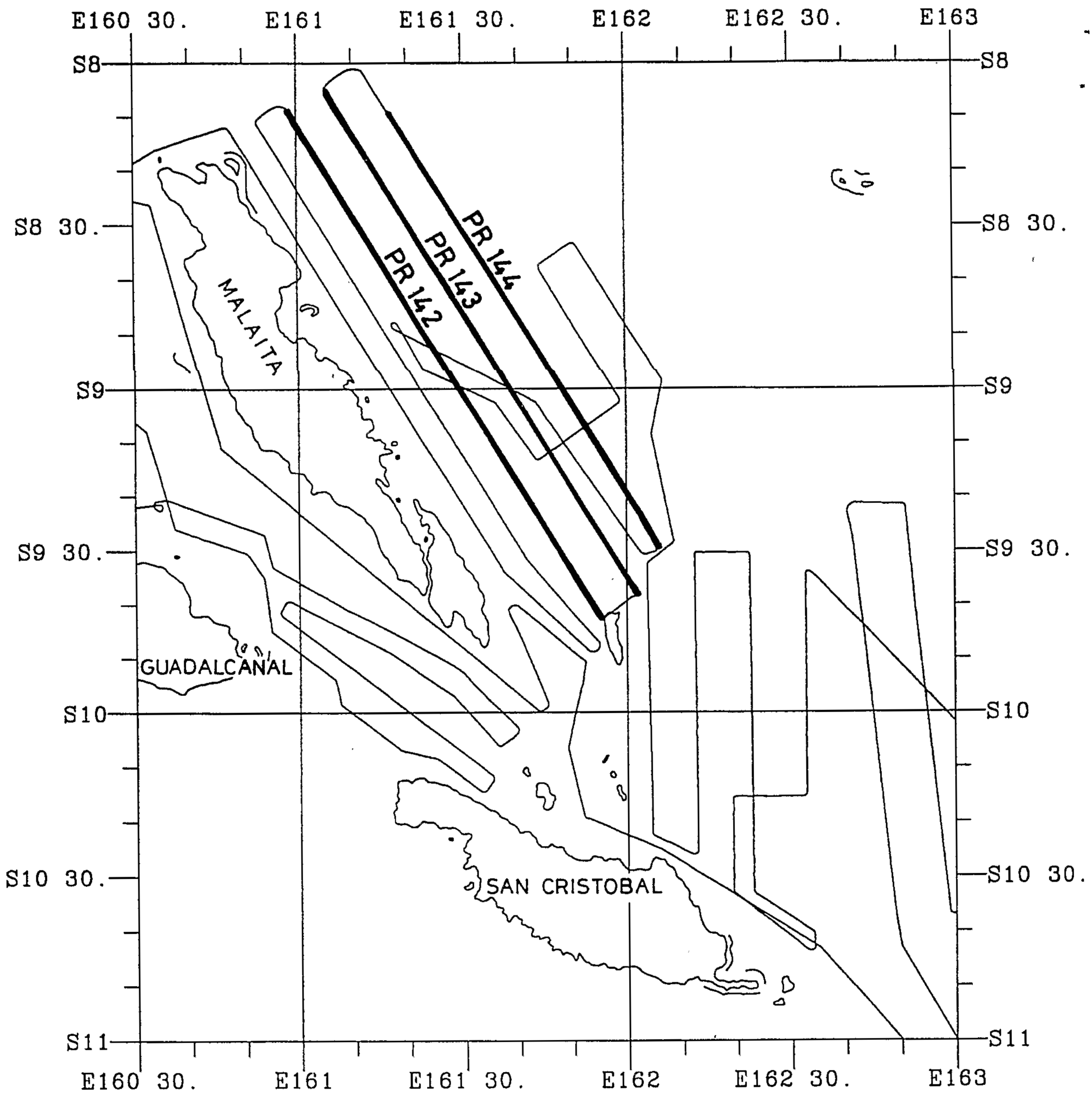


Fig. 3. Track lines of the SOPACMAPS II cruise. The seismic profiles shown on Figure 7 are in heavy lines.

3.2. Seismic reflection

Underway seismic reflection profiles were acquired along NW–SE and N–S aligned survey tracks (Lines 140 to 154 and Lines 155 to 163, respectively) across the eastern offshore flanks of Malaita, Ulawa, Olu Malau islands, respectively.

Although this alignment is roughly parallel to structure and thus is not the most favourable orientation to obtain good geological sections, the profiles do permit recognition of different types of acoustic basement and sedimentary structures in the eastern part of the Malaita Anticlinorium.

