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PREVIEW REPORT
EASTERN PAPUA CRUSTAL SURVEY

by

D. M. Finlayson

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SUMMARY

This Record has been prepared to provide background information for the proposed 1972 seismic crustal survey of east Papua. The known geology and geophysics of the region are summarised and the various crustal interpretations outlined. Proposals are put forward for a seismic refraction survey aimed at determining more exactly the crustal structure of the region. The proposed survey would last approximately six weeks and involve the detonation of up to fifty large shots along four lines. Associated marine reflection, refraction and magnetic work is also proposed.

1. INTRODUCTION

Only within the last six years have large scale geophysical surveys been undertaken in the New Guinea - Solomon Islands region and the results of these surveys are only just reaching the publication stages (Rose et al, 1968; Furnmoto et al, 1970; St John, 1967; Brooks, 1969; Ewing, M., 1970). The region is one of extremely complex geology and geophysics and although certain generalities can be applied to the crustal structure (Denham, 1969) a detailed interpretation will almost certainly have to await further crustal investigations.

BMR, has already contributed considerably towards crustal survey work in the area (Milsom unpublished; CGG, 1969; Brooks, in press; Wiebenga et al, in preparation). The results of this work will be published in due course but sufficient information is now available to guide future survey proposals.

At a meeting held in BMR during September, 1970, including interested parties inside and outside BMR, it was suggested that one obviously attractive survey area was the east Papuan peninsula. Geological and some geophysical work had already suggested interesting structural interpretations (Thompson and Fisher, 1965; St John, 1967; CGG 1969) and the geographic features of the area lend themselves to seismic refraction methods. The indications were that if such a project were programmed for 1972, various institutions in Australia and overseas may be prepared to contribute.

This Record has been written to aquaint the various interested parties with the nature of the geophysical problems and put forward proposals for an overall seismic survey programme.

2. TOPOGRAPHY AND BATHYMETRY

The broad features of topography and bathymetry in the survey area are illustrated in Fig. 1.

2.1 Topography

The survey area is generally characterised by rugged terrain and high relief except in some coastal areas and on the Trobriand Islands. Low lying coastal regions are generally swamp areas. Rivers in the higher regions are fast flowing in boulder strewn beds and develop into braided meandering rivers on the coastal plains.

The mainland area is dominated by the Owen Ranges with the highest point being Mt Albert Edward (3980 m). There are many peaks over 3000 m. The Ranges are bounded on their north-east by a fault valley which stretches from Salamaua on the northeast coast south of Lae to the junction of the Moni and Musa Rivers in the southeast.

Bowutu Mountains and the Otawa and Ajula Kajala Ranges are three of the larger regions of ultramafic rocks.

Andesitic volcanoes are features of the landscape in the region northeast of the Owen Stanley Ranges. Mt Lamington (south of Popondetta) and Mts Victory and Trafalgar on Cape Nelson have erupted in recent times. Volcanic centres also exist on the D'Entrecasteaux Islands.

Along parts of the north coast, precipitous terrain has been formed by the rapid uplift of Pleistocene sediments.

Much of the whole region is covered with dense tropical rain forest and kunai grass. At higher altitudes the vegetation becomes more sparse.

Offshore, the islands tend to be situated on the crests of two submarine rises, one tending ENE towards Bougainville Island (Woodlook Rise) and the other tending ESE towards Guadalcanal Island (Pocklington Rise). The D'Entrescasteaux Islands and Trobriand Islands border a region of shallow water called by Von Der Borch (1969) the Trobriand Platform.

2.2 Bathymetry

The bathymetry of the region has been summarised for geophysical and geological investigation in a number of publications (Rose et al, 1968, St John, 1967; Ewing et al, 1970; Van der Borch, 1969; Furumoto, 1970; Krause, 1967).

The Solomon Sea area has been charted in some detail by Rose et al, (1968) for the interpretation of their gravity data. (Fig. 2). The NE coastal regions and the Huon Gulf have been described in some detail by Von der Borch (1969). (Fig. 3). Ewing et al, (1970) have mapped the bathymetry for the interpretation of their seismic refraction/reflection work in the Coral Sea. (Fig. 4).

The principal feature of the northern Solomon Sea is the Planet Deep which follows the west coast of Bougainville Island, the south coast of New Britain and the northern edge of the Trobriand Platform in an almost triangular course. Strictly speaking the term Planet Deep is applied only to the deepest section.

Von der Borch interprets a kink in the 6000 m isobath near the Huon Gulf as the seaward continuation of the Markham Fault.

The southern boundary of the northern Solomon Sea region is formed by the Trobriand Platform and the Woodlark Rise. This latter feature also forms the northern boundary of what is sometimes called the Solomon Basin. This extends south to the Pocklington Rise and the Rennell Ridge extending from Milne Bay in T.P.N.G. to Renwell Island in the Solomon Island Group. This Ridge is broken in at least one place by water 3000 m deep (Pocklington Trough). The eastward boundary of this Basin is formed by the New Georgia Islands and there is a conspicuous absence of any deep water (in excess of 5000 m) at this boundary. The western part of this area Milson (unpublished) calls the Woodlark Basin.

South of the Papua mainland is the Coral Sea. The features of the bathymetry in this region are the Moresby Trough, the Papuan Plateau and, further south, the Coral Sea Basin (Fig. 4). Fig. 19 shows a section (J. Ewing et. al, 1970) across the Coral Sea Basin and into the shallow water near the D'Entrecasteaux Islands. The Moresby trough is the submarine canyon forming the main erosion channel from the Gulf of Papua.

The Trobriand Platform is an area of poorly surveyed shoal water to the NE of the survey area. Coral reefs occur over most of the platform with water depths generally less than 100 m. The Platform surrounds what Von der Borch (1969) calls the Trobriand Basin (Fig. 3) where incomplete soundings indicate water depths of the order of 970 m.

Krause (1967) in his regional structural interpretation of the bathymetric charts in the southern Solomon Sea area postulates a number of major faults, (Fig. 5). A steep ridge extends from Pocklington Reef to Guadalcanal Island and Krause concludes that such topography could only have been formed by regional shear probably coupled with folding and volcanism. The southern limit of the shear zone he calls the Pocklington Fault. At its western end the fault passes just north of Pocklington Reef, along the north side of the Louisiade Archipelago and into mainland east Papua. Krause indicates that it is a left lateral strike slip fault based on evidence of the offsets along the south coast of Guadalcanal and of the 1500 fm contour NW of Pocklington Reef.

Krause states that the whole shear zone extends northwards up to the Laughlan Fault (Fig. 5) and the whole area in between is extremely irregular and apparently been cut into a large number of fault blocks. The Pocklington Trough which lies to the SE of Pocklington Reef is interpreted as being a rift zone (Fig. 5) separating the area of irregular structure to the NW from the area of low structural relief towards the SE.

3. REGIONAL GEOLOGY

The geology of the region has been described by a number of authors from whose published and unpublished works the following has been summarised (Fig. 5).

The most recent synthesis of the geology (Davies and Smith, 1970) summarises the area as follows.

"Eastern Papua is a southeasterly-trending mountainous peninsula with islands to the east and southeast, between 7-12°S and 146-155°. The peninsula and islands consist of a linear core of Mesozoic sialic metamorphics flanked by Mesozoic and younger mafic rocks and partly concealed by still younger sediments and volcanics. The Mesozoic sialic rocks are exposed in a belt 900 km long and up to 60 km wide. They consist of Cretaceous (and possibly older) sediments which were metamorphosed in the Palaeocene or Eocene. Metamorphic grade is generally greenschist facies, but is higher in the D'Entrecasteaux Islands and on part of

Misima Island; lawsonite occurs only within a few kilometres of the Owen Stanley Fault which bounds the mainland metamorphics on the north and northeast.

Mesozoic mafic rocks include peridotite, gabbro and basalt of the Papuan Ultramafic Belt, metabasalt exposed in the Suckling-Dayman mountain block and on Normanby and the Deboyne Islands, and unmetamorphosed basalt elsewhere on the mainland. These rocks are, at least in part, Cretaceous. Younger mafic rocks include Eocene basalt on the southeastern mainland, and Upper Oligocene and Lower and Middle Miocene tuff and lava at scattered localities.

Eocene sediments consist of chert and deep-water limestone along the south coast of the mainland at Port Moresby and near Tapini. No Lower or Middle Oligocene rocks are known.

Upper Oligocene, Miocene and Pliocene sediments in the Aure Trough (145^{o}-146^{o}E) have a maximum thickness of about 12,000 m; the sediments are mainly alternating mudstone and greywacke, and are probably turbidites. Middle Miocene reef limestone occurs on the eastern hingeline of the Trough at 146^{o}E is 1000 m thick.

Pliocene and Quaternary volcanics range in composition from basalt to rhyolite and include some potash-rich rocks.

Intrusive rocks include Eocene tonalite in the Ultramafic Belt, Oligocene? gabbro near Port Moresby, Middle Miocene granodiorite west of Salamaua, alkali-rich intrusives on the southeastern mainland, and younger andesitic porphyries. Granodioritic intrusives in the D'Entrecasteaux Islands are late Pliocene.

The Cretaceous (and possibly older) sialic sediments are thought to have been metamorphosed in the Palaeocene or Eocene at the time of emplacement of the Papuan Ultramafic Belt. The Ultramafic Belt is though to be part of a thrust slice of oceanic mantle and crust which rode over or was underridden by the Cretaceous sediments on a low-angle fault (the Owen Stanley Fault). The metamorphic rocks were partly exposed in the Eocene but there was no major land mass in the area until the Upper Oligocene. In the Upper Oligocene, Miocene and Pliocene the sialic metamorphics emerged, perhaps isostatically. Erosion of the resulting mountain block and contemporary volcanism and limestone development contributed great volumes of sediment to the Aure Trough and lesser volumes to the Cape Vogel Basin. The history of the area can be interpreted in terms of interaction between Australian and Pacific lithospheric plates, and opening of the Coral Sea by rifting".

Thompson and Fisher (1965) have divided the whole of T.P.N.G. into a number of regional subdivisions and the area in which the proposed crustal study will be carried out falls into their subdivisions 3 (the Aure Tectonic Zone), 5 (the Owen Stanley Metamorphic Belt), 6 (The Papuan Ophiolite Province) and 8 (the Cape Vogel Basin) (Fig. 6).

3.1 Aure Tectonic Zone

This region has been considered as one unit by Thompson and Fisher (1965) although they point out that there are two distinct sets of tectonic trends. The region forms the western boundary of the present crustal survey. The region is characterised by a complex belt of compressional folding and high-angled reverse strike-faulting extending northwesterly from the eastern side of the Papuan Delta. In this area of the Delta (Aure Trough) there are Miocene and Pliocene sediments with a probable aggregate thickness of 16.8 km. Mesozoic sediments buried deeply beneath this thick Mio-Pliocene sedimentary pile in the Aure Trough may be metamorphosed.

3.2 Owen Stanley Metamorphic Belt

This dominant topographic feature of the whole region of the proposed crustal survey is composed essentially of regionally metamorphosed greywacke sediments and limestone and outcropping metamorphosed igneous rocks.

Three stages of metamorphism have been recognised. At various places low metamorphic grade rocks take the form of indurated and slightly sheared Cretaceous greywacke and sericite shist (Dow, 1961a, Dow and Davies, 1964). Similar Cretaceous metasediments occur in the SW of the region (A.P.C. 1961). Higher grade metamorphics have been recognised in the Snake River area (Dow, 1961a) where Cretaceous metasediments are markedly unconformable on a very thick contorted sequence of phyllite, schist and some marble. These are the dominant metamorphic rocks throughout the length of the Metamorphic Belt. They are generally considered to be of Palaeozoic age but could well be derived from Triassic, Jurassic or Lower Cretaceous sediments. Yet higher grade metamorphics in the form of amphibolite, gneiss and migmatite derived from both sedimentary and igneous rocks occur in the mountains south of Lae, on the D'Entrecasteaux Islands and on Misima Island.

The northern boundary of the Belt on the mainland is marked by a single narrow fault zone, the Owen Stanley Fault, which can be traced as a distinct topographic break for over 320 km. Left lateral Recent transcurrent movements have been recognized from displaced stream courses (Dow and Davies, 1964). At the eastern end of the mainland Smith and Green (1961) suggest that the Belt has been displaced transcurrently to the north along a prominent fault in the eastern Musa Valley and Davies and Ives (1965) suggest that the D'Entrecasteaux Islands are an offset extension of the Owen Stanley Range.

3.3 Papuan Ophiolite Province

The term "Ophiolite" has in the past been used to refer to intrusive, extrusive and sedimentary rocks derived from or deposited on oceanic crust away from the influence of clastic sedimentation from large land masses (Thompson and Fisher, 1965). Davies (1969) points out that the term "Ophiolite" is understood differently among various geologists throughout the world and has suggested that the term be dropped and that in eastern Papua the terms "peridotite-gabbro-basalt province" be used to refer to the Papuan Ultramafic Belt and that the term "basalt province" be used to the large volumes of pillow lavas and associated rocks which make up the majority of easternmost Papuan mainland.

The recognition of this apparent oceanic crust in a land environment has led to quite a lot of speculation about its formation which it is hoped the present crustal survey will help to resolve.

The Papuan Ultramafic Belt runs for 400 km from south of Mt Suckling in the east to the coast at Salamaua in the north-west and continues out to sea for an unknown distance. The maximum width of the Belt is 40 km.

The Belt contains approximately equal proportions of mafic and ultramafic rocks, the mafic rocks being gabbro and norite, the ultramafic rocks being peridotite, dunite and pyroxenite (Davies, 1967). The ultramafic rocks are found in the west and southwestern side of the Belt where they form elongated pods up to 80 km long and 18 km wide. They also occur as inliers within the mafic rocks. The mafic rocks generally intrude the ultramafic but at a few localities the two are interlayered in accumulative sequences.

From examination of composition, Davies (1967) indicates that the ultramafic rocks may represent primary mantle material and as such would have seismic velocities of the order of 8.0 km/sec and density of about 3.3 gm/cc.

The contact between the Ultramafic Belt and the Owen Stanley Metamorphic Belt is marked by the Owen Stanley Fault as mentioned earlier. Davies (1967) states that this is a thrust plane and notes that the grade of metamorphism in the sialic rocks decreases away from the fault and suggests that the metamorphism may have taken place during overthrusting. Schistosity within a few kilometers of the fault plane dips at 40°-60° to the east and north-east.

The basalt province or Oceanic Province is used to describe the suite of submarine basaltic volcanics and associated limestone, marls and cherts which form much of the remainder of eastern Papua. They range in age from Cretaceous to Lower Miocene and are notable for the absence of terrigenous material, indicating that they were laid down on a sea bed remote from actively eording land masses. Altered basalt lavas and pillow lavas are intimately associated with the Ultramafic belt throughout its length (Davies, 1967).

Large sections of the eastern Papua coastline falling within the Ophiolite Province show evidence of Recent submergence.

3.4 Cape Vogel Basin

Von der Borch in his background geological introduction to the Huon Gulf marine geological survey (von der Borch, 1969) summarises the Cape Vogel Basin as follows. "This name refers to a structurally depressed and topographically low lying coastal zone, extending from Morobe in a southeasterly direction and continuing an unknown distance out to sea to the east of Morobe. A thick section of Miocene and Pliocene sediments is exposed on Cape Vogel. Between here and Morobe, unconsolidated coastal plain deposits and Pleistocene to Recent volcanics mask any possible northwest extension of the Miocene - Pliocene succession. Many centres of Pleistocene to Recent volcanic activity exist within the Cape Vogel Basin in the area of this study. Most recent activity occurred at Mt Lamington in 1951 (Taylor, 1958). During this catastrophic eruption the volcano ejected an andesitic magma."

Thompson and Fisher (1965) indicate that the basement beneath the 4 km of Mio-Pliocene succession of clastic sediments on Cape Vogel is composed of basic submarine lavas.

The vulcanism to the north east of Cape Vogel is dominantly andesitic but basaltic and dacitic phases have been identified. Also fragments of ultramafic rocks have been identified which it has been suggested, have been stripped from the walls of the volcanic conduit during the passage of andesitic magma through the adjacent north easterly dipping Ultramafic Belt. Thompson and Fisher (1965) suggest that the magma chambers for these andesitic volcanoes lie beneath the basic and ultrabasic rocks of the Ophiolite Province and penetrate through them.

3.5 Geotectonic Development

The geological history of Papua - New Guinea has been summarised by Thompson (1967) as follows.

1. Late Cretaceous to Upper Miocene - Deposition of red shale, fine-grained pink limestone and chert on the ocean floor beyond the reach of terrigenous clastic sediment. Submarine vulcanism with the outpouring of pillow lavas and increase of silica concentration in sea water.

2. Upper Eocene/Oligocene - Low arching of ocean floor beyond the limit of terrigenous clastic sedimentation, mass slumping of oceanic sediments and possibly also of pillow lavas, dolerite and gabbro of the upper part of oceanic crust.

3. Oligocene - Crestal rupturing of arched oceanic crust and thrusting of the north-eastern limb of the arch towards the Australian continent and over Mesozoic and older sediments accumulated at the base of the continental slope.

4. Oligocene to Lower Miocene - Metamorphism of Mesozoic and older continental slope sediments by the weight of the thrust slice of oceanic crust, compression, frictional heat and magmatic heat.

5. <u>Lower Miocene</u> - Metasediments reacted as a homogeneous crystalline block and rose isostatically using the original thrust plane as a glide plane. The rapid emergence of the metamorphic block turned up the leading edge of the thrust plate of oceanic crust and exposed deep crust or upper mantle materila in the form of ultramafic rocks (the Papuan Ultramafic Belt).

6. <u>Lower Miocene onwards</u> - Continued emergence of the metamorphic block and tight folding and faulting of Eocene and Upper Cretaceous sediments (e.g. in the Port Moresby area). Complementary north-easterly downward sliding of oceanic thrust plate as part of regional isostatic adjustment. Generation of granodiorite magma from anatexis of metamorphosed pre-Tertiary sediments and rise of magma (e.g. in Wau - Bulolo and Waria Valley areas).

St John (1967) largely agrees with this sequence of events and in his reconstruction of events to fit his gravity interpretation of the Ultramafic Belt he suggests the sequence illustrated in Fig. 7.

1. Seaward thinning upper and lower crustal rocks overlying the mantle.

2. Thrusting from the north east during the Late Cretaceous producing a dipping thrust fault throughout the thinning sialic crust: concurrent erosion of Mesozoic and older metamorphic rocks occurs.

3. Relaxation of the thrusting forces: the upthrust block sinks and distorts due to gravity: formation of deep sedimentary basin by erosion of remaining uplifted area: exposure of parts of basic and ultrabasic lower and subcrustal material: submarine volcanics form.

4. Uplift during the Pliocene epoch followed by addition of light material to base of crust: uplift to present time.

On the basis of this sequence of events, St John (1967) favours his Model 2 (Fig. 13) to account for the gravity section through Papuan Ultramafic Belt. The gravity interpretation will be discussed in a later section.

Davies and Smith (1970) outline the tectonic development of the area and incorporate the concepts of plate tectonics and the opening up of the Coral Sea basin.

1. Deposition of sediments along the Australian continental margin (Cretaceous).

2. The Australian continental crust and marginal sediments entered a subduction zone along the line of the present Owen Stanley Fault and the Marginal sediments were metamorphosed (Palaeocene, or early Eocene)

3. The subduction zone became inactive and movement was taken up elsewhere, e.g. in the New Britain - Solomon Islands region. Parts of the metamorphics were exposed to erosion (Eocene).

4. The former subduction zone and a slice of the metamorphosed Mesozoic sediments moved away from the Australian continent as the Coral Sea opened by rifting (Eocene, possibly Lower Oligocene).

5. The metamorphosed Mesozoic sediments rose isostatically and the partly overlying plate of oceanic lithosphere was tilted as a result. Erosion of the metamorphics began (Upper Oligocene - Lower Miocene).

6. Uplift and rapid erosion continued and were accompanied by volcanism (Middle and Upper Miocene, Pliocene and Quaternary).

3.6 Regional Vulcanism

The volcanic centres in eastern Papua are indicated in Fig. 5 and all lie on the NE side of the areas of basic and ultrabasic rocks.

In the Mt Lamington region, volcanics activity has been recognised since the Lower Tertiary. The Hydrographer Range lying between Mt Lamington and the coast at Oro Bay is composed of tuffs overlain by agglomerates and flows of andesitic and basaltic lava. The height of the Range is over 1800 m and the main activity appears to have taken place in Pleistocene time but there is quite a bit of evidence of minor Recent activity.

