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Some geological notes on areas visited by the Royal Society Expedition to the British Solomon Islands, 1965

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(*Read at the Discussion by* J. A. E. Allum)

The British Solomon Islands consist of a double chain of elongated islands in the form of a bow whose apices lie in the single islands of Bougainville in the west and San Cristobal in the east. The length of the main island chain is 650 miles, if Bougainville, which is part of Australian New Guinea, is included.

The Royal Society 1965 Expedition field parties visited eight different areas selected to give the widest variation of environment. These areas are well scattered throughout the main islands of the Solomons and are underlain by representatives of all the major geological rock units. To relate the geology of the areas visited to the general geology, a summary is given below. Figure 1 shows the areas visited.

On all the main islands in the Solomons except the New Georgia group, the lowest unit of the geological succession is a basalt or basaltic andesite.

In Malaita, the age of the oldest sediments found directly overlying basal basalts has been determined as Upper Cretaceous (Coleman 1966). Elsewhere in the Solomons Oligocene and Miocene are the oldest deposits overlying the basal basalts. The age of the basal basalts on all islands may be pre-Upper Cretaceous as in Malaita, but the correlation is by no means established. The Malaitan Cretaceous sediments appear to have accumulated in deep water (over 1000 m), probably far from any source of detrital material, whereas the overlying sediments have increasing proportion of terrestrial detritus and an increasing proportion of shallower water fossils (Coleman 1966).

The first known emergence of any of the present land area of the Solomons appears to have occurred at the end of the Oligocene, when the basalts in Choiseul and Guadalcanal were subject to great stress causing local low-grade metamorphism. It is probable that the first thrust emplacement of the ultrabasics occurred at this time in all areas.

Sediments deposited after the Oligocene generally contain some fragments of ultrabasic material, and on some islands an erosion surface and basal conglomerate have been recognized. During the Lower Miocene widespread calcareous deposition occurred on all the main islands. On Guadalcanal a white limestone, locally coralline and locally replaced by detrital sediments, is exposed in all parts of the island. Calcarenites of a similar age are found elsewhere on all the large islands. After this deposition in the Miocene, the main mountain range of Guadalcanal continued to rise above the sea, the movement occurring along composite fault zones. Sediments derived from the exposed rocks were transported northwards filling the basin between Guadalcanal and Malaita to a depth of 4000 m (12000 ft.). As uplift continued, the edges of the earlier deposits became exposed to erosion, thus zones of progressively younger sediments are exposed as the north Guadalcanal coast

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is approached from the central mountain range. The volume of sediments might suggest that the presently exposed Guadalcanal mountain spine was insufficient to provide all the detrital material.

The geological histories of the other islands have followed a similar pattern, although their emergence from the sea may have occurred at a later date.

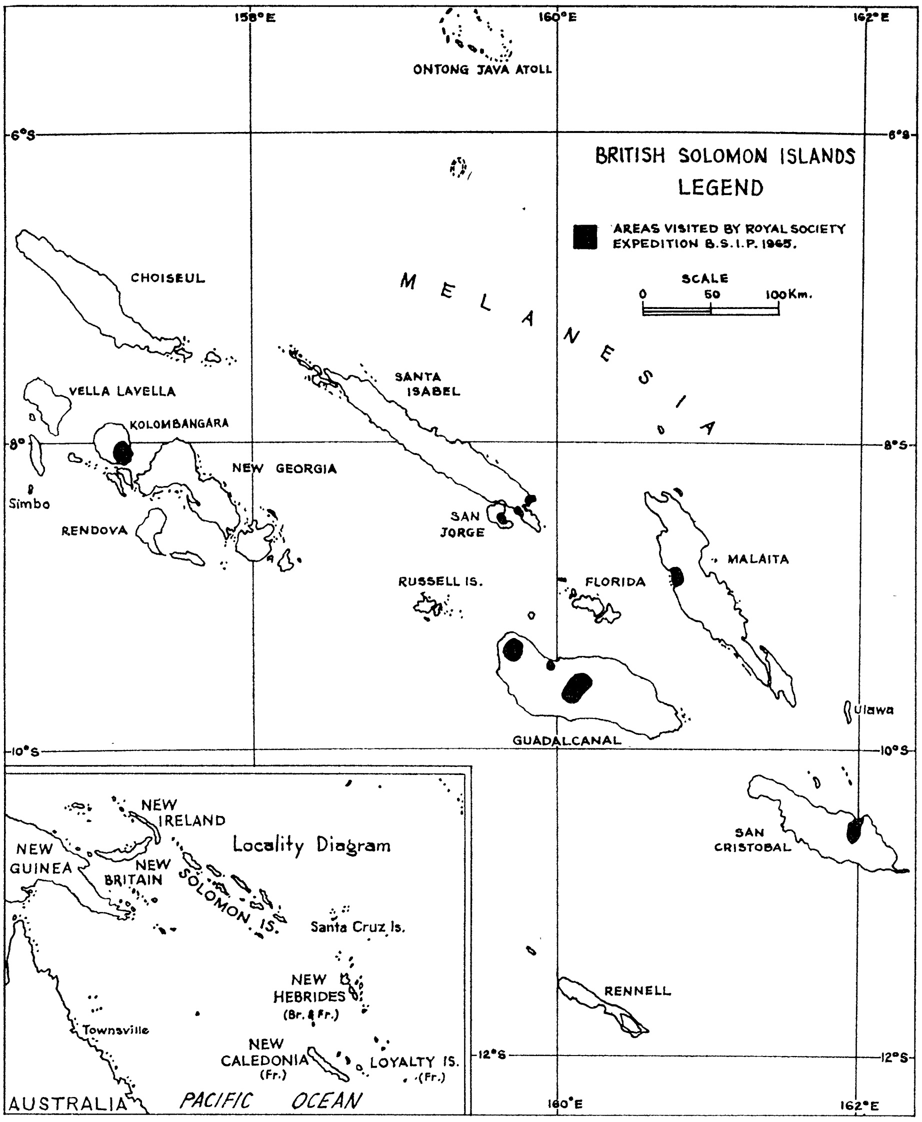

Figure 1. British Solomon Islands showing in black the parts visited by the Royal Society Expedition.

The New Georgia group of islands is an exception to the general pattern as the islands are an aggregation of volcanic cones and lava flows, many of which have coalesced to form larger islands. The volcanism commenced in the Pliocene and continued until the present time. It appears that there has been a gradual shift of volcanic activity south-westwards.