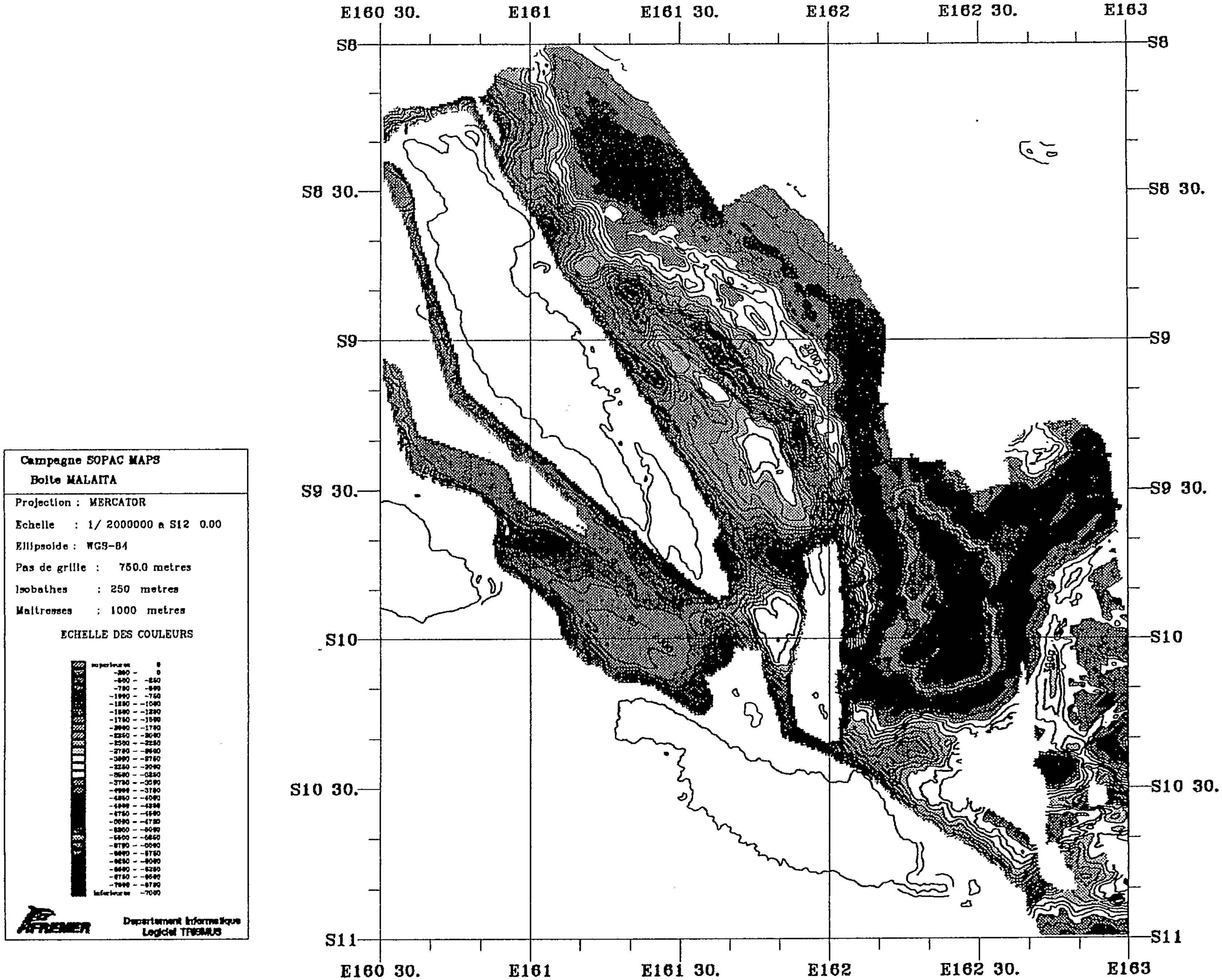
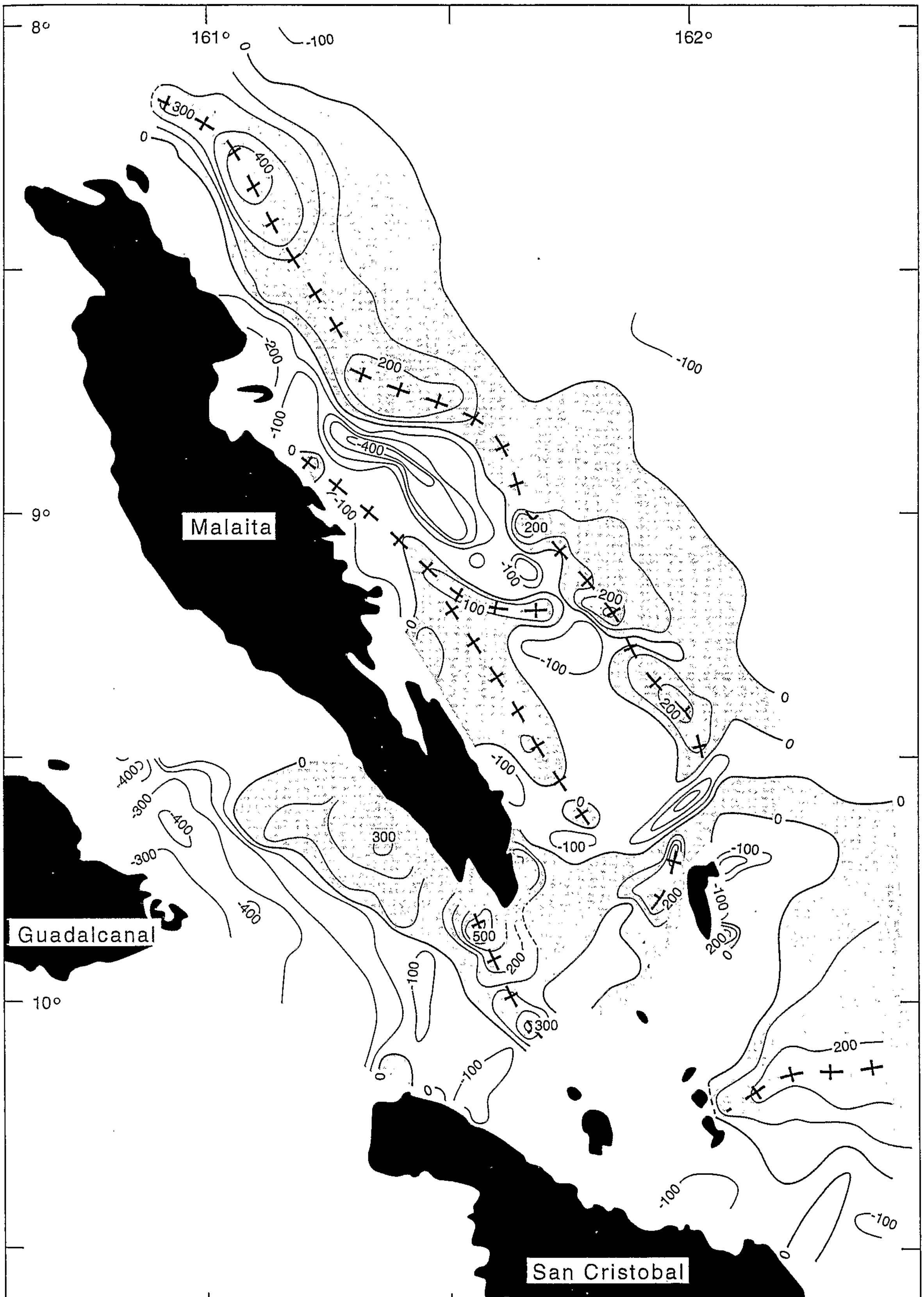