Mt Lamington itself erupted catastrophically in 1951 (Taylor, 1958) after having no record of activity in living memory or legend. The mountain rises 1800 m above sea level and is composed of andesitic lavas. Ultrabasic rocks were found as inclusions in the lava.

In the Cape Nelson area there are two large volcanic cones, Mt Trafalgar and Mt Victory, both about 1800 m high. Mt Trafalgar has been inactive for a long time judging from ercsion. Mt Victory still shows signs of activity and historical records indicate that it erupted last century.

A volcano was formed during 1943 about 48 km SSE of Mt Victory at the foot of the Goropa Mountains. Hot springs have been reported in the Monic River valley of the upper Musa River system.

Offshore on D'Entrecasteaux Islands there are a number of volcanic cones and extensive thermal areas. The area has been active in Recent times.

4. REGIONAL GEOPHYSICS

4.1 Seismicity

Brooks (1965) and Denham (1969) have examined the seismicity of the Papua and New Guinea region in some detail. Improvements to the seismic station network in the area during recent years have improved the accuracy of location of epicentres. Fig. 8 shows the seismicity in the east Papua-Solomon Sea region up until May 1970 drawn from the data files of the B.M.R. Observatory at Port Moresby.

The major seismic zone in the region follows the line of the deep sea trench along the SW side of the Solomon Islands chain, along the New Britain arc and into mainland New Guinea through the Huon Peninsula. Relative to this major zone, the seismicity of the eastern Papua peninsula and a substantial part of the Solomon Sea is comparatively minor. In Fig. 8 there are only three epicentres south of latitude 10°S.

In the Huon Gulf - Huon Peninsula and the neighbouring New Guinea Highland regions there is a tendency for the deeper earthquakes to occur further to the SW than the shallower ones (Denham, 1969) and this is taken to indicate a Benioff zone dipping under the New Guinea mainland from the north, a feature which can be demonstrated from the Huon Gulf along the north coast into West Irian.

In the east Papua Peninsula south of latitude 8°S the trends of earthquake distribution are not well defined because there are relatively few earthquakes in the region. The earthquakes which do occur seem to lie towards the NE side of the peninsula and extend in an ill-defined band across the Solomon Sea between the latitudes 9° and 10°S. A few epicentres are located on the Trobriand Platform and there are also some placed in the Solomon Sea north of the Woodlark Rise. There does not appear to be any significant distribution of deeper earthquakes relative to shallow ones. There are apparently no earthquakes associated with the Louisiade Archipelago. Most of the deep earthquakes are of small magnitude and consequently the hypocentres are not well defined. It is likely that if further records were available, they would turn out to be shallow earthquakes.

Moores (1970) associates the occurrence of basic and ultrabasic rocks with the dipping of a Benioff zone away from a continental land mass and if this is the method of formation of the Papua Basic Belt during the Tertiary (Davies and Smith, 1970), an earthquake zone would presumably have dipped down under the NE oceanic environment for the Australian continental environment. From present earthquake studies it would appear that the dip of the Benioff zone is down under the continental environment in the Huon Gulf region.

Denham (1968) has analysed the spectrum of seismic energy arriving at various stations in the New Guinea region from distant earthquakes and found a crustal thickness at Port Moresby of 32 kms for his best quality results.

4.2 Gravity Surveys

There are three main gravity interpretations relevant to the proposed survey region (a) marine gravity survey of Solomon Sea (Rose et. al., 1968) (b) the gravity survey of the whole of eastern New Guinea (St John 1967) and (c) the gravity survey of eastern Papua (Milsom, unpublished).

(a) The results of the Hawaii Institute of Geophysics Marine Gravity Survey of the Solomon Sea are summarised from Rose et. al. (1968).

The various sections discussed are given on their bathymetric map (Fig. 2). Sections AA' and BB' are the only ones really relevant to the present survey area (Fig. 9).

In section AA' between Bougainville Island and New Guinea "the bottom topography is characterised by an extremely rough surface often cut by deep grabens containing more than a kilometer of sediments and according to Kroenke, as quoted by Woollard et. al. (1967), is "an area of volcanic extrusion, intrusive diking, rifting, slumping, normal faulting and possible overthrusting." A prominent feature at the SW end of this section is a 50 km wide graben filled with about 2 km of sediments at the bottom of the slope north of the Trobriand Platform. This corresponds with the deep water feature (deeper than 5 km) mentioned in chapter 2.2. It is speculated that this graben extends the length of the deep water feature and would be compatible with Van der Borch's observation of a kink in the isobaths in the Huon Gulf but would conflict with his ideas of a left lateral fault. Rose et. al. (1968) attributes many of the features of the area to arching of the crust across the northern Solomon Sea. The upper mantle depth varies from at least 15 km at the edge of the Trobriand Platform to about 10 km depth in the centre of the northern Solomon Sea.

The Section BB' extends from the Woodlark Basin to the southern New Georgia Islands. The gravity interpretation indicates a relatively uniform bathymetry and the depth to the upper mantle is estimated to be relatively uniform at 16.5 km in the Woodlark Basin.

(b) St John (1967) has interpreted the Gravity Field over Eastern New Guinea but only his results from the eastern Papua region are summarised here i.e. his sections A1-B1 to A5-B5. (Figs. 10, 11, 12 and 13).

Section A1-B1 is located just west of Milne Bay. The nature of the gravity anomaly conflicts with the view (Thompson and Fisher, 1965) that this region of the Ophiolite Province consists of oceanic crust overlying sialic rocks. The interpretation model fitted to the gravity results consists of locally intruded basic and ultrabasic rocks into material of sialic density.

Section A2-B2 goes from Goodenough Island, through Cape Vogel and Mt Simpson to the south coast. The southern part again corresponds with the Ophiolite Province but the interpretation favours the short wavelength anomalies corresponding to density contrasts in the upper 10 km of a 30 km thick crust. The longer wavelength anomalies correspond to a thickening of the crust under Goodenough Island. St John presents this as evidence for a displacement of the orogenic axial zone 100 km north from the corresponding axis in section A3-B3.

The interpretations of sections A3-B3, A4-B4 and A5-B5 have in common a layer of high density material dipping northeast from the Papuan Ultramafic Belt to the mantle (approx. 35 km) at an angle of approximately 23°. This is used to account for the large gravity gradient and gravity highs to the northeast of the Ultramafic Belt. St John's proposed development of such a layer of high density material is illustrated in Fig. 7, taken from his thesis. The model does account for the present day gravity data but, as St John points out, "can hardly be considered to prove the reality of (his) Model 2" since the inversion of gravity data alone does not give a unique solution.

Thus this model is in agreement with the postulated structure of Thompson and Fisher (1965). St John also modelled the gravity profiles as being due to a shallow (less than 10 km) intrusion (Fig. 13) but although this fits the observed gravity he rejected the model on the grounds of the improbability of a shallow feature causing a major fault 400 km long (the Owen Stanley Fault) and that the dimensions of the modelled magmatic ultrabasic body were "geolcgically horrifying".

The deepest part of the crust (abcut 40 km) is interpreted as being along the axis of the Owen Stanley Ranges. From examination of the isostitic anomalies, St John concludes that the eastern Papuan region is approximately compensated according to "local" Airy hypothesis with a standard crustal thickness of 35 km.

(c) During 1966; 1967 and 1968 BMR conducted a more detailed land Gravity Survey of the Eastern Papuan Region (Milsom, unpublished) and the results are currently being interpreted by Milsom in London. The results of the interpretation are expected in the first half of 1971.

4.3 Seismic Surveys

Two major marine seismic surveys have been conducted in the seas adjacent to the east Papua; one conducted by the Hawaii Institute of Geophysics covered the Solomon Sea region and the other conducted by the Lamont-Doherty Geological Observatory and the University of N.S.W. covered the Coral Sea region. The details are summarised below.

(a) The Solcmon Sea survey conducted in 1966 completed twelve seismic refraction profiles, the results of which are illustrated in Fig. 14, taken from the publication by Furumoto et. al. (1970). A recording ship was stationed at each end of the profile and shots were fired from a third ship along the line between the other two. Distances were determined from the water wave arrivals using measured velocities in sea water. Most of the lines were reversed although in some cases only pseudo-reversals were obtained where the forward and reverse profiles were shot at different times and with consequent slight variations in position. Fig. 15 illustrates typical travel-time plots.

Furumoto estimates that all velocities are well determined except on lines M, I and J and that the probable maximum error in the crustal thickness is ± 15% but for most profiles is less than 10%. In Fig. 14 the crustal section over the Rabaul area is from the 1967 BMR work and has been altered by subsequent interpretation.

In the northern Solomon Sea the upper mantle velocity is subnormal i.e. 7.7-8.0 km/sec and the depths to mantle are of the order of 13 km thickening to about 20 km towards line M which is near the Planet Deep. The gravity interpretation of Rose et. al. (1968) indicates depths of 10 km and 16 km in the corresponding locations.

In the region between the Woodlark Rise and the Pocklington Rise/Rennell Ridge both subnormal crustal velocities (7.5-7.9 km/sec) and subnormal depths to upper mantle (7-10 km) were obtained. The gravity interpretation of Rose et al gives depths to upper mantle of 15 km. The evidence for the mantle velocity of 7.3 km/sec and crustal depth of 27 km in line E is not well supported.

Discussion of the other traverses is not really relevant to the survey area under review.

(b) The Marine Seismic Survey of the Coral Sea was conducted in 1967 as a two ship survey, shots being fired from H.M.A.S. Diamantina and recorded on board R.V. Vema. The locations of the refraction lines are illustrated in Fig. 16 taken from the publication by M. Ewing et al (1970). An associated reflection survey was conducted at the same time and has been reported by J. Ewing et al (1970) from whose publication Fig. 4 is taken to illustrate the bathymetry of the Coral Sea.

Figs. 17 and 18 illustrate the results of refraction work along the sections A-B and C-D in Fig. 16. Only in the profile No. 48 were upper mantle velocities measured. The indications are that the upper mantle depths are of the order of 13 km in the Coral Sea Basin increasing to about 20 km towards the NE.

Fig. 19 has been derived from the reflection survey and illustrates three sections across the Coral Sea Basin. J. Ewing et al suggest that the basement high indicated in Fig.   is a barrier ridge behind which Fly River detritus has accumulated to form the Papuan Plateau. The velocities recorded on location 54 were markedly lower than elsewhere.

4.4 Magnetic surveys

(a) The Hawaii Institute of Geophysics conducted a Total Magnetic Field Survey of the Solomon Sea concurrently with their gravity survey. Fig. 20 illustrates the wavelength of the anomalies and the depths of source and the results indicate that the majority of anomalies "are geologically controlled and originate from sources consisting of intrusive ultrabasic and basic rocks as well as extrusives of the same type of rocks over sedimentary rock structures on the ocean floor." (Rose et al, 1968).

(b) Compagnie Generale de Geophysique (CGG) conducted a high altitude aeromagnetic survey across the north part of the proposed survey region in 1967 under contract from BMR (CGG, 1969). Figs. 21 and 22 illustrate the essential total field magnetic anomaly pattern and the interpretation.

In the SE of Fig. 21 the E-W trending anomaly is associated with the andesitic volcanics in the Mt Lamington area. NW from this area lie the anomalies associated with the Ultramafic Belt and associated volcanics. The anomalies of under 20 gamma trend NW or NNW with a few E-W trends near the coast. The low amplitude of these anomalies supports the idea that they are not due to intrusives but rather to a large block of material.

An elongated negative anomaly is associated with the Owen Stanley Fault and seems to indicate that this fault has major structural importance.

The Owen Stanley low grade metamorphic region is characterised by a very quiet magnetic style in which the magnetic field increases gently towards the SW.

SW of the Owen Stanley metamorphics there is a belt of anomalies which can be attributed to various sources. In the region south and SE of Mt Albert Edward the anomalies are caused by basic igneous rocks, most probably basic volcanics. Further NW, in the Mt Yule region, the anomalies most likely have similar sources. The magnetic susceptibility is of the order of 0.014CGS e.m.u. corresponding to that of highly basic lava (andesite or basalt). These volcanics have been identified as Miocene/ Pliocene in age. Mt Lawson further north could be either a granodiorite intrusive or volcanic in origin.

The anomalies at the northern end of this belt around Wau are due to granodiorite intrusives which outcrop in the Ekuti and Kuper Ranges. Three intrusives can be inferred.

Further west of this belt of anomalies stretching from Mt Victoria in the south to Wau in the north, the magnetic style becomes much quieter owing to the influence of deep sediments.

The results of the aeromagnetic survey were modelled along a profile running NE across the Owen Stanley Fault and Timeno Fault to the coast at the mouth of the Mambare River. The simplest model which best fitted the angle of contact between the metamorphics and oceanic basement in the area between the Owen Stanley Fault and the Timeno Fault* and then the steeper dip of the contact down from the latter fault.

This profile would roughly correspond with north eastern parts of gravity profiles A4-B4 and A5-B5 interpreted by St John (Figs. 11 and 13). In the magnetic interpretation the basic and ultrabasic rocks are modelled as being a block overthrusting the metamorphics rather than as a layer extending up through the metamorphics.

* Author's Note: The "Timeno Fault" as used in the CGG interpretation is incorrectly named. The correct name should be the "Gira Fault" as designated on BMR geological map of the Papuan Ultramafic Belt.

(c) C.G.G. conducted further aeromagnetic survey work in Eastern Papua during 1969 (C.G.G., 1971). The area surveyed is indicated in Fig. 23a Fig. 23b is a reduction of the interpretation map of the area.

The objects of the survey were (1) to provide information about the possible continuation of the Ultramafic Belt south of latitude 9°S, (2) to discover the relationship, if any, between D'Entrecasteaux Islands and the mainland structures and (3) to define the form and extent of any sedimentary basins in the Trobriand Island shelf area and its relationship to Tertiary sediments in the Cape Vogel region.

The magnetic markers were identified as mafic and ultramafic rocks, Mesozoic metamorphics and Tertiary intrusives and less reliably as Pliocene and Recent volcanics and lower Miocene volcanics. Qualitatively, the trends of the main anomalies were in an E-W direction. On the mainland the magnetic basement is very near the topographic surface.

The conclusions reached were (1) that it appears probable that the Ultramafic Belt extends east of Mt Sucking below thin lower Miocene volcanics and sediments to the areas north and south of Milne Bay, (2) there is a real connection between the magnetic basement high on Cape Vogel and on Goodenough Island extending through Fergusson Island to the western part of Normanby Island, (3) that there exists a Tertiary sedimentary basin between the Trobriand Islands, Luscany Islands and their western extension and the D'Entrecasteaux Islands and the Papuan coast. Sediment thickness increases from 600-1200 m on Cape Vogel to 1500-2400 m at its deepest.

4.5 Palaeomagnetic Surveys

A reconnaissance palaeomagnetic survey of eastern New Guinea has been conducted jointly by Australian National University and BMR (Manwaring, unpublished) (Fig. 24). The ages of the rock samples are from Palaeozoic to Pleistocene. The results of the survey have been summarised by Manwaring as follows:

"1. Palaeomagnetic pole positions from at least the Permian to some time during the Tertiary all lie approximately in the same position (Fig. 25).

2. During the Tertiary (pre Miocene?) New Guinea rotated $118^0 \pm 25^0$ anticlockwise with respect to Australia.

3. There is an indication that the smaller islands to the east and north of the New Guinea mainland (New Britain, New Hanover, Manus) also subsequent to that mentioned in 2".

The development in 2 above may correspond to Thompson's 3rd stage of geotectonic development mentioned in chapter 3.5

These results substantiate the findings of earlier work on New Guinea samples (Green and Pitt, 1967). The hypothesis adopted from the earlier, more limited survey was that Australia moved northwards during the Tertiary with New Guinea rotating anticlockwise roughly through a right angle.

4.6 B.M.R. Marine Survey, 1970

During 1970 B.M.R. conducted an extensive marine survey in T.P.N.G. waters as part of a continuing programme to obtain geophysical data over the whole of the Australian continental shelf. Gravity, marine, seismic, topographic and magnetic data were recorded on a continuous basis over the traverses indicated in Fig. 25a. At the time of writing (Feb. 1971) the data has been compiled into preliminary map form only.

4.7 Hawaii Institute of Geophysics (H.I.G.) Marine Survey, 1970

H.I.G. conducted a marine survey during 1970 over the traverses indicated in Fig. 25b. B.M.R. and University of Queensland personnel also took part in the survey. The detailed results of the survey are not yet available but interpretation is being continued by H.I.G. and University of Queensland.

4.8 Tectonic Syntheses

A number of authors have published syntheses of the present day tectonics of the New Guinea-Solomon Island region. Carey (1958, 1970) attaches great importance to the structure of the region in connection with his expanding earth hypothesis. The sinistral shear in the New Guinea region is seen as part of a Tethyan Shear Zone. Krause (1967) also sees the Woodlark Basin and eastern Papua as part of a sinistral shear zone. Ripper (1971) has added earthquake focal mechanism evidence in the New Guinea region to support the hypothesis of earth expansion and resultant tensions.

Denham (1969) indicates from seismicity considerations that the development of the region is consistent with the "new global tectonics" of Isacks et al (1968) and that an Australian "plate" is moving northward to meet a north-westward moving Pacific "plate". Milsom (1970) has taken the step of postulating a minor centre of sea-floor spreading extending across the Woodlark Basin from eastern Papua to the New Georgia Islands following the minor seismicity zone. The presence of basic marine lavas at both ends of the zone, extremely irregular topography with E-W lineations, extensive normal faulting on eastern Papua (Smith, 1970), heat flow and the geometry of deep trenches in the area are used as arguments in support of the idea.

4.9 B.M.R. New Britain/New Ireland Crustal Surveys 1967-69

During 1967 and 1969 B.M.R. conducted two major crustal surveys in the New Britain/New Ireland region. Although the results from this region are not directly relevant to the east Papua survey, the experience gained in conducting a crustal survey of the type envisaged was very valuable (Brooks, in prep.).

Logistically the problems in east Papua will be quite considerable and the experience is that considerable effort must go into establishing first class communications, developing suitable equipment, maintaining a timetable and giving suitable consideration of the results to be expected.

5. CRUSTAL SURVEY PROPOSALS

5.1 Resume

The crustal structure interpretations in the eastern Papua region by current geological and geophysical surveys do not present a simple picture. Geological evidence presents a picture of "oceanic" provimce material in a land environment and postulates that the earth's crust and part of the upper mantle has been thrust up "en bloc" to account for basic and ultrabasic rocks in the Ophiolite province. This immaginative interpretation would result in dipping layers from the Owen Stanley Fault northeast at about 26°. If this is the case it should be possible to detect this dip quite easily using reversed seismic profiles. However the indications are that the Regional structure is not simple and the magnitude of the seismic problems should not be oversimplified. If the layer of mantle material extends up to the surface and overlies sialic rocks, there should be variations in the results from various recording stations due to the velocity reversals in the crust. The current gravity and aeromagnetic survey interpretations do not disagree with the geological interpretation.

The present indications are that the depth to the Moho under the peninsula is of the order of 34-40 km decreasing southwards to about 11 km in the centre of the Coral Sea Basin and north eastwards to about 13 km in the centre of the north Solomon Sea. However, whereas in the Coral Sea Basin shallow seismic profiling reveals low submarine relief, northeast and east from the Papuan peninsula the relief indicates very disturbed near surface crustal layers featuring intrusions, normal faulting, grabens and crust arching. The structure is complicated by the Trobriand Platform/ Woodlark Rise structure and the Pocklington Rise/Rennell Ridge structure and the nature of the crust in these structures requires investigation.

5.2 Seismic Refraction Proposals

The aims of the refraction aspects of the crustal study should be to determine the broad structural features of the area. Therefore in such a complex area it will be important to choose the shooting targets such that it is possible to separate out the geological structural units.

It is quite realistic to think in terms of their being 24 mobile recording stations available and that the number of shots will be between 40 and 50. The shots will be of the order of 900 kgm (2000 lb) and be recorded at distances up to 400 km away from the shot. The shots and stations must be deployed such that the reversed velocity profiles are recorded wherever possible and that shots be detonated at some locations where there is a nearby recording station to enable unique determination of structure. In addition to 24 land recording stations, it is hoped to use a seaborne recording station using sonar-buoys. It is expected that the shooting ship will be equipped with a satalite navigation system so that there will be few positioning problems.

It is proposed that the refraction work be undertaken along the lines A, B, C and D shown in Fig. 26. The lines can be split into two pairs in "V" formation. It is proposed that recording stations be positioned along the lines as indicated in Figs. 27 and 28 and that the shots be detonated along the seaward extensions of the lines.

