# Geometry and Structure of the Vitiaz Trench Lineament (SW Pacific)

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**Abstract.** Swath bathymetric, sonar imagery and seismic reflection data collected during the SOPACMAPS cruise Leg 3 over segments of the Vitiaz Trench Lineament and adjacent areas provide new insights on the geometry and the stuctural evolution of this seismically inactive lineament. The Vitiaz Trench Lineament, although largely unknown, is one of the most important tectonic feature in the SW Pacific because it separates the Cretaceous crust of the Pacific Plate to the north from the Cenozoic lithosphere of the North Fiji and Lau Basins to the south. The lineament is considered to be the convergent plate boundary between the Pacific and Australian Plates during midde to late Tertiary time when the Vitiaz Arc was a continuous east-facing arc from the Tonga to the Solomon Islands before the development of the North Fiji and Lau Basins. Progressive reversal and cessation of subduction from west to east in the Late Miocene-Lower Plioene have been also proposed. However, precise structures and age of initiation and cessation of deformation along the Vitiaz Trench Lineament are unknown.

The lineament consists of the Vitiaz Trench and three discontinuous and elongated troughs (Alexa, Rotuma and Horne Troughs) which connect the Vitiaz Trench to the northern end of the Tonga Trench. Our survey of the Alexa and Rotuma Troughs reveals that the lineament is composed of a series of WNW–ESE and ENE–WSW trending segments in front of large volcanic massifs belonging to the Melanesian Border Plateau, a WNW trending volcanic belt of seamounts and ridges on Pacific crust. The Plateau and Pacific plate lying immediately north of the lineament have been affected by intense normal faulting, collapse, and volcanism as evidenced by a series of tilted blocks, grabens, horsts and ridges trending N 120° to N 100° and N 60°–70°. This tectonism includes several normal faulting episodes, the latest being very recent and possibly still active. The trend of the fault scarps and volcanic ridges parallels the different segments of the Vitiaz Trench Lineament, suggesting that tectonics and volcanism are related to crustal motion along the lineament.

Although the superficial observed features are mainly extensional, they are interpreted as the result of shortening along the Vitiaz Trench Lineament. The fabric north of the lineament would result from subduction-induced normal faulting on the outer wall of the trench and the zig-zag geometry of the Vitiaz Trench Lineament might be due to collision of large volcanic edifices of the Melanesian Border Plateau with the trench, provoking trench segmentation along left-lateral ENE–WSW trending transform zones. The newly acquired bathymetric and seismic data suggest that crustal motion (tectonism associated with volcanism) continued up to recent times along the Vitiaz Trench Lineament and was active during the development of the North Fiji Basin.

## Introduction

The Vitiaz Trench Lineament (Brocher, 1985a) forms the northern border of the North Fiji Basin and consists from west to east of the Cape Johnson Trench, the Vitiaz Trench (Udintsev, 1958 in Fairbridge and Stewart, 1960) and three discontinuous and elongated troughs, the Alexa, Rotuma and Horne Troughs (Fairbridge and Stewart, 1960), which connect the Vitiaz Trench to the northern tip of the Tonga Trench (Figure 1). However, the exact location of this lineament east of the Vitiaz Trench is still unclear. The Vitiaz Trench Lineament is also bordered by the Melanesian Border Plateau (Fairbridge and Stewart, 1960), a volcanic belt of seamounts, ridges, banks and islands which parallels northward the Vitiaz Trench Lineament and extends toward the WNW over more than 1500 km from the Samoan Islands.

The Vitiaz Trench Lineament is one of the most important tectonic features of the SW Pacific area because it separates the Cretaceous crust of the Pacific plate to the north from the late Cenozoic lithosphere of the North Fiji and Lau Basins to the south. This lineament is believed to be the site of former subduction of the Pacific plate below the Australian plate (Chase, 1971) from the Eocene to the late Miocene, before the development of the North Fiji and Lau Basins. At that time the Vitiaz Arc was a single continuous east-facing arc from the Tonga to the Solomon Islands (Gill and Gorton, 1973; Falvey, 1975 and 1978; Coleman and Packham, 1976; Gill *et al.*, 1984). The cessation of the westward Vitiaz subduction and its northern prolongation, the North Solomon subduc-

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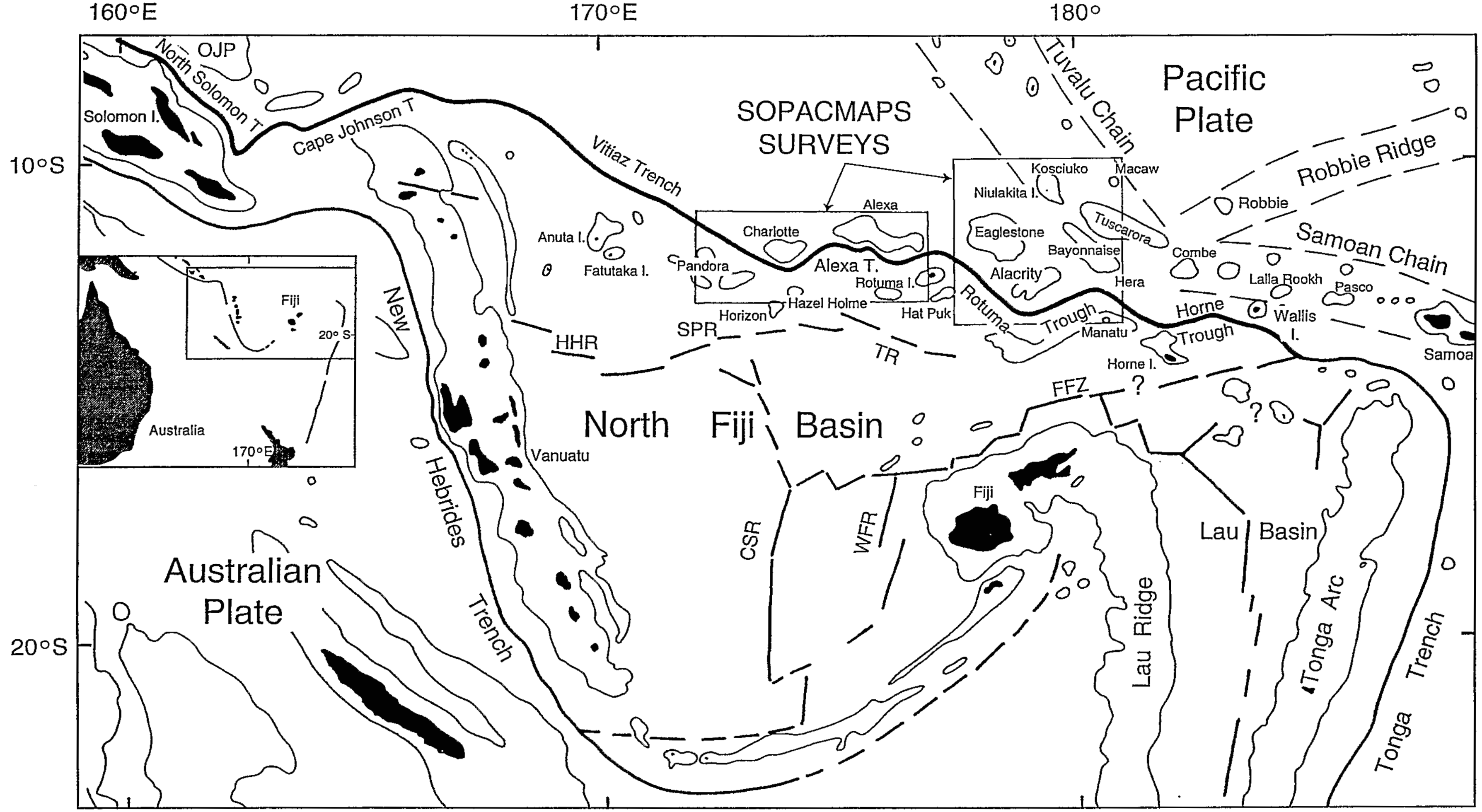



Fig. 1. The Vitiaz Trench Lineament in the Southwest Pacific and location of surveyed areas presented in this paper. The bathymetry is from Kroenke *et al.* (1983). Active segments in the North Fiji and Lau Basins are taken from Auzende *et al.* (1988, 1994 and 1995), Huchon *et al.* (1994), Hughes Clarke *et al.* (1993), Lagabrielle *et al.* (this volume), Parson and Tiffin (1993) and Pelletier *et al.* (1993). CSR: Central Spreading Ridge; WFR: West Fiji Rift; FFZ: Fiji Fracture Zone; HHR: Hazel Holme Ridge; SPR: South Pandora Ridge; TR: Tripartite Ridge; OJP: Ontong Java Plateau.

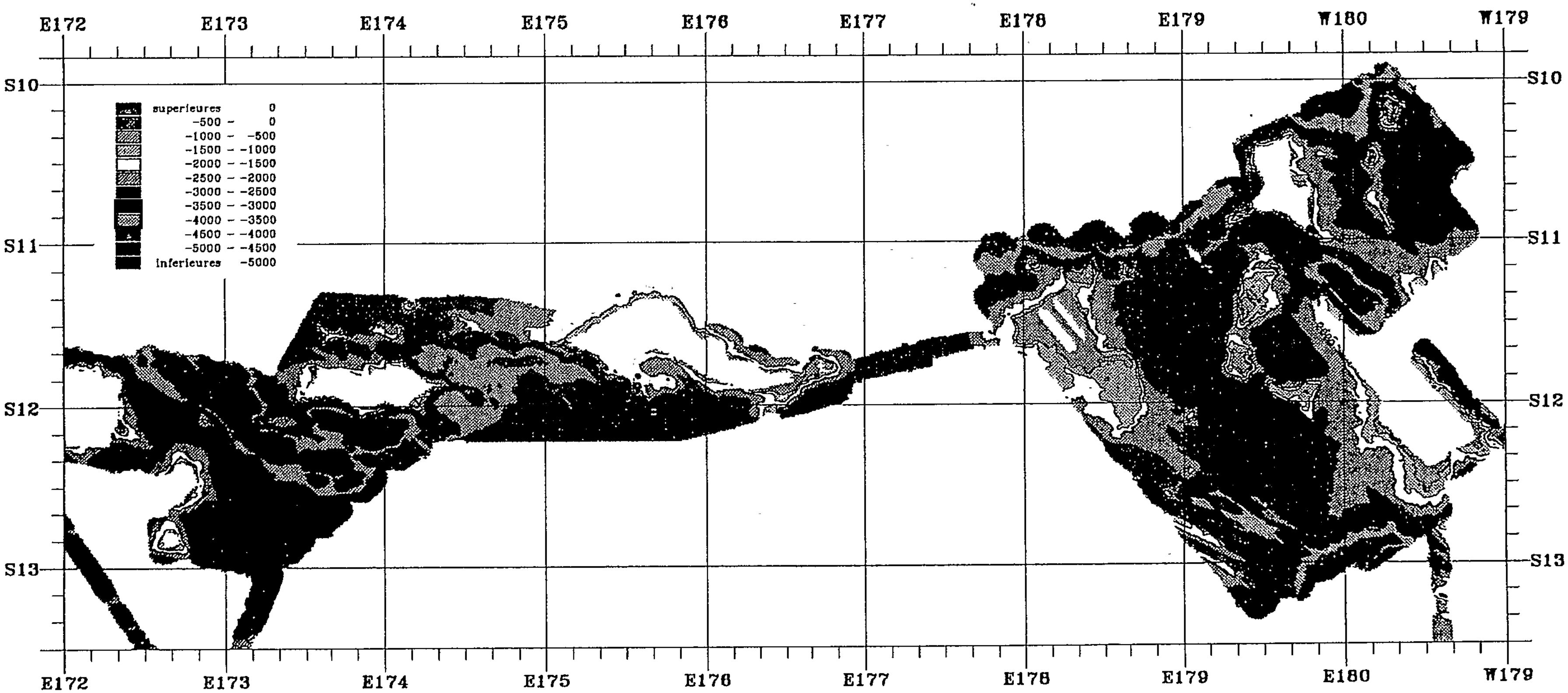



Fig. 2. Simplified multibeam bathymetry of the two surveyed areas along the Vitiaz Trench Lineament. Contour interval is 500 m.

tion, is explained by the arrival at the trench of the Ontong Java Plateau, which induced in the Late Miocene 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 authors agree with this model, the details of this arc reversal history is still unclear and precise age of initiation and cessation of Vitiaz arc and subduction is unknown. More recently, Brocher (1985a) proposed a progressive reversal along the Vitiaz Trench Lineament from west to east beginning in the Late Miocene and ending in the Late Pliocene (around 3 Ma). The Vitiaz Trench Lineament was also considered to be the site of transform motion between the Pacific and Australian plates (Fairbridge and Stewart, 1960; Udinstev *et al.*, 1974).

During Leg 3 of the SOPACMAPS program in September-October 1993, two areas along the Vitiaz Trench Lineament were surveyed by the French R/V L'ATALANTE (IFREMER, 1994) (Figures 1 and 2). We present here the swath bathymetry and seismic reflection data obtained during the survey. The first study area is located north of the Rotuma Trough on a series of banks of the Melanesian Border Plateau belonging to the Tuvalu's EEZ. The second area is centred on the Alexa Trough and the southeastern end of the Vitiaz Trench.

## Geological Setting and Previous Works

### The domain north of the Vitiaz Trench Lineament: the Pacific crust and the Melanesian Border Plateau

The Pacific crust immediately north of the Vitiaz Trench Lineament is considered to be formed during the upper Cretaceous magnetic quiet zone (110 to 80 Ma). A tholeiitic basalt sample, recovered on a fault scarp (3400–4000 m) northeast of Niulakita Island (Sinton *et al.*, 1985), yields a Ar/Ar age of 83 Ma (Duncan, 1985) which is in agreement with the inferred age of the oceanic crust in the region.

A series of volcanic seamounts, ridges, banks and islands on the Pacific oceanic crust parallels the Vitiaz Trench Lineament from 173°30′ E to 176° W and forms the main part of the so-called Melanesian Border Plateau (Fairbridge and Stewart, 1960). Because these highs are either located in the continuation or at the junction of different volcanic chains (Figure 1), their origin, still largely unknown, is likely not unique and could be related to various plate tectonic processes (Brocher, 1985b).

The Samoan Chain extends WNW–ESE from the Samoan Islands and includes numerous islands and banks (Figure 1). The geochemical character of the Samoan Islands volcanism (shield-building alkalic and tholeiitic basalts covered by late Quaternary to historic post-erosional nephelinitic lavas: Stearns, 1944; Mac Donald, 1944; Hawkins and Natland, 1975; Natland, 1980) appears to extend westward to Combe Bank (Brocher 1985b; Duncan, 1985; Sinton *et al.*, 1985; Natland and Turner, 1985; Johnson *et al.*, 1986). Increase of age of this shield-building volcanism along the chain with a rate of $7.7 \pm 2.5$ cm per year supports the idea that the Samoan Chain has been generated by hotspot (Hawkins and Natland, 1975; Natland, 1980; Natland and Turner, 1985) which is now 100 km east of Samoan Islands (Duncan, 1985). Wallis Islands located on the western part of the Samoan Chain (Figure 1) are composed of Quaternary (less than 0.8 Ma) tholeiitic and alkalic basalts likely resting on an older shield (Stearns, 1945; Sinton *et al.*, 1985; Duncan, 1985; Price *et al.*, 1991). Although these Pleistocene basalts are similar to shield lavas of the Samoan Islands, they are too young to be related to the Samoan hotspot and are thought to be derived, like the post-erosional undersaturated volcanism of the Samoan Islands, from peculiar deformation along the hinge fault and the transform plate boundary at the northern tip of Tonga subduction zone (Hawkins and Natland, 1975; Natland, 1980; Price *et al.*, 1991).

