Vedder, J.G., and Bruns, T.R., editors, 1989, Geology and offshore resources of Pacific island arcs—Solomon Islands and Bougainville, Papua New Guinea Regions: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 12.

GEOLOGY OF THE SHORTLAND BASIN REGION, CENTRAL SOLOMONS TROUGH, SOLOMON ISLANDS—REVIEW AND NEW FINDINGS

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ABSTRACT

Multichannel seismic-reflection data acquired during 1982 in the Solomon Islands over the Shortland basin region were used to establish a preliminary framework for the seismic stratigraphy, structure, and tectonic history of the basin. Four seismic-stratigraphic units, A through D from oldest to youngest, were identified; these units form distinct sedimentary wedges that can be correlated with geologic units and tectonic events on the surrounding islands. Basin development was largely driven by vertical tectonics on the northeastern and southwestern flanks of the basin. These vertical movements were in turn controlled by tectonic events associated with the subduction and arc-reversal history of the Solomon Islands region.

Additional seismic-reflection data acquired during 1984 resulted in new findings as follows: (1) A basement half graben with as much as 6 km of relief is present in the center of the basin. Unit B strata, of inferred late Oligocene and Miocene age, thicken into and fill the half graben and onlap against the bounding faults. The half graben may have developed as a pull-apart basin or by block rotation in a strike-slip fault or oblique subduction system. Development of the half graben is coincident with and may have been caused by entry of the Ontong Java Plateau into the early Tertiary subduction zone. (2) The maximum sediment thickness in the basin is over 7 km, which is greater than previously reported. Subsidiary depocenters are present beneath Vella Ridge and west of Mono Island, where sediment thicknesses are as much as 3 and 2 km, respectively. (3) We find no obvious connection between Shortland basin and Bougainville basin on the southwestern side of Bougainville because a basement high apparently separates the two basins. The thick sedimentary section in the axial part of Shortland basin could extend northwestward beneath the volcanic rocks of southern Bougainville; however, the basin strata thin toward the island, and the basin may end near or beneath the island. (4) Refraction data confirm that a thick basin fill of interbedded volcaniclastic and volcanic rocks is present beneath the New Georgia wedge region. This observation corrects an erroneous interpretation of thin fill that was based on shallow acoustic basement on seismic-reflection data.

INTRODUCTION

Geographic Setting

The Solomon Islands consist of two uplifted island-arc chains that are separated by New Georgia Sound (Figure 1). New Georgia Sound is in turn underlain by an intra-arc basin, the Central Solomons Trough (Katz, 1980). Herein, we discuss the Shortland basin, which is the westernmost subsidiary basin of the Central Solomons Trough, and the regions surrounding Shortland basin (Figure 2).

Shortland basin is bounded on the west and northwest by Bougainville and the Shortland Islands, on the northeast by Choiseul, on the southeast by Vella Ridge, and on the south by the New Georgia island group (Figure 2). Southeastward, the New Georgia wedge separates Shortland basin from the other subsidiary basins of the Central Solomons Trough. Much of Shortland basin lies beneath 1,300 m of water, and maximum water depths are as great as 1,500 m. Sill depths around the basin are less than 600 m north of Kolombangara and New Georgia, 200 m beneath Bougainville Strait, and 300 m over Vella Ridge. The deepest sill lies in the 1,300 m-deep gap that separates Mono Island and Vella Ridge. South of Mono Island, Vella Ridge, and Vella Lavella, which form the south flank of the basin, the slope drops steeply into the New Britain Trench.

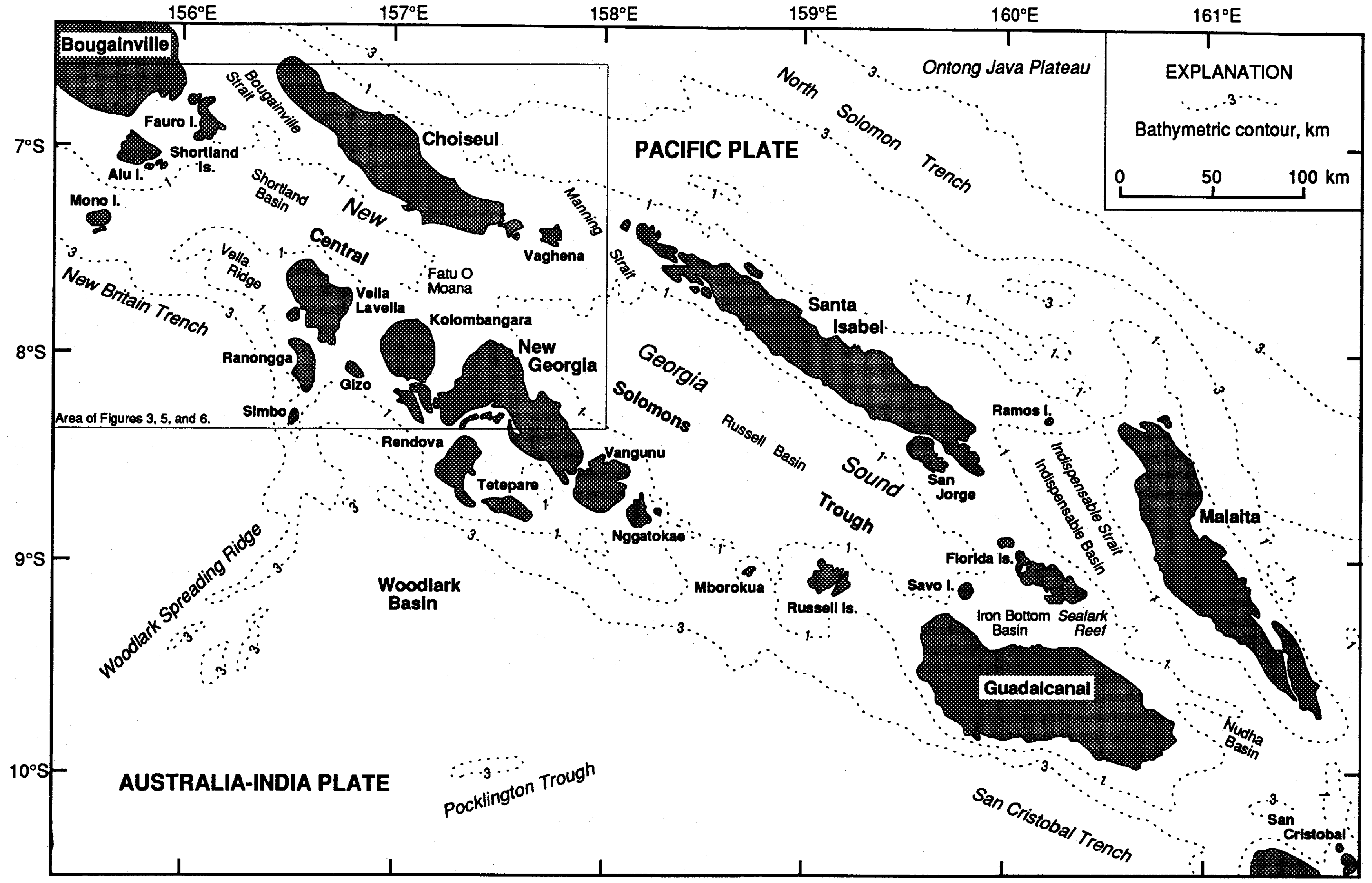

Figure 1. Place names, tectonic features, and bathymetry of the central and western Solomon Islands area.

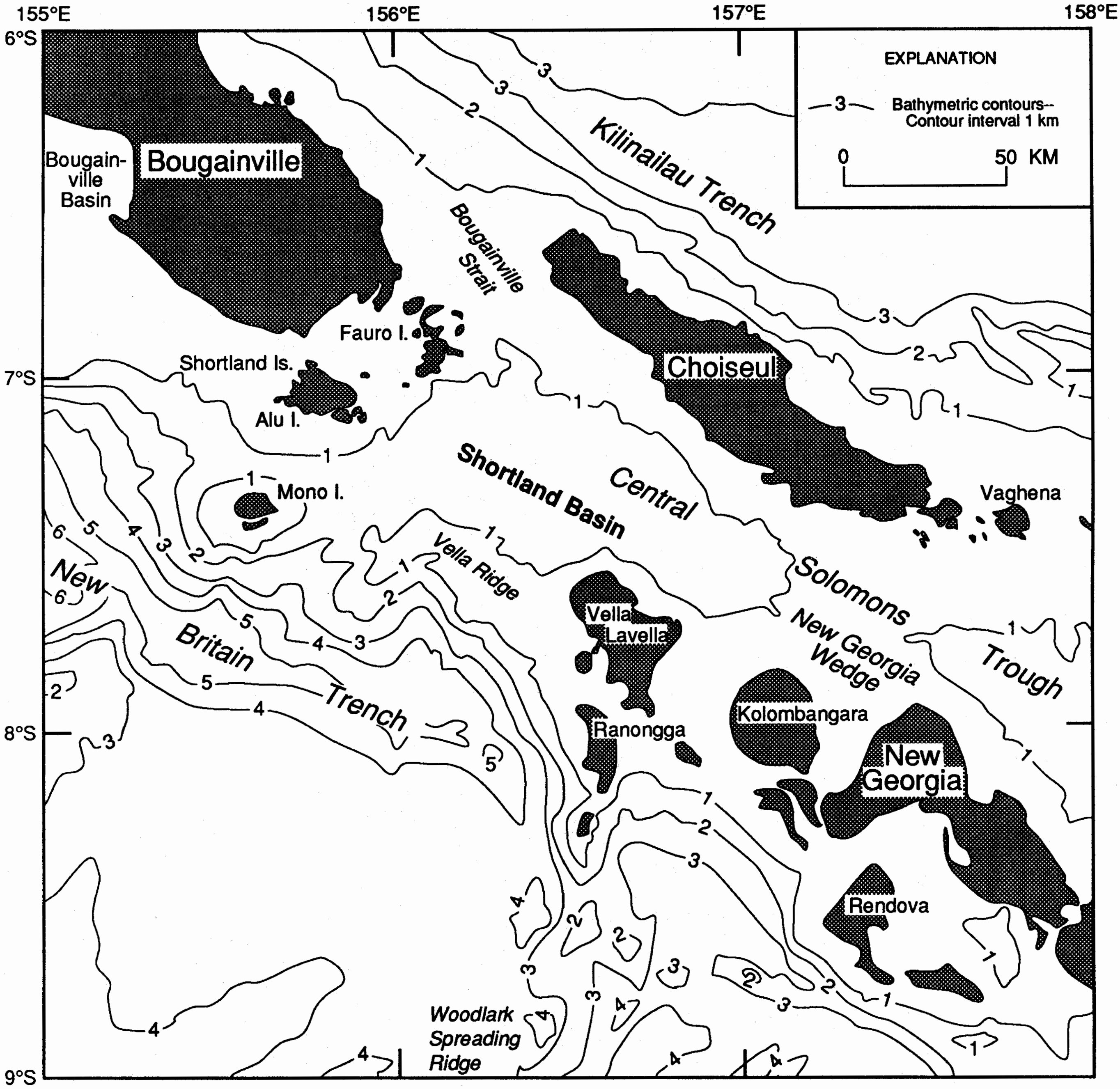

Figure 2. Map of the Shortland basin region. Bathymetry from Chase, Seekins, and Lund (1986) and Chase, Seekins, and Young (this volume).