Fig. 4. EM12 Bathymetric map of the Malaita domain. Contour interval is 250 m. Color interval is 250 m.


8°
161°
162°
9°
10°
Malaita
Guadalcanal
San Cristobal
-100
0
300
400
200
-400
500
-300

In the westernmost part of this area (profile 142 in Figure 7), adjoining the island of Ulawa, the profiles reveal numerous basement vertical offsets representing the seaward extension of geological structures observed on the islands of Malaita and Ulawa. Here the sedimentary section overlying acoustic basement is relatively thin, 100 to 200 ms in thickness, and is cut by normal faults extending from the basement to the seafloor, that suggest recent activity. The sedimentary cover thickens in the square slump headwall basins, reaching 500 to 800 ms in the basin between Malaita and the westernmost basement ridge (WR) (see profile 144 in Figure 7).

In the central area, the seismic profiles show an intensely faulted basement ridge rising to less than 1275 mbsl (1.7 sec twt). Although it is difficult to estimate sediment thickness in the area, it is clear that the top of the ridge is capped by a layer of sediment approximately 300 ms-thick and that basement crops out on the ridge flanks. The sediments are vertically offset by high-angle faults which extend upward from the basement to the seafloor.

To the northeast, the most prominent feature is the North Solomon Trench and associated ridges lying at the foot of the basement ridges previously described. From the axis of the North Solomon trench (more than 4000 m-deep) up to the foot of the easternmost basement ridge (profiles 143 and 144 in Figure 7), the bottom topography is rough and is characterized by a discontinuous succession of ridges elevating the seafloor in three steps from 4000 m up to 3000 m. These ridges are underlain by deformed sediments more than 1 second thick. The thickness of the sedimentary section here precludes any reliable identification of the basement horizon. The deformation of the sedimentary section, as in other areas, extend upward to the seafloor. Farther to the northwest, the southwest dipping trench outer slope is underlain by about one second of sediment overlying an undisturbed basement. The southeastern area east of Ulawa Island (profiles 155 to 163, located in Figure 3) is dominated by the aforementioned major N–S aligned scarp extending from about 9° S to 10°30′ S. This fault appears as a very steep scarp with a throw or vertical offset of the basement as much as 4500 m. Basement is exposed over most of the scarp, except at the foot of the scarp where sediments form a talus slope. To the east, the Ulawa Trough forms a deep basin separating the East Malaita region from the Melanasian Arc Gap region. The Ulawa trough floor lying more than 6000 mbsl is rough and faulted in some places and smooth in others. The most prominent feature within the trough is an axial NE–SW trending ridge cropping out in the northeastern part of the trough and buried beneath 500 ms of sediment in the southwestern part of the trough. NS and EW normal faults branch from this ridge, separating associated low-amplitude ridges and basins.

← Fig. 5. Magnetic map established from SOPACMAPS II cruise data. The contour interval is 100 nano Tesla. In gray, the positive magnetic anomalies. The magnetic positive lineaments are underlined by crosses.

3.3. Magnetism

Magnetic anomalies off the east coast of Malaita (Figure 5) range between -500 nT and +500 nT. They generally trend N 160° E to N 130° E and reflect seafloor topography. Their high amplitudes indicate the presence of magnetized material of igneous origin. This supports the interpretation, that the ridges off Malaita are the underwater continuation of the volcanic basement that is known to outcrop on Malaita and Ulawa islands (Coulson and Vedder, 1986).