The NNW–ESE trending Tuvalu Chain 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 (Epp, 1978).

The origin of the ENE–WSW trending Robbie Ridge is still debated. Watts *et al.* (1980) proposed that the Robbie Ridge was formed on or close to a spreading center in the Cretaceous, while Brocher (1985b) considered the Robbie Bank to be post-Cretaceous and to be possibly part of the Samoan Chain.

These three chains converge in the central part of the Melanesian Border Plateau forming numerous highs and banks (Tuscarora, Hera, Bayonnaise, Martha, Kosciusko and Macaw Banks) (Figure 1). Further west, the Melanesian Border Plateau is composed of the Eaglestone Ridge and the Alexa and Charlotte Banks. Watts *et al.* (1980) proposed that Eaglestone Ridge and Alexa Bank formed off-axis after the Cretaceous. A basalt dredged from Alexa Bank has tholeiitic to transitional alkalic affinity and is broadly similar to shield lavas from the Samoan Islands (Sinton *et al.*, 1985). However its age of 36.9 Ma is too old to be related to the Samoan hotspot volcanism (Duncan, 1985). Alexa Bank may have formed on Cretaceous Pacific seafloor during an episode of latest Eocene mid-plate volcanism.

## The Domain south of the Vitiaz Trench Lineament: the fragmented Vitiaz Arc and the North Fiji Basin

This domain corresponds to the oceanic crust of the North Fiji Basin formed during complex back-arc opening since the late Miocene (Chase, 1971; Gill and Gorton, 1973; Falvey, 1975 and 1978; Malahoff *et al.*, 1982; Brocher, 1985a; Auzende *et al.*, 1988; Price and Kroenke, 1991; Pelletier *et al.*, 1988 and 1993; Auzende *et al.*, 1995; Lagabrielle *et al.* this volume). This opening accompanied the arc reversal and initiation of subduction along the New Hebrides Trench, the outward migration and clockwise rotation of the New Hebrides and Tonga Arcs, and the anticlockwise rotation of the Fiji Platform (Falvey, 1978; James and Falvey, 1978; Malahoff *et al.*, 1982) resulting in a dismemberment of the upper Oligocene to middle Miocene Outer Melanesian Arc or Vitiaz Arc now exposed in the arc rock suites of Viti Levu in Fiji (Gill *et al.*, 1984; Rodda and Kroenke, 1984: Whelan *et al.*, 1985; Rodda, 1994) and of the western belt of the New Hebrides Arc (Carney *et al.*, 1985; Macfarlane *et al.*, 1988).

Volcanic edifices with uncertain or unknown geochemical affinity, age and origin lie in the northern North Fiji Basin and forms the southern boundary of the Vitiaz Trench Lineament. They are listed in the following order from west to east (Figure 1).

- A series of highs, banks and islands, including Anuta and Fatutaka (or Mitre) Islands, Strathmore Shoal and Pandora, Hazel Holme and Horizon Banks, lie south of the Vitiaz Trench. Island-arc basaltic andesite lavas and agglomerates on Anuta and Fatutaka Islands and uncertain midde Miocene (12.5 Ma) and more reliable late Pliocene (2.2 Ma) ages for Fatutaka have been reported and interpreted as part of the Vitiaz Arc (Jezek *et al.*, 1977; Hughes, 1978).
- Quaternary alkalic volcanism is present on Rotuma Island (Sinton *et al.*, 1985; Woodhall, 1987) located on the eastern tip of the NE–SW trending Rotuma Ridge. This volcanism is correlated with active extension along the South Pandora Ridge on the North Fiji Basin, or local extension along the Vitiaz suture zone during recent plate reorganization (Sinton *et al.*, 1985).
- Volcanics of possible island arc-affinity (Sinton *et al.*, 1985) and dated as latest Pliocene (1.8 Ma: Duncan, 1985) have been recovered from the Manatu Seamount, southeast of Rotuma Trough.
- Lower Pliocene (4.9 Ma: Duncan, 1985) tholeiites with island arc affinity (Sinton *et al.*, 1985) have been dredged on the northern flank of the Horne Islands (Futuna and Alofi Islands), south of the Horne Trough, and are interpreted to reflect subduction along the Vitiaz Trench (Sinton *et al.*, 1985). A geological study of the Horne Islands (Grzesczyk *et al.*, 1987 and 1991) reported two upper Pliocene volcanic series capped by Quaternary reef limestones: 1. submarine tholeiitic basalts and basaltic andesites with first back-arc and then island arc affinities; 2. alkali-enriched tholeiites and transitional basalts of latest Pliocene in age.

The volcanism-type change in Horne Islands coincides with the change at 3–2 Ma in Fiji and Lau volcanism from subduction island arc tholeiites to tensional-rifting alkali basalts reported by Gill *et al.* (1984), Cole *et al.* (1985) and Whelan *et al.* (1985), and is correlated with a major plate reorganization at the northern tip of the Tonga Trench from convergence (Vitiaz-Tonga subduction) to left-lateral transform motion (Fiji Fracture Zone) (Grzesczyk *et al.*, 1991).The Fiji Fracture Zone, which northward bounds the Fiji Platform and connects the end of the Tonga Trench to the N–S trending spreading ridges of the North Fiji Basin (Figure 1), is a left-lateral transform zone with pull-apart basins (Hamburger *et al.*, 1988; Pelletier and Louat, 1989; Hughes Clarke *et al.*, 1993) and has to be regarded as a major active tectonic element of the SW Pacific.

## The Vitiaz Trench Lineament

The eastern (Alexa, Rotuma and Horne Troughs) and western (Vitiaz Trench) parts of the Vitiaz Trench Lineament partly described by Fairbridge and Stewart (1961), Udinstev *et al.* (1974) and Halunen (1979) have been more recently surveyed by Brocher and Holmes (1985) and Pelletier *et al.* (1988 and 1993), respectively.

The Vitiaz Trench is a more than 600 km-long depression extending from 8°30′ S at the northern tip of the North Fiji Basin to 12° S east of Pandora Bank. The depth of the trench, which is mainly more than 4500 m, reaches a maximum of 5600 m. The trench appears composed of NW–SE trending segments left laterally offset by E–W trending features. However these trends have to be taken with care because they are only based on 10 mile-spaced bathymetric profiles. The trench floor is flat and is underlain by 0.2–0.3 s thick sediments. The shape of the trench is almost symmetric and the water depths on each side of the trench are quite similar. Between 167 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 parallel to the trench, and by a NW–SE elongated rise culminating to 3200 m depth. The southern flank of the trench is in general steeper than the northern flank. A narrow and discontinuous ridge parallels the different segments of the trench to the south. No large structure, which could be interpreted as a volcanic arc, extends along its southern flank, especially north of 11° S. However, from 12 to 11° S, large volcanic edifices adjacent to the trench could be regarded as pieces of the fragmented Vitiaz Arc.

The structure of Alexa, Rotuma and Horne Troughs distributed along the eastern part of the Vitiaz Trench Lineament, which extends from 174° E to 176° W, were addressed by Brocher (1985a). Alexa Trough (4000 m-deep) strikes WSW–ENE and lies south and west of the Alexa Bank and north of the Rotuma Island and Ridge (Figure 1). Rotuma Trough is a curved trough, composed of two parts (Figure 1). In its western part, it is narrow, 4000 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 (4800 m-deep) and trends NE–SW between the Alacrity and Hera banks to the north and a bathymetric high in the south including the Arabis seamount and Rotuma shoal (also called Manatu seamount by Brocher and Holmes (1985). The Horne Trough (4600 m-deep) trends E–W and extends west of Wallis Island and north of Horne Islands. Brocher (1985a) proposed that the Vitiaz 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, the inner (southern) wall is steeper and is generally flanked to the south by a structural high. The eastern part of the lineament is, as the Vitiaz Trench, characterized by lack of well-defined forearc and magmatic arc south of it. Brocher (1985a) proposed a progressive reversal of Vitiaz subduction from west to east since the late Miocene and a cessation of the subduction around 3 Ma.

## Geophysical Data

Swath bathymetry, sonar imagery, seismic reflection, 3.5 Khz sub-bottom profiler, magnetic and gravity data were collected during the survey. The swath mapping system mounted on the R/V L'ATALANTE is the SIMRAD EM12 Dual system composed of two low frequency (13 Khz) multibeam (81 beams) echo sounders providing from shallow to full ocean depths a swath coverage up to 7.4 times the water depth or 22 km, capabilities varying with different bottom conditions. In addition to wide swath bathymetry, the system provides co-located and geometrically-corrected sonar image of the seabed reflectivity. The survey was realized at 9–10 knots. The orientation of the profiles was chosen parallel to the main structural trends to optimize the bathymetric survey. Bathymetric maps presented in this paper were produced using TRISMUS software from IFREMER.

The high-speed seismic reflection data were obtained using a 300 m-long, 6-channel streamer, and two 75 cubic inches, SODERA G.I. guns which were operated in air gun mode and fired every 10 s. The sections shown in this paper are single-channel sections displayed for real-time control on a Dowty thermal recorder after the data have been filtered (25–125 hz) and sampled at the rate of 0.25 ms. Interpretation of the seismic profiles is somewhat difficult because the profiles were oriented parallel to the main structural trends.

## Results of SOPACMAPS Cruise

### The area north of the Rotuma Trough

The first studied area is almost entirely located on a series of banks in the southern part of the EEZ of Tuvalu, immediately north of the Vitiaz Trench Lineament (Figures 1 and 3). However, a small portion of the Rotuma Trough, a segment of the lineament, has also been surveyed. The main morphological and structural characteristics of these two domains will be described below.

*The South Tuvalu Banks Province*

This region is composed of a series of large bathymetric highs and banks, referenced here as the South Tuvalu Banks, delimiting flat bottom basins ranging in depth from 2550 to 4000 m. The whole province, belonging to the central part of the Melanesian Border Plateau, is elevated about 2000 m from the 5000–5500 m-deep Pacific Ocean floor. Although some of the banks had been previously reported, our

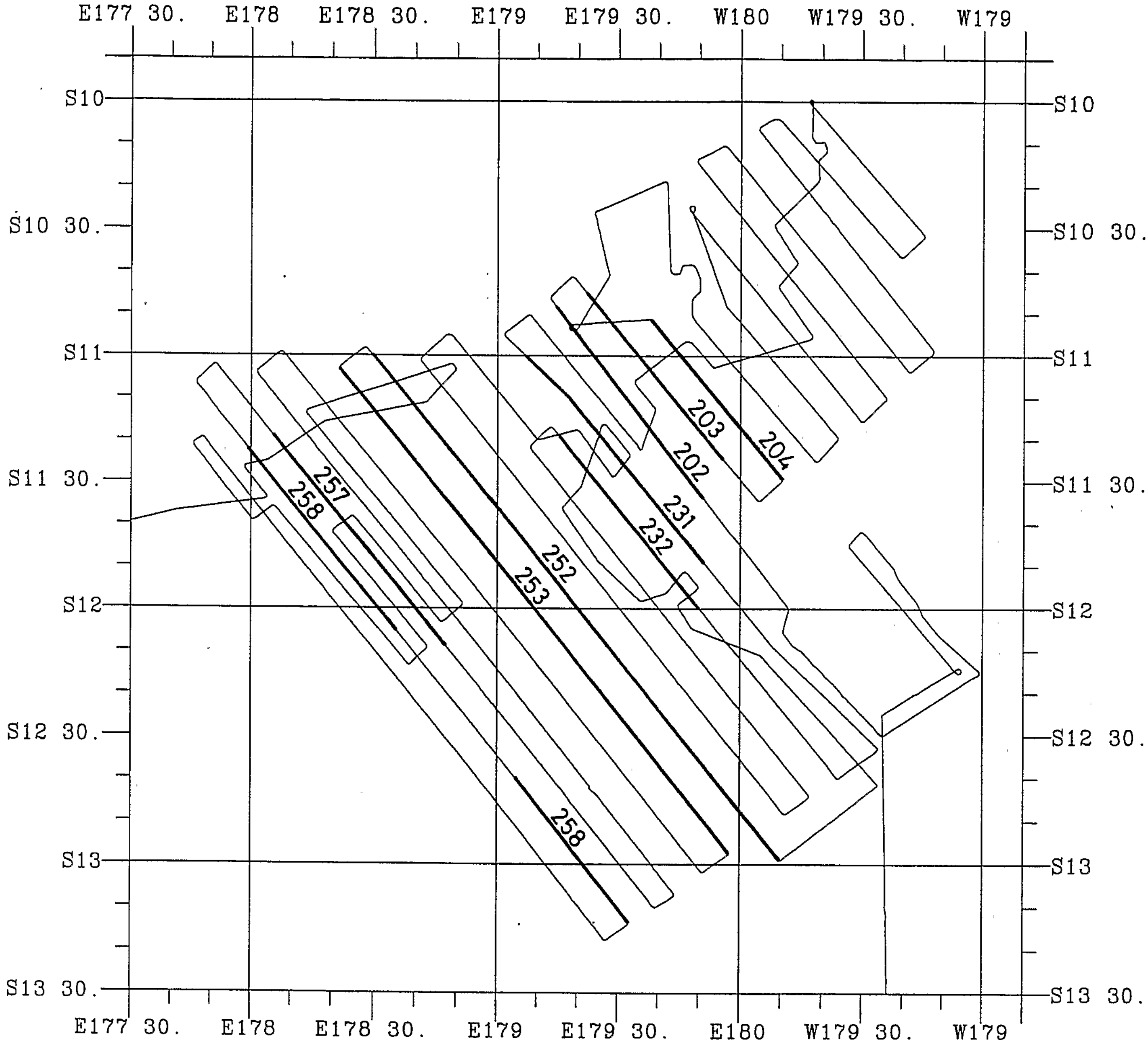



Fig. 3. Location map of the surveyed area north of the Rotuma Trough, and identification of profiles. The heavy lines indicate the portion of seismic reflection profiles shown in figures 6, 7, 8, 9 and 12.

survey (Figure 3) allow us to precisely locate them and define their shape (Hera-Bayonnaise Banks, Kosciusko-Martha Banks with Niulakita Island, Eaglestone Plateau), to definitively discard some mislocated banks (eight unnamed peaks ranging in depth from 18 to 40 m reported northeast and west of Hera-Bayonnaise Banks and between Niulakita Island-Martha bank and Macaw Bank), and to discover new seamount chains (Luao Seamounts, South Kosciusko-Martha Seamounts, North Eaglestone Seamounts) (Figure 4).