Line A is designed to cut across the Huon Gulf, the Papuan Ultrabasic Belt, the Owen Stanley Metamorphic and the Aure Trough. The line will make use of a recording station at Finschhafen to obtain reversed profiles across the Huon Gulf and to reverse shoot through the mainland area.

Line B is designed to shoot across the Tobriand Platform, the Cape Vogel Basin with associated active volcanic region, the Papuan Ultramafic Belt, the Owen Stanley Metamorphic Belt and the southwestern Basalt Province. The line will be reversed through the mainland section and on the seaward extensions if seaborne recording is available.

Lines A and B together should enable travel times to be measured not only along the lines of shots but at substantial angles to these lines, so that adequate information should be obtained on any velocity anisotropy.

Some qualitative estimates can be made of the features to be expected on the travel time plots. If a simplified geological cross-section is assumed as in Fig.   , considerable asymmetry in the travel time curves would be obtained from reversed profiles. The numbers at the top of the idealised geology section can be taken as imaginary seismic stations.

Shooting from the SW, arrivals at stations 1-8 can be expected to travel through a 6.0 km/sec crust with a thickness at Port Moresby of 33 km (Denham, 1968) overlying a mantle with a P wave velocity of 8.0 km/sec. At stations 8-14 no arrivals can be expected because of the velocity reversal due to the ultramafic material projecting from the mantle. A shadow zone of approximately 50 km can be expected and this would mean that the location of good stations on the coast NE of the Ultramafic Belt is important.

Shooting from the NE, there should again be very obvious discontinuities in the travel time curves. Travel times from stations 18 down to 8 should indicate high velocity refractors at comparatively shallow depth. Arrivals at stations 8, 9 and 10 should be very much earlier than at any of the other stations for comparable distances. By contrast the arrivals travelling through a 36 km crust to stations 7 down to 1 should be obviously of the order of 1.5 seconds later than those to the Ultramafic belt station.

Quite considerable dips (20^o-30^o) can be expected in the gross structures on the NE side of the Owen Stanley Fault so it would be relatively easy to detect these dips using seismic arrays of the order of 2-3 km in linear dimensions. Sites for arrays of this size are probably limited in number but should be possible on airfields etc.

Line C is designed to cut across the Tobriand Platform, the Cape Vogel Basin and associated active volcanic region, the Owen Stanley Metamorphic Belt, and its possible extension through the D'Entrecasteaux Islands, and the south-western Basalt Province.

Line D is designed to cut across the Tobriand Platform, the possible extension to the Owen Stanley Metamorphic Belt through the D'Entrecasteaux Islands, and the south-western Basalt Province.

Substantial parts of these lines traverse areas of basaltic crust and thus high crustal velocities can be expected (greater than 6.5 km/sec). There should be a noticeable lack of velocities of 6.5 km/sec and less except those that can be explained by sedimentary coverage or the extension of the Owen Stanley Metamorphic Belt.

It is proposed that use be made of seven "permanent" recordings stations for all shooting, four installations being operated by the Port Moresby and Rabaul Observatories and the other three being set up in the Cape Nelson area for the duration of the survey.

The proposals for the other 21 mobile recording stations are that the lines A and B be shot (10-12 shots per line) with approximately 10 stations along each line so that essentially the lines A and B can be considered as a unit. Similarly it is proposed that lines C and D be shot as a unit (10-12 shots per line) with approximately 10 mobile recording stations along each line. In this way there will be sufficient recordings of arrivals "off-line" to enable any velocity anisotropy to be detailed. A diagramatic representation of the stations from the various shooting lines is given in Figs. 27 and 28.

Logistically the survey can be divided into three stages;

Stage 1 - shooting lines A and B from the south-west.

Stage 2 - shooting lines C and D from the south-west and from the north-east.

Stage 3 - shooting lines A and B from the north-east.

5.2 Marine Seismic Reflection/Refraction Proposals

It is proposed that, associated with the major refraction work, there be a marine seismic reflection/refraction survey to determine shallow structure in the areas around the east Papuan peninsula. The ship will have a certain amount of "free" time while land recording stations are moving between Stages 1 and 2 and between Stages 2 and 3. This "free" time can be put to good use by arranging suitable marine seismic traverses. In addition it is proposed that at least a fortnight be allowed at the end of the major refraction shooting for the ship to conduct further detailed marine seismic work. This should enable approximately 4000 km of marine traverses to be surveyed.

The proposed targets for this work are indicated in Fig. 29. They include the Huon Gulf, the Trobriand Platform, the Trobriand Trough, the Woodlark Rise, the Woodlark Basin, the Papuan Platform and the Moresby Trough.

5.3 Marine Magnetic Proposals

It is proposed that throughout the survey, the shooting ship carry out total magnetic field measurements on all reflection/refraction traverses.

6. COMMENTS

The proposed survey has been designed to fit into a six week field survey with large refraction shots being detonated on approximately 25 days at the rate of two shots per day. The days when no shots are being detonated will be required for deployment and servicing of recording stations and ships.

The proposed shooting programme is by no means rigid and considerable variations are possible. However it is not expected that the shooting targets will be varied to any great extent. There have been suggestions already to extend the survey both east and west but it is felt that these extensions would add considerably to an already complex logistic programme.

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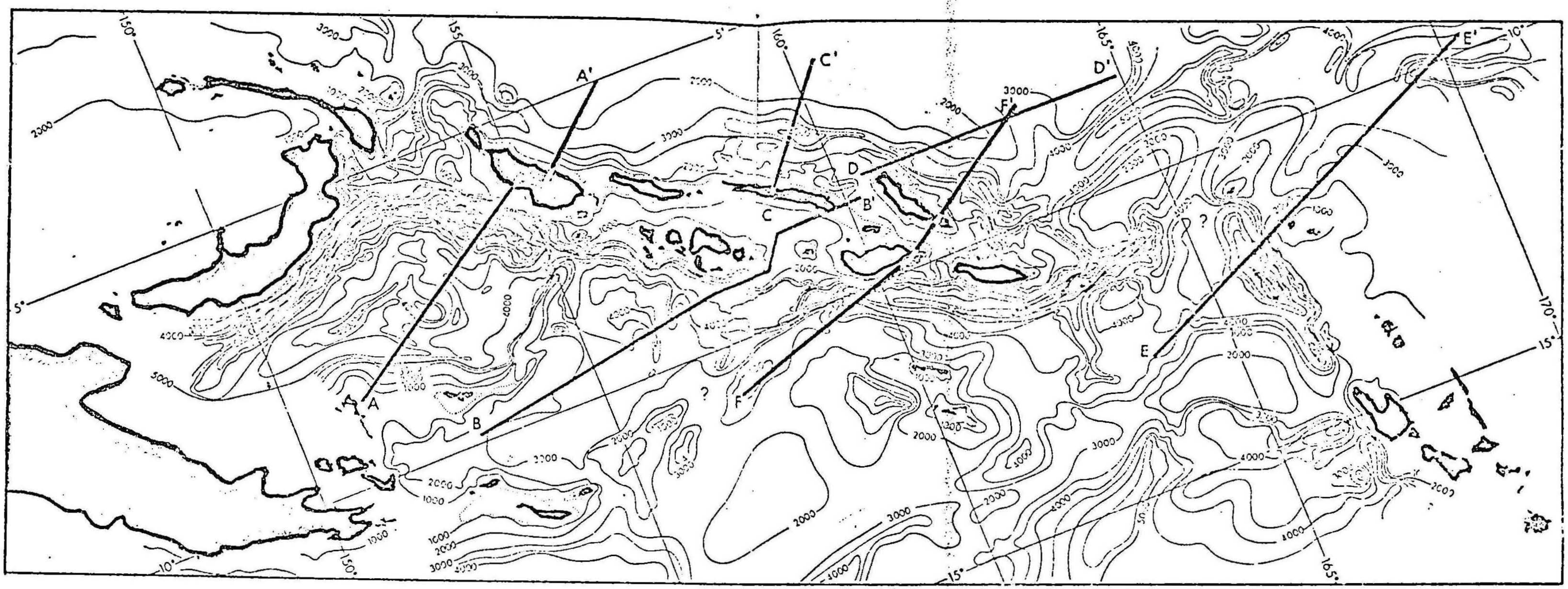


Preliminary bathymetric map of Solomon Islands region, and gravity profiles discussed in this paper. Bathymetric contours are in meters.

Fig. 2 : Bathymetry and location of gravity sections, Solomon Sea marine survey (Rose et al, 1968)

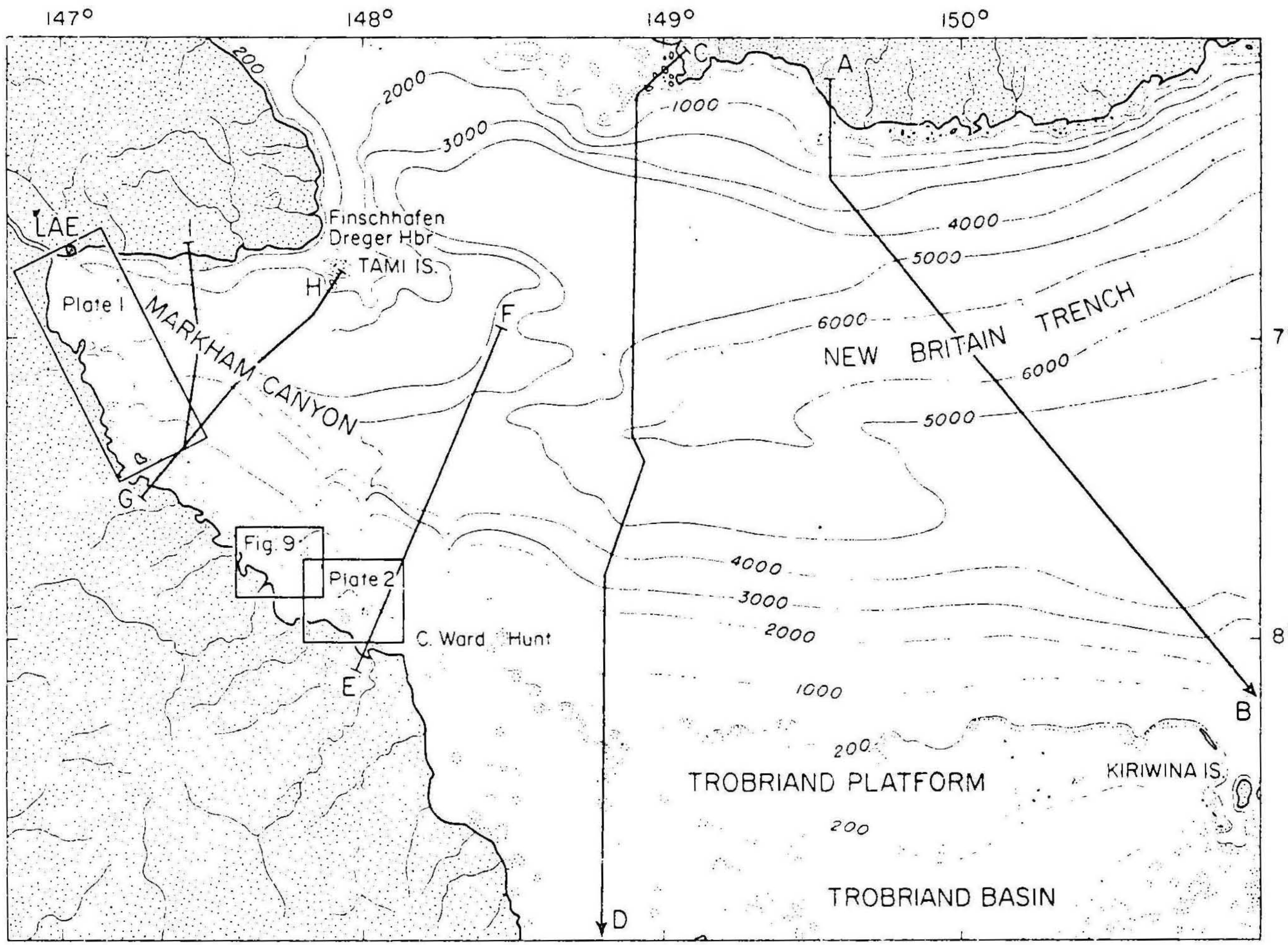
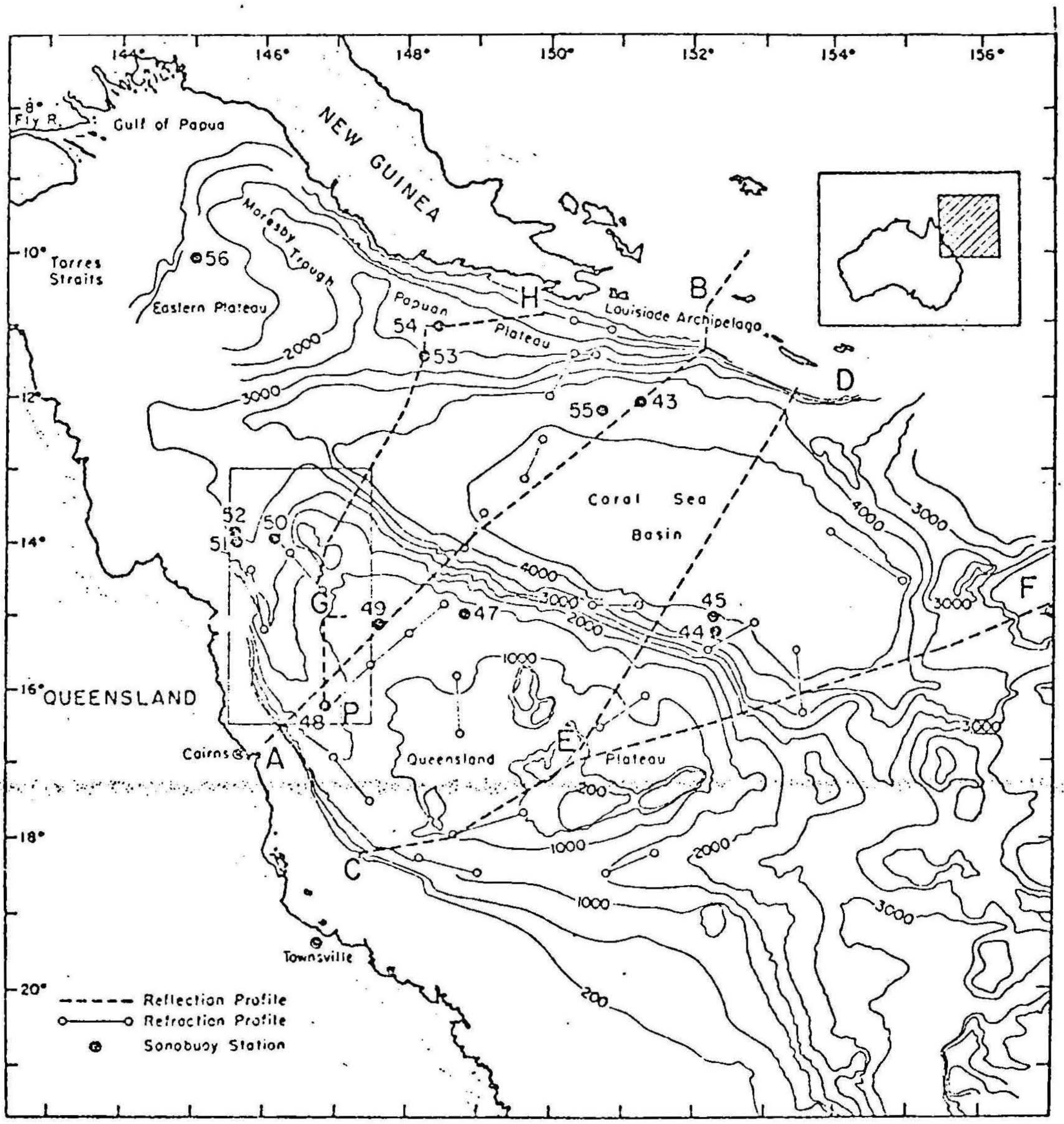


Fig. 3 : Huon Gulf bathymetry (Van der Borch, 1969)

Fig. 4 : Coral Sea bathymetry and location of seismic reflection profiles (J. Ewing et al, 1970)

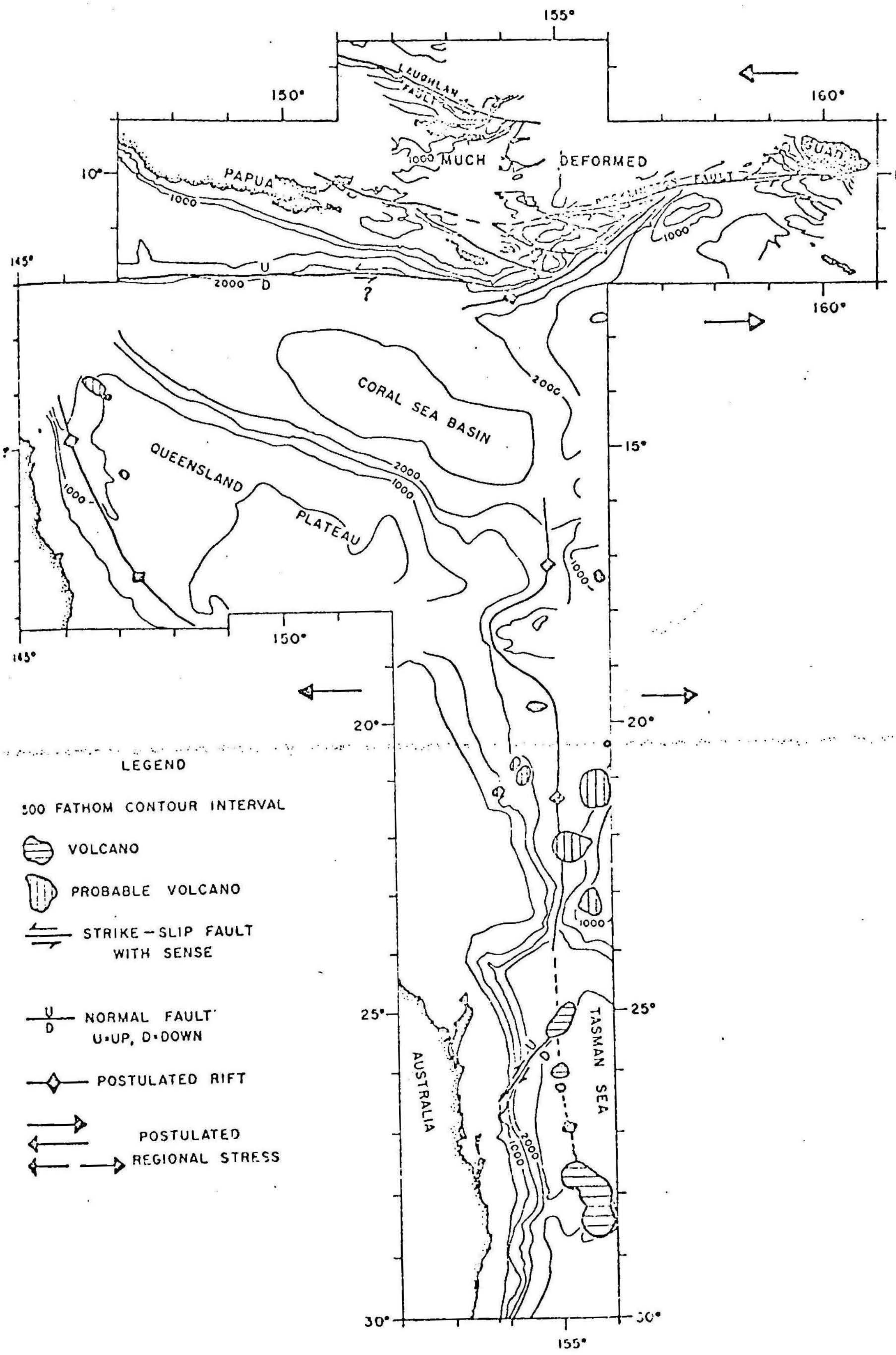


Location map of seismic-reflection profiles and sonobuoy stations. Bathymetry in meters from J. R. Conolly, D. A. Falvey, and L. V. Hawkins (unpublished data, 1970).

FIG. 4a

Structural interpretation of the Australia-Solomon region. Many small geologic structures are not plotted, neither are many large structures of uncertain character. Depths in fathoms corrected for sound velocity.