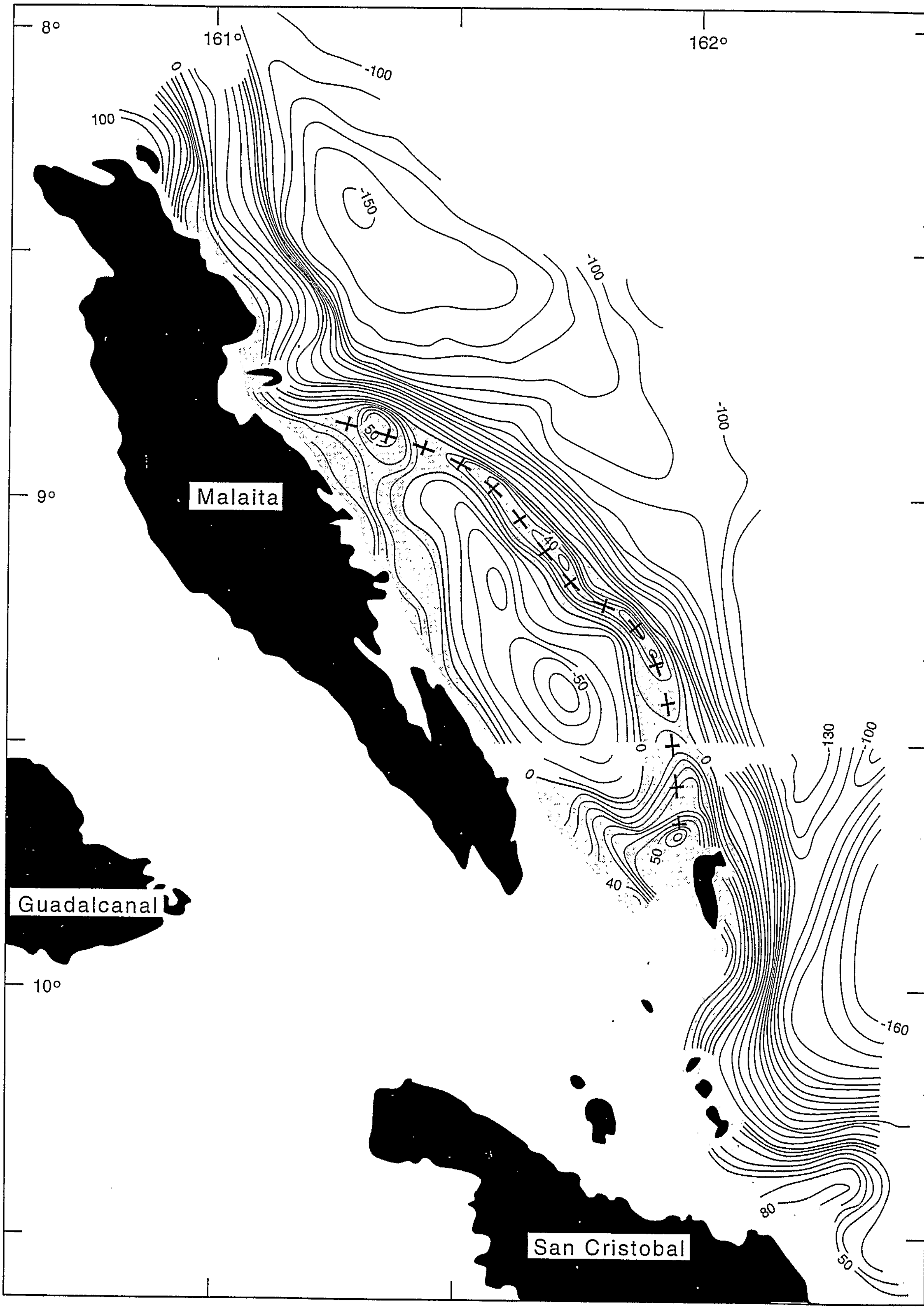
East of Ulawa Island, average magnetic anomaly amplitudes range between 0 and 200 nT. Isocontours are smooth, showing a slight negative gradient, from 200 nT in the Ulawa Trough at the foot of the slope, to zero at the top of the slope (note that the gradient is steeper to the west than to the south). This magnetic anomaly pattern is believed to be associated with seafloor topography and not a magnetized body at shallow crustal levels.

3.4. Gravimetry

The mean discrepancy in gravity measurements calculated at 6 trackline intersections was determined to be 1.2 mGals (ignoring a 17 mGals discrepancy obtained at one intersection). This mean discrepancy permits contouring the free air anomalies in 10 mGals intervals (Figure 6).

Free air anomalies obtained within the study area range from –167 mGal over the 6000 m deep trench east of Ulawa Island to +110 mGal over the shallow seafloor off northeastern Malaita Island. From west to east, free air anomalies can be separated into three groups corresponding to the three arcuate structural trends described previously: a western gravity low reaching –63 mGals, an arcuate gravity high reaching +60 mGals, and two eastern gravity lows reaching –167 mGals.