The geometry of the seamounts, guyots, and banks of the South Tuvalu Banks appear to be controlled by two conjugate structural orientations trending respectively NW–SE (N 140°–150°) and ENE-WSW (N 60°) (Figures 4 and 5). The Hera-Bayonnaise Banks consist of a 120 km-long, 13 to 45 km-wide, N 140° trending guyot. Its summit is flat and 40 m-deep (Japan Interna-

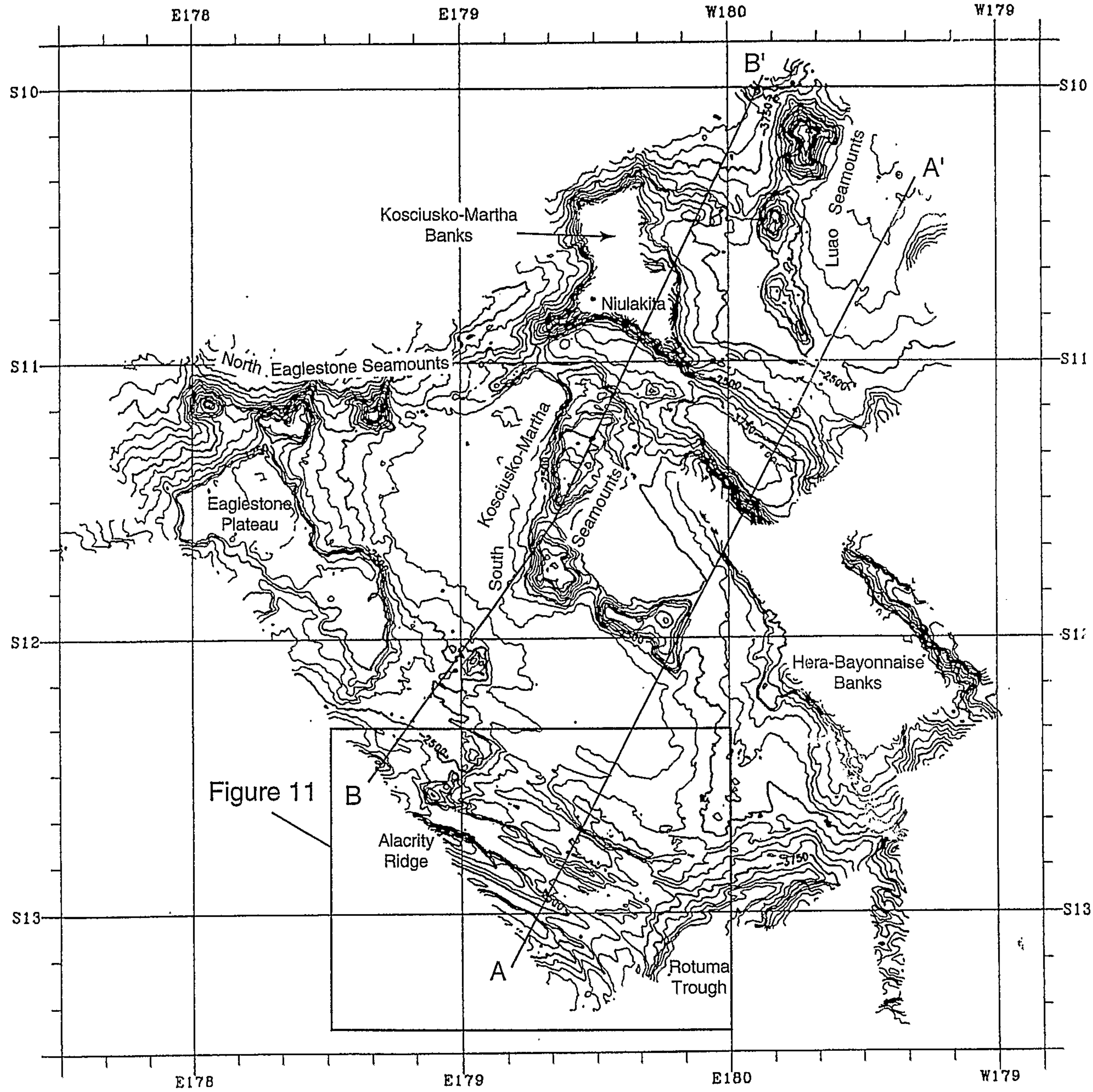



Fig. 4. Multibeam bathymetry of the area north of the Rotuma Trough. Contour interval is 250 m. The two cross sections labelled A-A′ and B-B′ are shown in Figure 10.

tional Cooperation Agency, 1989) with peaks at 18 m (hydrographic chart). Its steep eastern flank is delineated south of 11°45′ S by en echelon N 130° to N 120° trending scarps and north of 11°45′ S by a unique 3200 m-high, N 140° trending scarp. The Kosciusko-Martha Banks, topped by the Niulakita Island and several reported shoals at 18 to 26 m, consist of a 65 km-long and 20 to 30 km-wide guyot delineated by N 140°–160° and N 60° trending scarps. North of a N 65° trending transverse ridge, on which Niulakita Island is located, the western and eastern flanks of the bank are cut by faults trending, respectively, N 60° and N 90°–100°. Transverse graben possibly separates the Kosciusko Bank to the north from the Martha Bank to the south. The newly discovered Luao Seamount chain is composed of three en echelon volcanic edifices,

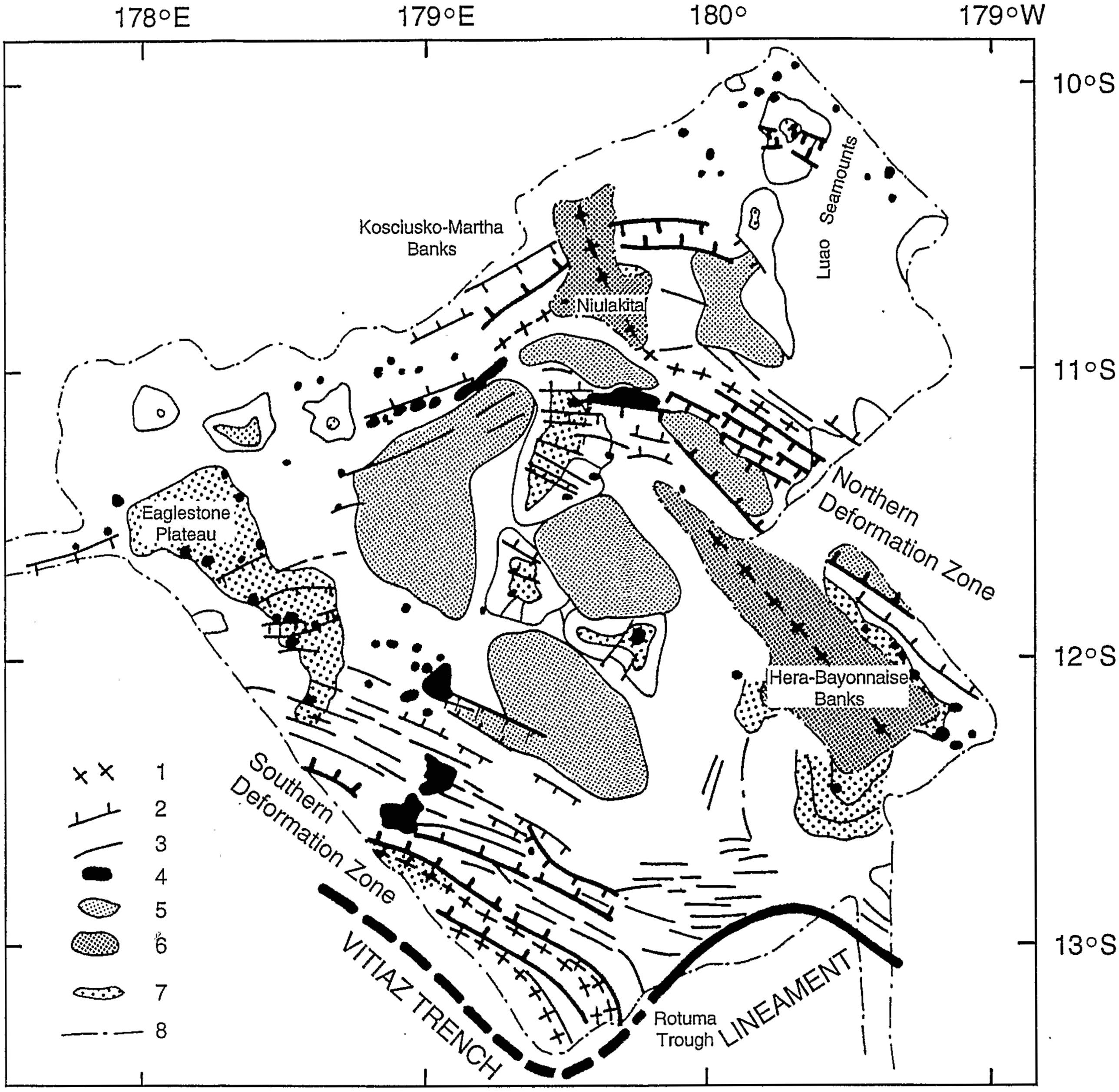



Fig. 5. Structural interpretation of the area north of the Rotuma Trough. 1: ridge; 2: normal fault; 3: structural trend; 4: recent volcanism; 5: basin; 6: bank; 7: terrace; 8: limit of the survey.

along N150° and NE–SW trending structural directions. The chain shallows northward, the depths of the summits being respectively 1500, 750 and 20 m. The eastern flank of the northern seamount, the Luao Bank, shows a major reentrant along N120° trending scarps. The Eaglestone Plateau, delineated by a 500 to 1500 m-high continuous scarp, is a 100 km-long, 18 to 50 km-wide and N150° trending plateau. It deepens southward and is divided into three main blocks by N 60°–70° trending transverse faults (Figures 4 and 5). The northern part of the plateau, bounded in the north by a linear N 60° scarp, is flat at 750 m depth, while the central and southern parts are at about 1000 and 1100 m depth, respectively.

Several terraces indicating large vertical subsidence have been recognized on the South Tuvalu banks

(Figures 4 and 5). A general terrace at the depth 750 m, especially well marked in the acoustic imagery by a continuous and mid-grey reflectivity, has been observed on most of the guyots (Luao Seamounts, South Kosciusko-Martha Seamounts, Eaglestone Plateau) or along the scarps of the banks (Hera-Bayonnaise Banks, Kosciusko-Martha Banks and Luao Bank). Seamounts north of the Eaglestone plateau are, however, flat topped guyot at 650 m. Deeper terraces at 1000, 1250 and 1400 m also exist on the southwestern extension of the Hera-Bayonnaise Banks, the South Kosciusko-Martha Seamounts, and the Eaglestone Plateau, and are interpreted as collapsed parts of the 750 m-deep terrace caused by relatively recent tectonics (see below).

Seismic reflection data indicate that the South Tuvalu Banks are underlain by a thick sedimentary section. A 0.4–0.6 s-thick sequence is observed on the South Kosciusko-Martha Seamounts (Figure 6: profiles 202 and 231) and the southwestern extension of the Hera-Bayonnaise Banks. On the Eaglestone Plateau (Figure 7), a 0.2–0.3 s-thick flat sequence (locally tilted, see below) unconformably overlies a 0.3–0.5 s-thick series of reflectors with an apparent dip toward the southeast (northern part of the plateau) or the northwest (southern part of the plateau).

The bank and seamount chains delimits several basins which have depths of 2550, 3200 or 4000 m. The sedimentary sections vary largely from basin to basin and range in thickness from at least 0.5 to 1.4 s. The enclosed basins have the thickest sedimentary sections which are mainly derived from the erosion of the volcanic edifices. Generally, the sedimentary section can be divided into three units separated by unconformities. An upper unconformity observed in most of the basins is overlain by 0.1 to 0.3 s-thick unit (Figure 8: profiles 252 and 253; Figure 9: profile 204). This unit is restricted to the flat central part of the basins and is likely composed of turbiditic deposits supplied by the neighbouring canyons which cut the basin's slopes. A deeper unconformity in the 2550 m-deep enclosed basin northwest of Hera-Bayonnaise Banks is observed at 0.5 to 0.6 s below the seafloor (bsf) (Figure 6: profile 232). This older unconformity possibly resulted from emplacement of the volcanic edifices.

*Recent Tectonism and Volcanism*

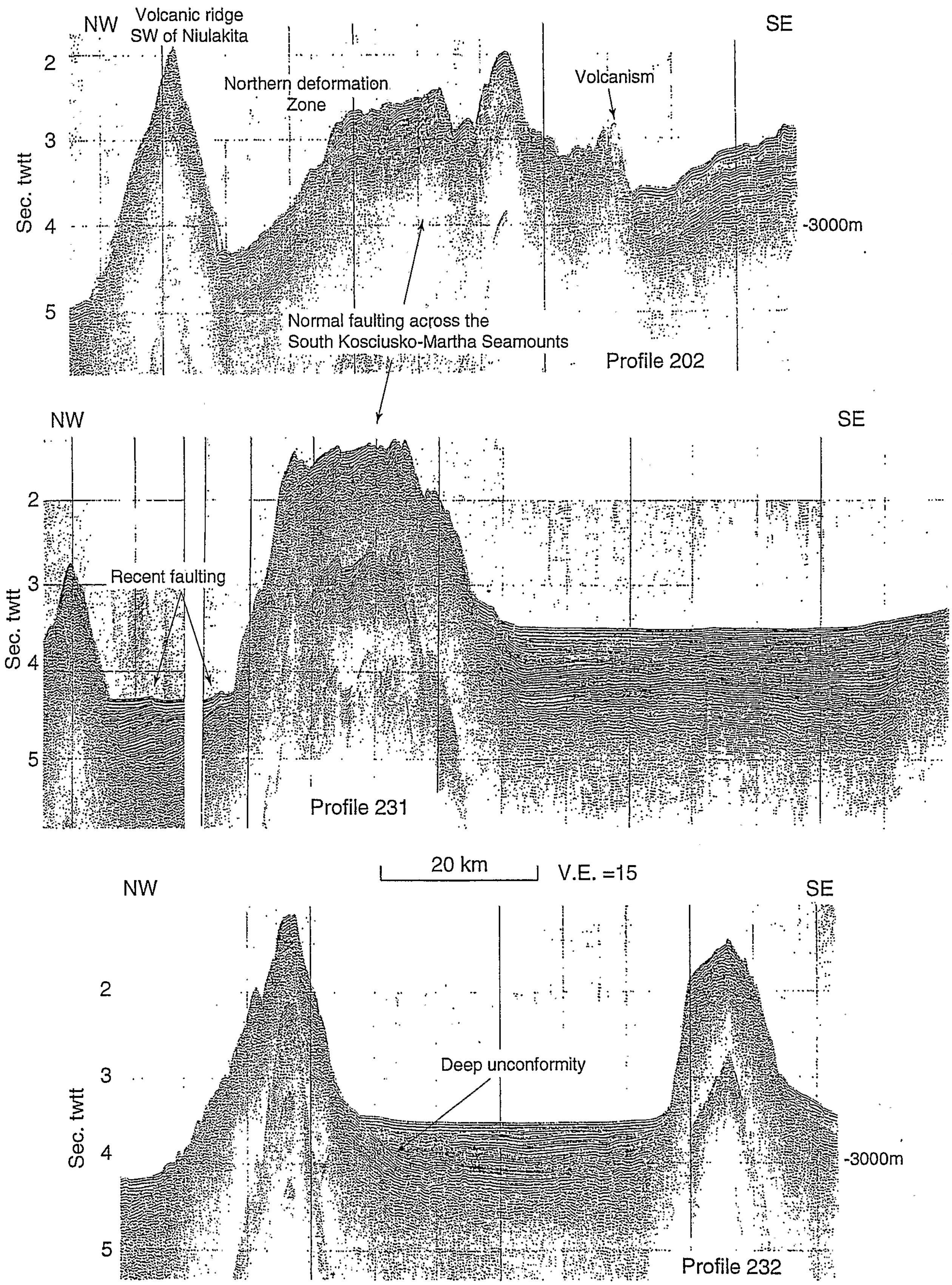
The South Tuvalu Banks province has been subjected to intense and relatively recent normal faulting and volcanism. The deformation is mainly localized in two parallel zones which strike N 120° and turn to E–W and ENE-WSW toward the northwest (Figures 4, 5 and 10).