During the Pleistocene and Recent Periods there has been a general emergence of all the larger islands. Elevated coral reef terraces are evidence of earlier sea-level stands. Evidence is also accumulating from drilling records that the sea level has also been at much

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lower levels than at present. River valleys are over deepened such as the Lungga where the rock floor is 150 ft. below surface, and evidence exists of a soil surface about 160 ft. below present sea level (Baker 1950).

Lowering of sea level by say 60 m (30 fathoms) would provide land links between Bougainville, Choiseul, Santa Isabel, the Shortlands Group and possibly Florida and Guadalcanal. Such a lowering of sea level would hardly affect the distance of sea separating Malaita, New Georgia, the Russell Islands and San Cristobal from the other islands of the Solomons.

Generalized geological succession

Recent	Volcanism and coralline terrace development
Pleistocene	Volcanism and coralline terrace development
Pliocene	Volcanism and sedimentary deposition
Miocene	Sedimentary deposition and volcanism
Lower Miocene	Widespread calcareous deposition
Oligocene } Eocene	------------------ erosion ------------------
	Emplacement of ultrabasics. Stress metamorphism of basalts Volcanism and emplacement of diorites and gabbros
Upper Cretaceous	Deposition of deepwater sediments (Malaita)
Cretaceous	Effusions of basaltic lavas

Central Guadalcanal

This report gives a brief summary of the geology of Central Guadalcanal, with particular reference to the valley of the Sutakama and the mountain ranges drained by the upper part of that river (see figure 2).

Central and eastern Guadalcanal have a high mountain spine, rising to 7643 ft. in the summit of Mt Popomanaseu, although the peak of Pukaravaghalo, 2 miles to the south-west, may reach to over 8000 ft. above sea level. The axis of the mountain chain trends east–west (however, the north–south profile is asymmetrical, the ranges falling very steeply to the south or weather coast, while to the north there is a gradual descent through a zone of foothills to a strip of alluvial plain up to 8 miles in width.

A generalized stratigraphical succession for Central Guadalcanal may be given as follows:

Quaternary	9	Ngalimbiu Alluvials
	8	Honiara Beds
Pliocene	7	Toni Beds and Gold Ridge Volcanics
	6	Tangareso Shale
	5	Tina Calcarenite
Miocene	4	Mbetilonga Limestone
	3	Suta Volcanics and Koloula Granodiorite
Oligocene	2	Ultrabasics of Suta, Marau, and Ghausava
Pre-Miocene	1	Mbirao Complex, a series of basaltic lavas intruded by gabbro and dolerite sills, locally metamorphosed to chlorite—actinolite-schists

The Mbirao Lavas, probably the oldest series of rocks in Guadalcanal, form a pile of over 5000 ft. of pyroxene basalts including a high proportion of pillow lavas. There are

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minor dolerite sills and ash beds. These rocks give rise to the rugged, deeply dissected ranges which extend from the Sutakama and Kuma river valleys as far east as Marau. The lava pile dips gently to the north, but although fresh and unaltered in the south–east the basalts grade northwards into a zone of intense shearing, where they have been converted into flaser rocks, breccias and basic mylonites, forming the higher ground of

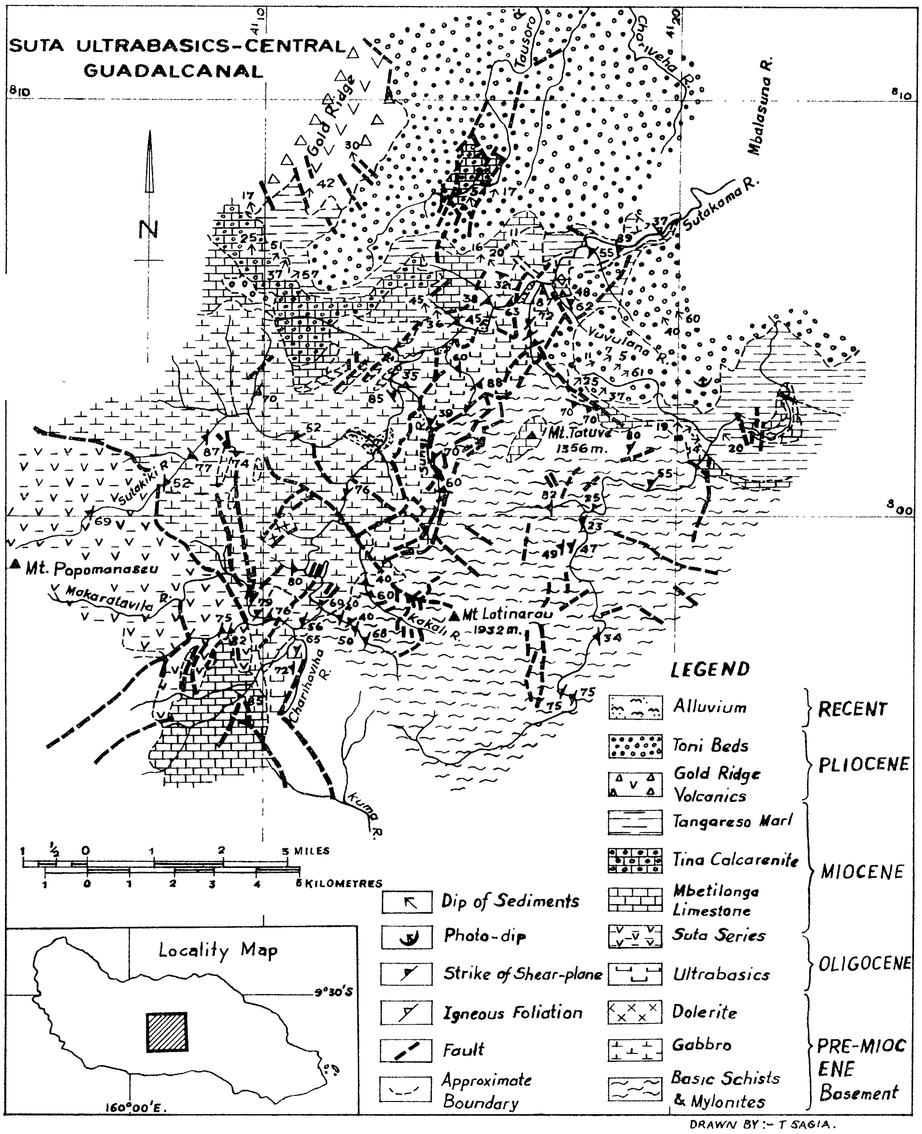

FIGURE 2. Geological map of Central Guadalcanal around the route taken by the Land Party of the Expedition from the Chariveha River (NE) to Mt Popomanaseu (W).

the Tatuve–Latinarau Range. There the planes of schistosity dip steeply north–west and form regular, easily lubricated surfaces most liable to landslip.