Previous Work

Marine geological and geophysical surveys in the Solomon Islands region are reviewed in Vedder and Coulson (1986) and Vedder and Bruns (1986; this volume). Major work within the Shortland basin and New Georgia wedge regions included the delineation of the Central Solomons Trough by de Broin, Aubertin, and Ravenne (1977) (part of their Solomon Basin), an interpretation of a seismic profile in Manning Strait by Landmesser (1977), a study of a regional grid of seismic-reflection data across the Central Solomons Trough by Katz (1980), and a study of the petroleum potential of the Central Solomons Trough and adjoining areas by Maung and Coulson (1983) using interpretations of marine geophysical records contained in the files of the Solomon Islands Geological Survey.

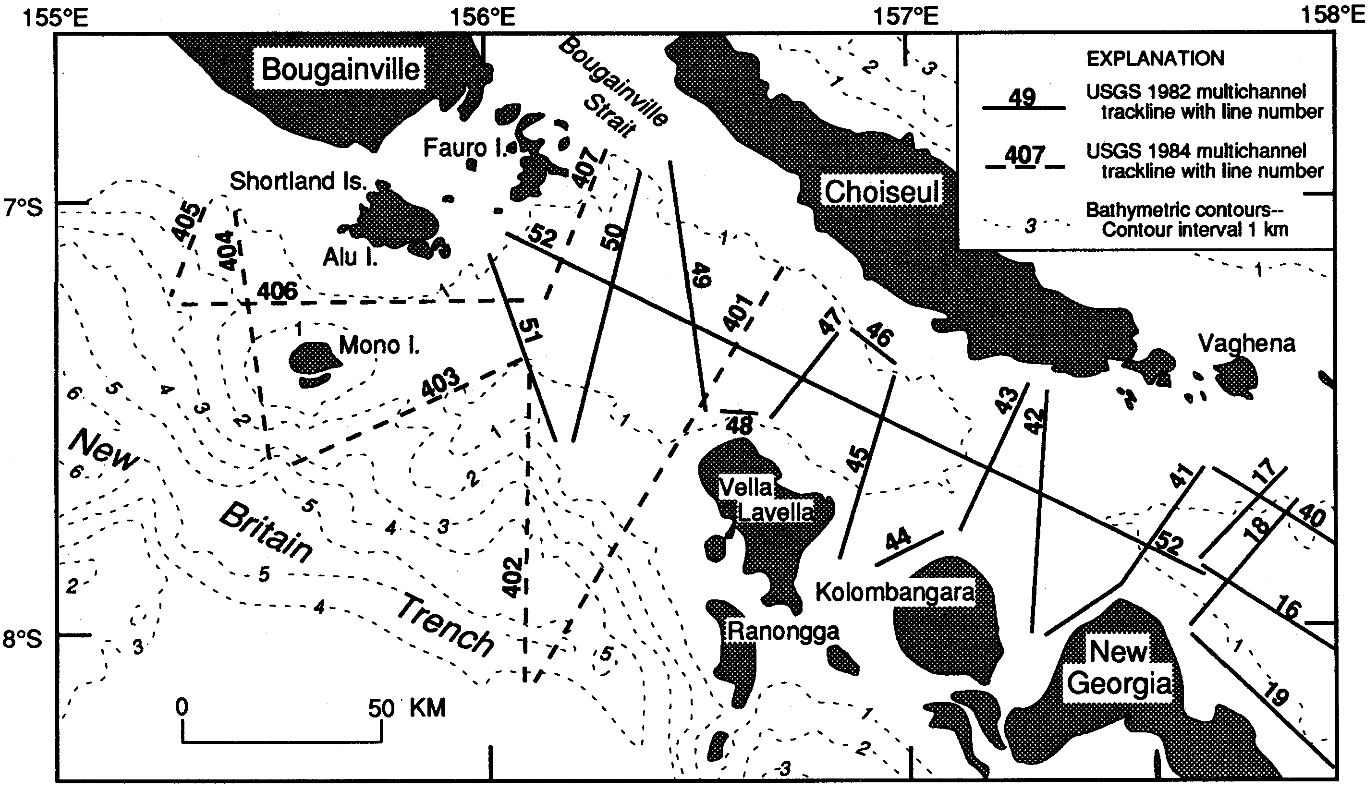

Figure 3. Multichannel seismic-reflection lines acquired from the U.S. Geological Survey research vessel R/V *S.P. Lee* in the Shortland basin region in 1982 and 1984.

In 1982, two cruises acquired data in the Solomon Islands region as part of an Australia-New Zealand-United States Tripartite Agreement coordinated by the United Nations Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC). Scientists aboard the R/V *Kana Keoki* investigated the New Georgia wedge region and the Woodlark Basin south of the Solomon Islands (Taylor and Exon, 1987).

In May, 1982, scientists on board the U.S. Geological Survey research vessel R/V *S.P. Lee* recorded 24-fold seismic-reflection data plus ancillary seismic-refraction, gravity, and magnetic data along about 2,000 km of tracklines over the sedimentary basins in the Solomon Islands region; bottom samples were also acquired (Figures 1 and 3; Vedder, Pound, and Boundy, 1986). These data were used to delineate the seismic stratigraphy, sediment thickness, structure, and depositional history of the basins (Bruns et al, 1986; Bruns, Cooper, and Vedder, 1986; Cooper, Bruns, and Wood, 1986; Cooper, Marlow, and Bruns, 1986).

The 1982 work in the vicinity of Shortland basin showed that sedimentary wedges within the basin could be correlated with the geology and uplift episodes of the surrounding islands and could be used to interpret the development history of the basin. Geological problems that remained after the 1982 survey included delineating the extent of Shortland basin to the west and south, and resolving whether or not this basin connected with Bougainville basin, which underlies the shelf area on the west side of Bougainville (Figure 2; Shaw, 1985; Stewart, Francis, and Pederson, 1987; Hilyard and Rogerson, this volume). Another unsolved problem was the sediment thickness and structure southeast of Shortland basin, where the New Georgia wedge flanks the islands of Kolombangara and New Georgia. A single seismic-refraction line from the 1982 survey suggested the presence of a thick (greater than 5-km) sedimentary sequence (Cooper, Bruns, and Wood, 1986), whereas seismic-reflection data showed a shallow acoustic basement overlain by a thin (2-km or less) sedimentary sequence (Bruns et al, 1986).

In June 1984, additional 24-fold seismic-reflection data and refraction data were acquired by the R/V *S.P. Lee* over Shortland basin and the New Georgia wedge (Figures 2 and 3). The new multichannel data over Shortland basin helped to further delineate the basin extent, especially to the south toward the New Britain Trench and northwest toward Bougainville basin (Figure 2). Refraction data were acquired over the New Georgia wedge to define the sediment thickness and answer unresolved questions about the extent beneath the Central Solomons Trough of volcanic flows and volcaniclastic deposits derived from volcanoes of the New Georgia island group (see Cooper, Cochrane, and Bruns, this volume).

The purpose of this paper is to present new interpretations and reinterpretations based upon data from the combined 1982 and 1984 data sets. These findings include: (1) better definition of a basement half graben in the center of Shortland basin; (2) new maps of structure and sediment thickness in the Shortland basin region; (3) a clearer delineation of the extent of the basin to the south and west; and (4) a reevaluation of the sediment thickness in the region of the New Georgia wedge.

REGIONAL TECTONIC AND GEOLOGIC SETTING

Tectonic Setting

The regional geologic and tectonic setting of the Solomon Islands region is described at length by Kroenke (1984), Coulson and Vedder (1986), Vedder and Coulson (1986), Bruns, Vedder, and Culotta (this volume), Vedder, Bruns, and Cooper (this volume), and Wells (this volume). The following is a brief summary from these papers.

The Solomon Islands are composed of a diverse assemblage of rocks of Mesozoic and Cenozoic age. Basement rocks include oceanic crust of Cretaceous and early Tertiary age and metamorphic equivalents. Overlying this basement are rocks and features that reflect volcanic-arc growth during at least two time periods--late Eocene to early Miocene, and late Miocene and younger. The late Eocene to early Miocene volcanic arc (the North Solomon Island Arc of Kroenke, 1984) lies beneath the northern island chain of the Solomon Islands, including Bougainville, Choiseul, part of Santa Isabel, and Guadalcanal. The late Miocene and younger volcanic arc crosses the early Tertiary arc on Bougainville and underlies the southwestern island chain, including the Shortland Islands, the New Georgia island group, the Russell Islands, Savo Island, and western Guadalcanal. Oligocene through Quaternary volcaniclastic and carbonate rocks cover large parts of the volcanic arc, and lie in the interarc basins such as the Central Solomons Trough.

The regional structure and stratigraphy indicate that four main tectonic episodes affected the Solomon Islands. The basement rocks reflect uplift of Cretaceous and early Tertiary oceanic or oceanic-plateau rocks. During and after uplift, these rocks were markedly deformed, regionally metamorphosed, and eroded, possibly as a result of late Eocene subduction along the northeastern margin of the Solomon Islands.

During late Eocene through early Miocene time, southwestward-directed subduction of the Pacific plate beneath the Solomon Islands created the early Tertiary North Solomon Island Arc (Kroenke, 1984). Growth of the arc was accompanied by an influx of volcaniclastic detritus into the adjacent back-arc basin. These back-arc strata now form the lower units in the Shortland basin and other subbasins of the Central Solomons Trough.

In the middle Miocene, the arc was characterized by volcanic and tectonic quiescence, possibly caused when the thickened Pacific plate crust of the Ontong Java Plateau, which lies immediately north of the Solomon Islands, entered and blocked the subduction zone about 22 to 20 Ma. During the middle Miocene, uplift and faulting occurred on all the islands, and was accompanied by extensive deposition of carbonate rocks.

In the late Miocene, about 10 Ma, subduction shifted to the presently active northward-dipping New Britain and San Cristobal subduction zones on the south side of the Solomon Islands, thus completing a subduction polarity reversal. This subduction shift was accompanied by the development of the late Cenozoic arc that underlies Bougainville and the southern island chain of the Solomon Islands and that closed off the early Tertiary back-arc basin to form the intra-arc basin of the Central Solomons Trough. Deposition into the Central Solomons Trough formed the upper sedimentary wedges of the Shortland basin.