The northern deformation zone is about 50–60 km-wide and follows the abnormally deep basin between the Hera-Bayonnaise Banks and the Kosciusko-Martha Banks, underlined by large negative gravity anomaly reaching –90 mgal (SOPACMAPS data: IFREMER, 1994). The sedimentary infilling of the basin is deformed by gentle folding (Figure 9). The basin is divided in two parts by an E–W, south facing scarp associated with a volcanic massif (Figure 9). The southeastern part of the basin reaches 4000 m of depth at the foot of the steep northern scarp of Hera-Bayonnaise Banks and is bounded to the north by a horst-like ridge affected by N 120° trending parallel normal faults. The northwestern part of the basin is 3250–3400 m deep at the foot of the southern scarp of the Kosciusko-Martha Banks and is bounded in the south by the northern guyot of the South Kosciusko-Martha Seamounts which is collapsed from 1000 m to 1500–2000 m along N 120° to EW trending faults (Figure 6: profiles 202 and 231). Further northwest this deformation zone turns and includes ENE–WSW trending volcanic ridges southwest of Niulakita Island and ENE–WSW faults cutting all the sedimentary section in the adjacent basin (Figure 5, Figure 6: profile 231; Figure 8: profile 252). The transverse fractures across the Kosciusko-Martha Banks are also interpreted as being part of this tectonic corridor.

The southern deformation zone of about 100 km-wide is located immediately north of the Rotuma Trough and is documented by the tilt and collapse of the Eaglestone Plateau and by a N 120° trending spectacular structural fabric resulting from intense normal faulting (Figures 4, 10 and 11). From northeast to southwest, the tectonic fabric is composed of:

a) small amplitude grabens, horsts and tilted block facing SSW (50 to 300 m-high scarps) across a 3150 m-deep flat basin (Figure 8: profile 253);
b) a 10 km-wide 3500–3750 m-deep graben bounded by a 1000–1250 m-high scarp in the north and a 750 m-high scarp in the south;
c) then a series of tilted blocks facing NNE along 750 to 1800 m-high scarps, at the foot of which elongated flat basins are developed. Seismic reflection data indicate (Figure 12: profiles 258) that a 0.4 thick sequence constituting the SSW continuous

Fig. 6. Selected part of single-channel seismic profiles across the South Kosciusko-Martha Seamounts and the northern deformation corridor. Note the deep unconformity on the Profile 232 and the tilting of the seamounts and the recent faulting and volcanism (Profile 202, 231). Location of the lines is shown in Figure 3.


NW
Volcanic ridge
SW of Niulakita
SE
Northern deformation
Zone
Volcanism
Sec. twtt
2
3
4
5
-3000m
Normal faulting across the
South Kosciusko-Martha Seamounts
Profile 202
NW
SE
Recent faulting
Sec. twtt
2
3
4
5
Profile 231
20 km
V.E. =15
NW
SE
Deep unconformity
Sec. twtt
2
3
4
5
-3000m
Profile 232

slope of the tilted blocks is unconformably overlain by 0.1 to 0.4 s-thick sequence which is restricted to the elongated basins and is also affected by normal faulting. The geometry of the sequences suggests a turbiditic origin for the upper sequence and the succession of several tectonic episodes of normal faulting. The different tilted blocks and basins slowly deepen along-strike toward the ESE but shallow perpendicularly toward the SSW. The minimum recorded depth is 1100 m (Alacrity Ridge) and the depth of the three main elongated basins is 3550–3750, 2900–3100 and 2750 m from NE to SW. This configuration suggests that normal faulting sliced a preexisting high or bank. The structural fabric includes some N 150° trending scarps which appear as relay zones along the main N 120° scarps. Since they parallel the main trend of the neighbouring highs and banks they could represent parts of the contour of this dismembered high. The normal faulting zone extends to the northwest across the Eaglestone Plateau and turns progressively to the ENE–WSW. The southern termination of the Eaglestone Plateau is collapsed along N 120° trending normal faulting fabric. At 11°55′ S, ENE–WSW to E–W trending normal faults cut the Plateau in a 200–300 m-deep graben. At 11°45′ S, the flat summit of the plateau is tilted southward along a N 60° fault (Figures 5 and 7: profile 258).

Cone-shaped edifices interpreted as volcanoes are frequently observed either on the summits of the highs and banks or in the basins (Figures 4 and 5). These include: a 800 m-high, E–W massif obstructing the deep basin between Hera-Bayonnaise and Kosciusko-Martha Banks (Figure 9: profile 203); ENE–WSW trending volcanic ridges extending SW of Niulakita Island; a N 50° trending volcanic line at 12°30′ S–179° E transverse to and obstructing the N 120° trending tectonic fabric; a 8 km in diameter, 400 m-high cone located on the 1350 m deep-terrace of the southern guyot of the South Kosciusko-Martha Seamounts; numerous 2–3 km in diameter, 50 to 250 m-high cones on the top of the Eaglestone Plateau along the transverse flaults (Figure 7: profile 258), on the terraces along the eastern and western flanks of the Hera-Bayonnaise Banks, on the southeastern lower slope of the Eagleastone Plateau, and in the basins east and west of the Luao Bank. This volcanism pierces the sedimentary cover and is closely associated with faults in the two zones of deformations. These cones are thus interpreted as relatively recent volcanism synchronous with or immediately post-dating the normal faulting.

*The Rotuma Trough*

The western part of the Rotuma Trough lies immediately southwest of our survey and parallels the N 120° trending southern zone of deformation. Only the eastern part of the Rotuma Trough has been mapped and is restricted to the southeasternmost part of the survey (Figures 4 and 5). From 179°45′ E to 179°50′ W, it corresponds to a NE–SW trending narrow and flat bottom trough at a depth of 4800–4900 m. East of 179°50′ W, the trough shortens, turns E–W then NW–SE and shallows up to 2700 m at 179°20′ W. West of the 179°50′ E the lower part of the northern wall of the trough is characterized by N 130° to N 160° trending ridges which form curvilinear features with the N 120° trending normal faulting fabric previously described (Figures 5 and 11). From 179°50′ E to 179°35′ W, the lower part of the northern wall is characterized by E–W trending scarps oblique to the trough. The upper part of the northern wall shows N–S to N 20° trending scarps. Although poorly mapped the southern wall of the Rotuma Trough appears, from 179°50′ E to 179°35′ W, steeper than the faulted and sedimented northern flank (Figures 5 and 8: profile 252). East of 179°35′ W, the northern wall of the trough is marked by N 120° trending scarps on the southern flank of the massif rising up to 950 m. The eastern part of the Rotuma Trough corresponds to a large turn of the Vitiaz Trench Lineament. Structures developed along its northern wall suggest strike-slip motion along this NE–SW trending segment.

## The Southern Part of the Vitiaz Trench and the Alexa Trough

On the basis of morphological, structural and geophysical evidences, the second surveyed area (Figure 13) can be divided in three provinces: the Alexa and Charlotte Banks province in the north, the Vitiaz Trench Lineament including the Vitiaz Trench and the Alexa Trough, and the Pandora-Hazel Holme Banks province in the south.

*The Alexa and Charlotte Banks Province*

This region is characterized by very rough topography, mainly due to volcanic construction, and is marked by a pervasive structural direction trending N 130° to N 100°. The major topographic highs are the Alexa Bank area in the east and the Charlotte Bank area in the west (Figures 14 and 15).

The Alexa Bank area, referenced in the following as the Alexa Bank, is a series of shallow water (13 to 21 m) banks with flat summit, and includes from east to west Morton Bank, Louisa Bank, Turpie Bank,

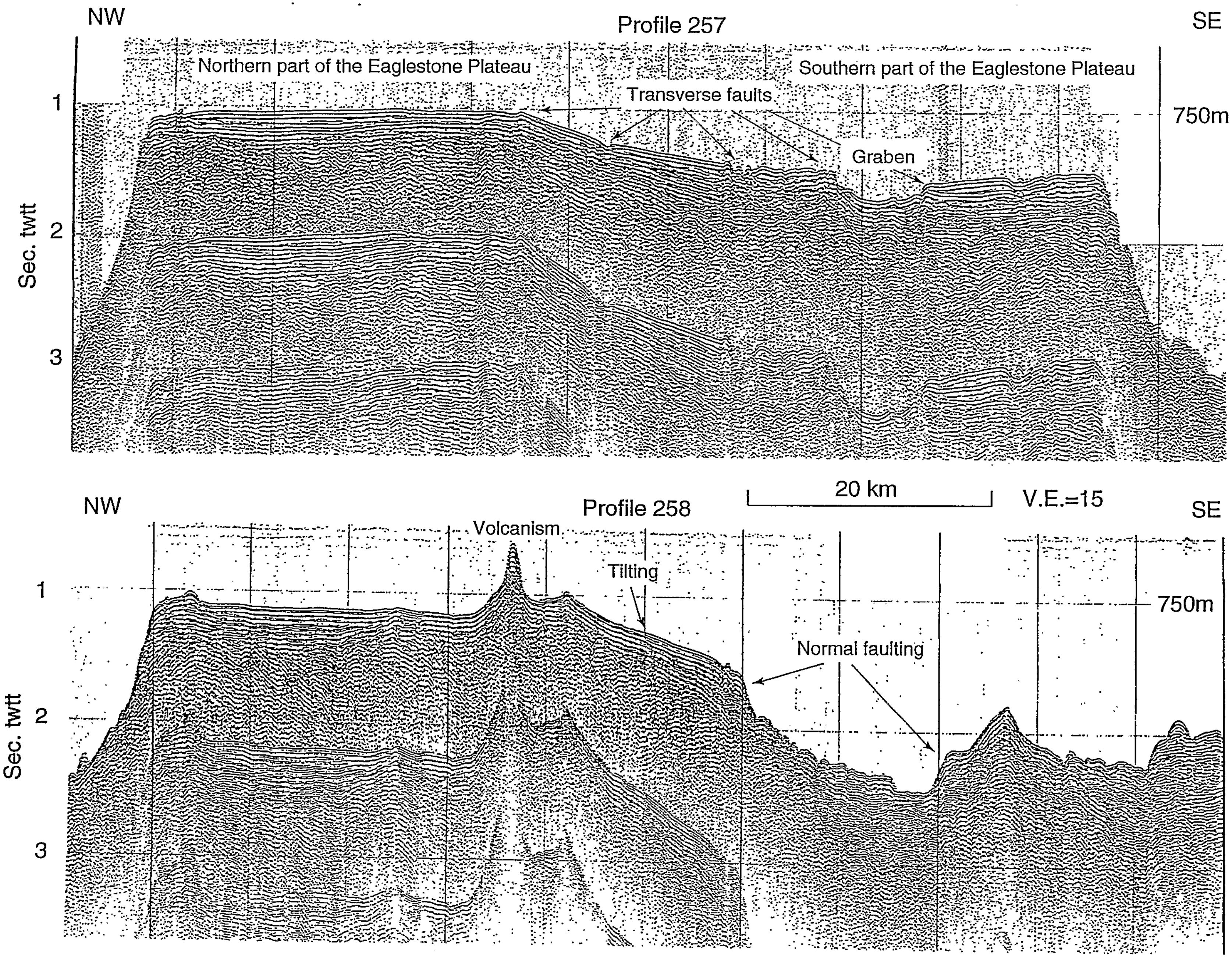



Fig. 7. Selected single-channel seismic reflection profiles across the Eaglestone Plateau. Note the two sedimentary sequences on the plateau and the tilting and normal faulting associated with intrusion. Location of the lines is shown in Figure 3.