In depth the Mbirao Lavas have been intruded by extensive bodies of gabbro; this gabbro has been upfaulted on the west side of the Sutakama valley giving rise to extensive outcrops in the Sutakiki and Tina headwaters.

A linear zone of ultrabasic rock has been intruded into this major fracture zone, giving rise to a low ridge with typically rounded profiles which follows the eastern side of the

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Sutakama valley for about 8 miles (see figure 2). The dominant rock type is a serpentinized harzburgite, probably of Oligocene Age.

The high mountains to the south and west of the Suta valley, including Popomanaseu, are composed of a group of intermediate lavas, agglomerates and tuffs which have been described as the Suta Volcanics. Some of the pyroclastic rocks are interbedded with material very similar to the Lower Miocene limestones of north central Guadalcanal. South of Popomanaseu, in the Koloula Valley, this younger volcanic complex has been intruded by a body of biotite—granodiorite; together these highly resistant igneous rocks form the highest and most rugged area in the Protectorate.

The structural pattern in these older Tertiary rocks is dominated by faulting; there are three main directions NE–SW, WNW–ESE and NNE–SSW. Many of the faults have horizontal as well as vertical components of throw.

The overlying sediments dip at 20° to the north; the succession commences with the Lower Miocene, Mbetilonga Limestone, predominantly a calcarenite, which gives rise in many areas to a steep escarpment facing south (for example on the north side of the Sutakiki valley). In the middle Sutakama valley the Pliocene sediments overlap the Miocene right on to the basement—they form a sheet of conglomerates with subsidiary pyroclastics, as at Gold Ridge, giving rise to the upper part of the foothills belt.

The lowest foothills correlate with the Honiara Beds, a series of calcareous sands, tuffs and subsidiary reefs which forms a line of grassy ridges flanking the southern edge of the Guadalcanal Plains.

Mount Gallego, Guadalcanal

Mount Gallego is a 3500 ft. high volcanic peak situated about 11 miles west of Honiara on Guadalcanal. The southern and western flanks are drained by tributaries of the Umasani River and the eastern flanks by tributaries of the Sasaa River. The less strongly dissected northern flanks are drained by short consequent streams which radiate from the summit and flow down a straight course to the sea.

Although Mt Gallego is a volcanic vent, it does not exhibit any signs of having been a cone with a crater like Mount Esperance or Savo Island.

The first stage in the volcanic activity appears to have occurred in the late Pliocene when flows of lava, tuff and ash were poured out over an uneven landscape of diorites, basaltic andesites, limestones and sediments ranging in size from sandstones to conglomerates and composed of fragments of the first three mentioned rock types.

The first effusion of lava flows form flattish cappings to the ridges on the southern flanks of Mt Gallego. The lava is a dark grey andesite with phenocrysts of pyroxene and hornblende. The bulk of the volcanic material is a pale grey andesite with phenocrysts of plagioclase and black oxyhornblende, minor pyroxene and occasional quartz crystals. Flows of this lava, commonly thick with moderately good flow textures, are interspersed with tuff beds of a comparable material. The uppermost 1500 ft. of the mountain are composed of this material which undoubtedly spread as a thick canopy over a wide area and reached down to sea level. The well-preserved, grass-covered lava flows and breccia beds, which finger out from the base of the northern flanks of Mt Gallego towards the sea, are mostly composed of this coarse hornblendic andesite material. This effusion post-dates the

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development of the coral terraces which are such a conspicuous feature of north western coast of Guadalcanal.

On the southern flank of Mt Gallego in the porphyritic hornblende andesites a wide composite fault zone striking approximately north and south is filled with a fault breccia and gouge. The erosion of the soft fault gouge and breccia has produced a comparatively wide valley (Hidden Valley) contrasting with the narrow river gorge in the unfaulted country to the south of the east–west striking cross fault, which terminates the composite fault zone. The fault gouge is extensively mineralized with pyrite.