The most recent events to affect the region were the initiation of sea-floor spreading on the Woodlark spreading ridge at about 5 Ma and the subsequent subduction of the newly formed oceanic crust beneath the Solomon Islands. Ridge subduction was accompanied by pronounced tectonic uplift and subsidence along Vella Ridge and in the New Georgia island group, and by near-trench volcanism and markedly low levels of seismicity in the New Georgia island group.

Geology of Islands Surrounding Shortland Basin

Bougainville

Rocks on Bougainville include a succession of volcaniclastic, carbonate, and volcanic rocks initially described by Blake and Miezitis (1967) and recently remapped and redescribed by Hilyard and Rogerson (this volume). The oldest rocks exposed are Eocene(?) and Oligocene(?) basalt, basaltic andesite, and interbedded volcaniclastic rocks (Atamo Volcanics) derived from the early Tertiary arc. These basement rocks are unconformably overlain by shallow-water, late Oligocene to latest early Miocene limestone (Keriaka Limestone), by middle Miocene to Pliocene volcaniclastic debris flows (Toniva Formation and Arawa Conglomerate), and locally by a sequence of middle and late Miocene andesite flows (Aropa Andesite). The late Oligocene to Pliocene rocks are distributed along the southeastern end of Bougainville and probably extend well beneath the adjacent slope, Bougainville Strait, and the Shortland Islands. Igneous rocks of latest Miocene and younger age (Isinai Monzonite, Kupei Complex, and unnamed intrusives) intrude the older rocks. The latest Pliocene and younger volcanic rocks of the Bougainville Group cover most of the northwestern and southeastern parts of the island.

Shortland Islands

The oldest rocks in the Shortland Islands are volcanic rocks of Oligocene(?) and early Miocene age on Fauro Island; these rocks are similar to those found on nearby Bougainville. Basement rocks on the other islands of the Shortland Islands are mainly formed of intrusive and extrusive rocks of Pliocene(?) and younger age (Coulson and Vedder, 1986; Ridgway and Coulson, 1987).

Pliocene and Pleistocene sedimentary rocks and shallow-marine carbonates occur on Alu and Mono islands and record a transition from hemipelagic deposition of fine volcanic detritus to shallow-water reef construction. On Alu Island, about 300 m of Pliocene siltstone, claystone, and fine-grained sandstone of the Kulitanai Siltstones indicate open-marine shelf environments. These strata are overlain by late Pliocene and Pleistocene calcareous and carbonate rocks and locally derived alluvial deposits. On Mono Island, about 250 m of Pliocene siltstone beds of the Mono Siltstones constitute an outer shelf deposit that is similar in age and lithology to the Kulitanai Siltstones. Overlying and interbedded rocks are reef limestone. As much as 1,400 m of Pliocene(?) to early Pleistocene tuffaceous sandstone beds of the Koria Sandstones are present on the Fauro islands, and probably represent rapid deposition of locally derived volcaniclastic sediment on a shallow shelf.

Choiseul

Choiseul is underlain by an oceanic-basement complex composed of the Choiseul Schists and Voza Lavas. The Choiseul Schists consist largely of metamorphosed Cretaceous(?) and early Tertiary basaltic rocks. The age of the Voza Lavas is uncertain, but interpretations of geological and geochemical data indicate that the Voza Lavas are the protolith for the Choiseul Schists, and therefore are also of Cretaceous(?) and early Tertiary age (Coleman, 1965; Coulson and Vedder, 1986; Pound, 1986; Ridgway and Coulson, 1987).

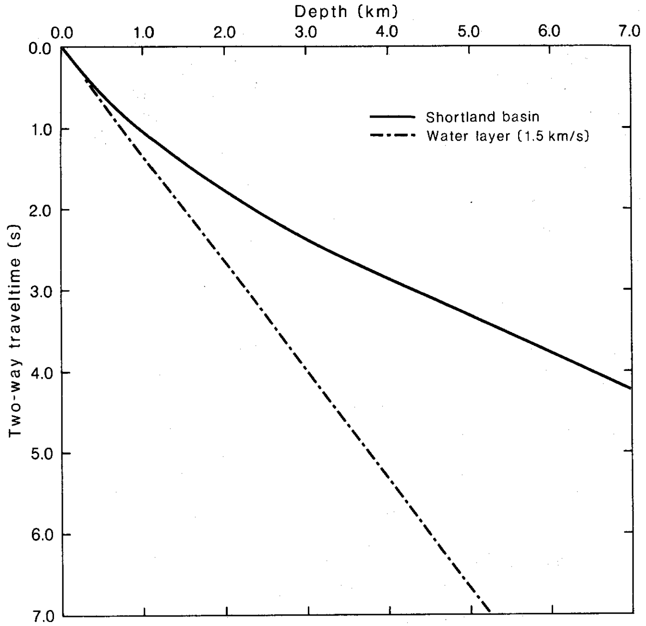

Figure 4. Time-depth conversion curves for the Shortland basin region for converting two-way traveltime on the seismic-reflection records to depth. Water-layer thickness must be added to cumulative sub-seafloor depth to obtain total depth.

Sedimentary rocks directly above the basement schist and basalt are assigned to the late Oligocene and Miocene Mole Formation. The formation is as much as 450 m thick and has a late Oligocene basal conglomerate, the Koloe Breccia Member, which is overlain by Miocene dominantly turbidite-derived siltstone and sandstone and subordinate shallow-water near-shore deposits. The Pliocene Pemba Formation overlies the Mole Formation conformably or with slight discordance. The Pemba Formation has a maximum thickness of 600 m and consists of a lower calcarenite member and an upper calcisiltite member. Both the Mole and Pemba Formations dip and thicken to the west and southwest toward Bougainville Strait and the Central Solomons Trough. Overlying all these units are the Quaternary reef deposits of the Nukiki Limestone Formation, which are now elevated as much as 440 m above sea level at the northwestern end of Choiseul and up to 600 m above sea level at the southeastern end of the island (Coulson and Vedder, 1986; Pound, 1986; Ridgway and Coulson, 1987)

New Georgia Island Group

The New Georgia island group is formed mainly of late Miocene to Holocene calc-alkaline volcanic rocks and minor coeval epiclastic deposits. The volcanic rocks consist of large volumes of olivine basalt, basaltic andesite, and andesite flows. Typically, the volcanic rocks display lateral facies changes from massive flows to volcaniclastic strata. Sedimentary rocks are limited in distribution and are late Pliocene and younger in age. These rocks consist largely of reef platform deposits, although sequences of terrigenous sedimentary rocks locally occur on some of the islands. Uplifted calcareous siltstone deposits on Tetepare are nearly 900 m above the depth at which they were deposited, indicating the magnitude of tectonic uplift throughout the island group (Coulson and Vedder, 1986).

GEOPHYSICAL DATA

Multichannel seismic-reflection data were acquired along seven lines in 1984 in the Shortland basin region (lines 401-407, Figure 3), complementing lines acquired in 1982. These data were recorded using a 1,311 in^3 (21.5 l) airgun array, a Globe Universal Sciences (GUS)[1] seismic-

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[1] Any use of trade names is for purposes of identification only and does not imply endorsement by the U.S. Geological Survey, the New Zealand Geological Survey, or the Bureau of Mineral Resources, Geology, and Geophysics, Australia.

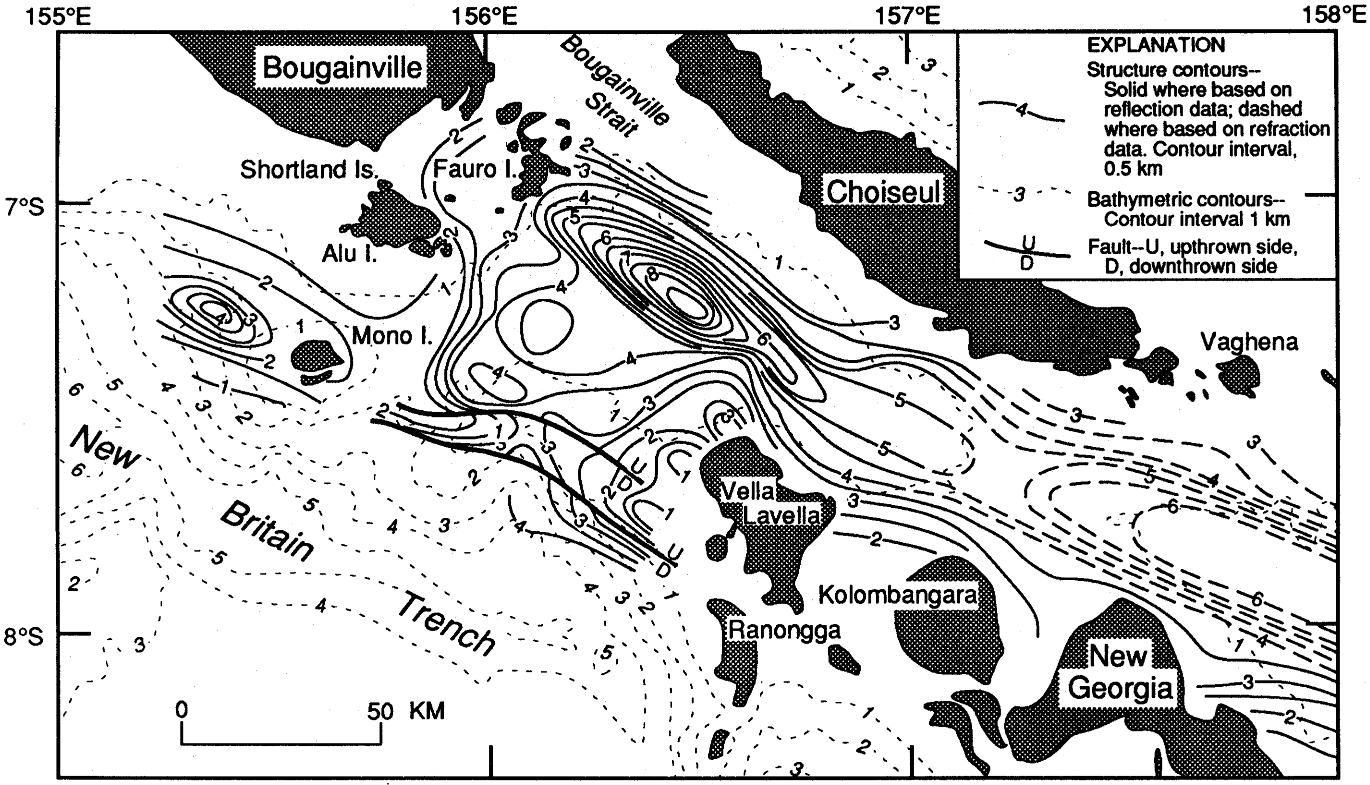

Figure 5. Structure contours at the top of seismic-stratigraphic unit A (acoustic basement). Contours are at the base of the sedimentary fill of the Shortland basin. Solid contours are based on interpreted multichannel seismic-reflection data; dashed contours on seismic-refraction data.

recording system, and a 2,400-m streamer. A shooting geometry with a 50-m shotpoint interval and a 100-m group interval provided 24-fold data. The ship's position was determined by a satellite navigation system that used doppler sonar, speed log, and gyrocompass information to calculate dead-reckoned positions between satellite fixes.