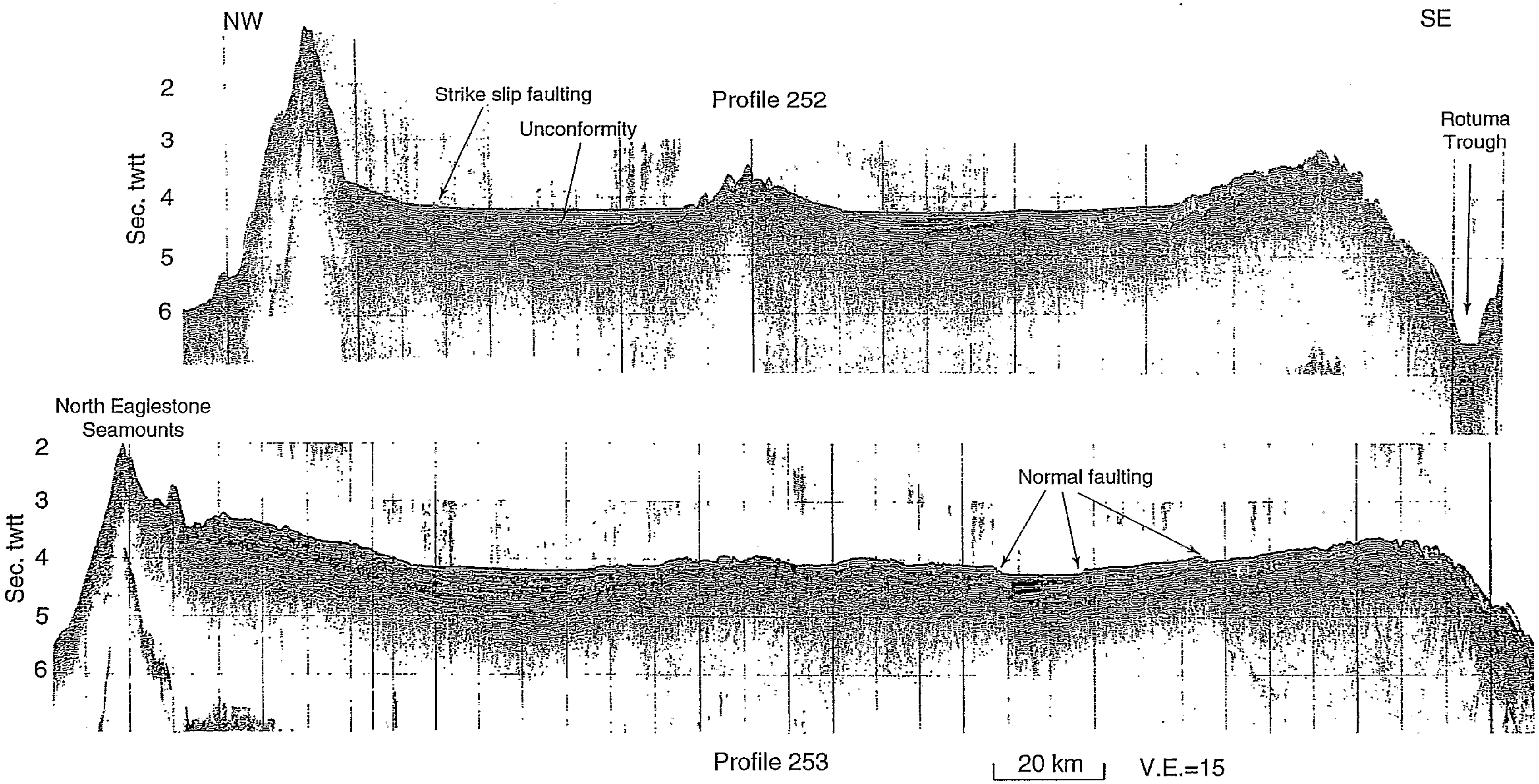
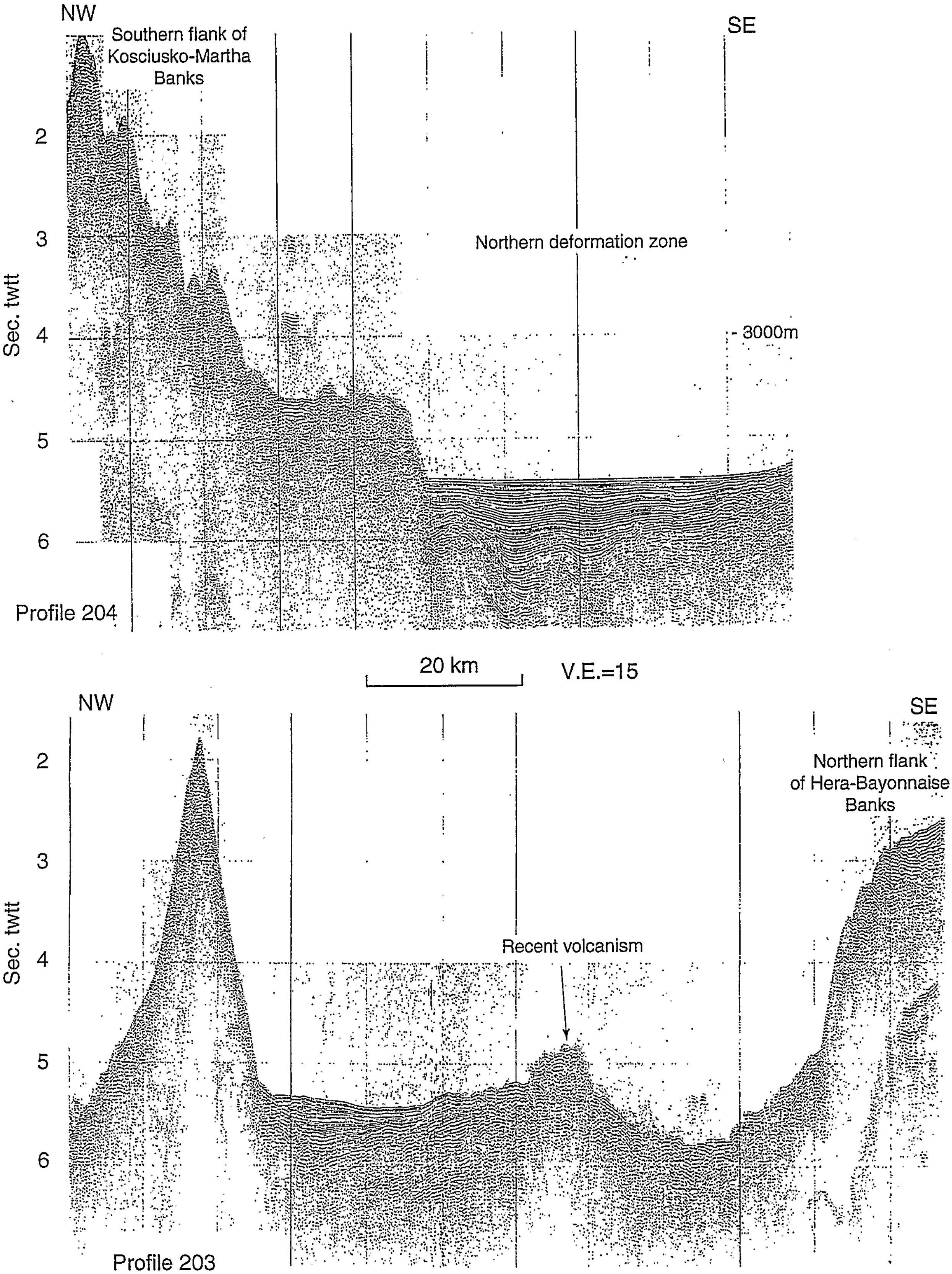



Fig. 8. Selected single-channel seismic profiles across the entire area. Note from right to left, the bulge and normal faulting close to the Vitiaz Trench Lineament, the unconformity at 0.2–0.3 s bsf in the basins, and the recent faulting and volcanism. Location of the lines is shown in Figure 3.


NW
Southern flank of
Kosciusko-Martha
Banks
SE
Northern deformation zone
- 3000m
Sec. twtt
2
3
4
5
6
Profile 204
20 km
V.E.=15
NW
SE
Northern flank
of Hera-Bayonnaise
Banks
Recent volcanism
Sec. twtt
2
3
4
5
6
Profile 203

Penguin Bank and Alexa Bank (Fairbridge and Stewart, 1960). The only previously surveyed bank is the Alexa Bank, which has a saucer-shaped top of a drowned atoll and is considered to have been an atoll in Pleistocene time (Fairbridge and Stewart, 1960). The Alexa Bank extends over 150 km, its width decreasing toward the east from 65 km to 20 km (Figure 14). The overall shape of the Alexa Bank appears to be controlled by two main directions trending respectively, N 120° and N 60°. A large flat terrace at the depth of 750 m has been identified on the eastern part of the bank. The southern flank of the bank is outlined by a steep 2000–3000 m-high scarp, and shows from 176° E to 175°35′ E a N 120° trending large reentrant. The northern flank is composed of a steep upslope (1000–1500 m-high scarp) and a regular lower slope characterized by numerous thalwegs.

The Charlotte Bank area, found in 1788, is composed of numerous shoals (18 to 40 m of water depth) which had been mainly reported in 1945 along a 100 km-long and 50 km wide E–W trending zone. However, the precise location and the shape of the Charlotte Bank were unknown before the SOPAC-MAPS cruise. In fact, the size of the Charlotte Bank does not exceed 80 km in length and 20 km in width. Its general orientation is nearly E–W. However, the morphology of the flanks reveals N 120°–130° and N 60° trending scarps, suggesting that the bank is likely composed, as the neighbouring area, of successive WNW–ESE ridges. Like the Alexa Bank, the southern flank of the Charlotte Bank is steeper and larger than the northern flank, the scarp reaching 4000 m of height.

The whole domain located between and around Alexa and Charlotte Banks can be described as several series of en echelon volcanic ridges orientated N 120° to N 100°, which enclose basins ranging in depth from 2500 to 4250 m (Figures 14 and 15). The western tip of the Alexa Bank is prolongated by a volcanic ridge that extends 150 km westward up to the north of the Charlotte Bank. In detail, this ridge is composed of five WNW–ESE trending 35 km-long segments. The morphology of the ridge is controlled by well-marked N 120° trending scarps and a secondary N 50°–60° trending structural direction. North of this ridge and in the northernmost part of the surveyed area, a 17 km-wide, 2.5 km-high and circular volcano rises to less than 700 m and is associated with six minor edifices of about 1.8 km in diameter. E–W and WNW–ESE trending volcanic ridges also lie south of the Charlotte Bank. Seismic reflection data reveal that, west–northwest of the Alexa Bank, a 0.6–0.7 s-thick sedimentary sequence, which likely corresponds to a large apron around the bank, is tilted, normal faulted and intruded by numerous volcanic ridges and peaks (Figure 16: profile 285 and 286). Shapes of the edifices and their relationship with the sedimentary section indicate that these volcanic manifestations are not very old.

The two large banks and the different ridges delimit several enclosed and flat bottom sedimentary basins. The deepest basin lies immediately along the southern flank of Charlotte Bank (Figure 14); it reaches a water depth of 4250 m and is 60 km-long. The largest basin (4000 m deep) is located between Alexa and Charlotte Banks, and is divided in two parts by a 1750 m-high and tight volcanic ridge that trends NW–SE (Figure 15). This basin is bounded in the southeast by a N 30° trending, 750 m-high scarp which delineated the northern boundary of a plateau at 3250 m of water depths. Sedimentary thickness in these enclosed basins reaches at least 0.8 to 1.2 s, the thickest sequence is observed in the basin south of Charlotte Bank (Figure 17: profile 289). The sequence likely derived in major part from the erosion of the large volcanic banks. In the two largest basins, an angular unconformity is overlain by 0.20 to 0.3 s-thick sediments (Figure 17: profile 289; Figure 18: profile 283). Basement highs observed in these basins are interpreted as volcanic intrusions related to the unconformity.

*The Vitiaz Trench and Alexa Trough*

The Vitiaz Trench Lineament is marked in the western part of the survey by the southeasternmost part of the so-called Vitiaz Trench (Figures 14 and 15). The trench with a NW–SE general orientation is composed of a series of 4500–4600 m-deep, 15 km-wide basins striking N 100° to N 120°. In fact, these basins are limited northward by N 90° to 130° trending scarps and ridges that sometimes clog (as for example at 172°30′ E in front of a sharp and elongated ridge trending N 110°) or shorten the trench (at 173°5′ E in front of a massive E–W ridge). The southern flank of the trench consists of a more linear scarp although it is also composed of N 90° and N 120° trending segments. The morphology of the trench thus appears largely controlled by the structure of the Charlotte Bank province. Seismic reflection profiles running very obliquely to the structure (Figure 17: profiles 289, 290 and 291) reveal that sedimentary section in the trench ranges from 0.4 to 0.6 s in thickness and is perturbed by normal faulting and intrusion. On profile 291 (Figure 17), a 0.2 s-thick lower sequence gently dips, together with the substratum, toward the WNW (apparent dip) and is unconformably overlain by a 0.15 to 0.25 s-thick upper sequence.

A banana-shaped ridge topped by a circular edifice extends along the southern flank of the trench between

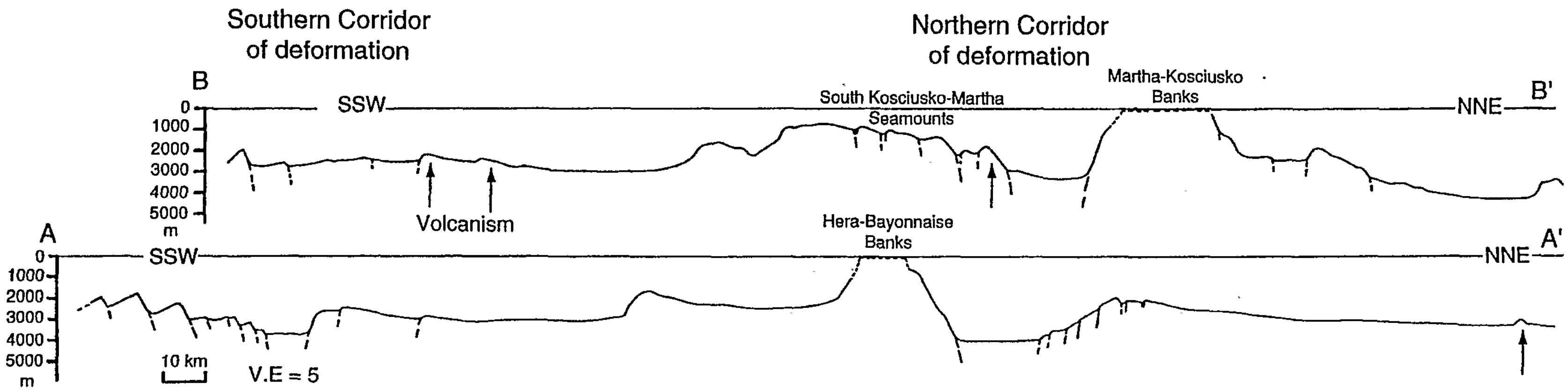



Fig. 10. Bathymetric profile across the area north of the Rotuma Trough. Location of profiles is shown in Figure 4.

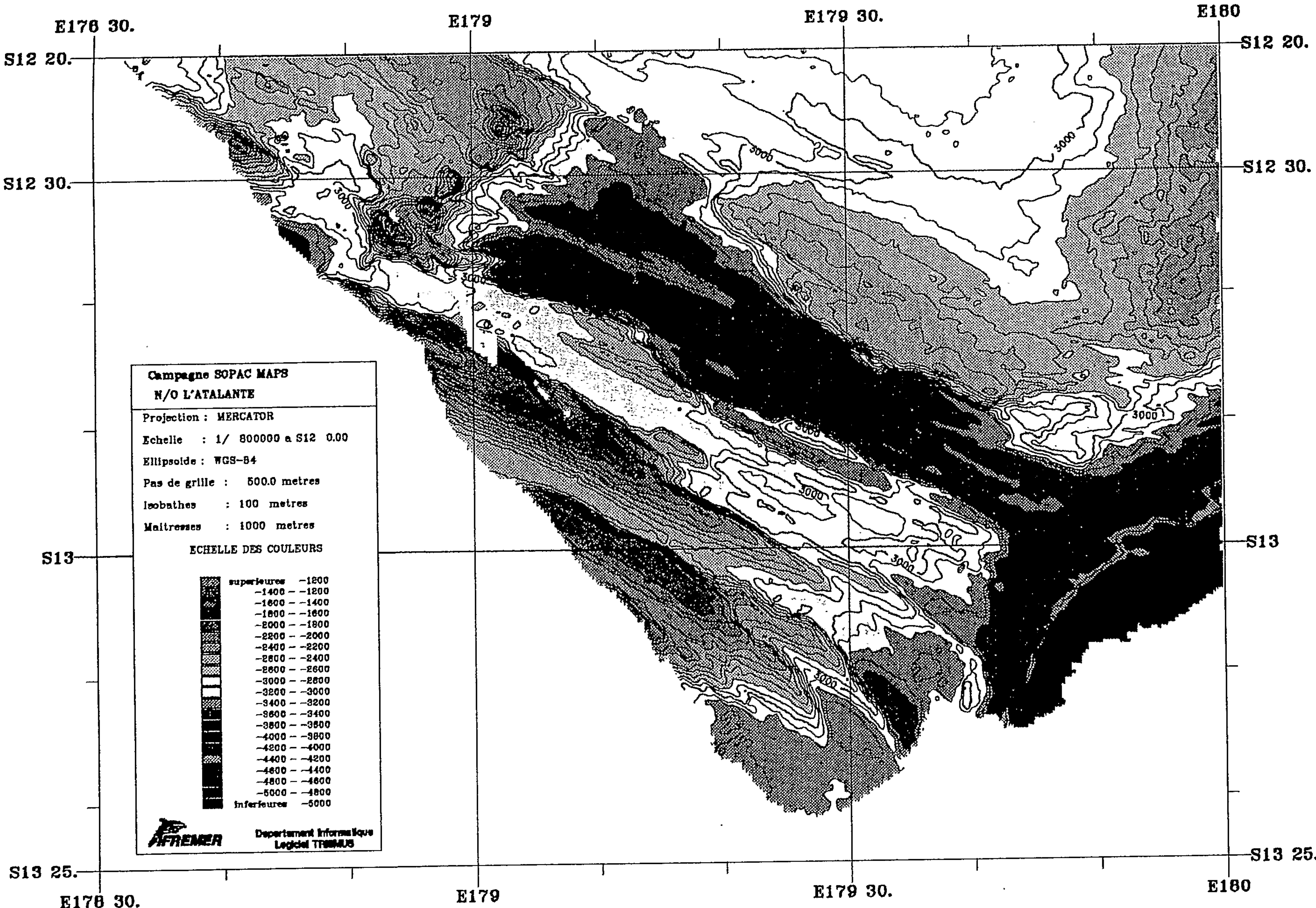



Fig. 11. Multibeam bathymetry of the southern deformation corridor along the northern edge of the Rotuma Trough. Contour interval is 100 m. Location in Figure 4.