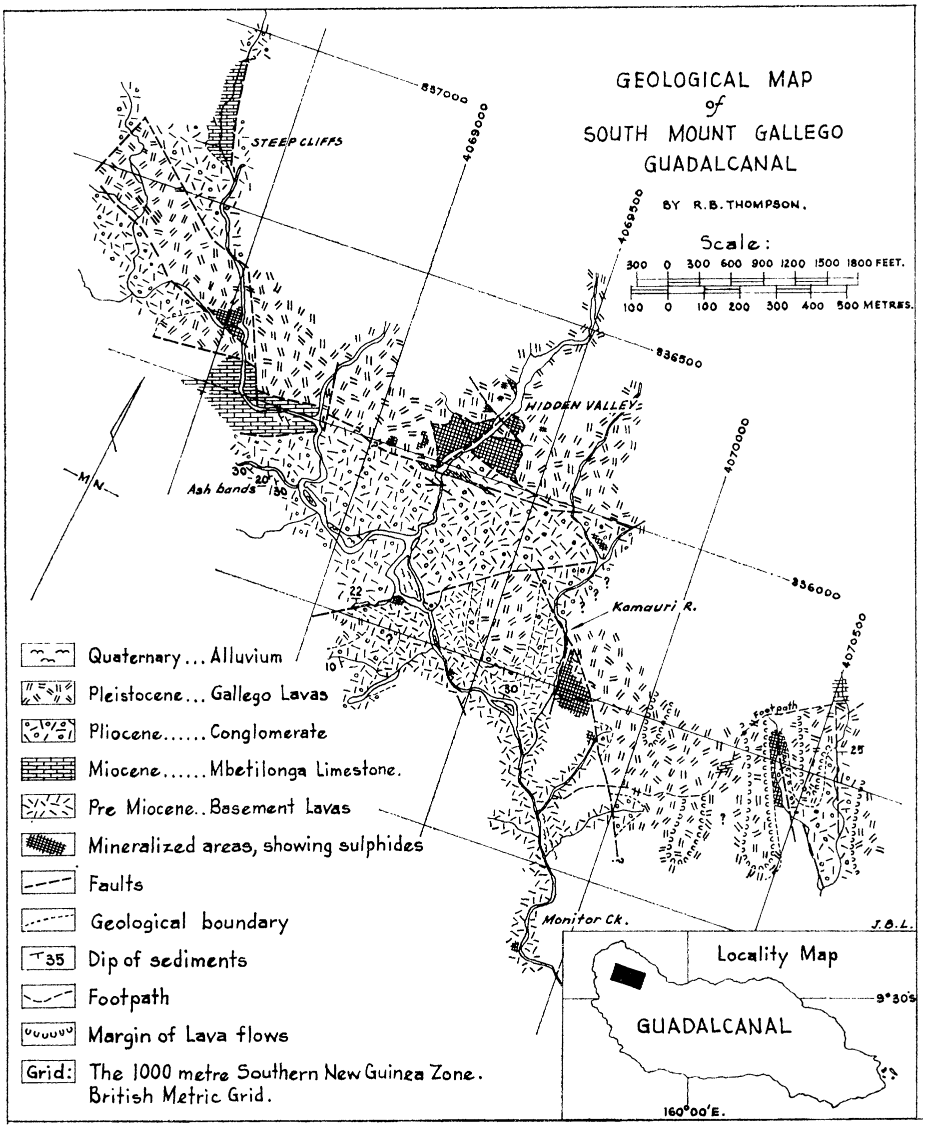

FIGURE 3. A geological map of south Mt Gallego.

Strong faulting on the flanks of Mt Gallego has post-dated the volcanic activity and in the vicinity of Hidden Valley several large slices of the underlying Miocene Limestone have been upthrust to outcrop amidst the Pleistocene lavas and conglomerates. The Miocene limestone in this part of Guadalcanal has a maximum thickness of 400 ft. and is hard, white, recrystallized, with a little bedding and occasional remnants of corals.

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Mount Austen, Guadalcanal

Mount Austen, a prominent hill, 1300 ft. high, lies about 4 miles south-east of Honiara. The hill stands up alone among the foothills and forms the western end of the Guadalcanal plains. Structurally, the hill appears to be a fault block which has been uplifted and tilted in comparatively recent times.

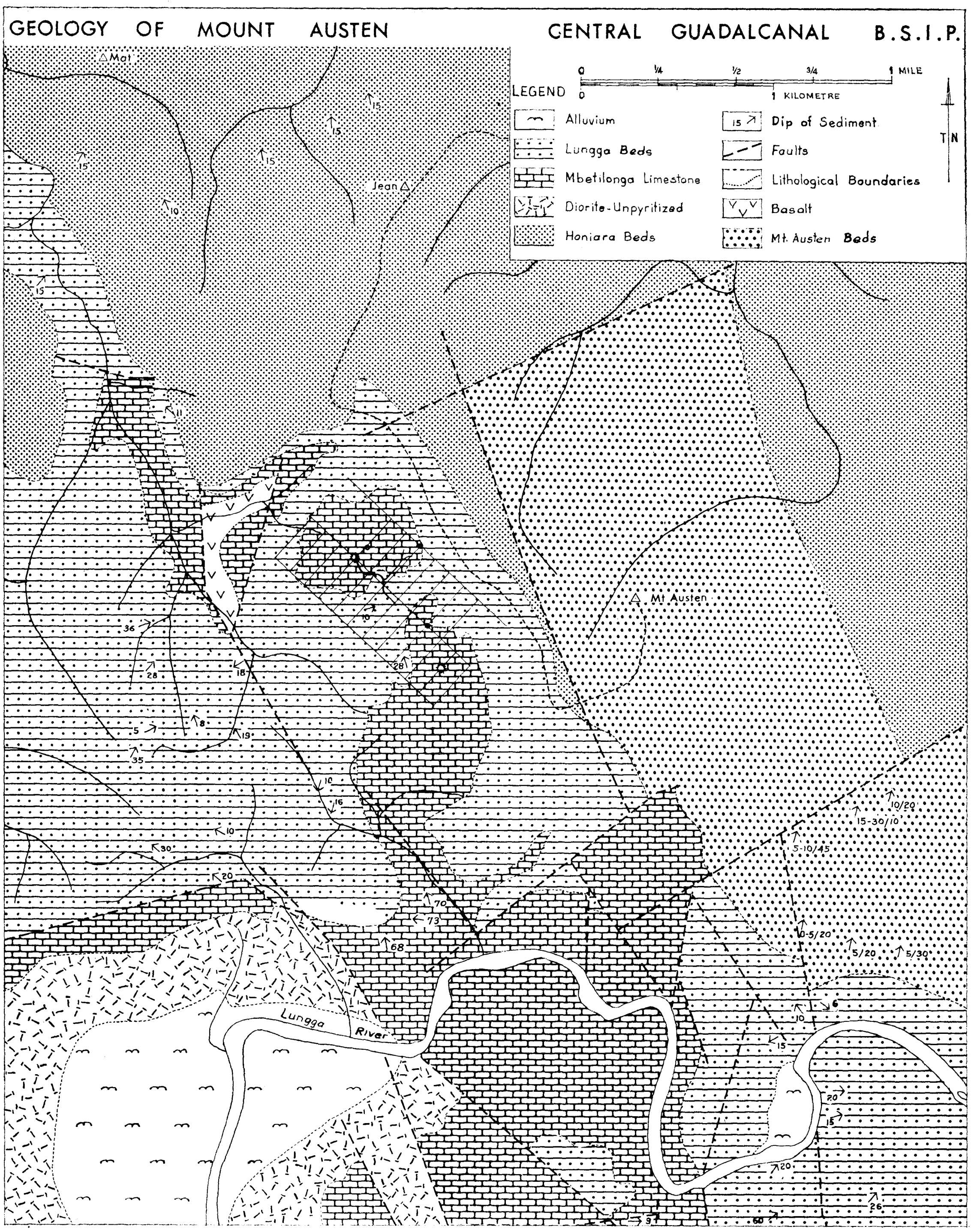

Figure 4. Geological map of Mt Austen.