(Krause, 1967)



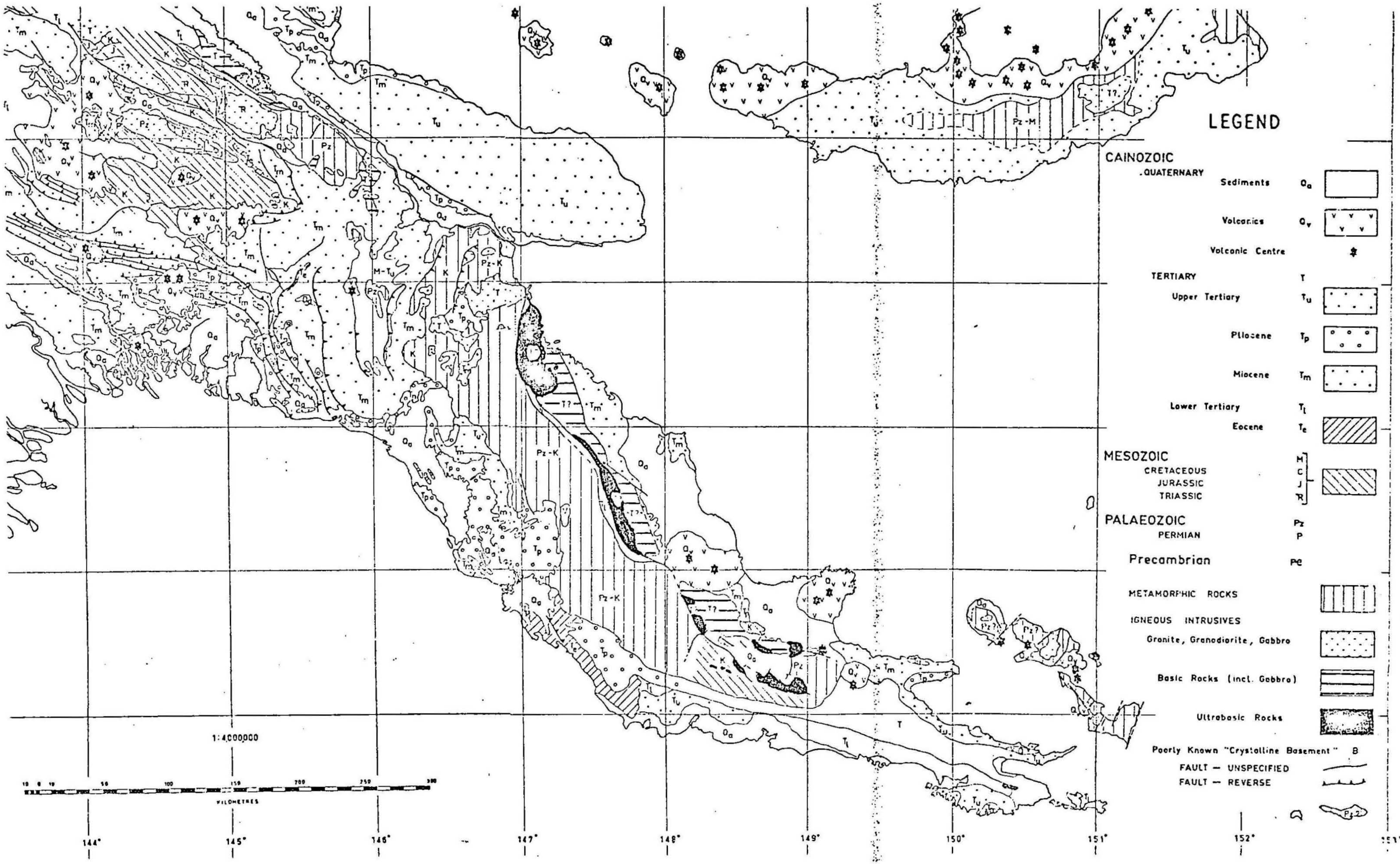
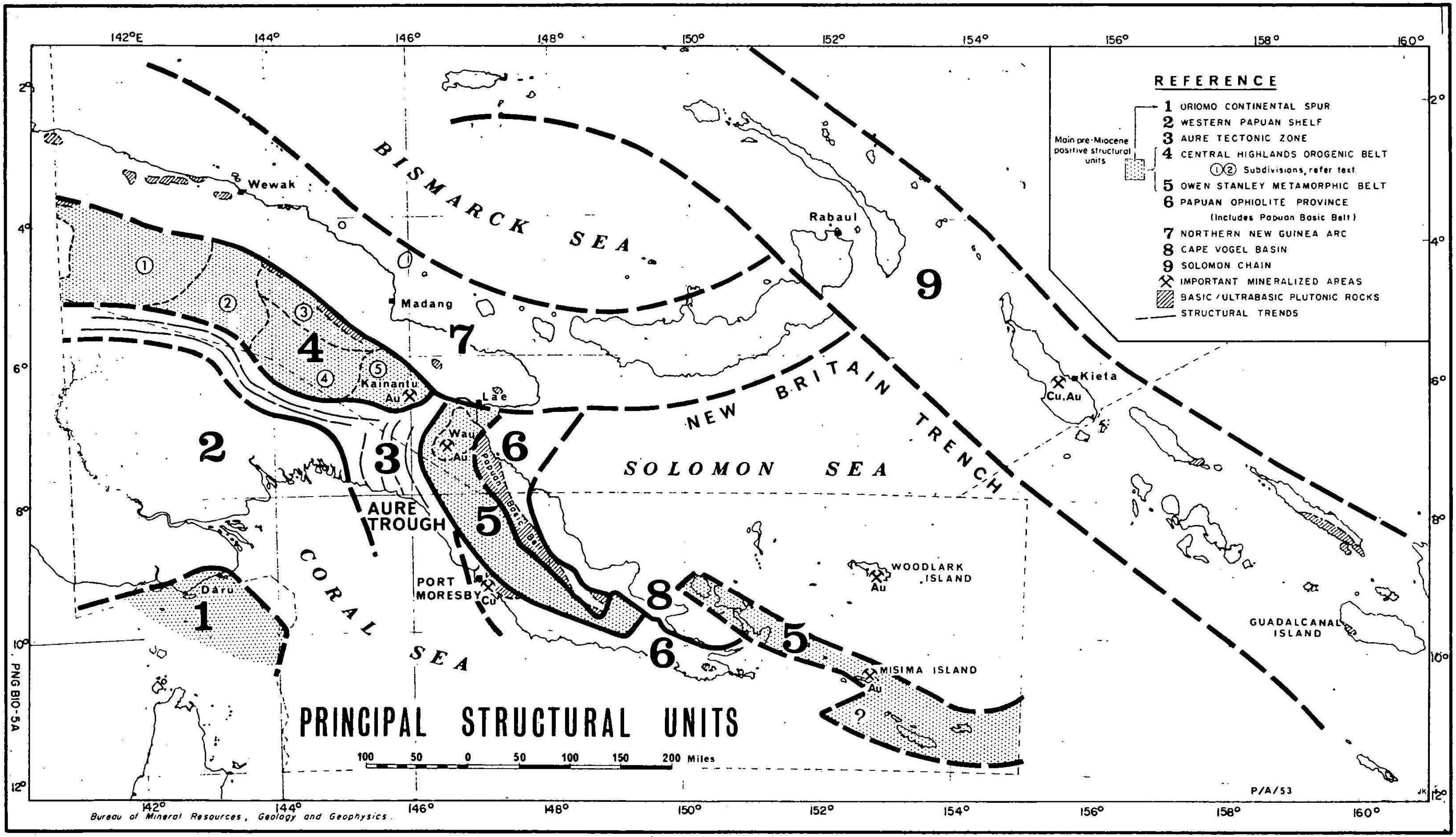


Fig. 5 : Papua and New Guinea regional geology (St. John, 1967)


PRINCIPAL STRUCTURAL UNITS
REFERENCE
Main pre-Miocene positive structural units
1 ORIOMO CONTINENTAL SPUR
2 WESTERN PAPUAN SHELF
3 AURE TECTONIC ZONE
4 CENTRAL HIGHLANDS OROGENIC BELT
①② Subdivisions, refer text
5 OWEN STANLEY METAMORPHIC BELT
6 PAPUAN OPHIOLITE PROVINCE
(Includes Papuan Basic Belt)
7 NORTHERN NEW GUINEA ARC
8 CAPE VOGEL BASIN
9 SOLOMON CHAIN
IMPORTANT MINERALIZED AREAS
BASIC / ULTRABASIC PLUTONIC ROCKS
STRUCTURAL TRENDS
BISMARCK SEA
SOLOMON SEA
CORAL SEA
NEW BRITAIN TRENCH
AURE TROUGH
Wewak
Madang
Rabaul
Kainantu
Lae
Wau
Kieta
PORT MORESBY
Daru
WOODLARK ISLAND
MISIMA ISLAND
GUADALCANAL ISLAND
Papuan Basic Belt
Au
Cu
Cu, Au
100 50 0 50 100 150 200 Miles
142°E 144° 146° 148° 150° 152° 154° 156° 158° 160°
2° 4° 6° 8° 10° 12°
P/A/53
PNG B10-5A
Bureau of Mineral Resources, Geology and Geophysics

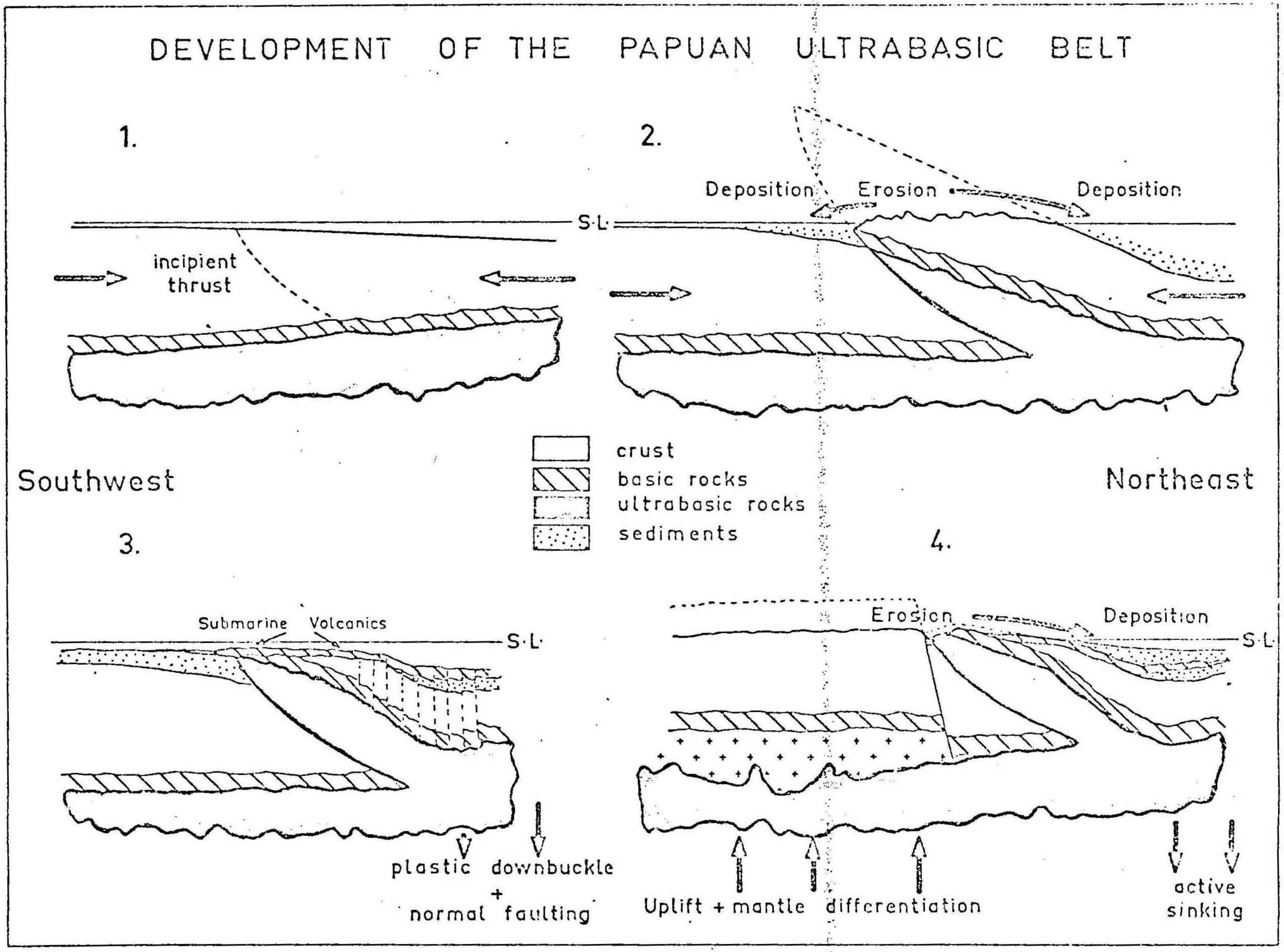
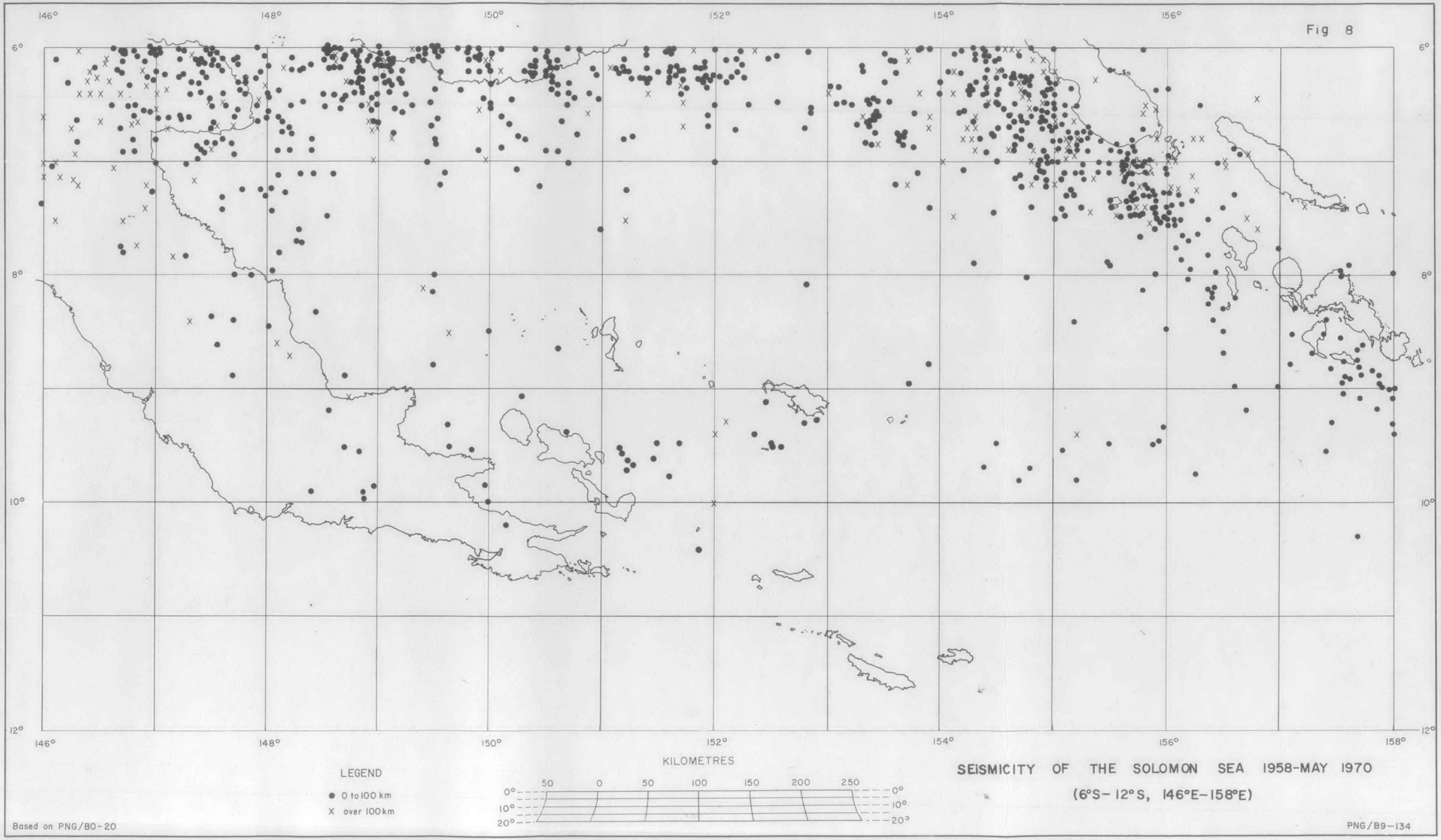
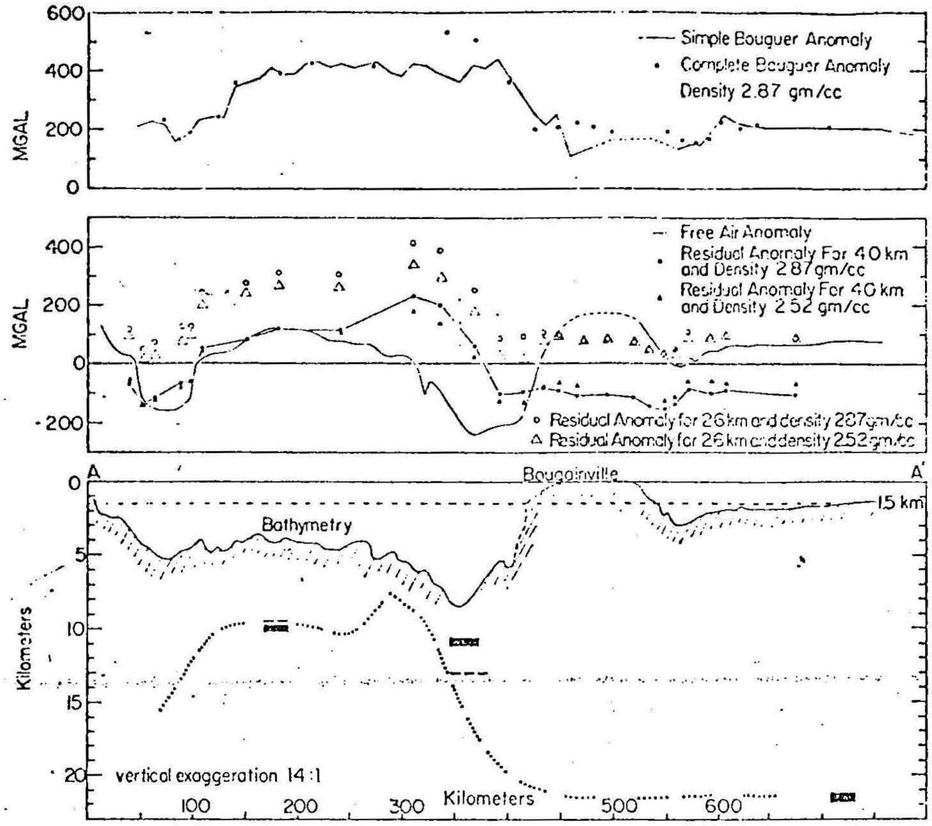


Fig. 7 : Development of the Papuan Ultrabasic Belt (St. John, 1967)

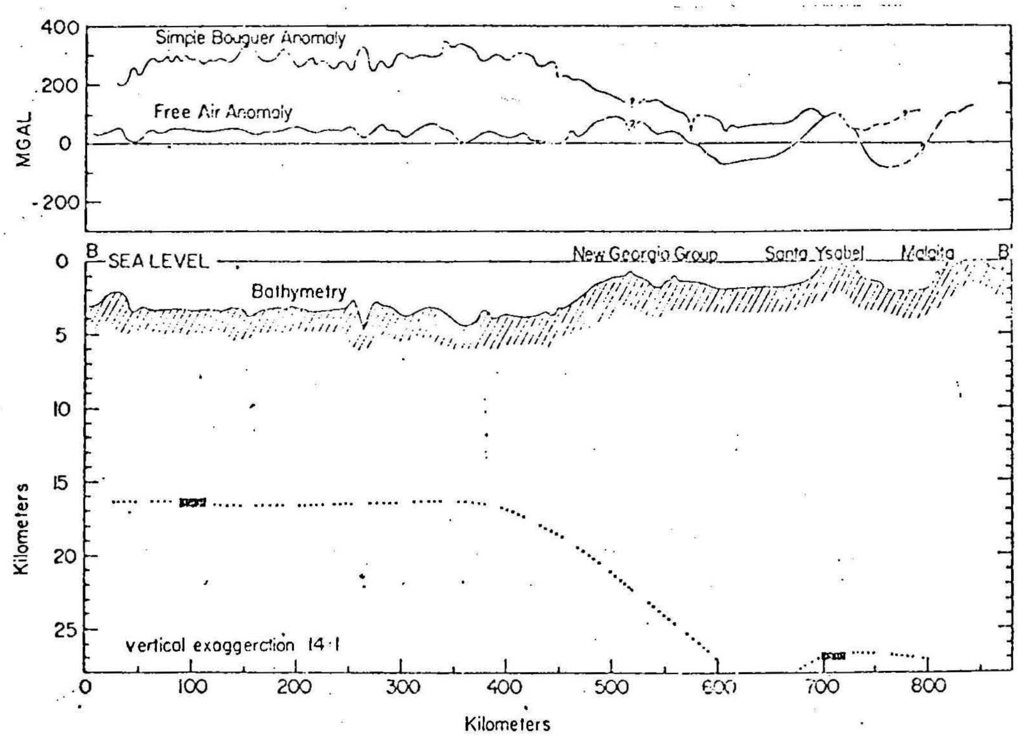


SEISMICITY OF THE SOLOMON SEA 1958-MAY 1970
(6°S- 12°S, 146°E-158°E)

Fig. 9 : Solomon Sea gravity interpretation along sections AA' and BB' (Rose et al, 1968)



Comparative data and crustal solution for profile AA'. Dotted line is approximate mantle depth drawn free-hand.