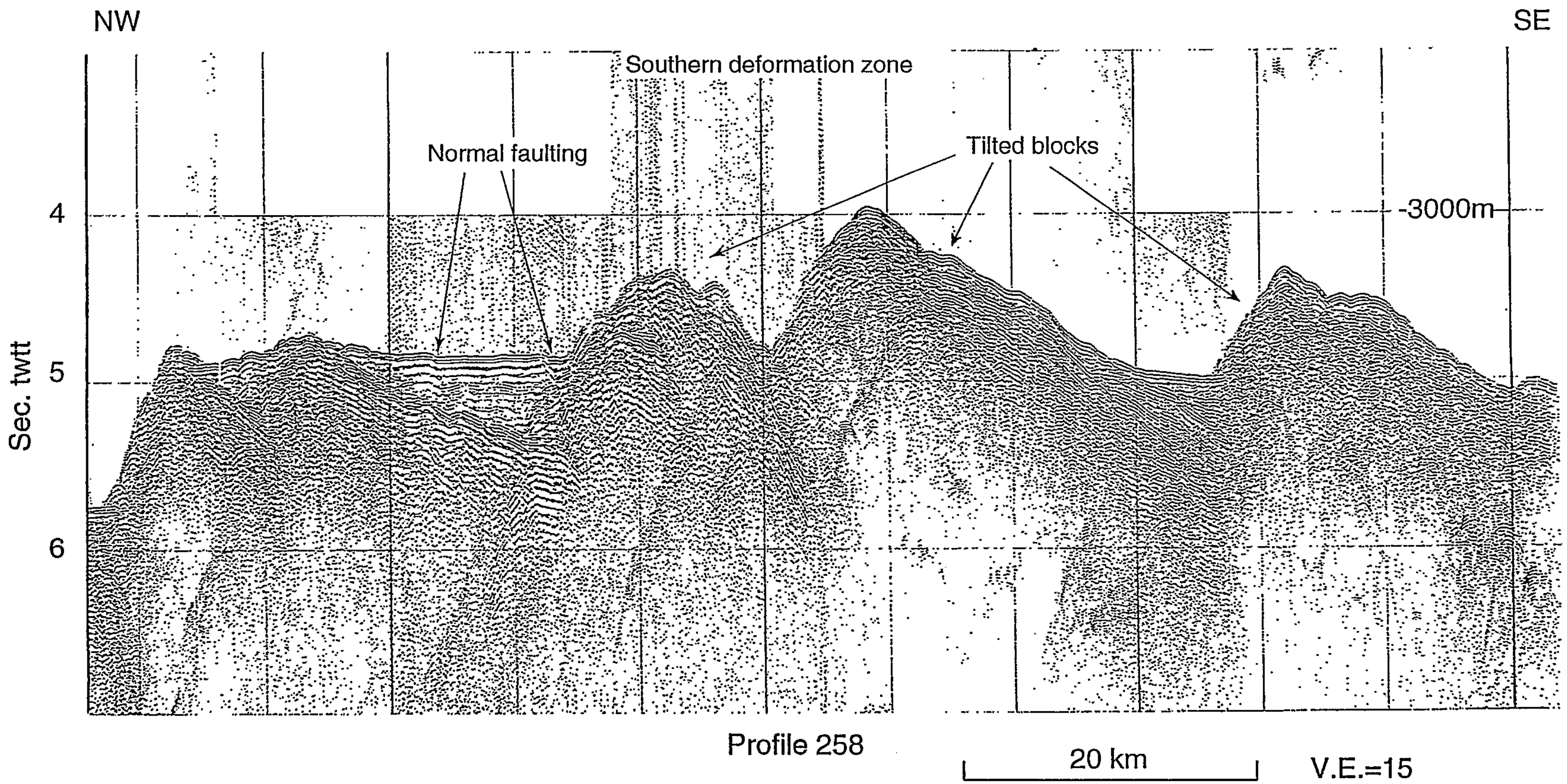



Fig. 12. Selected single-channel seismic reflection profile across the southern deformation corridor showing the tilted blocks. Note the angular unconformity and the normal faults affecting also the upper flat sequence. Location of the line is shown in Figure 3.

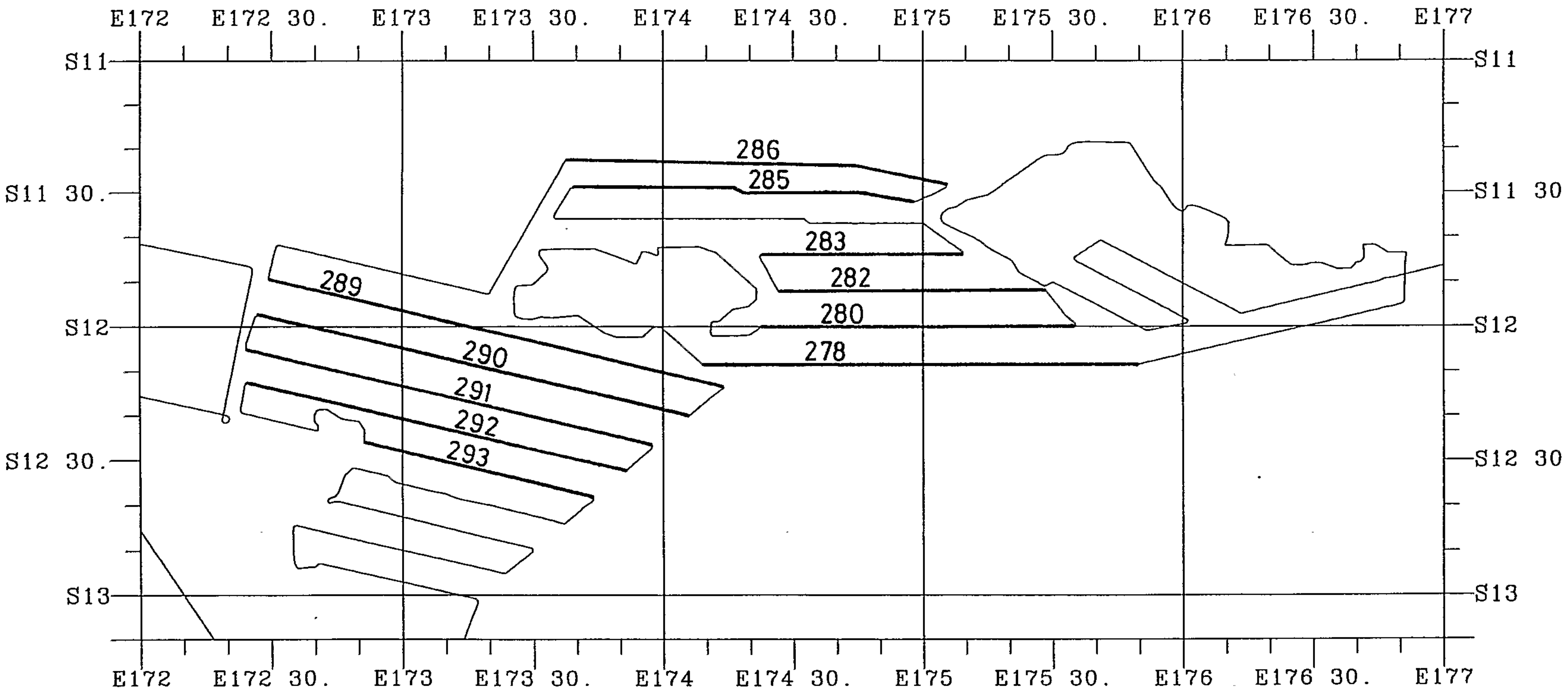



Figure 13. Location map of the surveyed area around the southern part of the Vitiaz Trench and the Alexa Trough, and identification of profiles. The heavy lines indicate the lines shown in Figures 16, 17 and 18.

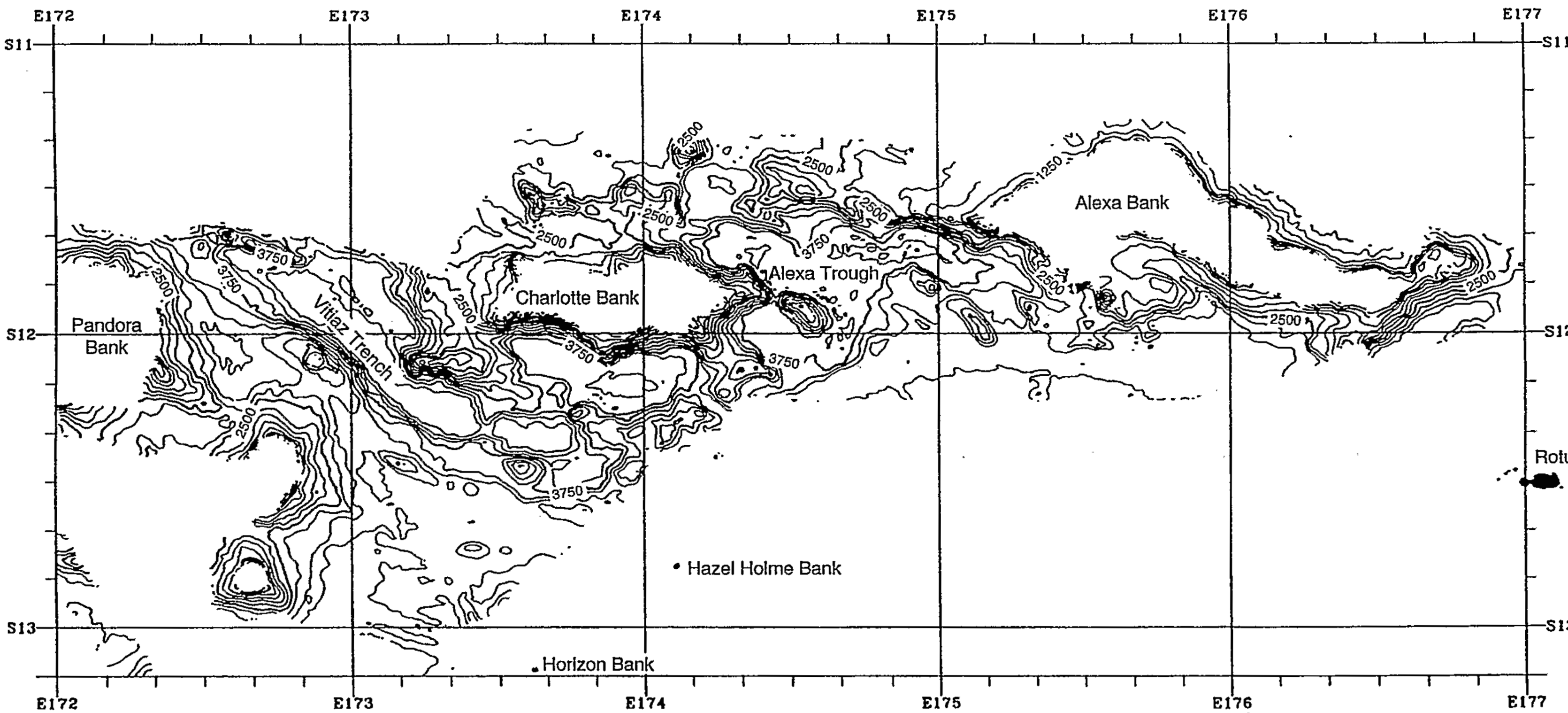



Fig. 14. Multibeam bathymetry around the southern part of the Vitiaz Trench and the Alexa Trough. Contour interval is 250 m.

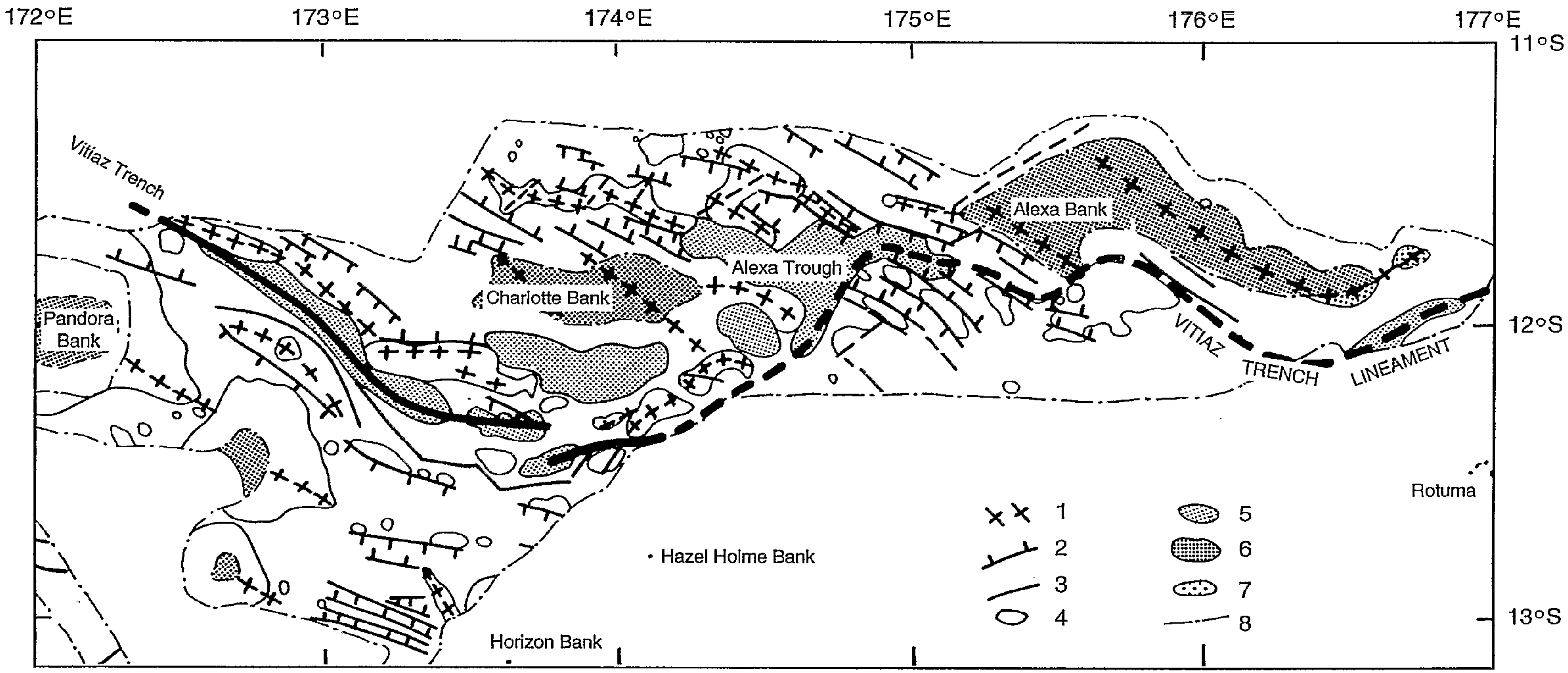



Fig. 15. Structural interpretation of the area around the southern part of the Vitiaz Trench and the Alexa Trough. 1: ridge; 2: normal fault; 3: structural trend; 4: volcanic edifice; 5: basin; 6: bank; 7: terrace; 8: limit of the survey.