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The tip of the mountain is a flattish surface rising from 900 ft. on the western edge to 1300 ft. at the summit on the eastern edge. This surface which is 2 miles from east to west was at one time horizontal and has recent reef and coralline deposits over it. It is concluded that these deposits may correlate with the similar coralline terrace deposits which are elsewhere found at 900 ft. above sea level.

Beneath the coralline deposits are thin sandstones and siltstones of the Mount Austen beds. Beneath these beds, a hard, white, re-crystallized limestone underlies the whole of the mountain. Sink holes in the sandstones, which have become enlarged to large pits, clearly expose the cavernous limestone beneath. This Mbonehe limestone is between 400 and 500 ft. thick and Lower Miocene in age.

Beneath the limestone andesite lavas, diorites and intrusives form the base of the geological succession and are probably Eocene in age.

The flanks of Mount Austen consist mostly of beds of coarse lagoonal debris, outwash fans and coralline growths which were deposited and eroded as the ground slowly emerged from the sea. Coral reef forms are almost always found on the northern or seaward side of any erosion level of which six have been recognized. Figure 4 shows the geology of the area.

San Cristobal—Warahito and Wainoni Peninsula

San Cristobal island is composed almost wholly of basaltic lavas on which sediments have been locally deposited. All the coast lines are collinear with fault lines and it is concluded that the present island is an elevated block of the former sea floor.

The Warahito River and the Pagato River both rise close to the southern coast of San Cristobal and together form one of the largest river systems on the island. The Wainoni Peninsula forms the eastern arm of Wainoni Bay into which the Warahito River drains. Although the area visited is restricted, it contains exposures of most units of the geological succession given below:

Formation of coralline terraces	Pleistocene
Deposition of sediments	Pliocene
Ravo Limestones	Miocene
Emplacement of ultrabasics and gabbroic rocks	Oligocene
Basaltic pillow lavas with included lenses of limestone and sediments	Mesozoic

The valley of the Warahito River and its tributaries are deeply incised into the thick pile of basalts, many of which exhibit pillow form. Limestones of a contemporaneous age to the basaltic extrusion occur as lenses within the basalts and are characterized by their pink colour. Recrystallization of the original calcite, probably at a time of stress, has destroyed most of the original texture of the rock and removed all chance of finding recognizable fossils. Red and brown chert bands, 0·5 to 1 in. thick are commonly found in this limestone.

Small exposures of gabbroic rock and ultrabasic rocks occur on the eastern edge of the Warahito along the line of the Bagarai–Wainoni fault, which separates the Wainoni Peninsula from the Warahito basin. Most of the ultrabasic bodies occur within the Wainoni Peninsula where alternating infaulted slices of harzburgite and gabbro are

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included in the basaltic country rock. The fault zones are characterized by a bluish grey serpentinous paste or rock flour which has spread at the surface to cover much of the ultrabasic area.

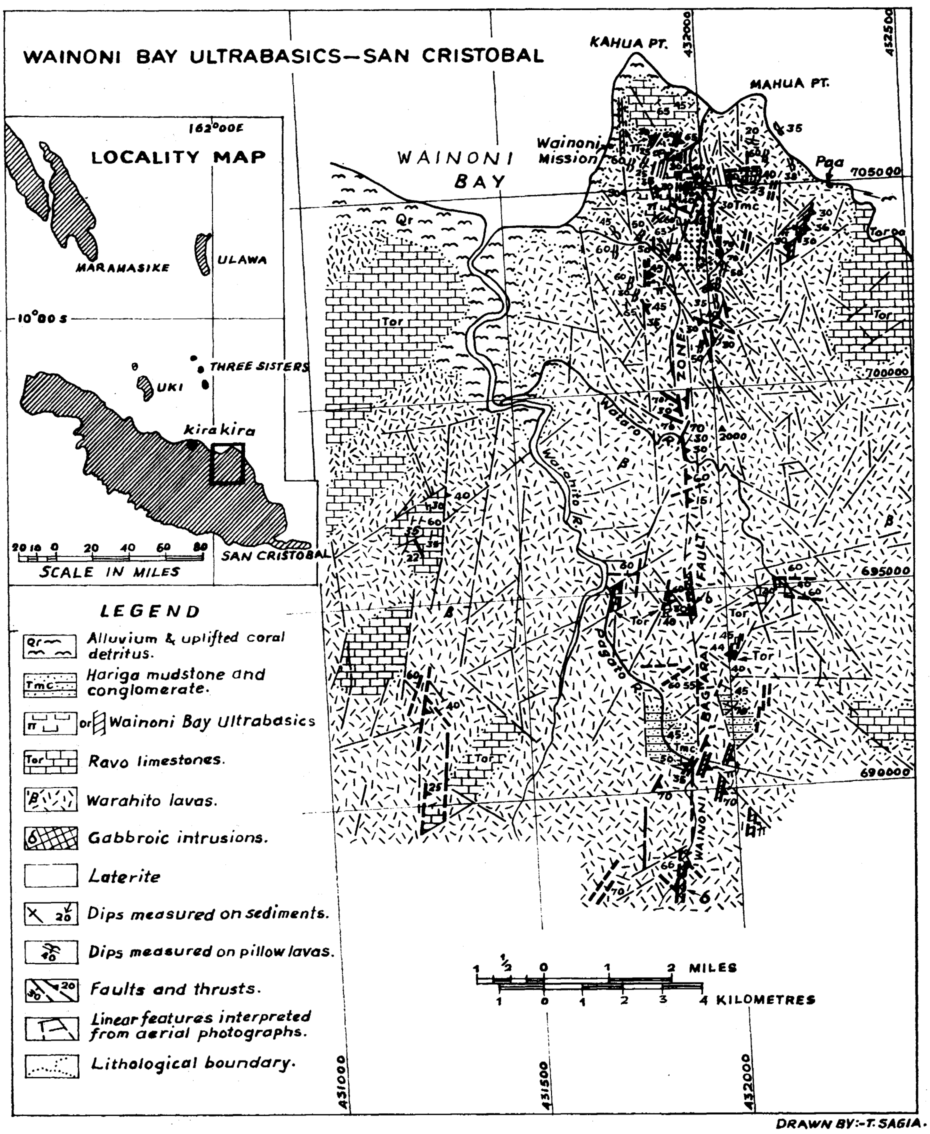

FIGURE 5. Geological map of the Warahito River.