Comparative data and crustal solution for profile BB'. Dotted line is approximate mantle depth drawn free-hand.

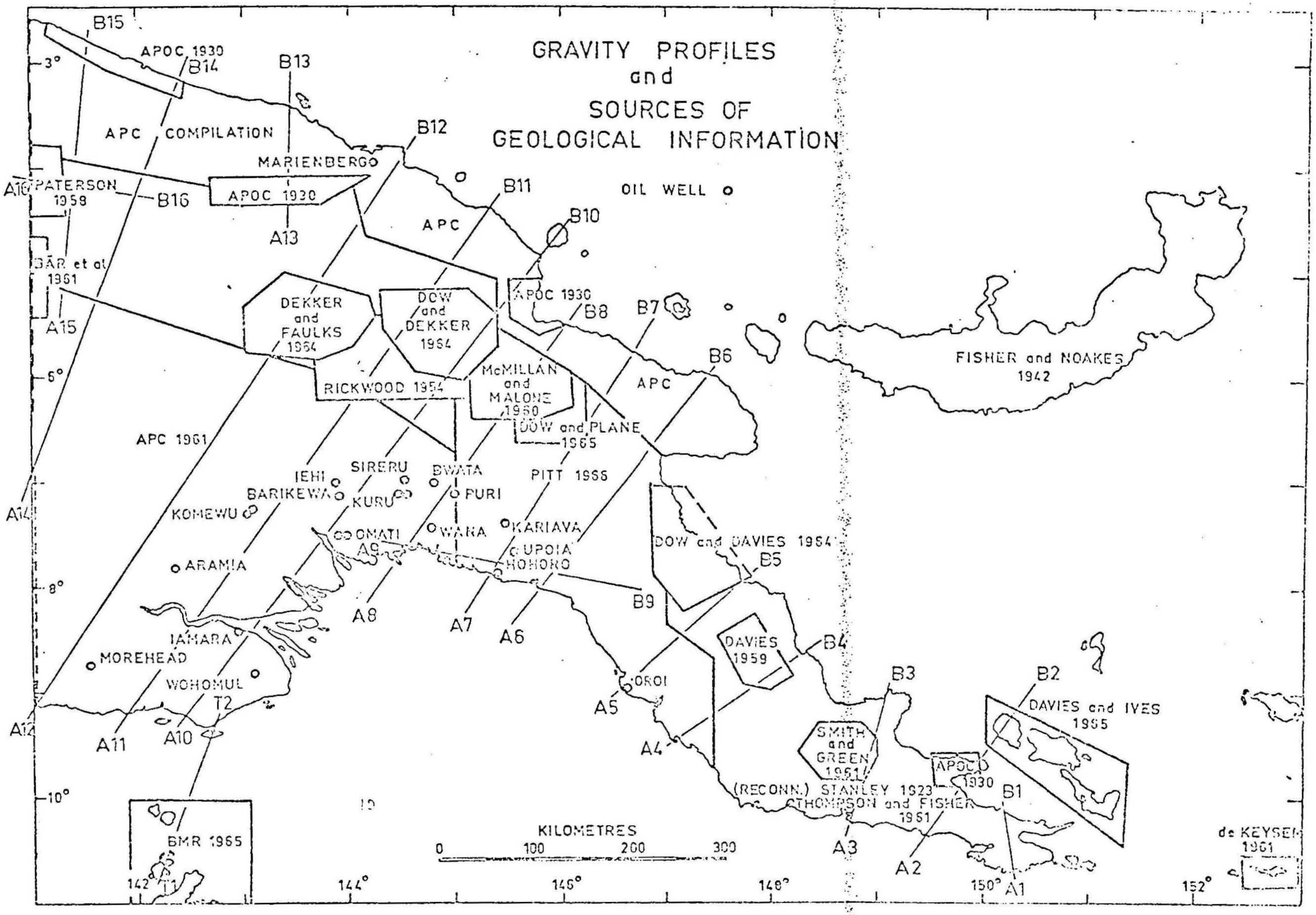


Fig. 10 : Gravity profile locations (St. John, 1967)

Fig. 11 : Gravity profiles A2-B2 and A5-B5 (St. John, 1967)

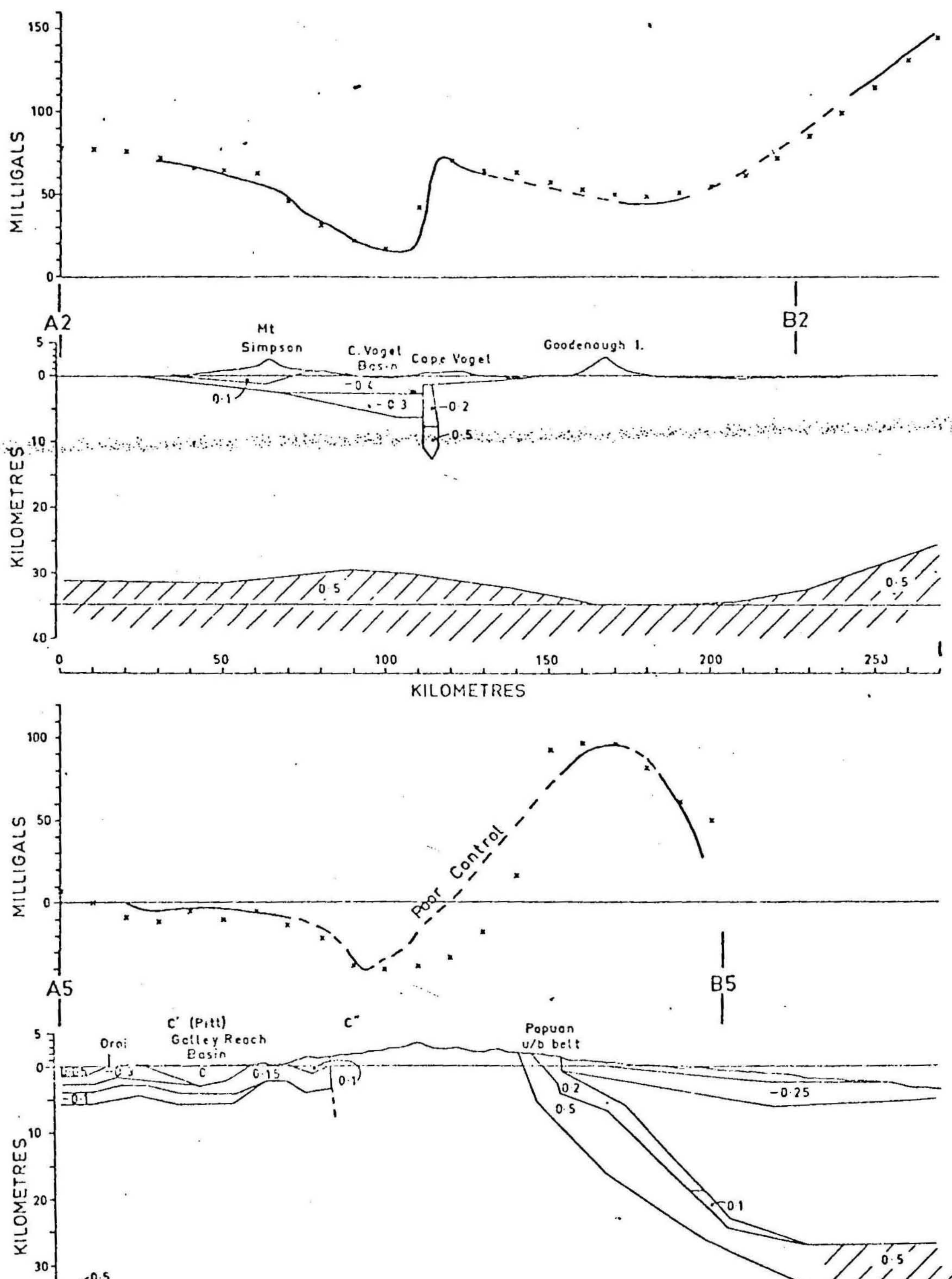


Fig. 12 : Gravity profiles A1-B1 and A3-B3 (St. John, 1967)

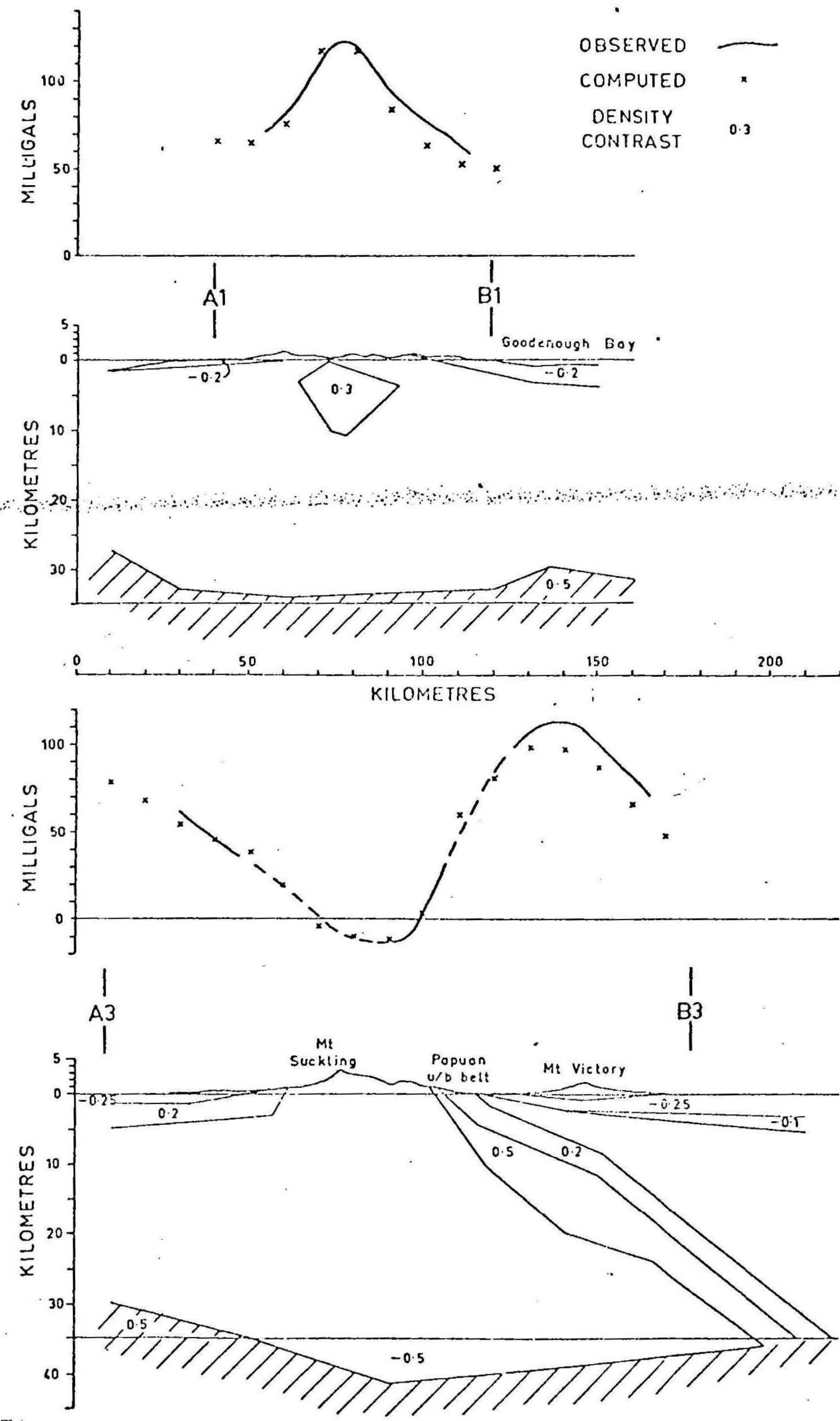


Fig. 13 : Gravity profile A4-B4, models 1 and 2 (St. John, 1967)

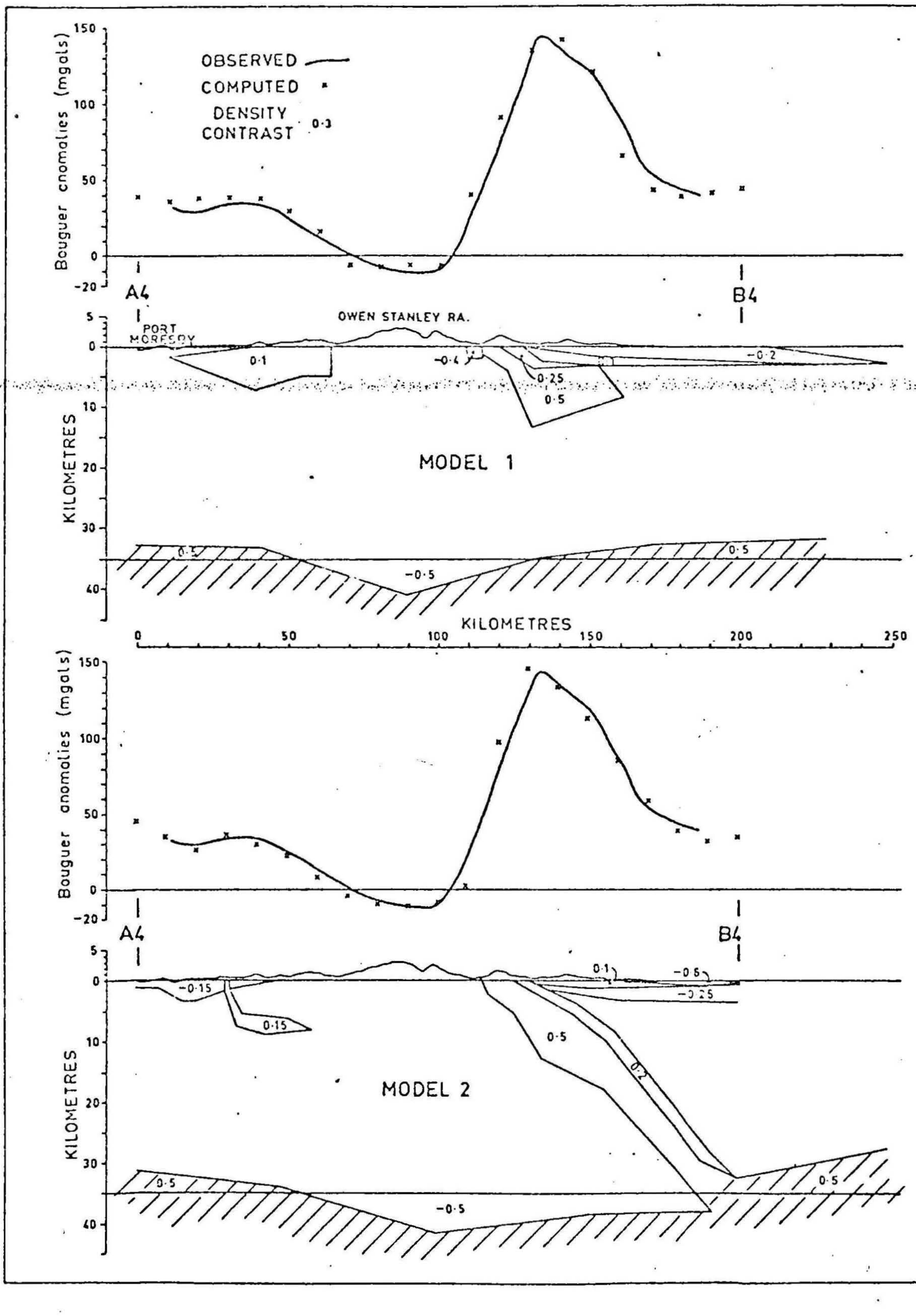
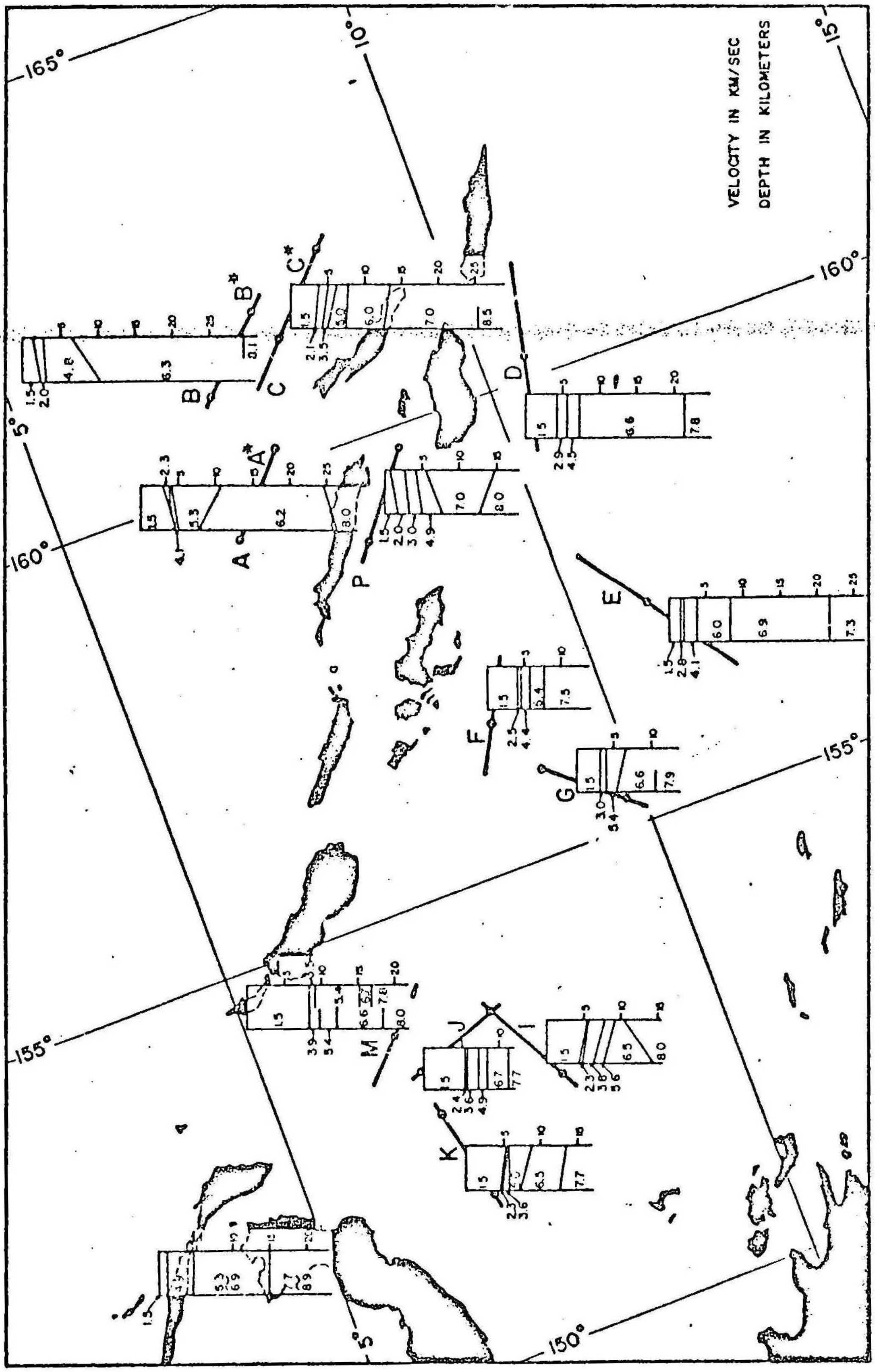