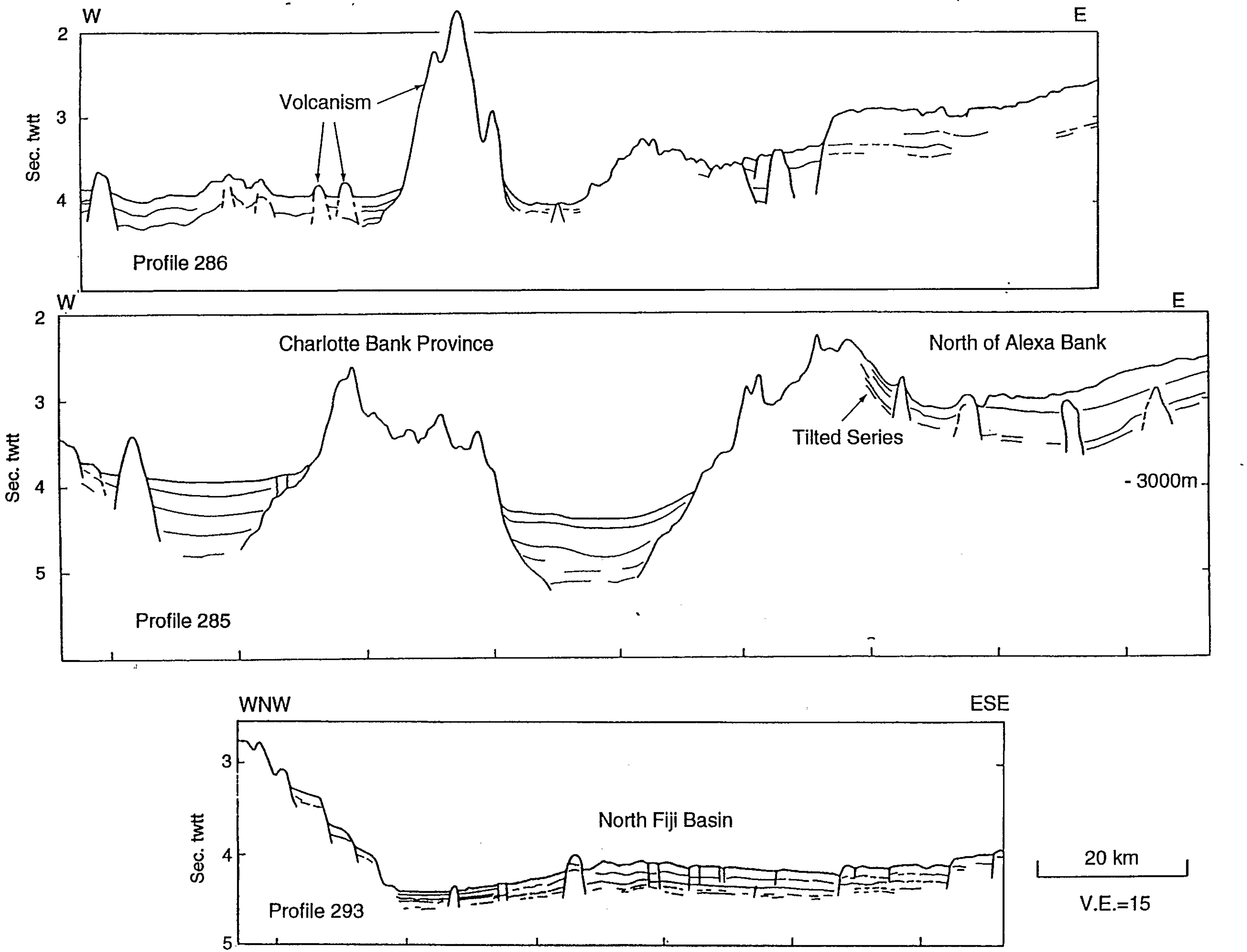



Fig. 16. Line drawings of single-channel seismic profiles across the Alexa and Charlotte Banks province (Profiles 285 and 286) and the Pandora-Hazel Holme Banks province (Profile 293), respectively, north and south of the Vitiaz Trench Lineament. Location of the lines is shown in Figure 13.

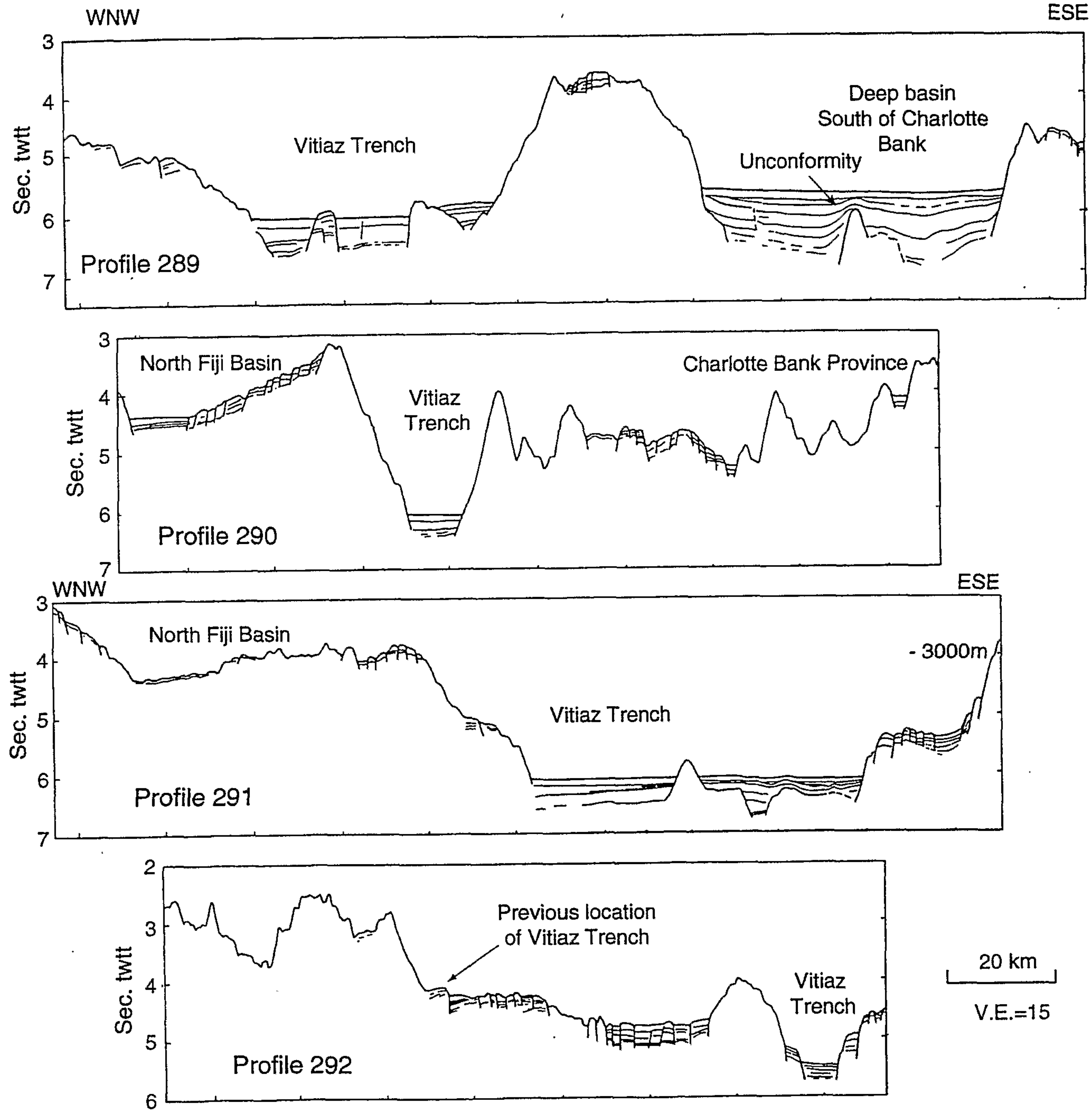



Fig. 17. Line drawings of single-channel seismic profiles across the southern part of the Vitiaz Trench. The location of the Vitiaz Trench Lineament is indicated. Location of the lines is shown in Figure 13.

172°40′ E to 173°10′ E (Figure 14). A 0.2 s-thick, intensively faulted and tilted sedimentary sequence covers the southwestern flank of this arcuate ridge, suggesting an uplift of the ridge (Figure 17: profiles 290). East of 173°15′ E, a 500 m-high scarp composed of N 130° and N 90° trending segments runs southerly, parallel to the southern flank of the trench (Figures 14 and 15). The terranes located between this scarp and the Vitiaz Trench include from west to east (Figure 17: profile 292): a 3500 m-deep flat area underlain by a 0.4-s thick and faulted sedimentary sequence, a circular volcanic edifice, and, at 173°45′ E, a 4050 m-deep flat basin underlain by 0.3-s thick sediments and perched 500 m above the southeasternmost segment of the Vitiaz Trench. The characteristics (morphology and sedimentary thickness) of these terranes are like those of the Vitiaz Trench and the Charlotte-Alexa Bank province. The zig-zag geometry of the scarp parallel to the Vitiaz Trench, the resemblance of these terranes with those located north of the Vitiaz Trench, and the position of these terranes adjacent to and above the Vitiaz Trench, suggest that these terranes could be a part of the Charlotte-Alexa Bank province which has been accreted to the North Fiji Basin due to a northward jump of the Vitiaz Trench, the scarp described above representing a previous position of the trench.

East of 173°45′ E, the Vitiaz Trench disappears and abuts a volcanic edifice (Figures 14 and 15). The continuation of the Vitiaz Trench Lineament toward the east is less clear. However, morphological and seismic reflection data suggest that this lineament describes, as previously proposed by Brocher (1985a), a major curvature southeast of the Charlotte Bank. It follows the 4000 m-deep arcuate basin located between Charlotte and Alexa Banks and labelled the Alexa Trough, and runs at the foot of the southern flank of the Alexa Bank (Figures 15 and 18). The turn of the lineament is outlined by NE–SW elongated ridges between the Vitiaz Trench and the Alexa Trough, and the NE–SW trending, 500 to 1000 m-high scarp separating the Alexa Trough from a 3250 m-deep plateau.

*The Pandora-Hazel Holme Banks Province*

Belonging to the North Fiji Basin, the main part of the survey area south of the Vitiaz Trench Lineament is located between the Pandora Bank area in the west, and the Hazel Holme and Horizon Banks in the east, north of the South Pandora active spreading ridge (Price and Kroenke, 1991; Lagabrielle *et al.*, this volume). It is characterized by large sub-circular volcanic constructions on a 3250 m-deep relatively flat basin (Figures 14 and 15).

A large volcanic edifice, 50 km-wide, 3200 m-high and topped by a 18 km-wide, 30 km-long bank (less than 500 m-deep), is centered on 12°30′ S–172°43′ E where unnamed shoals ranging from 20 to 30 m depth below sea level were previously reported. A new seamount was discovered during SOPACMAPS Leg 3 cruise; it is centered on 172°40′ E, 12°50′ S and is a 32 km in diameter circular volcano. Minimum depths identified during our survey are 500 m, but the shape of the seamount suggests that shallower water depths likely exist in a 12 km-wide summit area. Lobated and conical forms on the lower part of the flanks of the seamounts suggests lava flows and associated adventive small volcanoes. A third, smaller but noticeable volcano lies at 12°05′ S, 172°53′ E and constitutes with the two others a N 15° volcanic line.

The area adjacent to these seamounts is 3250 m-deep in average. It is characterized by N 100°–110° trending scarps, grabens and elongated small volcanic ridges (Figures 14 and 15), by N 100° trending lineations of magnetic anomalies, and by a thin sedimentary cover of about 0.10 to 0.2 s-thick, faulted and pierced by volcanoes (Figure 16: profile 293). Magnetic fabric parallels the normal faults which are perpendicular with the previously cited volcanic line and parallels the protrusions observed on the southeastern flanks of the seamounts. All these observations suggest that part of the volcanism, synchronous with the normal faulting, reused the primary grain of the oceanic crust. The flat area south of Alexa Bank has similar characteristics (depth, morphology, sedimentary cover) as the zone described here (Figure 18: profile 278), which suggests that it is a part of North Fiji Basin oceanic crust, and the eastward continuation of the Vitiaz Trench lies further north, just at the southern foot of the Alexa Bank.

## Discussion-Conclusions

### The Melanesian Border Plateau

The origin and age of the bathymetric highs and banks of the Melanesian Border Plateau are largely unknown. These volcanic edifices could have been formed from various processes at different periods because they are located at the junction of several volcanic chains, the WNW–ESE trending middle Miocene to Holocene Samoan Chain, the ENE–WSW trending Robbie Ridge of unknown age, and the NNW–SSE trending Cretaceous (?) Tuvalu Chain (Figure 1). Only tholeiitic to transitional alkalic massive basalt dated at 37 Ma by Ar39/Ar40 method (Duncan, 1985) has been dredged on the steep southwestern flank of the Alexa bank, as well as dolerites, amygdaloidal basalt, breccia, argillite, black laminated shale and siltstone (Sinton *et al.*, 1985; Brocher, 1985b). The new data presented here do not give precise answers about the origin and age of these banks but do increase our knowledge concerning their structure, existing sedimentary thickness and therefore relative age and vertical evolution.