The western gravity low that reaches –63 mGal is superimposed on a series of 2500–3000 m-deep, bathymetric lows trending NW–SE. The arcuate gravity high extends from Ulawa Island obliquely toward the north-


8°
161°
162°
9°
10°
Malaita
Guadalcanal
San Cristobal
-100
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-150
-100
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50
40
-50
0
0
0
-130
-100
50
40
-160
80
50

eastern part of Malaita Island. This high coincides with the central ridge (CR) that crests near 700 m and obliquely intersects the deformed eastern margin of Malaita. Gravity anomaly values of + 50 to + 60 mGals suggest that the ridge is probably not composed solely of pelagic sediments but must be formed from igneous basement. From comparison with the geology of Ulawa Island (Coleman, 1965) this ridge also appears to have a basaltic core which is overlain by Oligocene-Miocene carbonate sediment and capped by Pleistocene reefs.

The eastern gravity low shows two minima centered over the trenches. One gravity low reaches –150 mGals and coincides with the 4250 m-deep flat-bottomed trough that separates the Ontong Java Plateau from the Malaita eastern margin. The second low (–167 mGals) coincides with the NS 6000 m-deep trench east of Ulawa Island. The eastern slope of Ulawa Island is characterised by a gravity gradient of 12.1 mGals/km.

4. Geological Interpretation

The identification of the major structural features shown in Figure 8 is based on the interpretation of the swath bathymetry, imagery and other geophysical data acquired during the SOPACMAPS II cruise. Three distinct structural provinces are recognized: a northwesternmost province, characterized by the presence of large rotational slump blocks; a central province, characterized by a succession of linear ridges and narrow intervening basins; and a southeasternmost province, characterized by a major N–S aligned fault scarp and associated submarine landslides, and slumpscars and large sediment chutes.

The central province, confined between the eastern shorelines of South Malaita and Maramasike and the North Solomon trench axis and formed by three elongate, parallel ridges separated by deep basins, is the most striking province. The structural framework of the area is controlled by the two primary directions of faulting: N–S and N160°. The ridges and basins and structural fabric reflect the same trends as that mapped on the island of Malaita (Coleman and Kroenke, 1981; M. Petterson and B. McGrail, unpublished data, 1995).

The western, inner ridge (WR), located immediately east of Malaita, is probably part of the same terrain exposed on the eastern side of the island. This terrain is interpreted to be oceanic crust and sediment of the Ontong Java Plateau obducted onto the Northern Solomon frontal arc within the last 5 Ma, during the collision between the Woodlark Basin spreading system and the modern Solomon Island forearc. This interpretation is corroborated by the high amplitude (+ 110 mGals) of the gravity anomaly related to the ridge.

The central ridge (CR), showing the same trend as the western ridge but differing in morphology, stands in sharp relief, with a narrow, linear axial summit, and steep flanks barren of sediment. The linearity of the ridge crest and the steepness of the ridge flanks evidence the strong structural control exerted on the morphology of this ridge. In addition, the central ridge is marked by a strong positive magnetic anomaly, favoring the interpretation that this ridge is, at least in part, associated with recent volcanism.

The eastern, outer ridge (ER), in reality a series of low ridges near the foot of the Central Ridge, is constructed of faulted and folded sediment. It is difficult from our data to conclude whether or not the observed faulting is normal faulting or overthrusting. The fact that the faults do extend upward to the seafloor suggests that the deformation might still be active. Although shallow focus earthquakes have not been observed in the East Malaita Region, intermediate focus earthquakes have been registered (see Cooper *et al.*, 1986; Cooper and Taylor, 1987), suggesting that subcrustal movement along the old North Solomon Wadati-Benioff Zone is still occurring and supporting the conclusion that the deformation might still be active.

To the northwest, adjoining the 4000 m-deep NW–SE trending North Solomon trench, the lower trench outer slope is underlain by about 1 sec of undeformed sediment overlying a smooth basement surface. The present-day North Solomon trench axis seems to be inactive, with deformation having shifted southeastward into the trench inner slope. The axis of the North Solomon trench is not perfectly linear, being offset toward the east, at about 8°35′ S, by an oblique left-lateral transcurrent fault.

The southeastern province is demarcated by a large, steep, N–S scarp which traverses the entire area. The motion along this fault, considering the current approximately E–W direction of convergence between the Pacific and Australian plates (DeMets *et al.*, 1990) and the ongoing collision between the Woodlark Basin and the Solomon Island forearc appears to be left lateral with a strong compressive component.

Ulawa trough, at the foot of this large scarp, exhibits a complicated structural fabric dominated by a NE–SW trending axial ridge associated with N–S and E–W

← Fig. 6. Gravity anomaly map established from SOPACMAPS II cruise data. The contour interval is 10 mGals. In gray, the positive anomalies, the axis of which is underlined by crosses.