Fig. 14 : Solomon Sea refraction survey; crustal profiles (Furumoto, et al, 1970)



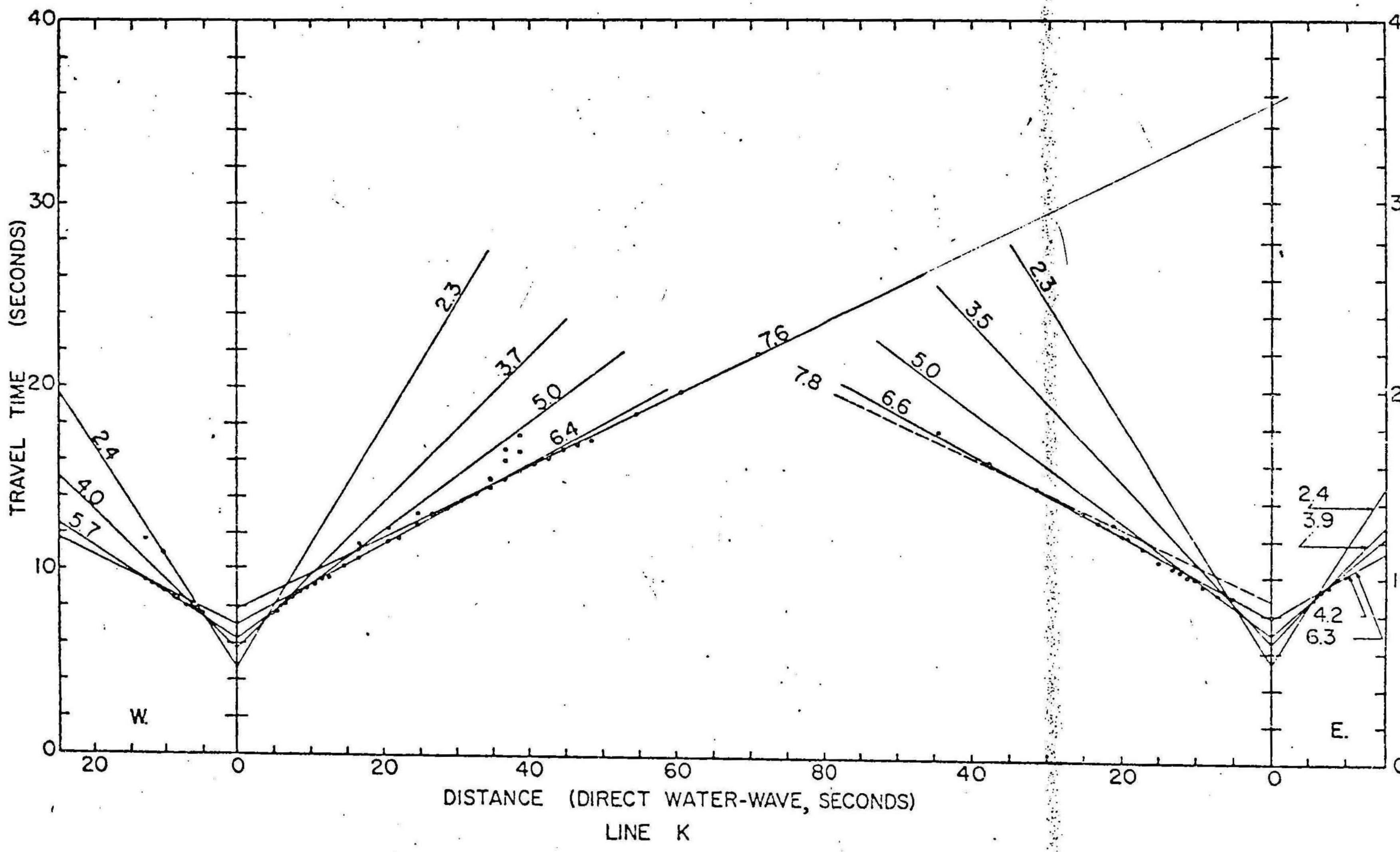
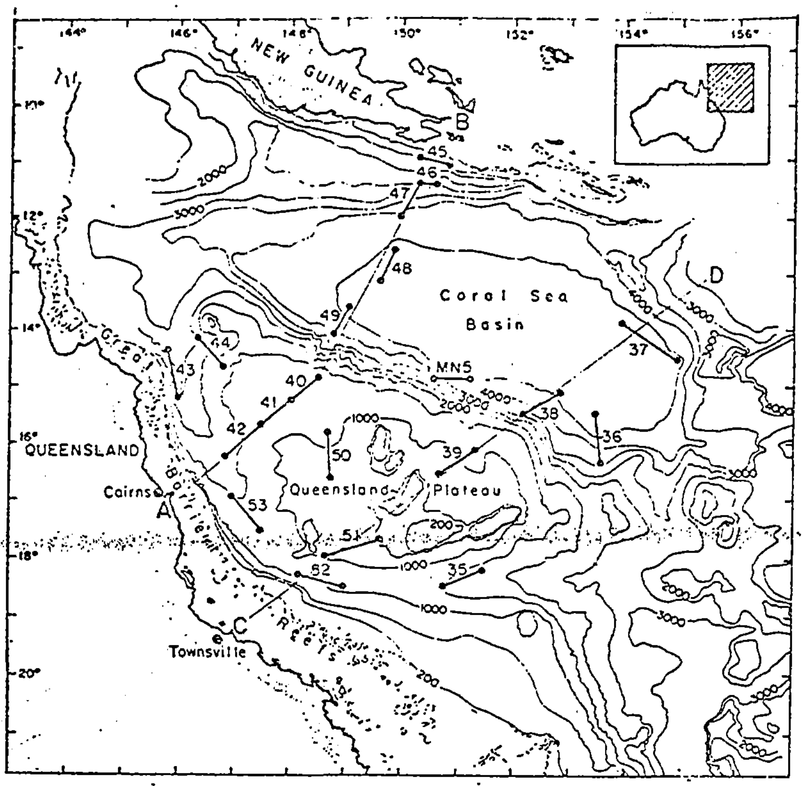


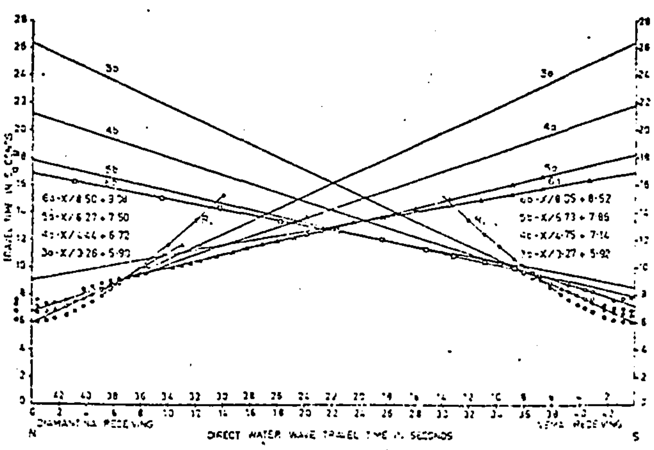
Fig. 15 : Solomon Sea refraction survey; example of time-distance plot (Furumoto et al, 1970)

Fig. 16 : Refraction lines, Coral Sea marine seismic survey (M. Ewing et al, 1970)



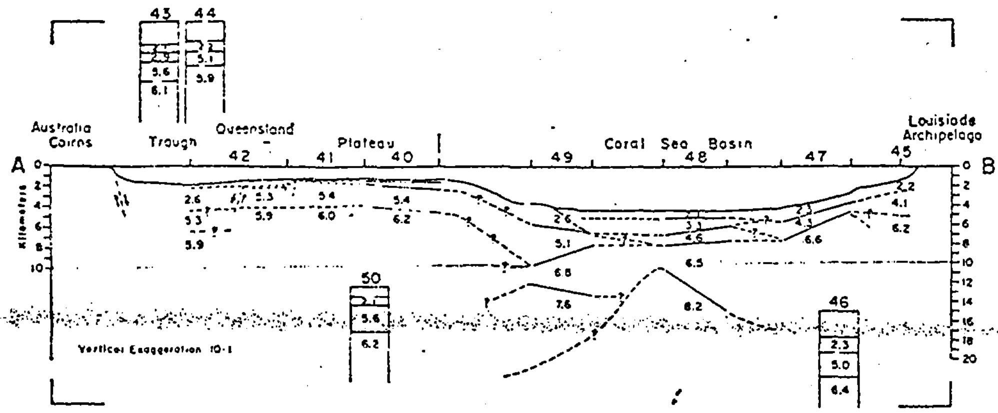
Location map of seismic-refraction profiles and sections. Bathymetry in meters from *J. R. Conolly, D. A. Falvey, and L. V. Hawkins* (unpublished data, 1970). Profile MN5 was recorded by *Shor* [1967].

Fig. 17 : Typical time distance plot Coral Sea marine seismic survey (M. Ewing et al, 1970)

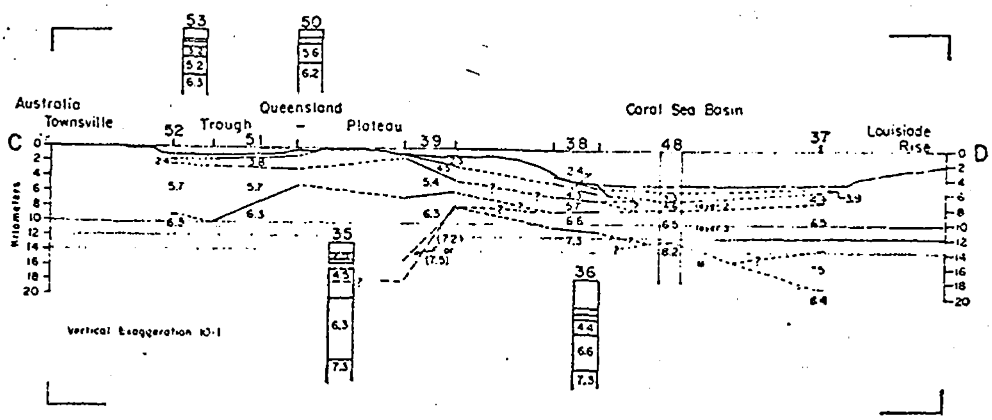


Time-distance graph of profile 48. The interpretation of this profile recorded in the Coral Sea basin is fairly straightforward. The 3.3- and 4.6-km/sec layers are governed mainly by velocity lines drawn through the first recorded arrivals and tangent to the sub-bottom reflection curves. The velocity in the topmost layer of sediments is assumed to be 2.1 km/sec [cf. R43 and R55, *J. Ewing et al.*, 1970] The 4.6- and 6.5-km/sec velocity lines do not give identical reverse points.

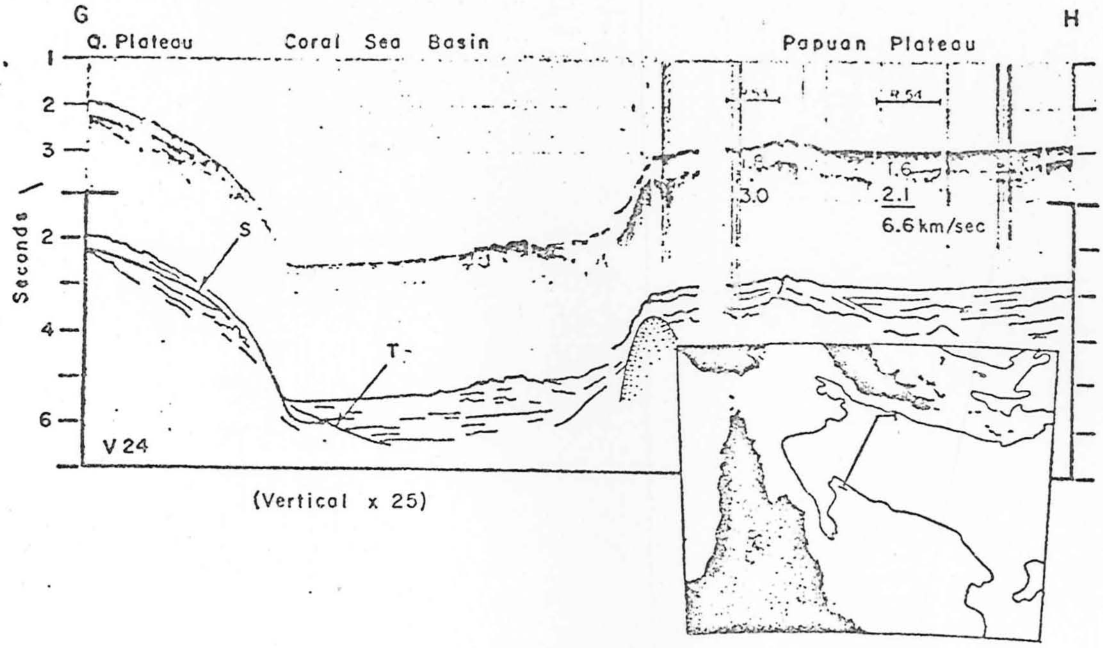
Fig. 18 : Structural interpretation along sections A-B and C-D, Coral Sea marine seismic survey (M. Ewing et al, 1970)



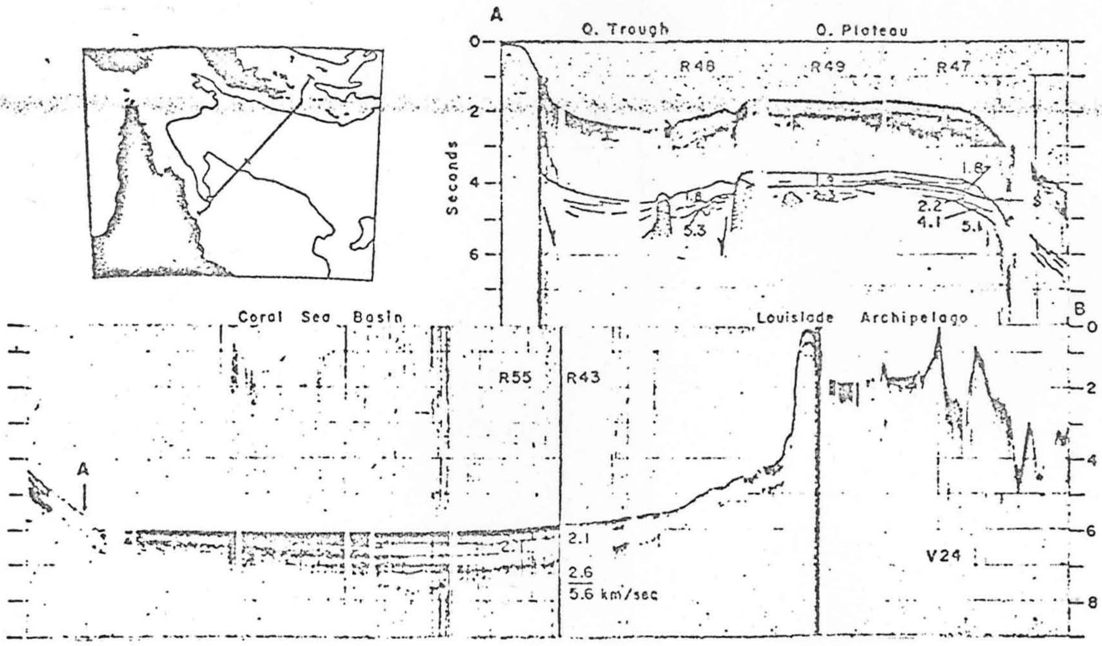
Seismic section A-B. The amount of displacement of the layers along the supposed fault(s) at profile 42 is not known (see Figure 5).



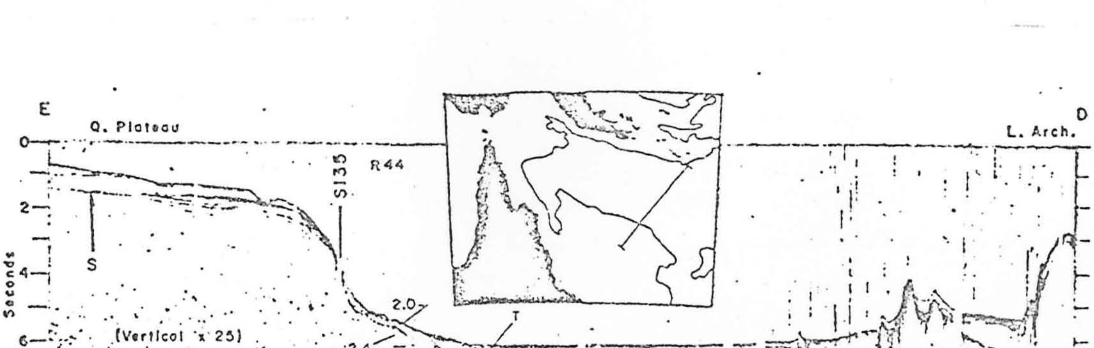
Seismic section C-D.



Seismic-reflection section G-H.



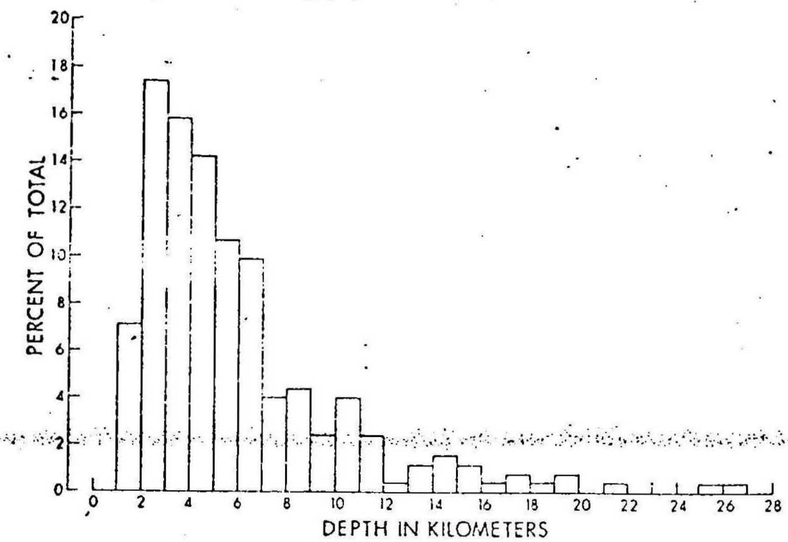
Seismic-reflection section A-B. Note the piercement-type structure and doming of sediments near the middle of the abyssal plain. The right end of the upper (SW) section is the same location as the left end of the lower (NE) section.



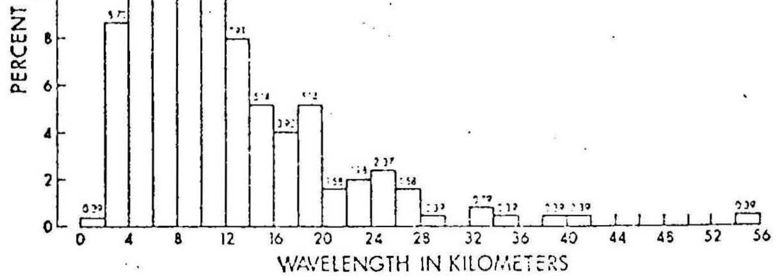
Seismic-reflection section E-D.

Fig. 19 : Seismic reflection sections across Coral Sea (J. Ewing et al, 1970)

Fig. 20 : Solomon Sea magnetic anomaly interpretation (Rose et al, 1968)



Histogram showing the distribution of depth of source of the magnetic anomalies below the ocean floor.



Histogram showing distribution of wavelengths (peak-to-peak of bipoles) of the magnetic anomalies.