The seismic-reflection data were processed by the U.S. Geological Survey in Menlo Park, California, on a DISCO (trademark of Digicon, Inc.) processing system. The main processing steps included demultiplexing, velocity analysis using coherence estimation and constant-velocity stacks, normal moveout correction, stacking, and filtering. Sections 49 and 50 were specially processed to attenuate the water-bottom multiple. Data for lines 50 and 407 are migrated; the migration velocities were selected from post-stack constant-velocity migrations. Further information about the standard U.S. Geological Survey acquisition and processing methods is given by Mann (1986).

TIME-TO-DEPTH CONVERSION OF SEISMIC DATA

The conversion of seismic-reflection traveltime to depth (Figure 4) is based on seismic-refraction data and on interval velocities measured from seismic-reflection data. Cooper, Bruns, and Wood (1986) used seismic-refraction data to derive a velocity function for Shortland basin of $v=1.42+1.95t$, where v is velocity (km/s) and t is one-way traveltime (s). For reflection times of less than 3 s two-way time, seismic-reflection interval velocities compared favorably with the refraction velocities. Therefore, the linear refraction-velocity function was used to make a regional time-to-depth conversion. Converting the refraction velocity function to a time-depth curve and two-way traveltime yields $D=0.71t+0.24t^2$ for Shortland basin, where D is sub-sea-floor depth (km) and t is two-way sub-seafloor traveltime in seconds for t less than 3 s (Bruns et al, 1986).

For t greater than 3 s, refraction and reflection velocities for sedimentary rocks are poorly determined because most refraction arrivals are from basement rocks (velocities greater than 4.5 to 5 km/s; Cooper, Bruns, and Wood, 1986). Velocities determined from reflection data are poorly determined in the few areas where reflection arrivals from layered rocks below 3 s are present. Therefore, for two-way traveltimes greater than 3 s, a constant interval velocity of 4.5 km/s was used, in agreement with the velocity that Cooper, Bruns, and Wood (1986) used as the dividing line between sedimentary strata and probable igneous and metamorphic basement rocks. This velocity function is different from that Bruns et al (1986), who did

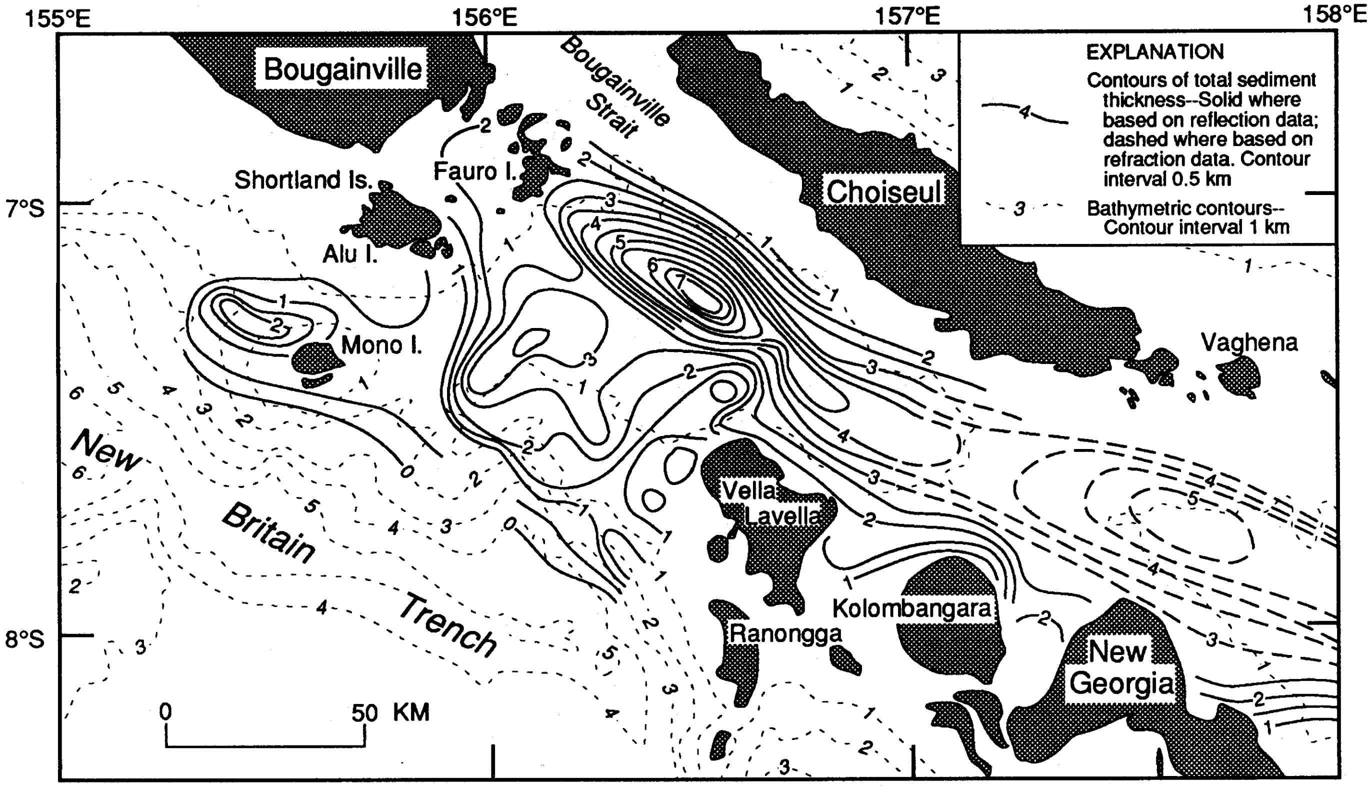

Figure 6. Isopach map of total sediment thickness above seismic-stratigraphic unit A (acoustic basement). Solid contours are based on interpreted multichannel seismic-reflection data; dashed contours on seismic-refraction data.

not use a constant interval velocity for times greater than 3 s. These velocity relationships were used to construct a structure contour map (Figure 5) and a sediment isopach map (Figure 6) from the seismic-reflection data.

SEISMIC STRATIGRAPHY OF SHORTLAND BASIN

Bruns et al (1986) divided the rocks underlying Shortland basin into four seismic-stratigraphic units, designated as A through D from oldest to youngest. The bounding surface of each of these units either is an unconformity or is characterized by an abrupt change in seismic velocity, or both. Two of these units, C and D, were further divided into upper and lower subunits, designated by subscripts "u" and "l" respectively; for example C_l and C_u for subunits C-lower and C-upper. The designation for a seismic-reflection horizon between two units is hyphenated; for example, horizon C-D separates seismic units C and D. The seismic units are shown on the seismic lines of Figures 7-11; a brief description of the units from Bruns et al (1986) follows.

Seismic unit A is acoustic basement and is characterized by discontinuous to choatic seismic reflections along the flanks of the basin and by occasional faint subhorizontal to horizontal reflections in the central part of the basin. On the south side of the basin, the top of unit A lies on a subsurface platform at a depth of about 2 to 3 km (Figures 8 and 9). Along the northern basin margin, unit A dips southward from Choiseul. The maximum depth to the top of unit A in the deepest part of the basin is unclear, because the horizon A-B reflector can only be discontinuously followed there. We interpret the maximum depth to be over 8 km and the maximum sediment thickness to be over 7 km on line 49 (Figures 5, 6, and 8). Seismic-refraction velocities within the unit range from about 4.5 to 5.9 km/s.

Unit B is characterized by laterally continuous parallel reflectors that dip and thicken southward from Choiseul, and we believe that the unit crops out on Choiseul. In the deepest part of the basin, the unit onlaps the south flank of a basement half graben (Figures 7-10). South of the half graben, the unit thins markedly and is truncated in the subsurface by overlying units C and D. Unit B is the thickest of the three basin-fill sequences, reaching a maximum thickness of about 5 km on line 49 (Figure 8). Velocities within the unit from seismic-refraction and seismic-reflection data range from about 3.4 to 4.4 km/s, indicating well-indurated sedimentary rocks.

Both units C and D are characterized by prominent, laterally continuous reflections, although the reflection continuity varies considerably near the basin flanks. Velocities within unit C range from 2.3 to 3.6 km/s, with an abrupt decrease across horizon C-D to velocities of 1.6

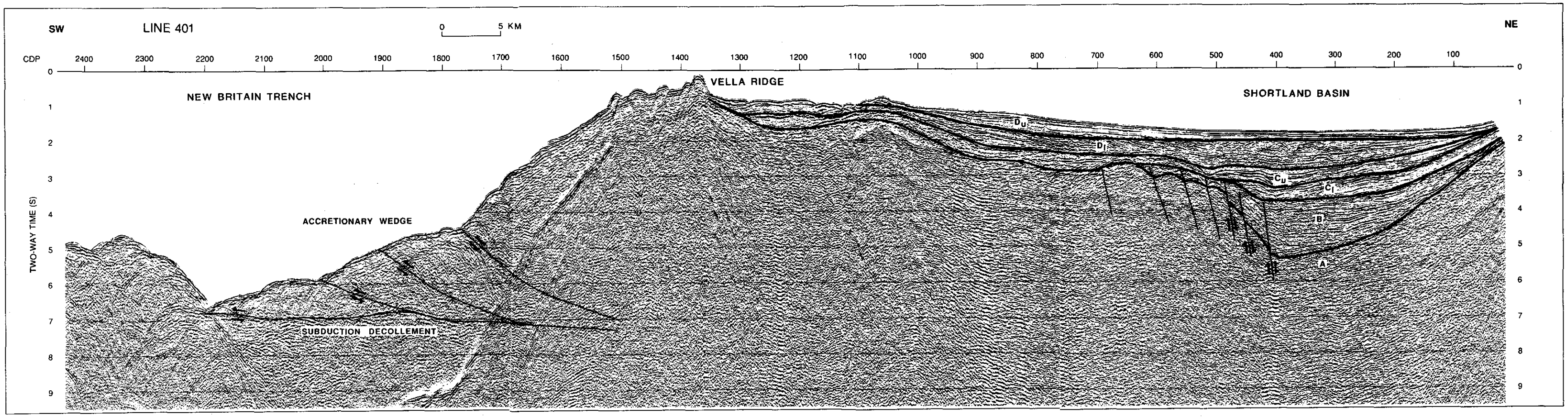

Figure 7. Multichannel seismic-reflection profile 401. This and subsequent profiles show interpreted faults and seismic-stratigraphic units A through D as described in text. CDP, common-depth-point. Vertical exaggeration at the sea floor is about 4:1. Location of seismic profile shown in Figure 3.

to 2.6 km/s in unit D. The velocity decrease across the horizon is generally about 1 km/s.