The serpentinous paste forms an impermeable layer which has retarded the development of a deep lateritic soil. Auger holes showed that the lateritic soils overlying the basic and ultrabasic rocks were not more than 3 to 4 m thick and were not markedly enriched in nickel. White limestones were also found in the Wainoni peninsula and these were dated by Dr P. J. Coleman to be Miocene in age. They appeared to post-date the ultrabasic emplacement. Several faulted blocks of similar white limestone, which have not been directly correlated with the dated Miocene limestone, occur within the Warahito basin. These basin. limestones contrast with the otherwise rather monotonous basalts of the Warahito

Pliocene sandstones, siltstones and calcarenites in part derived from basalts form the low

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hills on the western side of the Warahito basin and the sediments form a thin veneer over the basaltic ridges farther south.

The skyline of San Cristobal suggests that the upper surface of the basalts on which the Pliocene sediments were deposited was comparatively level and may have been an erosion surface.

Three levels of Pleistocene to Recent coralline reef terraces testify to the emergence of the north coast of San Cristobal. The levels appear to be approximately 20 and 100 ft. and 250 ft. above present sea level. The broad alluvium filled Warahito valley suggests that over deepening of this valley occurred at some period of sea recession during the glacial periods. A well-bedded clay-like soil found close to sea level in the wider San Cristobal valleys is interpreted to be an estuarine deposit formed when the sea was at a higher level.

Along the south coast, drowned valleys now form good harbours, indicating that the whole island has tilted southwards. A further result of the tilting movement is the large alluvium-filled valleys formed when ponding occurred in the middle reaches of many northward flowing rivers at the time when the outflow level to the sea was raised.

The Thousand Ships Bay area of Santa Isabel and San Jorge and Tatamba Harbour

Thousand Ships Bay is a large natural harbour lying between the island of San Jorge and the main island of Santa Isabel. On both sides of the harbour, bracken covered patches on gently rounded hills contrast with the dense forest and steep sharp ridged mountains, which cover most of the Solomons. Bracken and a particular type of forest grow on the lateritic soils developed over the main masses of serpentinized harzburgite which form the high ground on both sides of Thousand Ships Bay. The ultrabasic bodies are particularly noticeable on the aerial photographs as the texture of the vegetation cover, both jungle and fern, and the shape of the hills and ridges, contrasts with the other rock types outcropping in the neighbourhood.

Most units of the Santa Isabel and San Jorge geological succession occur within the Thousand Ships Bay area and the generalized geological succession is given below:

Serpentinous and non-serpentinous sediments	Pliocene
Major ultrabasic emplacement	Late Miocene
Tanakau sediments	Lower to Upper Miocene
Minor ultrabasic emplacement	Oligocene
Sigana volcanics	Mesozoic

The Sigana volcanics are the Santa Isabel equivalent of the ubiquitous basalts which constitute the oldest unit in the geological succession of most of the large islands of the Solomons. The basalts frequently exhibit pillow forms and intercalated tuff is lacking. The basalts form the core of the Bughotu Peninsula and the main axial mountain chain along the length of Santa Isabel. The basalt country is typified by steep relief and deep valleys.

The Tanakau sediments include massive Miocene limestones well exposed in the highest hills on the Bughotu Peninsula and well-bedded tuffaceous sandstones and siltstones, the upper members of which outcrop in the islands in Thousand Ships Bay.