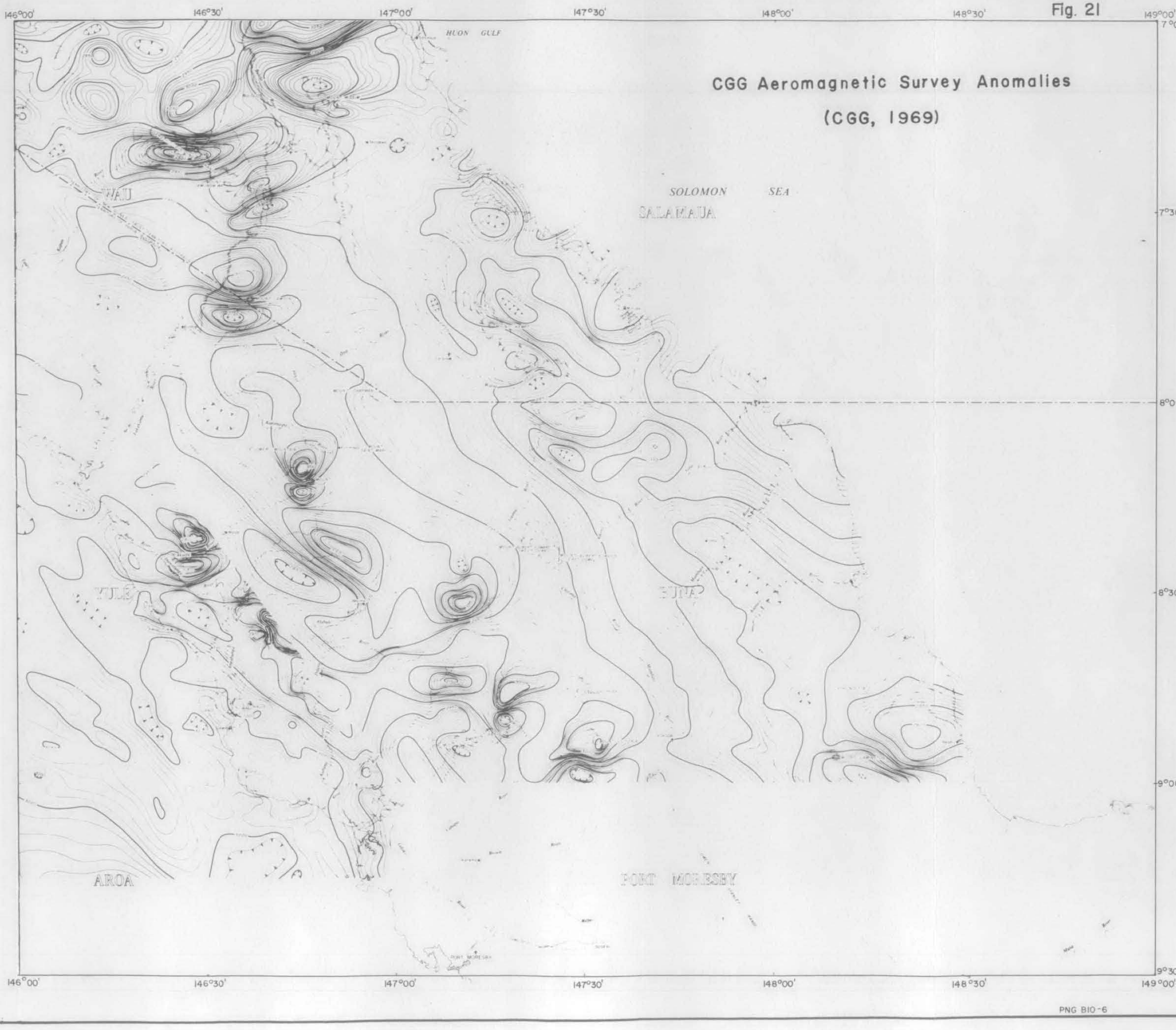


Fig. 21

CGG Aeromagnetic Survey Anomalies (CGG, 1969)

PNG BIO-6

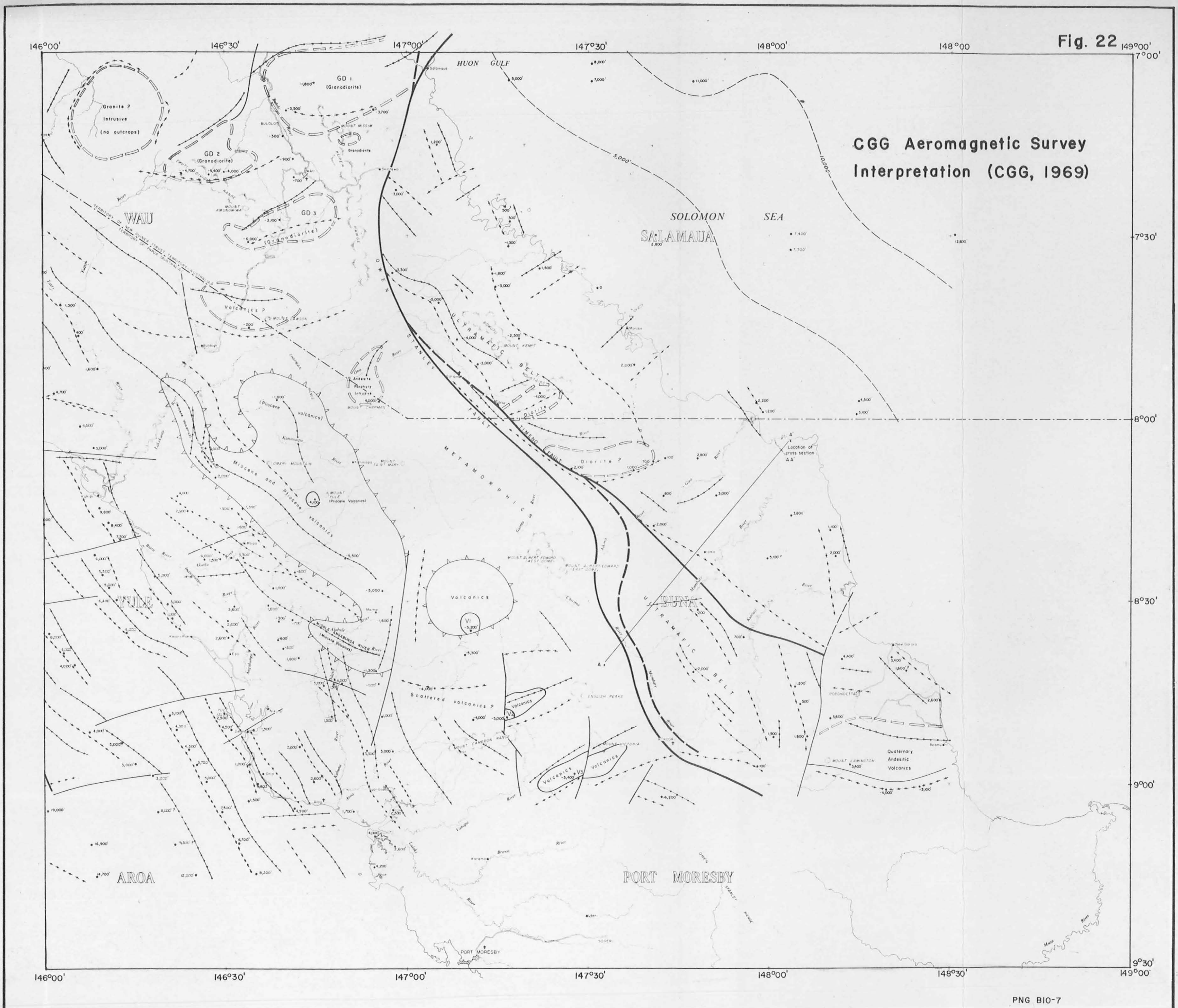
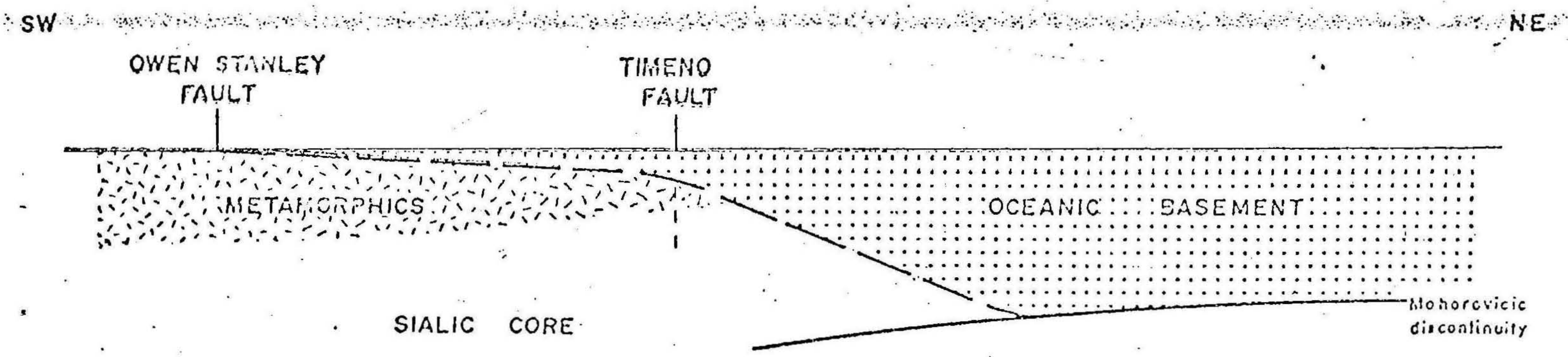


Fig. 22

CGG Aeromagnetic Survey Interpretation (CGG, 1969)

PNG B10-7

Fig. 23 : C.G.G. aeromagnetic survey interpretation across the Ultrabasic Belt (C.G.G., 1969)



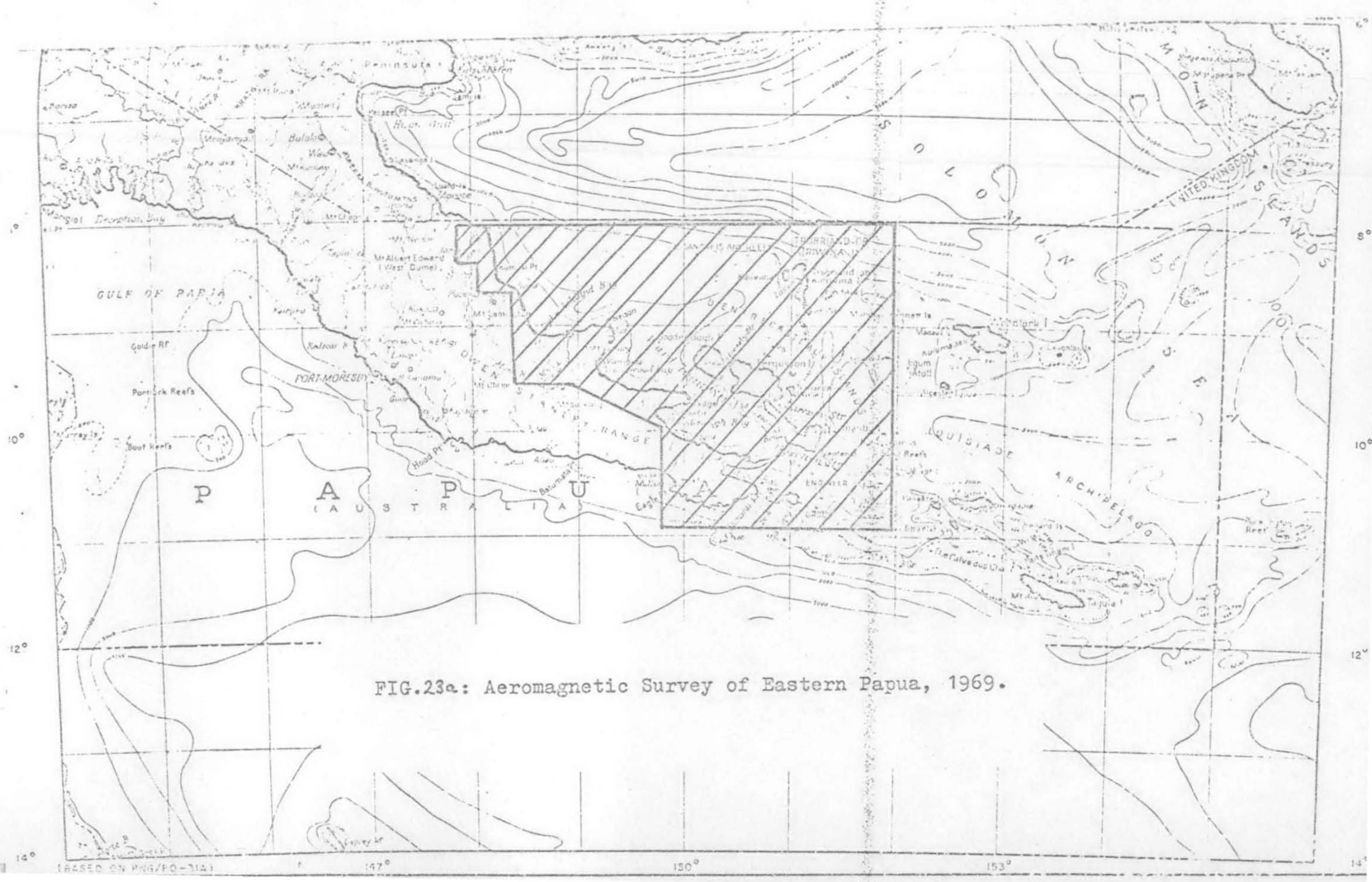
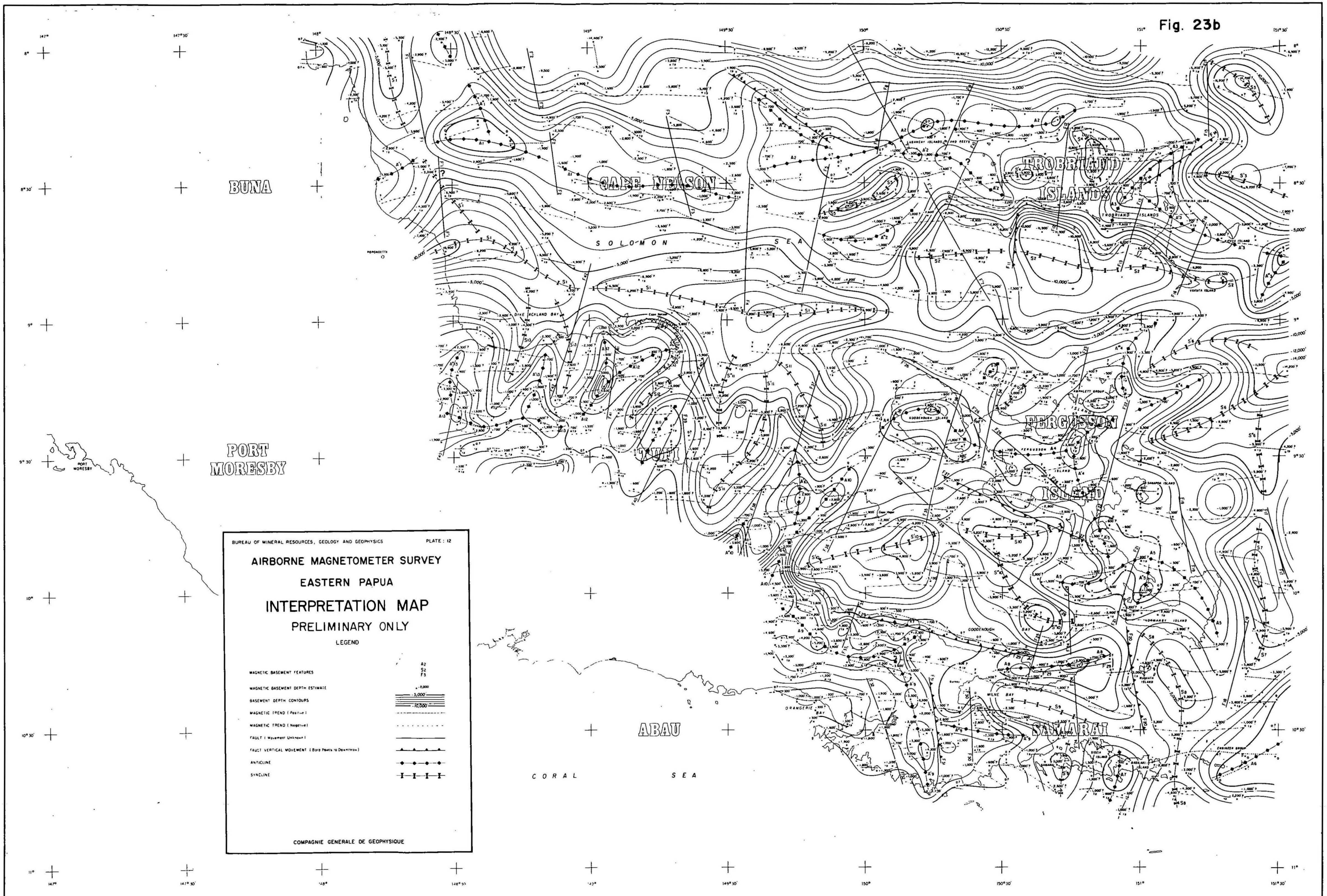


FIG.23a: Aeromagnetic Survey of Eastern Papua, 1969.

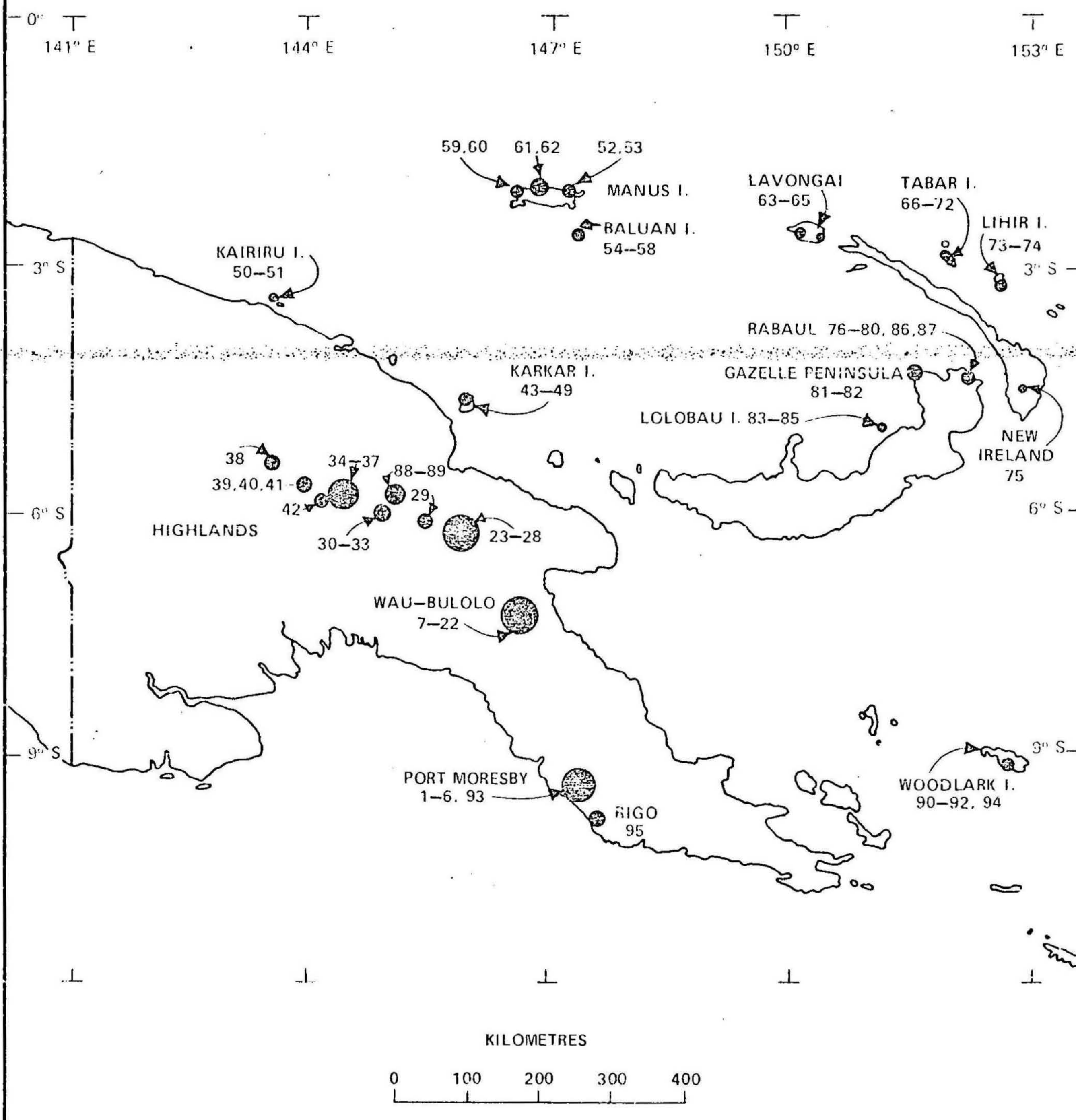
Fig. 23b



(BASED ON C55/BI-46)