In the central part of Shortland basin, the unit C subunits form two distinct sediment wedges. Unit C_l dips and thins southward from Choiseul, whereas unit C_u is thickest beneath Vella Ridge and dips and tapers out northward beneath the axis of the basin (Figures 7-10). The contact between the two subunits is a well-defined unconformity in the western part of Shortland basin. However, in the eastern part of the basin and near Bougainville, the wedge shape of the two subunits is absent, both subunits thin, and bedding is concordant across the contact between the subunits.

Unit D is a basin-filling unit that is flat lying and generally undeformed, except near the basin flanks and over Vella Ridge. Seismic reflections from the unit are mainly laterally continuous and of variable amplitude. However, moderately chaotic reflections and a hummocky or mounded appearance characterize strata in the lower part of the unit and near the basin edges, particularly near the Shortland Islands. This reflection character could indicate rapid deposition by debris flows derived from the islands, or the presence of carbonate reefs or reefal debris. Unit D unconformably overlies all older units and thins toward the basin flanks. The unit consists of two subunits, differing mainly in that subunit D_l has a hummocky reflector character and is uplifted on Vella Ridge whereas subunit D_u is everywhere laterally continuous and flat lying.

Geologic Correlation of Seismic Units

Bruns et al (1986) correlated the seismic-stratigraphic units with rock units on Choiseul and other islands surrounding the Shortland basin. Unit A is correlated with the basement rocks of the surrounding islands, and in particular with the Choiseul Schists and the Voza Lavas of Choiseul. The unit could also include the poorly bedded late Oligocene conglomeratic and brecciated rocks at the base of the overlying Mole Formation. Rocks on other islands that correlate with unit A include the Atamo Volcanics and Keriaka Limestone of Bougainville and the basement rocks of the Shortland Islands. The unit may also include volcanic flows and volcaniclastic rocks near the late Cenozoic volcanic centers.

Unit B is correlated with the bedded siltstones and sandstones of the late Oligocene and Miocene Mole Formation, which lies unconformably on the Voza Lavas and Choiseul Schist. Unit C is correlated with the calcarenites and calcisiltites of the Pliocene Pemba Formation of Choiseul and with the Pliocene siltstones of the Shortland Islands, which include the Koria, Alu, and Mono Siltstones. The uppermost part of unit C may have been sampled on Vella Ridge, where dredge samples from approximately the contact between units C and D are as old as earliest Quaternary (Colwell and Vedder, 1986). Finally, unit D is considered to be largely Quaternary.

STRUCTURE AND SEDIMENT THICKNESS

Structure

Shortland basin is surrounded by high-relief islands, and sediments eroded from these islands fill the basin. Although the basin has a complex development history, the resulting basin structure is relatively simple. Strata in the basin dip and thicken basinward from the flanks, and unconformities within, and deformation of, the sedimentary section are dominantly a result of differential uplift of the subsiding basin relative to its margins. The seismic lines shown here (Figures 7-11) illustrate the major features of Shortland basin.

Seismic line 401 (Figure 7) crosses the New Britain Trench, Vella Ridge, and the eastern part of Shortland basin. Based on a bathymetric map by Chase, Seekins, and Young (this volume), the steep slope on the southwestern side of the New Britain Trench (Figure 7, common-depth-points [CDP's] 2200 to 2440) is the flank of a small bathymetric high on the Woodlark Basin ocean plate. At the New Britain Trench, reflectors from oceanic crust can be traced beneath the lower slope for 25 km (Figure 7 at about 7 s beneath CDP's 1700 to 2200) until obscured by the water-bottom multiple. Overlying the oceanic-crust reflectors is an accretionary wedge that developed during subduction of the oceanic crust. Rocks within the wedge are either highly deformed or poorly bedded, as indicated by generally chaotic reflectors. Northeast of CDP 1700, bedded rocks are present beneath the upper slope southwest of Vella Ridge. These rocks taper out at about midslope on line 401 and other seismic lines that cross the slope (see also line 402 in Bruns et al, this volume). The slope strata are continuous with the thick basin strata beneath Vella Ridge (see especially unit C on line 50, Figure 9). Thus, the slope strata were at least in part deposited southward out of Shortland basin prior to the uplift of Vella Ridge.

Seismic lines 401, 49, 50, and 407 (Figures 7-10) illustrate the main structural elements of Shortland basin and show the seismic-stratigraphic wedges that characterize the sedimentary sequence within the basin. At least four episodes of uplift and erosion are reflected in the basin stratigraphy.

First, units A and B are truncated on the southwest side of the basin, where pronounced unconformities at the top of these units extend from the middle of the basin to beneath Vella Ridge (lines 49 and 50, Figures 8 and 9). The unconformities are a regional feature along the entire south island chain between the Shortland Islands and Guadalcanal (Bruns et al, 1986). The unconformity at the top of unit A presumably resulted from uplift and erosion of the southern basin flank during late Eocene and Oligocene subduction, prior to deposition of unit B. The unconformity at the top of unit B may have developed during the late Miocene and early Pliocene initiation of subduction along the New Britain and San Cristobal trenches (Bruns et al, 1986).

A third uplift episode caused the elevation and erosional truncation of units A, B, and C adjacent to

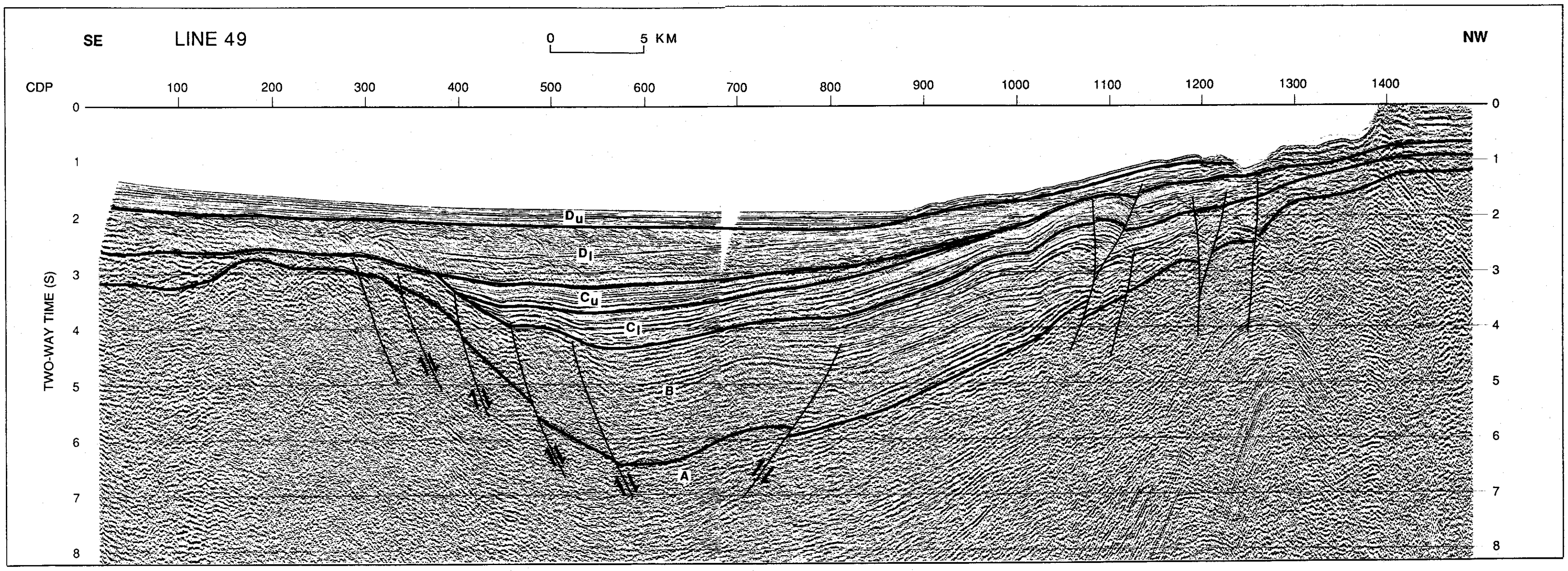

Figure 8. Multichannel seismic-reflection profile 49. Section is processed to attenuate deep-water water-bottom multiple. Profile crosses location of the thickest sedimentary section in Shortland basin. For further explanation, see Figure 7.