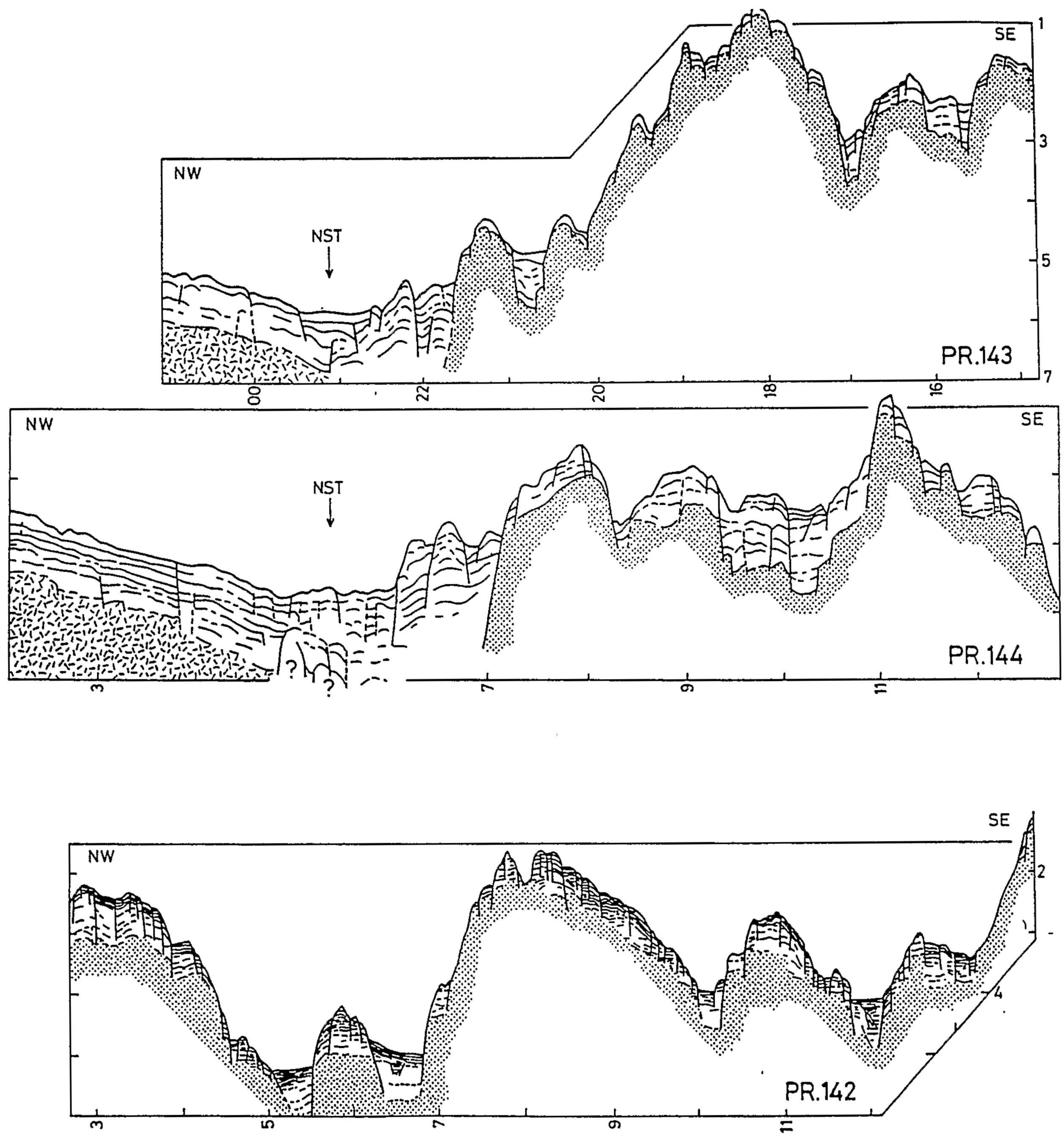

Fig. 7. Seismic profiles showing the succession of ridges along the east Malaita margin. Profile 142: highly fracturated topography of the different ridges bounding the Malaita Island. Vertical exaggeration is about 16. The dotted areas represent the oceanic or volcanic basement of the ridges. Profiles 143, 144: Section of the North Solomon Trench and of the ridges east of Malaita Island. Vertical exaggeration is about 16. The dotted area represents the oceanic or volcanic basement of the ridges. Stipped area is the oceanic basement of the Pacific plate subducting the East Malaita domain. The present-day location of the North Solomon Trench (NST) axis is marked by a black arrow.

branching normal faults. The SW–NE trending ridge crosses the entire basin and reflects the complex relative motions between the Pacific and Australian plate along the boundary between by the North Solomon and Cape Johnson trenches. The complexity of this boundary is also well demonstrated within the Melanesian border region east of the Malaita region (Pelletier and Auzende, this volume).

Figure 8 summarises the observations based on the interpretation of the bathymetry (Figure 4) and seismic