The banks, guyots and seamounts of the Melanesian Border Plateau, lying immediately north of the Vitiaz Trench Lineament from Hera Bank to Charlotte Bank, are controlled by three structural orientations trending respectively, NW–SE (N 140°–150°), WNW–ESE

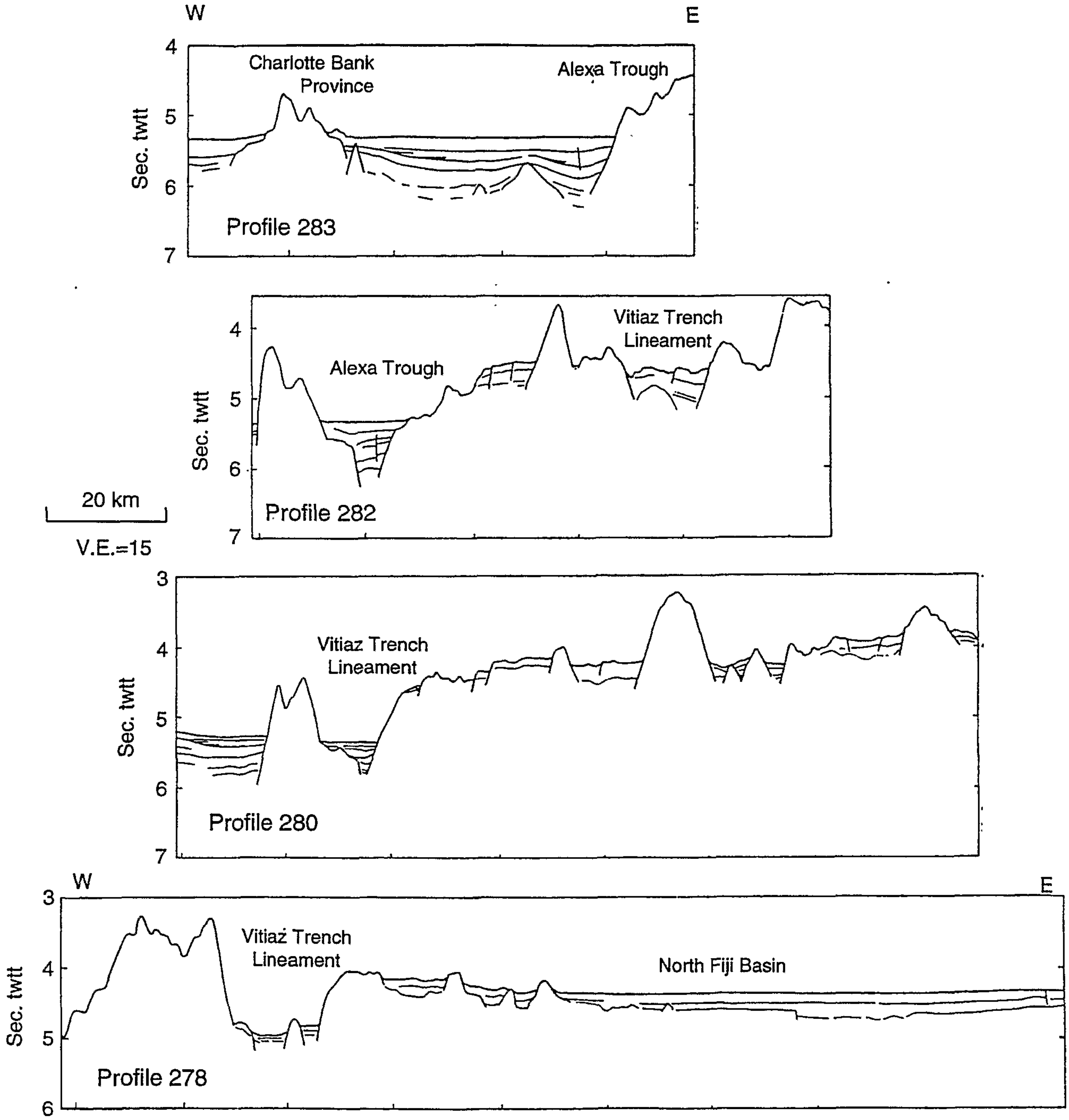



Fig. 18. Line drawings of single-channel seismic profiles across the Alexa Trough. The location of the Vitiaz Trench Lineament is indicated. Location of the lines is shown in Figure 13.

(N 120°) and ENE–WSW (N 50°–60°). Because the N 120° trend is obviously relatively recent and mainly restricted to the closest zones of the Vitiaz Trench Lineament (Alacrity Ridge and southern Eaglestone Plateau, Alexa and Charlotte Banks), the N 140°–150° trend, which shapes the Hera-Bayonnaise Banks, Kosciusko-Martha Banks and partly the Eaglestone Plateau, is considered to be one of the primary trends of the volcanic edifices, the other being the conjugate N 50°–60° direction. These trends are either parallel or perpendicular to the Tuvalu Chain joining the Melanesian Border Plateau around Hera-Bayonnaise and Martha-Kosciusko Banks, and to the Robbie Ridge which is aligned with the South Tuvalu Banks and Alexa-Charlotte Banks (Figure 19). This similarity in trend suggests a possible affinity of the edifices with the Tuvalu Chain and/or Robbie Ridge.

Seismic reflection data collected during SOPACMAPS cruise indicate that the guyots, banks and plateaus of the South Tuvalu Banks are underlain by a 0.4–0.8 s-thick sedimentary cover, and that thick aprons are developed in basins around these banks. At least 0.8 to 1.6 km of carbonate sedimentary cover or reef growth has been reported on Alexa Bank, on the basis of seismic refraction data collected during the 1953 Capricorn Expedition (Raitt (1963), in Brocher (1985b)). These thick sedimentary covers indicate that the volcanic constructions are relatively old.

A widespread terrace at the depth of 750 m has been recognized on edifices of the South Tuvalu Bank and Alexa Bank, either at the top of the guyots or along the scarps of the banks, indicating at least 700–800 m of subsidence since the formation of the edifices. This regional terrace suggests a thermal origin for the subsidence, although a tectonic origin can not be ruled out. Such an amount of thermal subsidence is compatible with late Eocene mid-plate volcanism (37 Ma at Alexa Bank: Duncan, 1985) on an underlying Upper Cretaceous crust (83 Ma northeast of Niulakita Island: Duncan, 1985). Local, deeper terraces are interpreted as the results of tectonic collapses (see below).

## The Vitiaz Trench Lineament

Although only a small part of the Vitiaz Trench Lineament has been mapped during our SOPACMAPS Cruise, the data presented here give for the first time precise information concerning the morphostructure of the Vitiaz Trench Lineament and allow us to better constrain its origin and evolution.

The Vitiaz Trench Lineament is composed of a succession of WNW–ESE and ENE–WSW segments. The Pacific crust and the Melanesian Border Plateau, lying immediately north of the Vitiaz Trench Lineament, have been subjected to intense normal faulting, tilting, collapse and volcanism. In the South Tuvalu Banks province this tectonics is developed along two corridors, one bounding northward the western part of the Rotuma Trough and one, more inside the Pacific domain, between Hera-Bayonnaise Banks and Martha-Kosciusko Banks, and is mainly evidenced by a series of tilted blocks, grabens, horsts and ridges trending N 120°. Northwestward, these two deformation corridors turn to N 50°–60° in the alignment of the segment connecting the Vitiaz Trench and Alexa Trough to the western part of the Rotuma Trough (Figure 19). The northern corridor likely extends southeastward between Tuscarora and Hera Banks, and join the Horne Trough (Figure 19). In the Alexa and Charlotte Banks province, the tectonics is marked by the two main N 120°–100° and N 60° trending structural directions which shape the whole province. The tectonics is interpreted as responsible for the widespread unconformity observed at 0.2–0.3 s bsf in all the basins of South Tuvalu Banks and Alexa and Charlotte Banks provinces, as well as deep terraces at 1000, 1250 and 1400 m of depth resulting from the collapse of 750 m-deep general terrace, and large (size of km) collapse and slicing of banks or guyots. Morphological and seismic reflection data indicate that this tectonic activity included several phases and is apparently still active, some of the faults crosscutting all the sedimentary cover. In the two surveyed areas, volcanic constructions are distributed along the WNW–ESE and ENE–WSW trending lineaments parallel to normal faults, indicating that the volcanism is associated with normal faulting.

The parallelism between the trend of the fault scarps and volcanic ridges with the different segments of the Vitiaz Trench Lineament, and the proximity of these features with the lineament, suggest that tectonics and volcanism are related to crustal motion along the Vitiaz Trench Lineament. Although the observed features are extensional, they can be interpreted as the result either of extension or shortening along the Vitiaz Trench Lineament, because they are superficial. In the first interpretation, extensional features could represent the initial rifting of the North Fiji back-arc basin after the Vitiaz subduction blockage and arc reversal, and/or a local extension along the Pacific-North Fiji Basin boundary during recent plate reorganization. In the second interpretation (Figure 19), the fabric north of the lineament would result from subduction-induced normal faulting on the outer wall of the trench, and the zig-zag geometry of the Vitiaz Trench Lineament would be due to interaction of the large seamounts, plateaus and banks of the Melanesian Border Plateau with the Vitiaz subduction zone, inducing modification of the geometry of the plate boundary as previously proposed by Brocher (1985a). Taking into account the main structural trend on the Pacific crust north of the lineament, as well as the shape of the lineament itself, the motion of convergence was probably close to ENE–WSW (N 50°–60°).

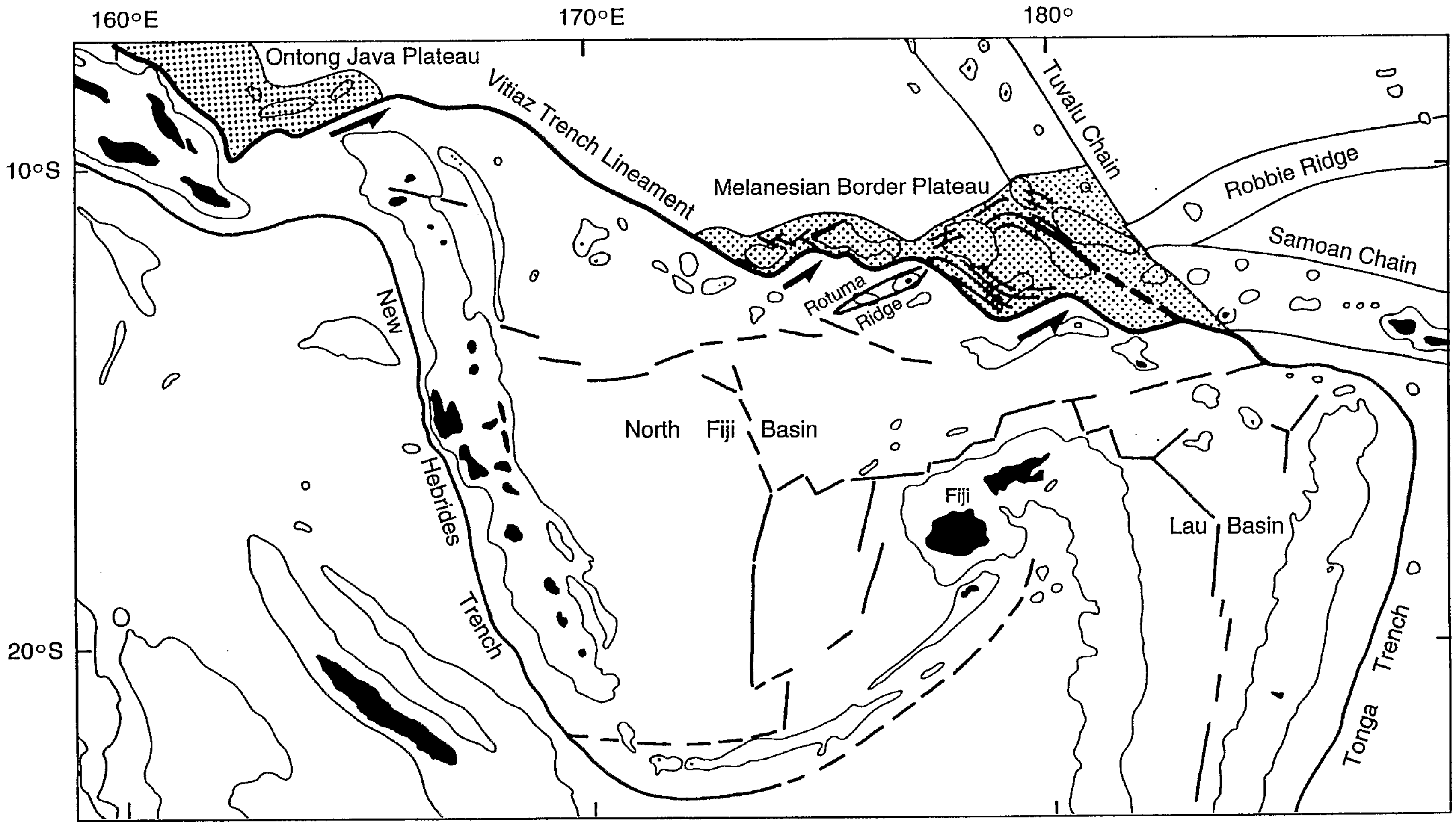



Fig. 19. Sketch illustrating the zig-zag geometry of the Vitiaz Trench Lineament. The plateaus (Melanesian Border Plateau and Ontong Java Plateau) which collided with the lineament are underlined. The bathymetry is from Kroenke *et al.* (1983).

We favor the second interpretation because:

1. ENE–WSW segments of the lineament are always located along the southeastern edge of the plateaus and banks of the Pacific crust (see for example the Horne Trough southeast of the Samoan Chain, the eastern part of the Rotuma Trough southeast of the Alacrity Ridge and Eaglestone Plateau; the Alexa Trough southeast of the Charlotte Bank; and the Cape Johnson Trench southeast of the Ontong Java Plateau) (Figure 1), suggesting a close link between the large volcanic edifices and the ENE–WSW trench segments along which left-lateral strike-slip motion occurred.
2. Normal faults are mainly developed north of the lineament, on the Pacific plate and across the plateaus and banks; similar normal faulting morphology (short wavelength and large throw) has been described in the outer wall of the active Japan, Tonga and New Hebrides subduction zones where seamounts are dislocated and sliced when they enter the trench.
3. The southern part of the Vitiaz Trench (the only full, swath-mapped segment of the lineament) has a trench-like morphology and structure (Figures 14, 15 and 17): the scarps and ridges of the northern flank control the structure of the trough and are slightly oblique to the southern flank of the trough; the apparent dip of the substratum of the trough is toward the southern flank; the southern flank appears uplifted. In such an interaction, part of the Pacific domain may have been accreted along the Vitiaz Trench Lineament, as for example part of the Charlotte Bank province in the structurally complex zone at the southeastern end of the Vitiaz Trench, and zones of deformation have been created oceanward inside the Pacific crust, like the tectonic corridor between Hera-Bayonnaise Banks and Kosciusko-Martha Banks. However, it should be noted that the intensity of volcanism associated with faulting of the plate as it bends into the trench is quite unusual.

The newly acquired bathymetry and seismic data indicate that crustal motion along the Vitiaz Trench Lineament continued up to recent times and might possibly be still active although the lineament is seismically inactive. Such a recent motion is also supported by:

1. The recovery, along the northern flank of the Tuscarora Bank, of a 89 cm-long piston core which penetrated into a lithified Pliocene shallow water limestone overlain by unconsolidated Pleistocene to Holocene sand with reworked late Miocene faunas, indicating a subsidence of 1000 m since the early Pliocene (Chaproniere, 1985).
2. The recovery of vitreous, fresh and very young (0.2 Ma) plagioclase-clinopyroxene aphyric basalt with an alkalic affinity on the northeastern and northwestern flanks of the Hera-Bayonnaise Banks, even if this K/Ar age has to be taken with care due to the high content of stable Ar in the sample (Japan International Cooperation Agency, 1989).

Active compressional motion has been also proposed along the northern continuation of the Vitiaz Trench Lineament, the North Solomon Trench east of Malaita Island (Auzende *et al.*, this volume). Consequently, it is proposed, following Brocher (1985a), that after the Vitiaz subduction blockage, arc reversal and inception of the New Hebrides subduction in the late Miocene time, a part of crustal shortening between Pacific and Australian Plates was still absorbed along the Vitiaz Trench Lineament during the development of the North Fiji Basin, synchronously with the subduction at the New Hebrides Trench. Late Pliocene island arc volcanism known at several places south of the lineament on the North Fiji Basin is also an evidence for convergence motion along the lineament after the late Miocene. Although part of the Pacific-Australian convergence has been transferred in latest Pliocene to the Fiji Fracture Zone, ENE–WSW shortening along the lineament might be also responsible for the Quaternary volcanism of the ENE–WSW trending Rotuma Ridge (Figure 19) and for other volcanic peaks of unknown ages (presumably recent) lying along the northern rim of the North Fiji Basin.

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