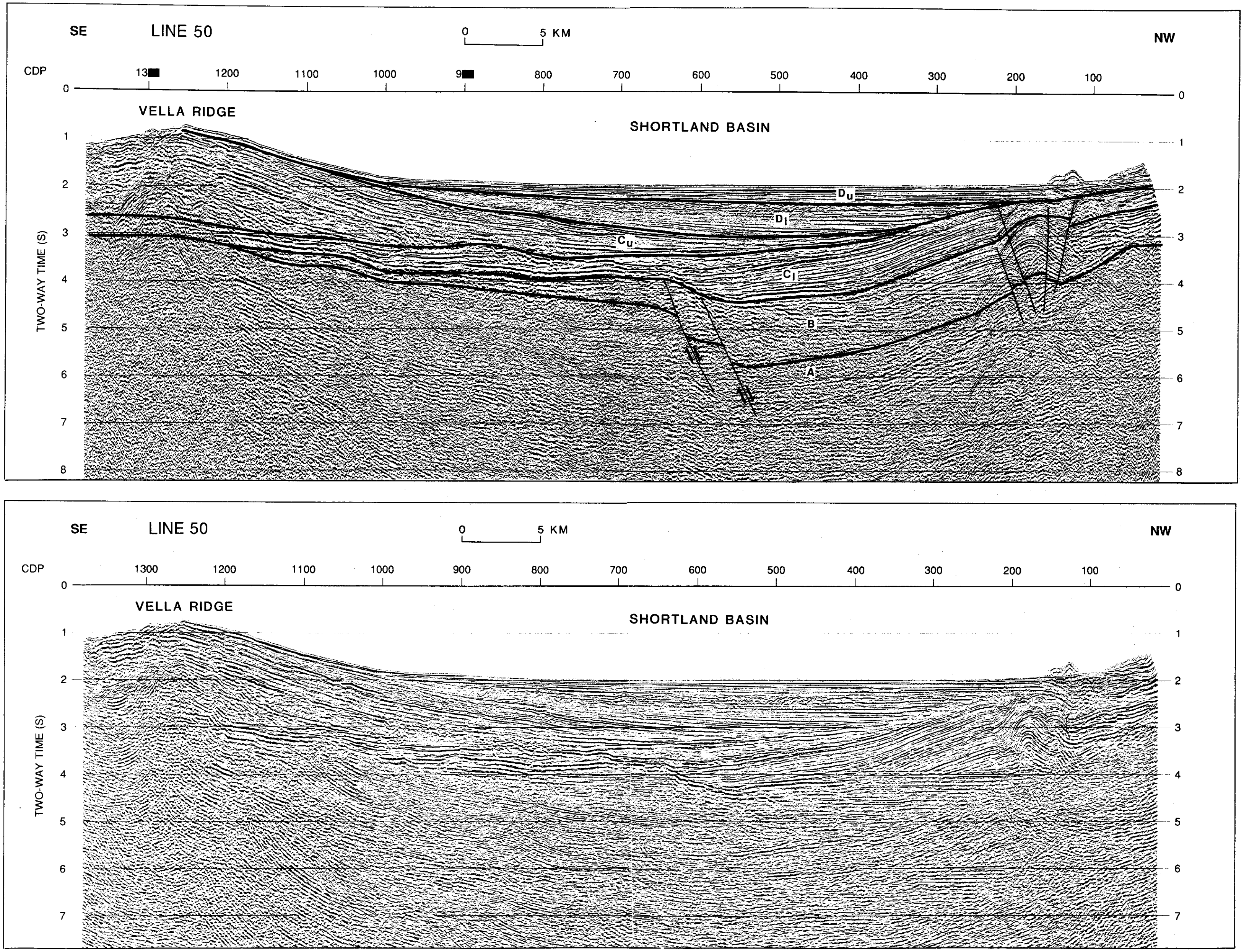

Figure 9. Multichannel seismic-reflection profile 50, unmigrated time section at top, migrated section below. Unmigrated section is processed to attenuate water-bottom multiple. Migrated section resolves diffractions in tightly folded anticline between CDP's 100 and 250. For further explanation, see Figure 7

Choiseul. The uplifted rocks are onlapped by flat-lying unit D strata. Uplift therefore occurred in about the late Pliocene or early Quaternary, coincident with the uplift of Choiseul.

Finally, marked recent uplift has occurred on Vella Ridge. Colwell and Vedder (1986) used analyses of dredged rocks to document a Quaternary history of 1,600 m of uplift followed by 700 m of subsidence of rocks beneath Vella Ridge. When restored to the original depositional depth, these strata were nearly flat lying at the time and depth of deposition. Thus, the present northward dip of units C and D strata is a measure of uplift along the ridge (see line 50, Figure 9). The uplift and subsidence of Vella Ridge was speculatively attributed to subduction of part of the Woodlark spreading ridge and (or) associated transform faults into the New Britain-San Cristobal trench system (Bruns et al, 1986).

Shortland basin rocks are faulted or folded in the center and on the northeastern flank of the basin. In the center of the basin, an extensional basement half graben trends northwestward for at least 80 km between lines 407 and 401 (beneath CDP's 400 to 600, line 401; CDP's 300 to 550, line 49; CDP's 500 to 700, line 50; and CDP's 250 to 400, line 407; Figures 7-10). The structural relief across the faults that bound the south flank of the half graben is over 6 km on line 49 (Figure 8) and decreases westward to 2 km on line 407 (Figure 10) and eastward to about 4 km on line 401 (Figure 7). At the western end of Shortland basin, the half graben trends beneath the Shortland Islands but is not evident on seismic profiles adjacent to Bougainville (see lines 6, 7, and 8 in Bruns et al, 1986). To the east, the half graben turns eastward beneath the western end of line 46 and the northeastern end of line 47 (Figure 3), and trends toward Choiseul.

Strata of unit B thicken southward into Shortland basin and onlap the faulted basement rocks on the south flank of the half graben. The unit B strata are moderately deformed adjacent to the south flank of the half graben, as shown by a gentle fold evident on line 49 in the lower part of the unit B section (Figure 8). The onlap, southward thickening, and early deformation of unit B strata indicate that the half graben must have developed prior to and during early deposition of unit B. The development time for the half graben is therefore about late Oligocene and early Miocene. If this age is correct, then the half graben developed during the time when the Ontong Java Plateau is believed to have entered and blocked the subduction zone north of the Solomon Islands.

Deformed rocks also lie along the northeastern flank of Shortland basin where northwest-trending faults and folds lie in a band at least 30 km long and 5 to 8 km wide on the northern ends of lines 49, 50, and 407 (Figures 8-10). This deformation does not effect unit D (Quaternary) strata and therefore occurred during about the late Pliocene or early Pleistocene, or at about the same time as the late Pliocene uplift of Choiseul. The extent of the deformed zone east and west of the seismic lines 49, 50, and 407 is unknown. The dip of faults within the deformed zone is highly variable (Figure 9), and the structural character suggests features formed as a result of transpression along a strike-slip fault (flower structures of Wilcox, Harding, and Seely, 1973; palm tree structures of Sylvester, 1988).

Line 406 (Figure 11) shows the western end of Shortland basin. The basin strata thin markedly beneath CDP's 1400 to 1700 onto a basement platform (the Mono Island platform on Figure 11) that underlies the Shortland Islands and the area to the west. Along the rest of the line, the sedimentary cover appears to be mainly late Cenozoic (unit D) and is mainly less than 1 km thick. Refraction data also indicate a thin sedimentary cover over basement rocks with no buried low-velocity section beneath the platform (Cooper Cochrane, and Bruns, this volume). Some minor normal faults are evident in the platform rocks. In particular, a scarp is present under about CDP 600; this position is a data gap on the multichannel record (Figure 11), but the scarp is apparent on single-channel seismic-reflection records acquired simultaneously with the multichannel lines.

Sediment Distribution and Basin Extent

The structure contour and sediment thickness maps of Shortland basin (Figures 5 and 6) show that the axis of the basin trends northwestward along the center line of the Central Solomons Trough. The thickest section lies in the basement half graben. The bulk of the sediment in this depocenter lies in unit B and has a maximum thickness of about 5 km. A subsidiary depocenter is present along Vella Ridge where the bulk of the sediment occurs in unit C; this depocenter thins both eastward and westward. However, a small basin west of Mono Island lies along the Vella Ridge trend and contains more than 2 km of sedimentary section in unit D above the acoustic basement. West of this basin, seismic-reflection lines show less than 1 km and commonly less than 0.5 km of sedimentary rocks overlying basement (Figures 6 and 11).

The total sediment thickness given here for Shortland basin is greater than reported by Bruns et al (1986) because of a reinterpretation of the position of the A-B horizon. Better definition of the horizon was obtained by the increased coverage given by the 1984 seismic-reflection data and by reprocessing of the 1982 seismic-reflection lines.

Along the northeast flank of Shortland basin, strata thin onto Choiseul. Nowhere does the thick sequence along the basin axis seem to outcrop on this island. Only a thin sedimentary sequence is present above acoustic basement on the north side of Bougainville Strait (line 403 in Bruns, Vedder, and Culotta, this volume).

At the western end of Shortland basin, the extent and thickness of basin strata are less clear. The thick strata below the basin axis trend beneath the Shortland Islands toward Bougainville. Seismic lines in these areas may not reveal the total sediment thickness, because near-surface volcanic rocks may conceal underlying strata as occurs beneath the New Georgia wedge region southeast of Shortland basin (Figures 1 and 2; Cooper, Cochrane, and

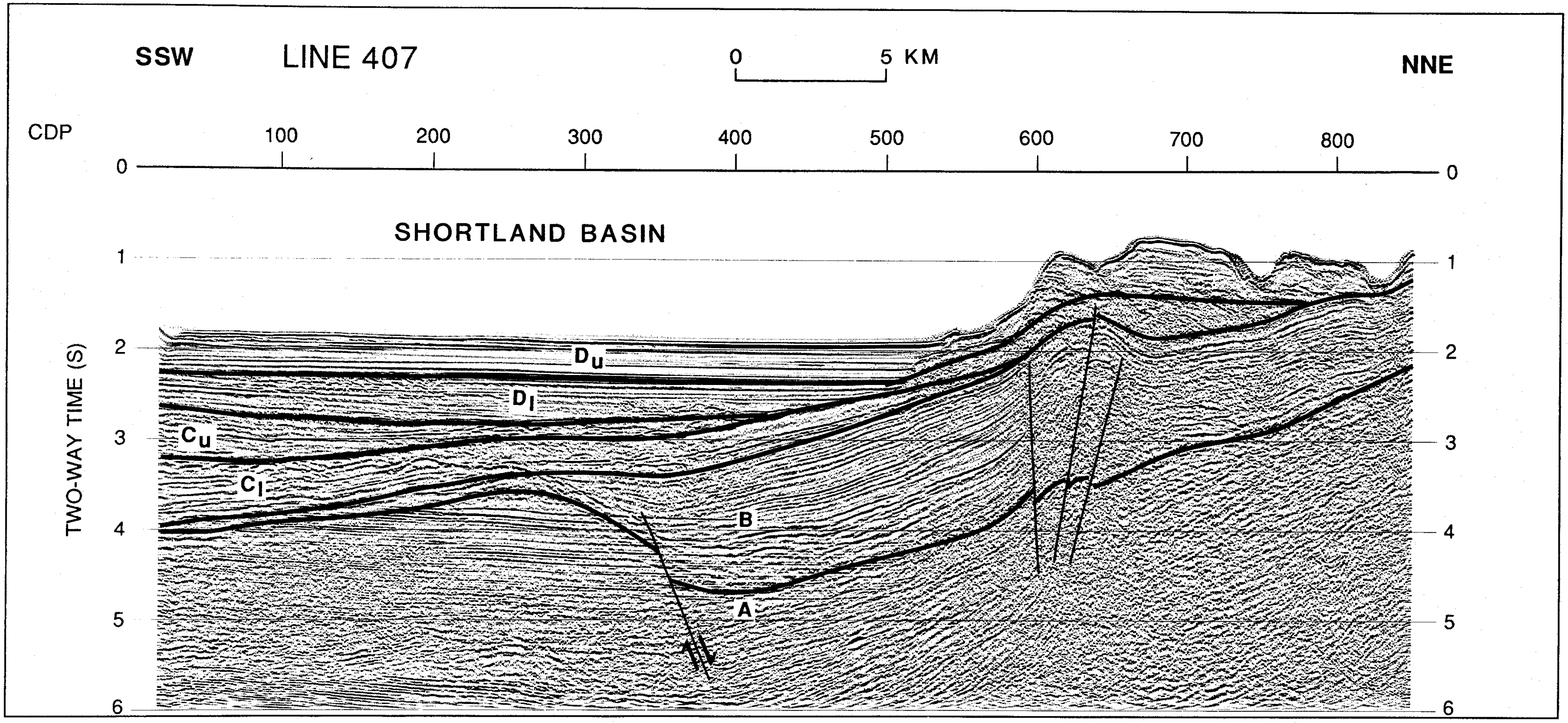

Figure 10. Multichannel seismic-reflection profile 407, migrated time-section. Features in the upper part of the section between CDP's 600 and 800 may be rotated slump blocks off Choiseul. For further explanation, see Figure 7.