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EASTERN SANTA ISABEL & SAN JORGE ULTRABASICS

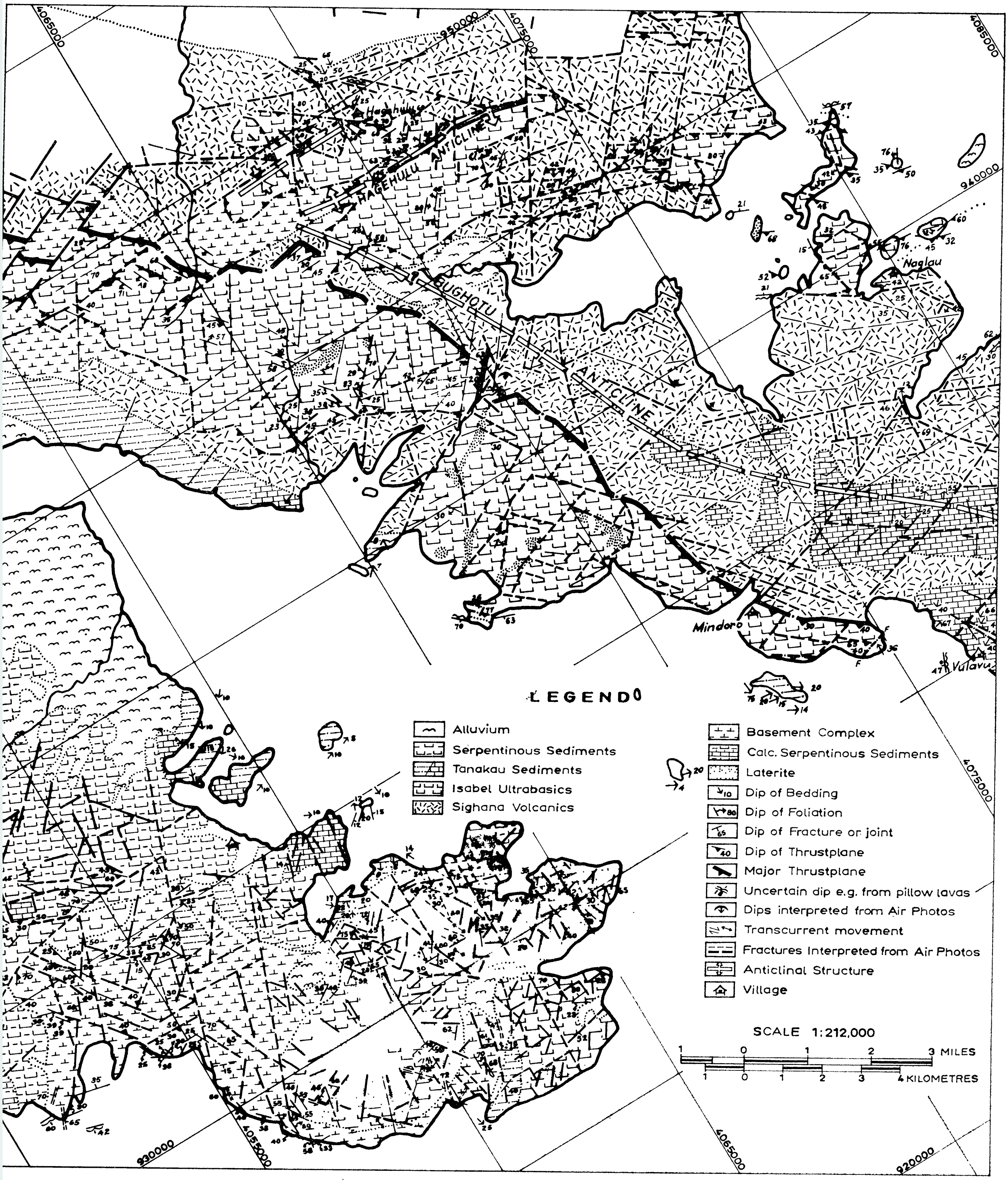

FIGURE 6. Geological map of the Thousand Ships Bay, Santa Isabel.

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The ultrabasic rocks consist of partially or wholly serpentinized harzburgites, associated with minor gabbroic intrusions around the margins of the main bodies. The harzburgite contains 20 to 25 % ortho-pyroxene, and the remainder of the rock is olivine with accessory magnetite and chromite. Pure olivine and pure pyroxene rocks are uncommon and only occur as lenses or dykes within the main body. All the ultrabasic bodies are fault bounded and on Santa Isabel the south-westerly dipping Kaipito–Korighole thrust plane is the major structural fracture up which the serpentinites were emplaced.

At least two periods of emplacement are recognized, one before the deposition of the Tanakau Sediments, and one after. The emplacement of the ultrabasic rocks on San Jorge was accompanied by the autobrecciation of large quantities of serpentinite with the development of a grey rock powder containing rounded serpentinized boulders. This clay-like serpentinite breccia underlies much of the lateritic soils on the northern slopes of San Jorge Island, and the western end of San Jorge is covered by this same ultrabasic breccia which is well exposed where rapid erosion has stripped off the laterite cover.

The blue-grey serpentinous breccia is confined to the zone of the Kaipito–Korighole thrust plane in Santa Isabel.

Both on San Jorge and Santa Isabel the lateritic soils overlying the ultrabasics are iron rich and contain appreciable nickel contents which may rise above 1 %.

The islands in Tatamba harbour and the peninsula on which the Government station was built, are all composed of serpentinized harzburgite. The relief is typical of the serpentinites and is very subdued. Inland the basalts of the Sigana volcanics give rise to a rugged terrain.

South–West Kwara'ae, Malaita

The geological succession in this part of Malaita is broadly as follows:

Tomba silts	Pliocene	
Suaba chalk	M.–Up. Miocene	
Alite limestones	Oligocene–M. Miocene	
Kware mudstones	Oligocene	
Fo'ondo clastics	Alite volcanics	Pre-Oligocene
Fiu lavas		

The area around Mt Alasa'a has not been studied by the B.S.I.P. Geological Survey; this general information is based on the work of F. K. Rickwood, P. A. Pudsey-Dawson and P. J. Coleman, who have made studies of other parts of Malaita.

The higher ground of the interior, but not including the summit of Mt Alasa'a, 1325 ft., is founded on the Fiu lavas, a group of basaltic pillow lavas, dolerites and rarer andesites. These rocks are well exposed in the upper reaches of the Kwaimanafu River, where they are locally rich in pyrite. Little is known of the structure of the volcanic pile, except that it is scored by faults trending NNE and roughly east–west. The Fo'ondo clastics represent a later pyroclastic phase.

The overlying Kware mudstones, chloritic clays with pyrite concretions, are less than 300 ft. thick; they are succeeded by at least 5000 ft. of predominantly calcareous sediments.

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The Oligocene–Pliocene succession forms an envelope to the volcanic core of the island which was folded fairly intensively in the Late Pliocene, although movements started probably in the Early Miocene. Two major synclines and two anticlines cross the Alasa'a area, their axes trending north–west. The coastal alluvium and recently raised fringing reef area of Langalanga Lagoon has not been uplifted to the same extent as comparable areas to the north and south along the Malaita coast.