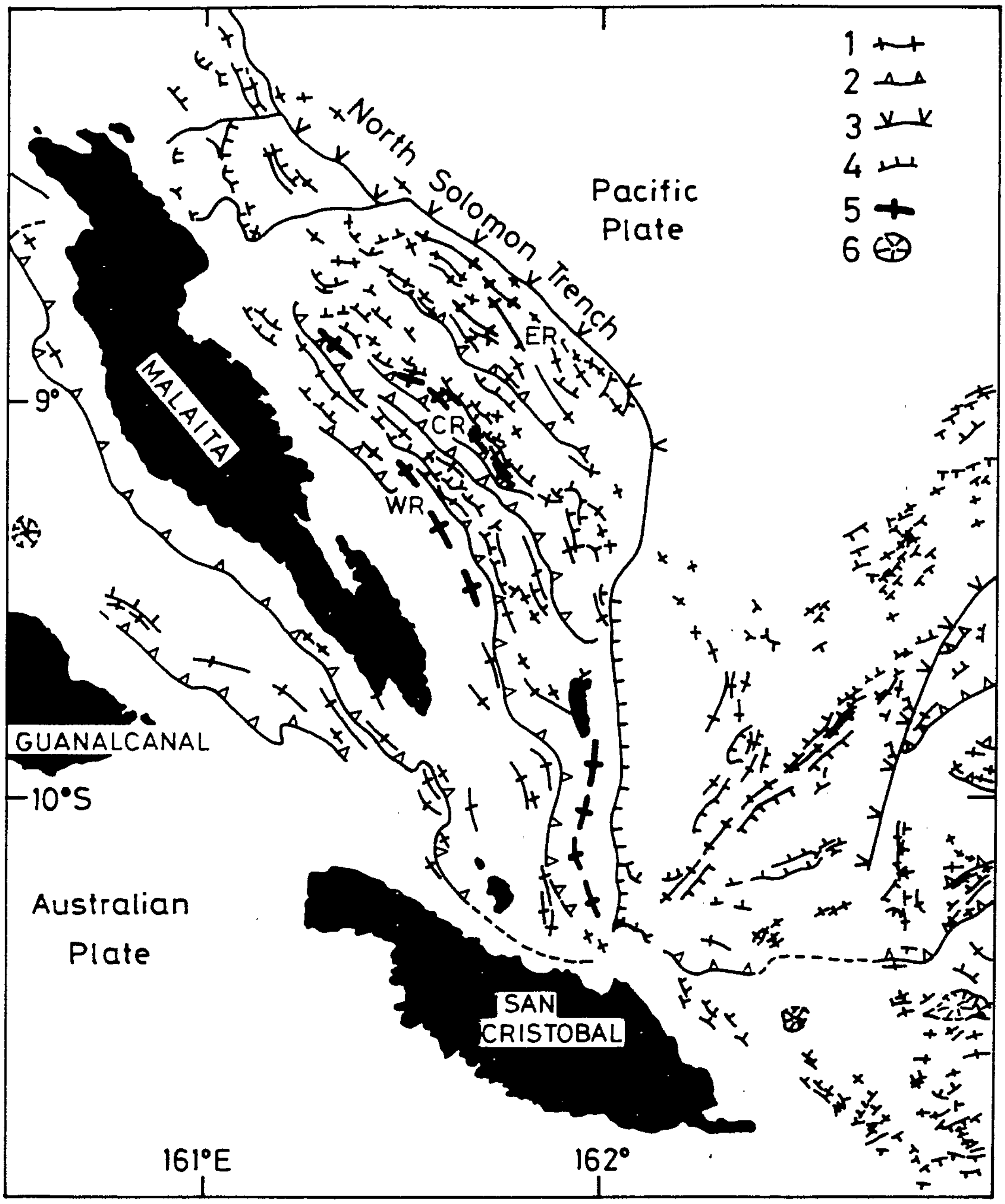

Fig. 8. Detailed structural interpretation of the East Malaita area. 1- ridge; 2- overthrust inferred from bathymetry and seismic profiles; 3- Pacific oceanic crust dipping eastward beneath the East Malaita area; 4- normal faut or scarp; 5- oceanic and/or volcanic basement ridge; 6- isolated volcano. WR = Western Ridge, CR = Central Ridge, ER = Eastern Ridge.

reflection profiles (Figure 7). The East Malaita area is characterised by a succession of parallel ridges, the nature of which differs depending on their location. The ridges located immediately east of the island of Malaita are primarily basement ridges probably representing pieces of Ontong Java Plateau crust uplifted and obducted in similar fashion to the island of Malaita. The central ridge may have recently sustained igneous intrusions. The outer ridge adjacent to the North Solomon Trench is totally different in nature, formed exclusively by folded and faulted sediment (Figure 9).