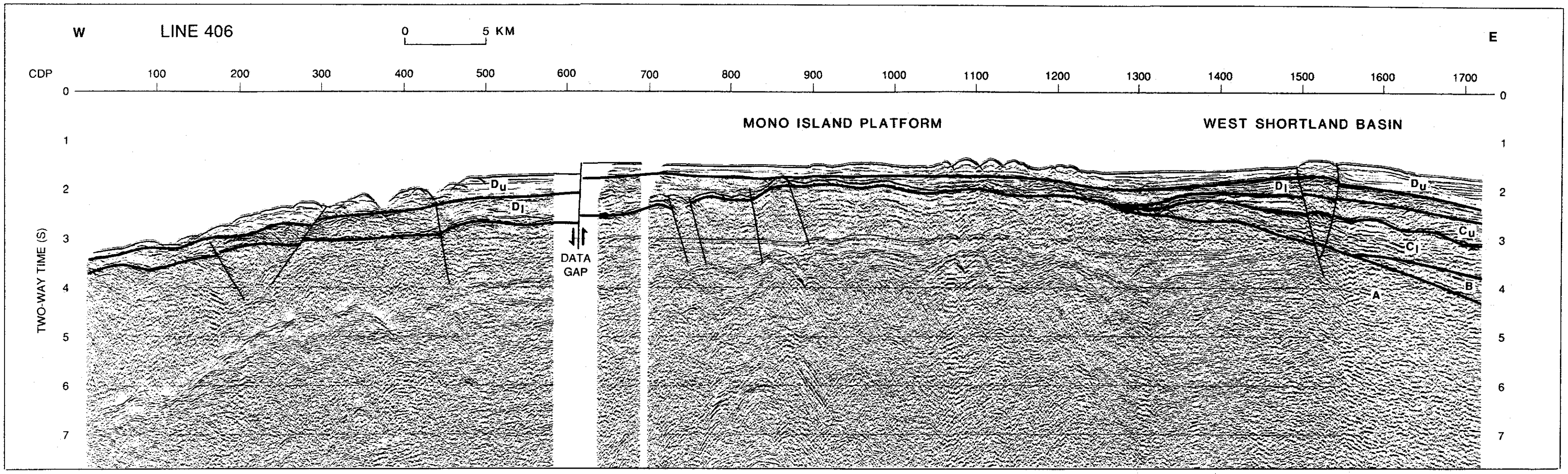

Figure 11. Multichannel seismic-reflection profile 406 across the western part of Shortland basin and the Mono Island platform. For further explanation, see Figure 7.

Bruns, this volume). However, the total sedimentary package thins northwestward toward Bougainville (compare thicknesses on lines 49, 50, and 407). Further, rocks correlated with units C and D of the Shortland basin outcrop on the Shortland Islands. Thus, although part of the basin could be buried beneath the Quaternary volcanic rocks and stratovolcanoes of southwestern Bougainville, the basin strata more likely are thin or uplifted, and Shortland basin may end beneath the Shortland Islands or near Bougainville.

The depositional axis of Shortland basin is on trend with the axis of thick strata in Bougainville basin, which lies along the southwest side of Bougainville (Figure 2; Shaw, 1985; Stewart, Francis, and Pederson, 1987; Hilyard and Rogerson, this volume). If the Shortland basin does end near Bougainville, however, then the two basins are not continuous. A basement ridge or high block (possibly the Aitara High described by Shaw, 1985) along the southwestern side of Bougainville separates Shortland and Bougainville basins there.

On the southwest flank of Shortland basin, strata thin markedly south of Vella Ridge and taper out part way down the slope into the New Britain Trench (Figures 6 and 7). Bruns et al (1986) speculated that during deposition of unit C strata, Shortland basin may have been open southward into the Woodlark Basin and that sediment may have spilled through the Vella Ridge region onto the slope. However, the volume of such material appears to have been small, because only a thin bedded section is discernible beneath the middle and lower parts of the slope. The chaotic character of reflections beneath the slope suggests that most of the slope is underlain by arc-basement rocks, probably rocks of the late Cenozoic arc, or that substantial deformation of strata beneath the slope has occurred as a result of subduction of the Solomon plate beneath the arc.

New Georgia Wedge

The southeastward extent of Shortland basin beneath the New Georgia wedge was interpreted differently by Bruns et al (1986) and Cooper, Bruns, and Wood (1986). The two different interpretations were, respectively, a basin sequence about 2 km thick based on multichannel seismic-reflection data, or a basin sequence about 5 km thick based on seismic-refraction data, a thickness equal to that of the Shortland and Russell basins.

Seismic-refraction data acquired in 1984 convincingly demonstrate that the New Georgia wedge region is underlain by a 5.5-km-thick sequence of interlayered sedimentary and high-velocity rocks, probably volcanic flows and related volcaniclastic debris from the active volcanoes of the New Georgia island group (Cooper, Cochrane, and Bruns, this volume). On seismic-reflection profiles, therefore, the high-velocity rocks form an anomalously shallow acoustic basement, and total basin thickness is obscured. The seismic-stratigraphic units of the Shortland basin, and in particular the acoustic basement, cannot be traced with confidence southeastward from Fatu O Moana, which lies north of Kolombangara (Figure 1). Structure and sediment-thickness contours shown in Figures 5 and 6 for the New Georgia wedge region are based on interpretations of refraction data.

BASIN EVOLUTION

Bruns et al (1986) described a model for the evolution of Shortland basin that is based on the geometry and inferred ages of the sedimentary wedges in the basin. We have somewhat altered that on the basis of interpretations of the 1984 data. The most significant change is the recognition of the half graben that formed during the late Oligocene and Miocene. The character of the half graben was not recognized earlier because of the limited data across the feature. A second significant change is the recognition that unit B strata thin onto Choiseul, rather than being erosionally truncated. As in the previous model, however, the geometry of the basin fill indicates that the evolution of the basin has been primarily driven by vertical uplift and subsidence of the northeastern and southwestern flanks of the basin relative to the subsiding basin depocenter.

Prior to the late Oligocene, rocks that correlate with unit A were uplifted, metamorphosed, and eroded, probably as a consequence of southward directed subduction and related arc growth. The pronounced unconformity at the top of unit A developed during this period.

During the late Oligocene and early Miocene, widespread magmatism and southward subduction of the Pacific plate beneath the Solomon Islands arc caused uplift of the northern basin margin. Sediments shed off the resulting structural high formed unit B in the incipient back-arc Shortland basin (Figure 12A). Also, during the late Oligocene or early Miocene, a basement half graben with relief of 2 to 6 km formed within the back arc. The unit B sediment thickened into and filled the half graben, onlapped the southern flank, and eventually overtopped the half graben and spread southward. The half-graben development is coincident with the arrival of the thick oceanic crust of the Ontong Java Plateau at the subduction zone. The half graben may have developed as a pull-apart basin or by block rotation within the arc as a result of oblique subduction and transpression during the collision and arc-shutdown process. During the middle Miocene, subduction and arc volcanism ceased. The entire basin region subsided, and remnant high areas of the early Cenozoic arc continued to shed into the back-arc basin.

In about the late Miocene, uplift on the south side of the basin led to a shallowing of the basin and to truncation of B (Figure 12B). This uplift may have been caused by compression and volcanic-arc growth associated with the initiation of subduction at the New Britain Trench.

In the early Pliocene, renewed subsidence of the basin allowed deposition of subunit C_1, which probably was derived dominantly from the northern side of the basin (Figure 12C). These sediments covered eroded remnants of the underlying units.

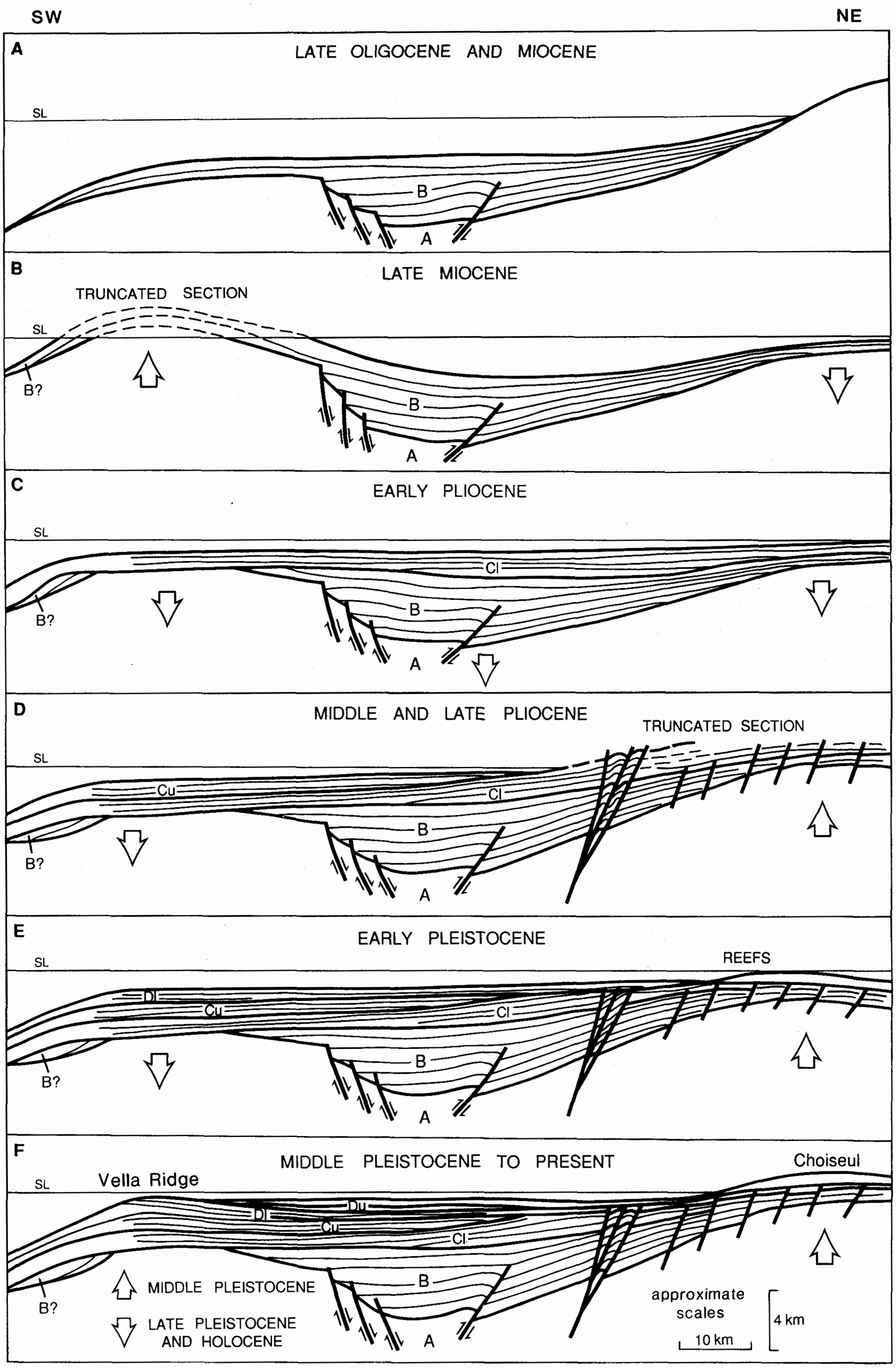

Figure 12. Diagrammatic basin-development history of the central Shortland basin region. Horizontal and vertical scales are approximate. Within limits of seismic control, diagrams are derived from depth conversion and flattening of seismic-reflection horizons. Outside of area of seismic control, diagrams are speculative. Large arrows indicate relative uplift and subsidence during annotated time interval. Seismic-stratigraphic units are as described in text and shown on seismic profiles. Revised from Bruns et al (1986).