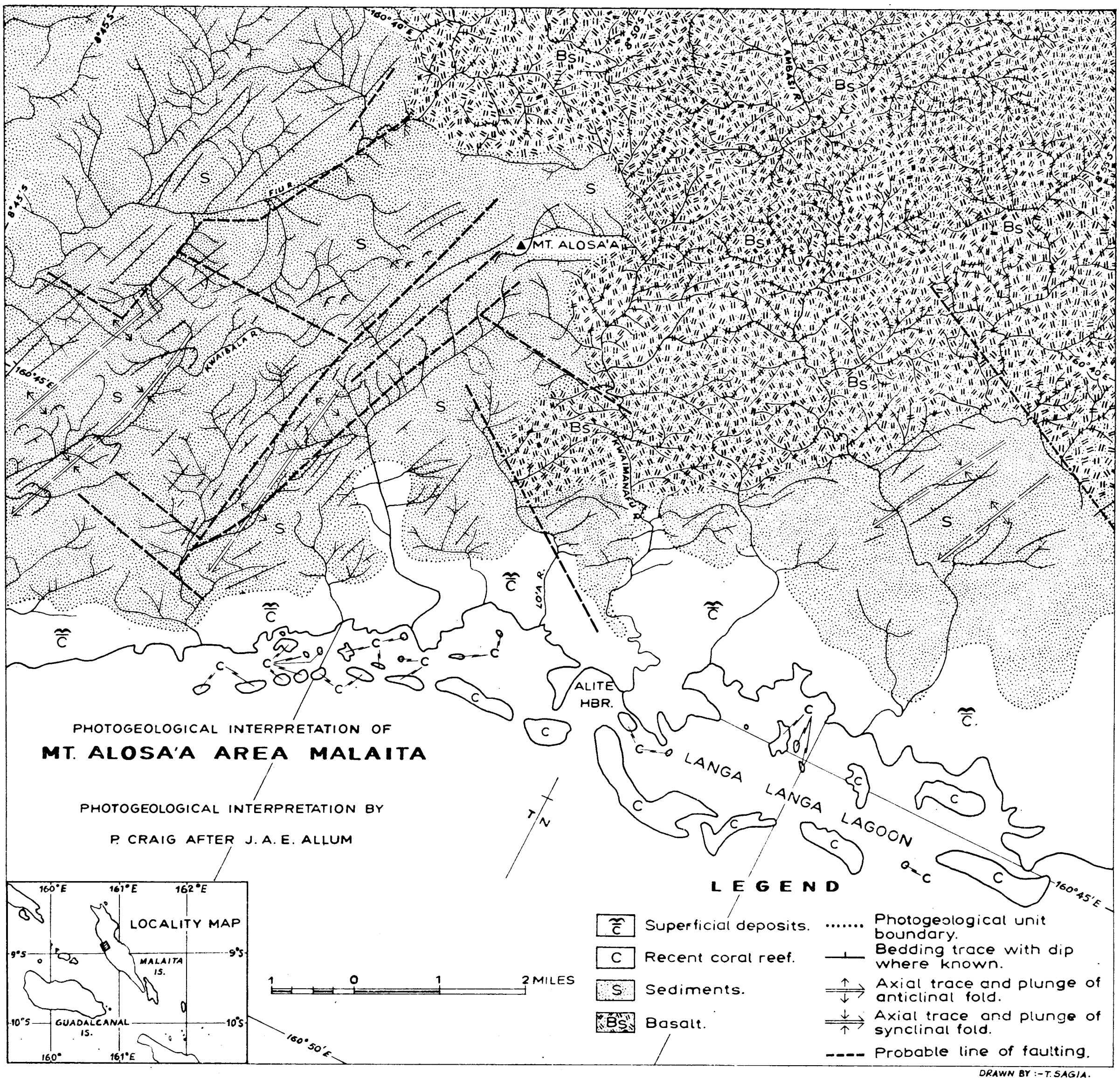

FIGURE 7. Geological map of the district round Mt Alasa'a. The map is reproduced with the original spelling 'Alosa'a'.

KUZI–KOLOMBANGARA

Kolombangara Island is a large single volcanic cone, and its original form is comparatively well preserved. The crater which is nearly 2 miles in diameter has been breached on the south-east by the Vila River.

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The southern flanks of Kolombangara are drained by consequent streams which are not deeply incised into what appears to be original depositional slopes. These are composed of olivine basalt flows and pyroclastic beds of the same material, all dipping away from the crater.

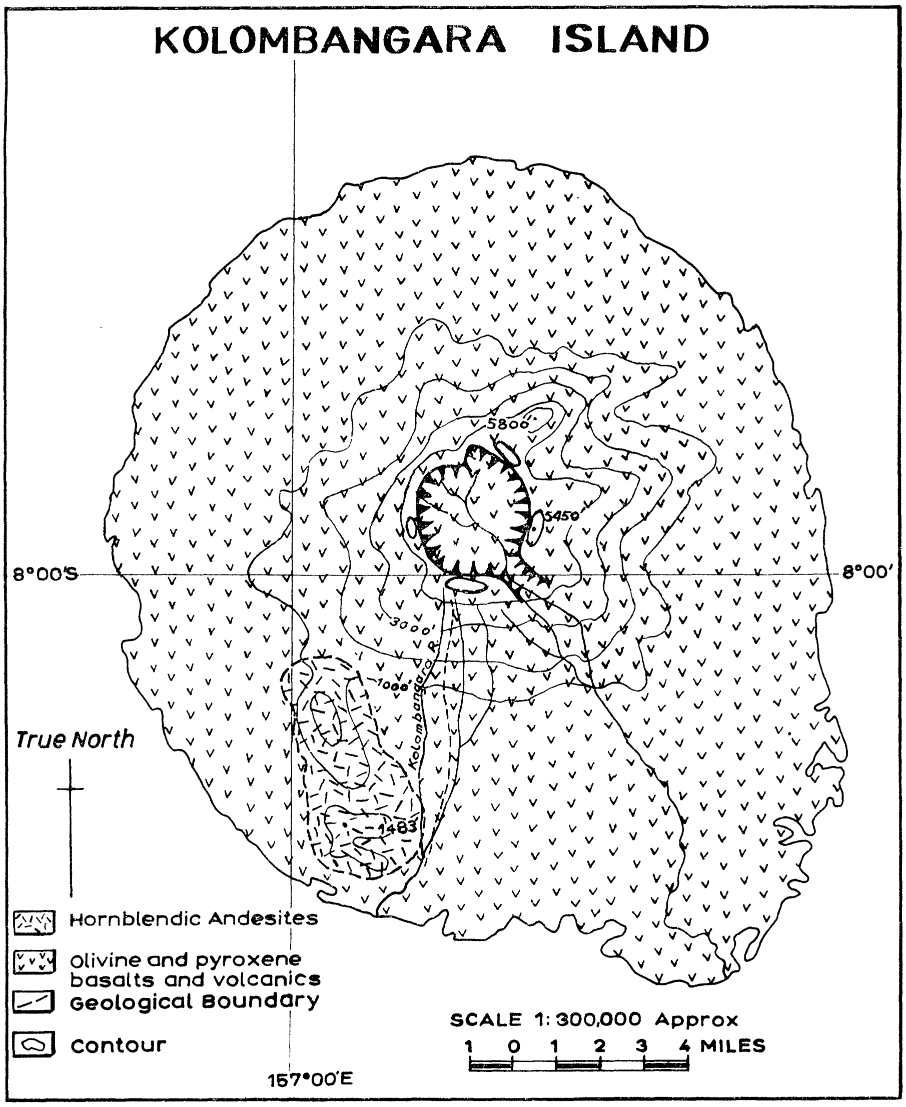

FIGURE 8. Geological map of Kolombangara.

The smooth southern slope is interrupted by the steep hills which are the remnants of the outpourings of a daughter vent which broke through the flank of the main cone at a later date. The lava and volcanic ejectamenta from this source are typically a hornblende andesite.

REFERENCES (Thompson & Hackman)

Baker, R. C. 1950 An occurrence of saline ground water on Guadalcanal. *Trans. Am. Geophys. Un.* **31**, 58–60.

Coleman, P. J. 1966 Upper Cretaceous (Senonian) bathyal pelagic sediments with *Globotruncana* from the Solomon Islands. *J. Geol. Soc. Austral.* **13**, pt. 2, 439–447.

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