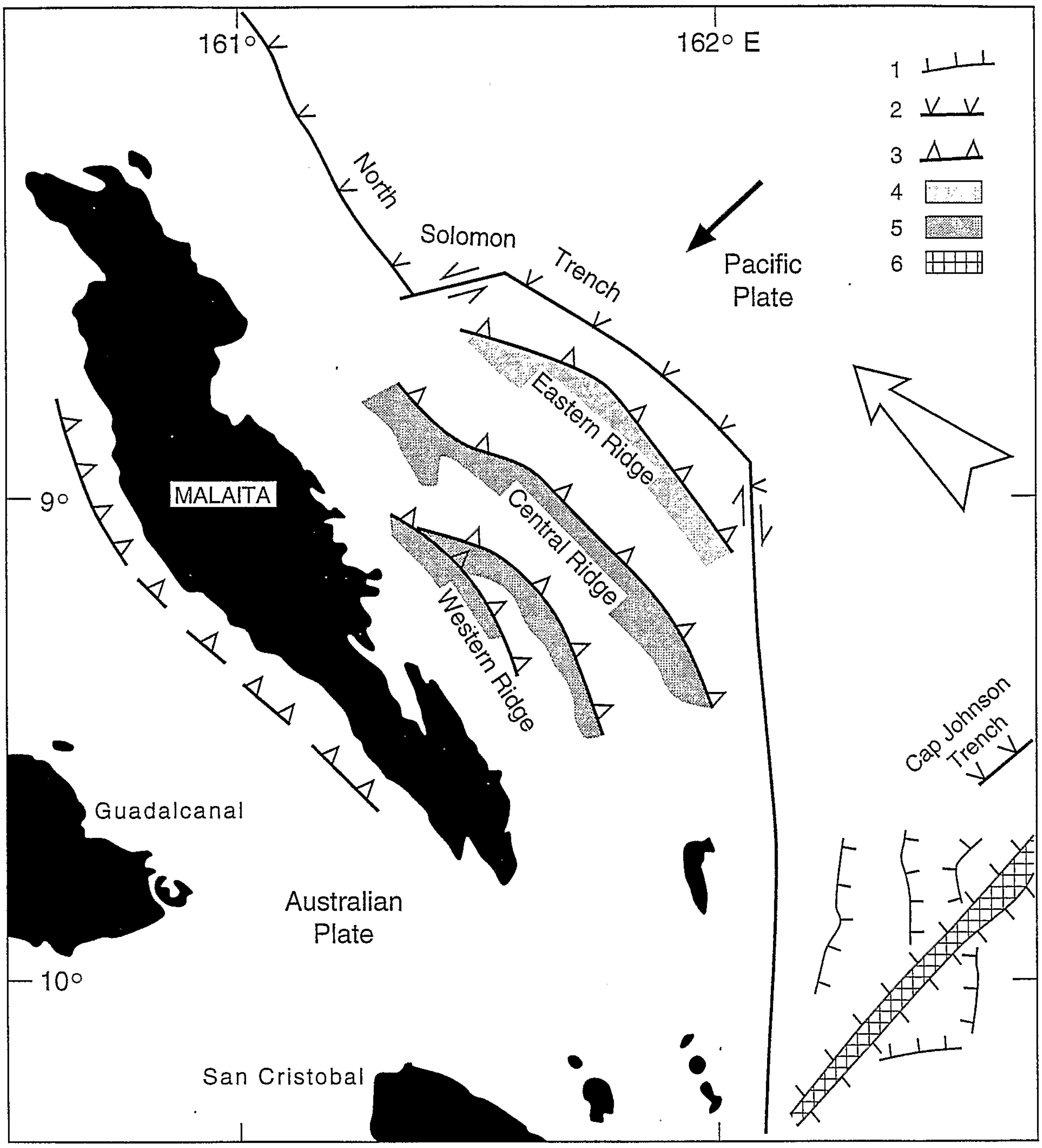

Fig. 9. Geodynamical interpretative sketch of the Malaita Island area. 1 = Normal fault; 2 = Subduction-compression zone; 3 = basement or sedimentary overthrusting zone; 4 = deformed sedimentary ridge; 5 = Basement or volcanic ridge; 6 = basement ridge in the deep basin east of the major N–S scarp. The white arrow corresponds to the absolute motion of the Pacific plate. The black arrow corresponds to the relative motion between Pacific and Australian plate deduced from DeMets *et al.* (1990) parameters.

5. Conclusions

The northeastern margin of the Solomon Islands archipelago from Choiseul to Ulawa, curvilinear in shape, and the North Solomon Trench inner slope off Santa Isabel and Malaita, bulging to the east, clearly attest to an northeastward shift of the deformation front between the Indo-Australia and Pacific plates. The East

Malaita region, including the island of Malaita and the area offshore extending from the coastline to the North Solomon Trench axis, is the most intensely deformed region in the Malaita Anticlinorium. In fact, folding, faulting, and mass wasting of the seafloor here is much more intense than any other region surveyed so far during the SOPACMAPS Project.

The original location of the North Solomon Trench axis in the East Malaita region probably lay far west of its current position perhaps along a line extending from the present trench axis north of Choiseul to the southern termination of the Ulawa Trough. The youthful appearance of the structural deformation in this region suggests that compression was active here well after the main docking phase of the Ontong-Java Plateau against the Australian Plate more than 22 Ma. The compressive event may have been initiated as recently as 5 Ma concomitant with entry of the Woodlark Basin spreading system into the San Cristobal Trench. As compression intensified, the ensuing crustal shortening was absorbed within the trench outer slope; the deformation front progressively moving further eastward into the Ontong Java Plateau. Crustal shortening may have proceeded by delamination and detachment of successive layers of Ontong Java Plateau crust along the trench outer slope with obduction occurring.

The two ridges east of Malaita are believed to be the leading edges of two such obducted slices of Ontong Java Plateau crust, probably emplaced in similar fashion to the Malaita basement. The prominent central ridge, east of the 2000 m-deep basin at the foot of the western ridge adjoining the eastern side of Malaita, has obviously undergone intense faulting and recent uplift. The strong positive magnetic anomaly associated with this ridge may also indicate the presence of a younger volcanic event, postdating the formation of Ontong Java Plateau igneous basement. The precise age of this event is still unknown, but it might be related to the Eocene or younger intraplate volcanism known to occur on the island of Malaita or even be associated with the crustal shortening that has occurred since 5 Ma.

The discontinuous outer ridge situated between the base of the central ridge and the North Solomon trench axis is constructed of deformed sedimentary layers. The deformation, involving both folding and faulting, affects the entire sedimentary column from the deepest layer discernible in the reflection profiles to the surface of the seafloor, and suggests that crustal shortening has been very active recently or even, despite the lack of shallow seismicity in the area, still active today.

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