In the middle and late Pliocene, renewed uplift of the northern flank of the basin tilted unit B and subunit C_l upward essentially as a packet, and subunit C_l strata were truncated on the north (Figure 12D). Uplift also shifted the subunit C_u depocenter southward relative to the unit B and subunit C_l depocenter to a position beneath the present Vella Ridge. The anticlinal deformation along the northern basin margin probably also occurred during this uplift phase. Shortland basin may have opened southward into Woodlark Basin during this period; however, only a thin sediment cover was deposited onto the slope.

During the early Pleistocene, subsidence and erosion of the northern landmass resulted in the growth of the extensive reef deposits of western Choiseul (Figure 12E). Subunit D_l strata were deposited southward across the strait between the Shortland Islands and Vella Lavella.

Finally, in the late early and middle Pleistocene, renewed uplift began on both sides of the basin (Figure 12F). On the northern side, Quaternary reef deposits were elevated to at least 600 m above sea level on Choiseul, with uplift possibly caused by the development of Pleistocene volcanoes. On the southern side, subunits C_u and D_l on Vella Ridge were elevated above sea level by about 1 Ma (Colwell and Vedder, 1986). Subsequently, during late Pleistocene and Holocene time, these strata again subsided to their present depth of about 700 m. The vertical tectonic movements of Vella Ridge may be caused by subduction of the Woodlark spreading center and associated transform faults into the New Britain-San Cristobal trench system (Bruns et al, 1986).

CONCLUSIONS

Multichannel seismic-reflection data acquired in 1982 were used by Bruns et al (1986) to provisionally define the stratigraphy and structure of the Shortland basin region. Additional data acquired in 1984 resulted in four new findings and reinterpretations:

(1) A basement half graben underlies the center of Shortland basin, and contains the maximum sediment thickness in the basin. Relief across the south flank of the half graben is as much as 6 km but decreases eastward to 4 km near the middle of Choiseul and westward to 2 km adjacent to the Shortland Islands. Basin strata onlap and overtop the south flank of the half graben. The half graben developed in the late Oligocene and early Miocene, coincident with the arrival of the Ontong Java Plateau at the early Tertiary subduction zone. The half graben may have developed as a pull-apart basin or by block rotation in a transform or oblique subduction system.

(2) New maps of structure and sediment thickness show that the depositional sequence in the basin is thicker than previously reported. The maximum sediment thickness is about 7 km in the northwest-trending main basin depocenter in the Central Solomons trough. Subsidiary depocenters are present beneath Vella Ridge and west of Mono Island, where maximum sedimentary-rock thicknesses are as much as 3 and 2 km, respectively.

(3) The regional extent of the Shortland basin to the northwest and southeast is better determined than previously. The thick sedimentary section in the axial part of Shortland basin thins towards the Shortland Islands and Bougainville, and a thick basin fill cannot be traced or inferred beneath the stratovolcanoes and volcanogenic rocks of Bougainville. Thus, Shortland basin could end beneath the Shortland Islands or near Bougainville. A basement high on the southwestern side of Bougainville separates Bougainville basin from Shortland basin. However, a connection between Shortland and Bougainville basins that lies beneath the thick volcanic rocks of southeastern Bougainville cannot be ruled out. On the southwest flank of Shortland basin, sediment moved out of the basin and accumulated on the slope, but these slope strata thin out midway down the slope. Thus, major volumes of sediment probably were not moved southward into the New Britain Trench prior to uplift of Vella Ridge.

(4) Refraction data clearly show that the basin fill beneath the New Georgia wedge region is substantially thicker than was previously interpreted from seismic-reflection data. The new structure and sediment thickness maps reflect this finding and show at least 5 km of interbedded volcanic and volcaniclastic rocks beneath the New Georgia wedge region.

The evolution of Shortland basin was largely driven by vertical tectonics on the northeastern and southwestern flanks of the basin. These vertical movements were in turn driven by tectonic events associated with the subduction and arc-reversal history of the Solomon Islands region. Major uplift of the northern basin margin and early Tertiary faulting within the basin were probably related to early Tertiary subduction and to arrival of the Ontong Java Plateau at the early Tertiary subduction zone. Late Miocene and early Pliocene uplift of the basin margins is coincident with the initiation of subduction along the New Britain-San Cristobal trench system. Uplift possibly was governed by compressional tectonics associated with this subduction. Pliocene and Quaternary uplift of the northern basin margin may have been controlled by late-episode intrusive and volcanic activity on Choiseul. Finally, major recent uplift of the south basin margin may have been caused by subduction beneath the arc of the Woodlark spreading center. Thus, the unique sedimentary wedge geometries in Shortland basin are caused by tectonic events associated with the subduction and arc-reversal history of the Solomon Islands region.

ACKNOWLEDGMENTS

We thank R.C. Culotta, D.M. Mann, and P.E. Hart for processing the seismic data, Susan Vath for drafting support, and T.M. Martin-Funnié for typing support. M.A. Fisher and S.L. Eittreim provided reviews that significantly improved the manuscript.

REFERENCES CITED

Blake, D.H., and Miezitis, Y., 1967, Geology of Bougainville and Buka Island, New Guinea: Department of National Development, Bureau of Mineral Resources, Geology and Geophysics Bulletin 93, PNG 1, Canberra, A.C.T., 56 p.

Bruns, T.R., Cooper, A.K., Mann, D.M., and Vedder, J.G., 1986, Seismic stratigraphy and structure of sedimentary basins in the Solomon Islands region, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 177-214.

Bruns, T.R., Cooper, A.K., and Vedder, J.G., 1986, A multichannel seismic-reflection profile across the Solomon Islands arc, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 215-224.

Chase, T.E., Seekins, B.A., and Lund, K.E., 1986, Submarine topography of the Solomon Islands region, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 21-32.

Coleman, P.J., 1965, Stratigraphical and structural notes on the British Solomon Islands with reference to the first geological map: British Solomon Islands Geological Record (1959-1962), v. 2, p. 17-31.

Colwell, J.B., and Vedder, J.G., 1986, Description and interpretation of dredged rocks, Solomon Islands, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 225-236.

Cooper, A.K., Bruns, T.R., and Wood, R.A., 1986, Crustal structure of the Solomon Islands intra-arc basins from sonobuoy seismic studies, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 135-156.

Cooper, A.K., Marlow, M.S., and Bruns, T.R., 1986, Deep structure of the central and southern Solomon Islands region: implications for tectonic origin, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 157-176.

Coulson, F.I., and Vedder, J.G., 1986, Geology of the central and western Solomon Islands, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 59-88.

de Broin, C.E., Aubertin, F., and Ravenne, C., 1977, Structure and history of the Solomon-New Ireland region: International Symposium on Geodynamics in Southwest Pacific, Noumea (New Caledonia), 27 August-2 September 1976, Editions Technip, Paris, France p. 37-50.

Katz, H.R., 1980, Basin development in the Solomon Islands and their petroleum potential: U.N. ESCAP, CCOP/SOPAC Technical Bulletin, no. 3, p. 59-75.

Kroenke, L.W., 1984, Cenozoic tectonic development of the southwest Pacific: U.N. ESCAP, CCOP/SOPAC, Technical Bulletin, no. 6, 122 p.

Landmesser, C.W., 1977, Evaluation of potential hydrocarbon occurrence in the Solomon Islands: U.N. ESCAP, CCOP/SOPAC Technical Report, v. 1, no. 5, p. 47-53.

Mann, D.M., 1986, Multichannel seismic operations for CCOP/SOPAC Cruise, Leg 3, Solomon Islands, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 35-40.

Maung, T.U., and Coulson, F.I., 1983, Assessment of petroleum potential of the central Solomons Basin: U.N. ESCAP, CCOP/SOPAC Technical Report n. 26, 68 p.

Pound, K.S., 1986, Correlation of rock units in the central and western Solomon Islands, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 89-98.

Ridgway, J., and Coulson, F.I.E., 1987, The geology of Choiseul and the Shortland Islands, Solomon Islands: British Geological Survey Overseas Memoir 8, 134 p.

Shaw, R.D., 1985, Hydrocarbon potential of the Bougainville basin, Papua New Guinea: 14th BMR Symposium, Extended Abstracts—Petroleum Geology of South Pacific Island Countries, Marine Studies Workshop, Canberra, Australia, 22-23 October, p. 19-29.

Stewart, W.D., Francis, G., and Pederson, S.L., 1987, Hydrocarbon potential of Papua New Guinea's Bougainville, southeastern New Ireland basins: Oil and Gas Journal, v. 85, n. 47, p. 83-87.

Sylvester, A.G., 1988, Strike-slip faults: Geological Society of America Bulletin, v. 100, p. 1666-1703.

Taylor, B. and Exon, N.F., 1987, Marine geology, geophysics, and geochemistry of the Woodlark Basin-Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 7, 363 p.

Vedder, J.G., and Bruns, T.R., 1986, Offshore petroleum potential, Solomon Islands, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 277-294.

Vedder, J.G., and Coulson, F.I., 1986, Regional offshore geology of the Solomon Islands, *in* Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4, p. 99-108.

Vedder, J.G., Pound, K.S., and Boundy, S.Q., eds., 1986, Geology and offshore resources of Pacific island arcs—central and western Solomon Islands: Houston, Texas, Circum-Pacific Council for Energy and Mineral Resources

Earth Science Series, v. 4, 306 p.

Wilcox, R.E., Harding, T.P., and Seely, D.R., 1973, Basic wrench tectonics: American Association of Petroleum Geologists Bulletin, v. 57, p. 74-96.