C55/BI-46-1

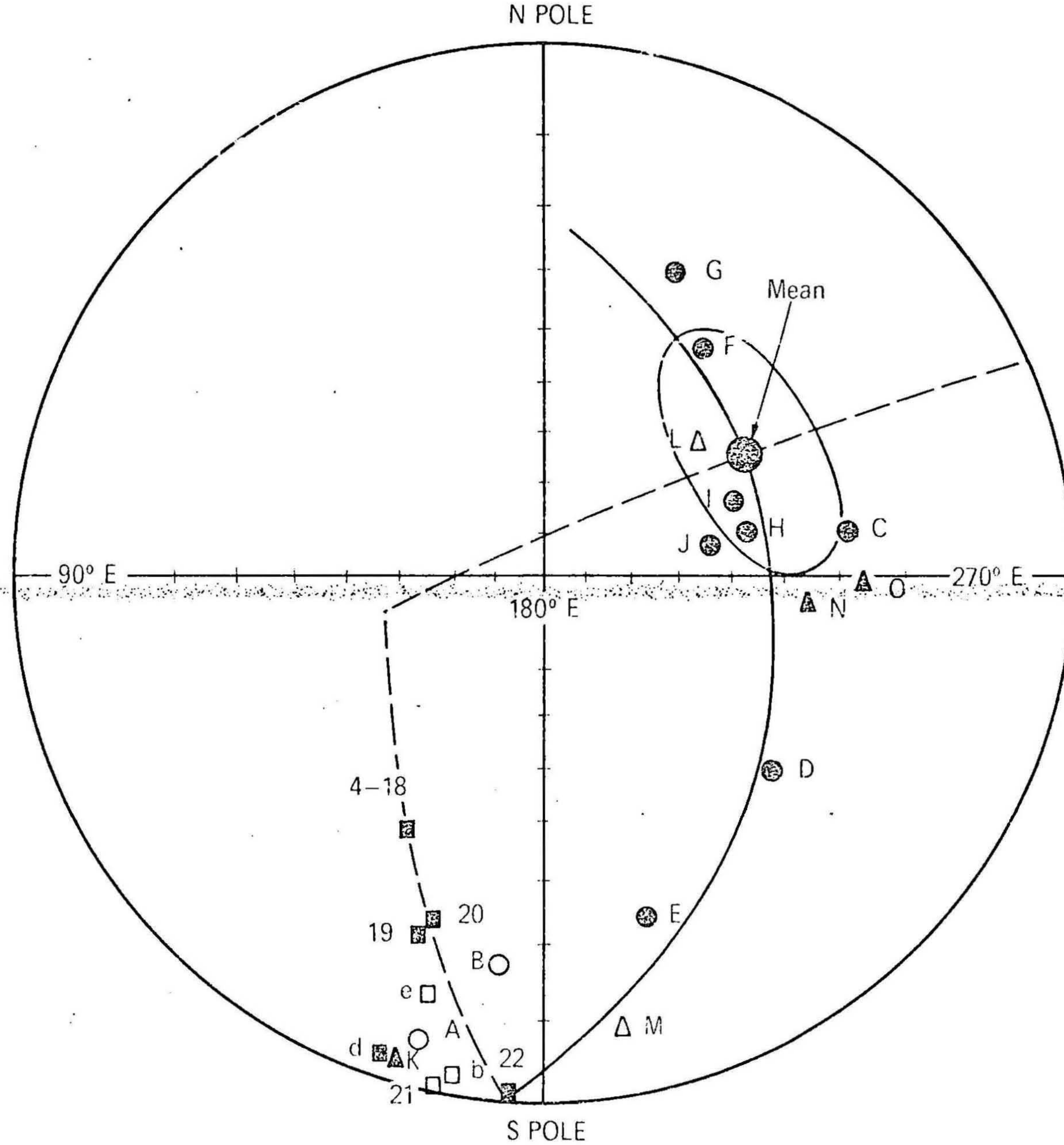
FIGURE 24



PALAEOMAGNETIC SAMPLING SITES, TERRITORY OF PAPUA AND NEW GUINEA

PNG/B9-136A

FIGURE 25



Equal-angle stereographic plot of earth showing palaeomagnetic pole positions as listed in Tables 1 and 2.

Circles : poles from New Guinea mainland (A to J; Table 1)

Triangles : poles from New Guinea islands (K to O; Table 1)

Squares : poles from Australia (4 to 22, b,d,& e; Table 2)

Solid symbols are poles plotted on the top of the stereogram (i.e. on the hemisphere centred around 180° longitude).

Open symbols are poles plotted on the underneath of the stereogram (i.e. on the hemisphere centred around 0° longitude).

PNG/B9–135A

Fig. 25a

BMR Marine Survey 1970 : Ship Traverses.

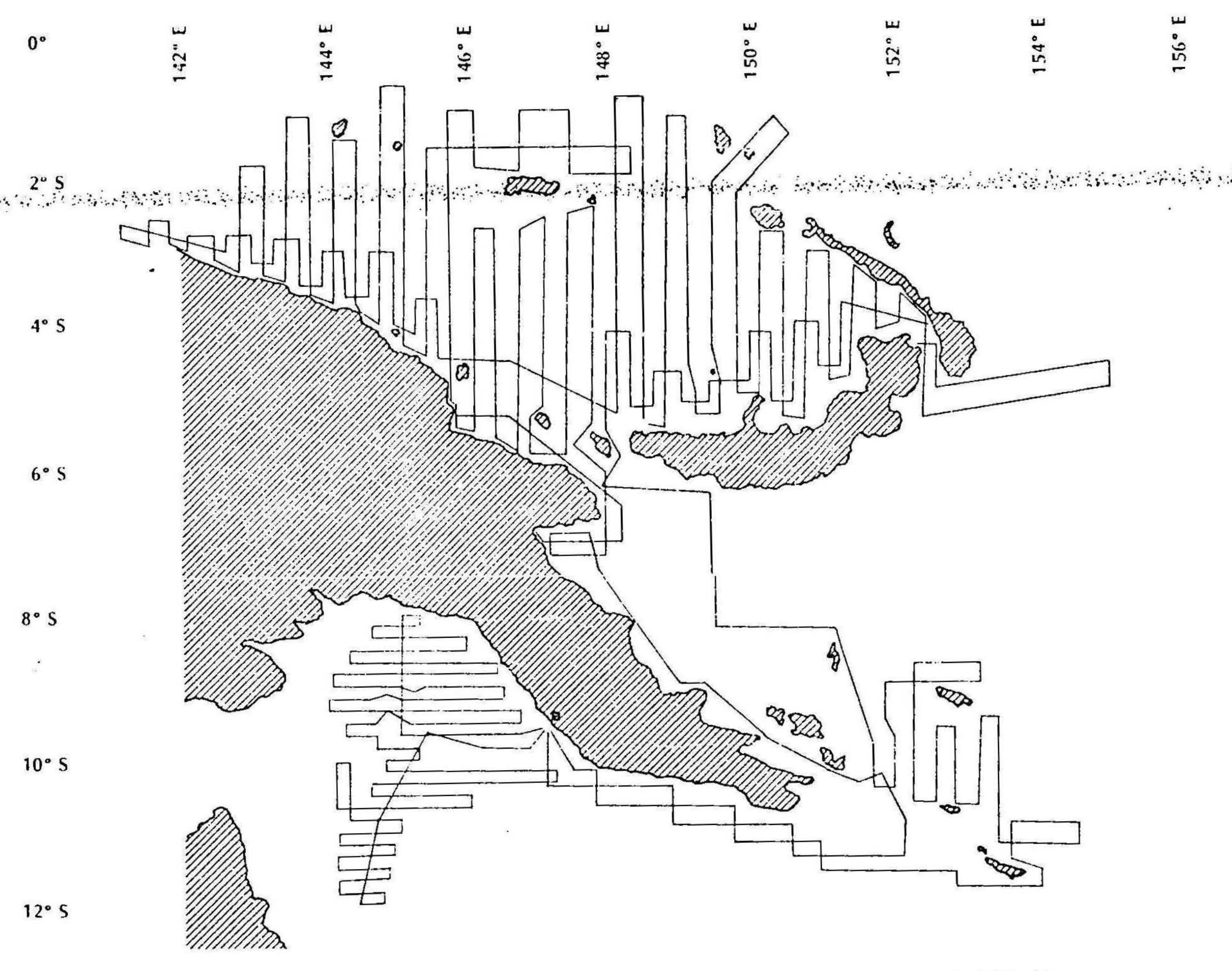
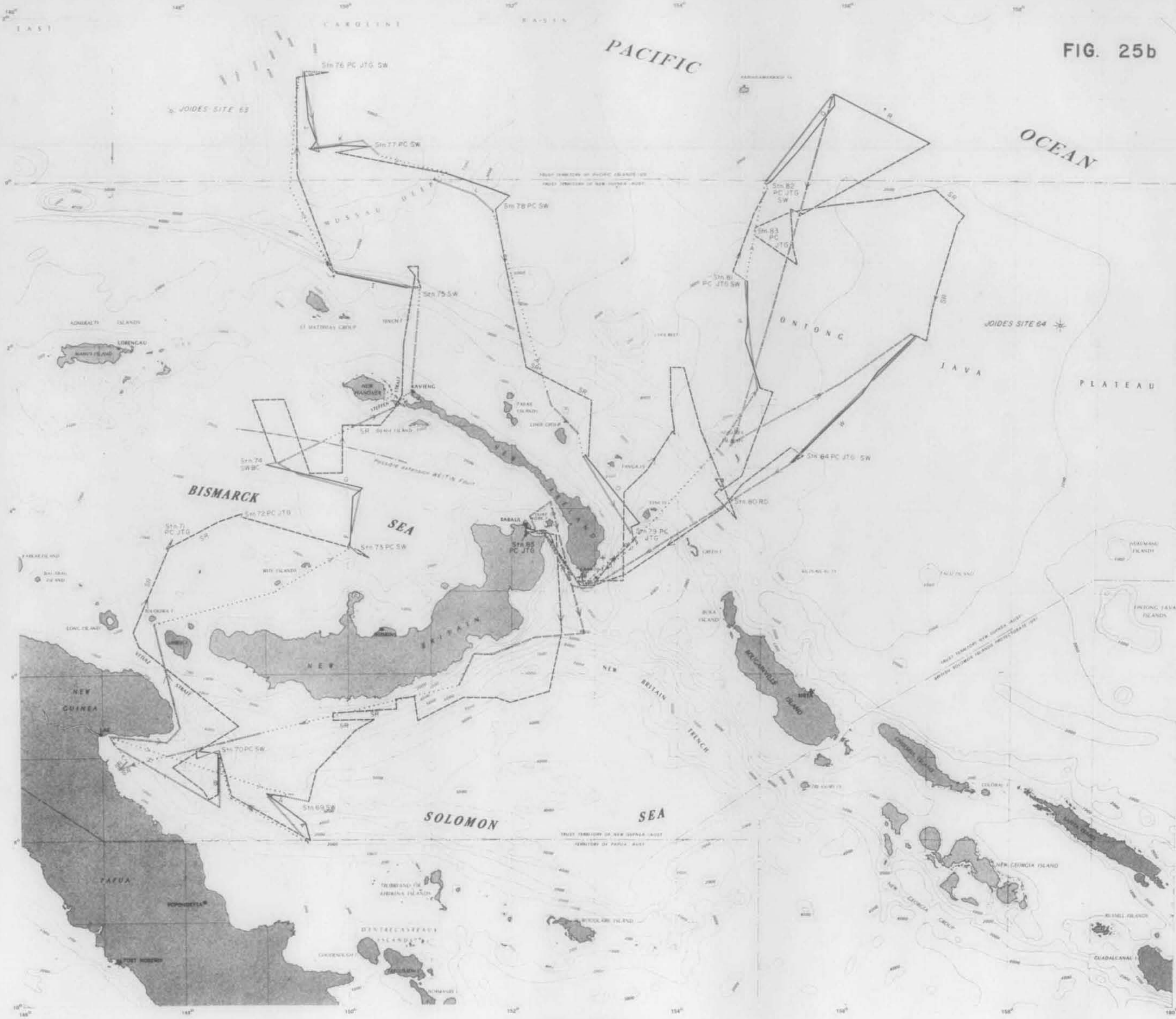


FIG. 25b



LEGEND

R/V MAHI	M/V CORAL QUEEN	
		Refraction line
		Continuous profiling
		Drifting on station
		No profiling

A Refraction Line A

SR Sonobuoy wide-angle reflection /refraction line

PC Piston Core and Trigger Cores
SW Surface Water samples
JTG Jaeger Thermal Gradiometer
BC Bottom Camera
RD Rock Dredge

MELANESIA

HAWAII INSTITUTE OF GEOPHYSICS
OCEANOGRAPHIC INVESTIGATIONS IN MELANESIA
1970

TRACKS OF R/V MAHI & M/V CORAL QUEEN

KILOMETRES 50 0 50 100 150 KILOMETRES

Bathymetric contours in metres

Drawn by Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics, Canberra.

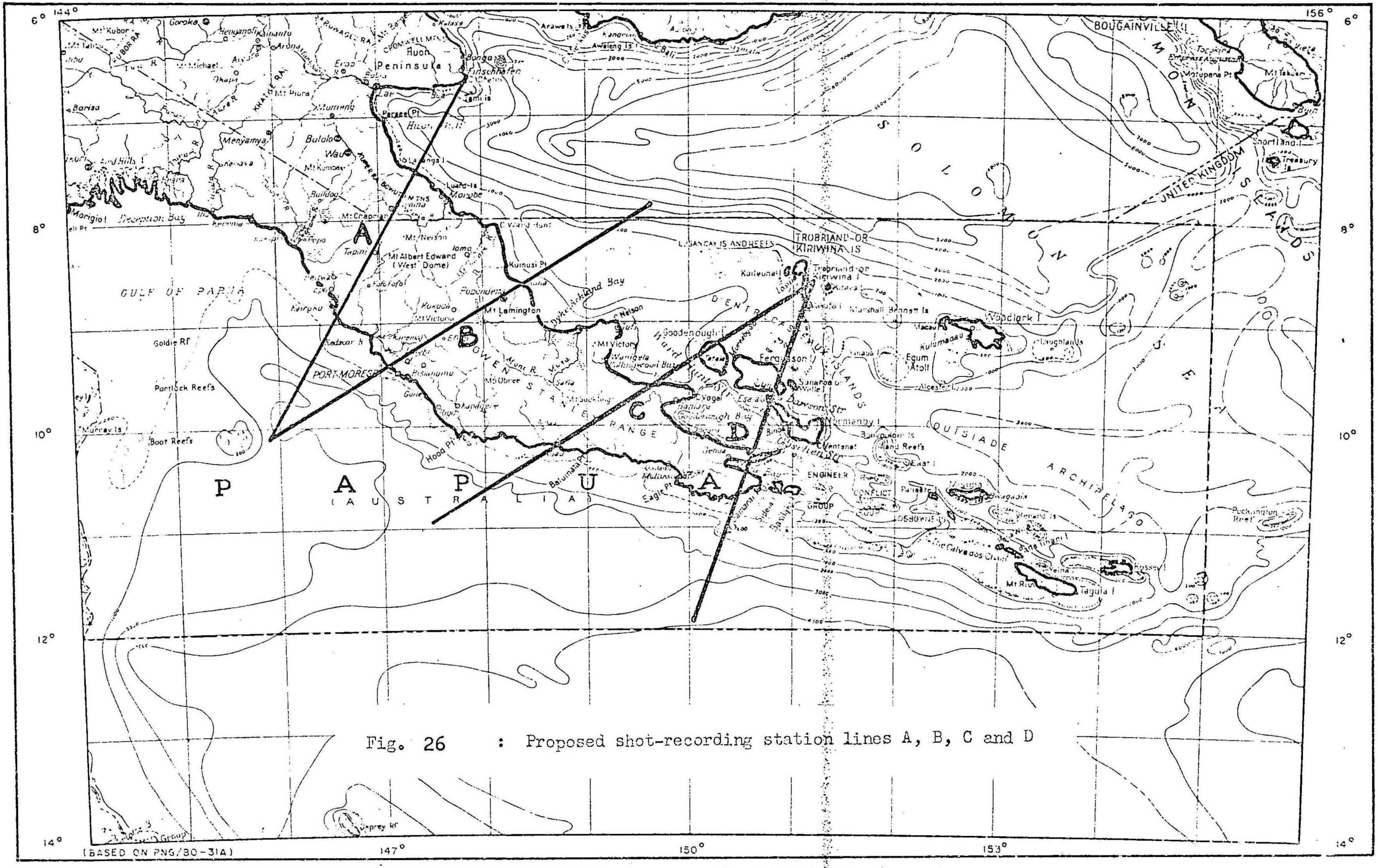
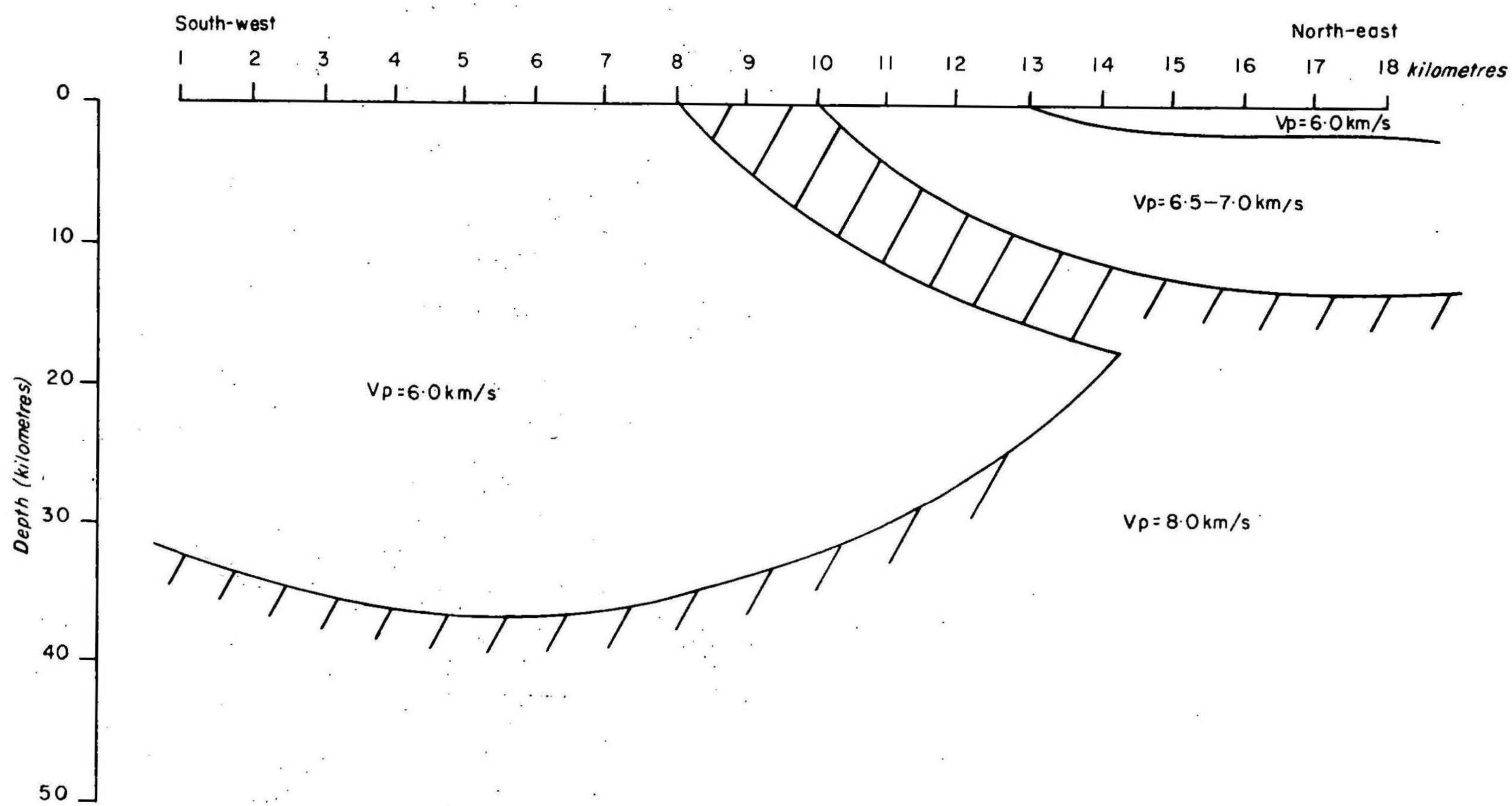


Fig. 26 : Proposed shot-recording station lines A, B, C and D



SCHEMATIC CRUSTAL CROSS-SECTION, EAST PAPUA.

Fig. 26a

PNG/B10-8A

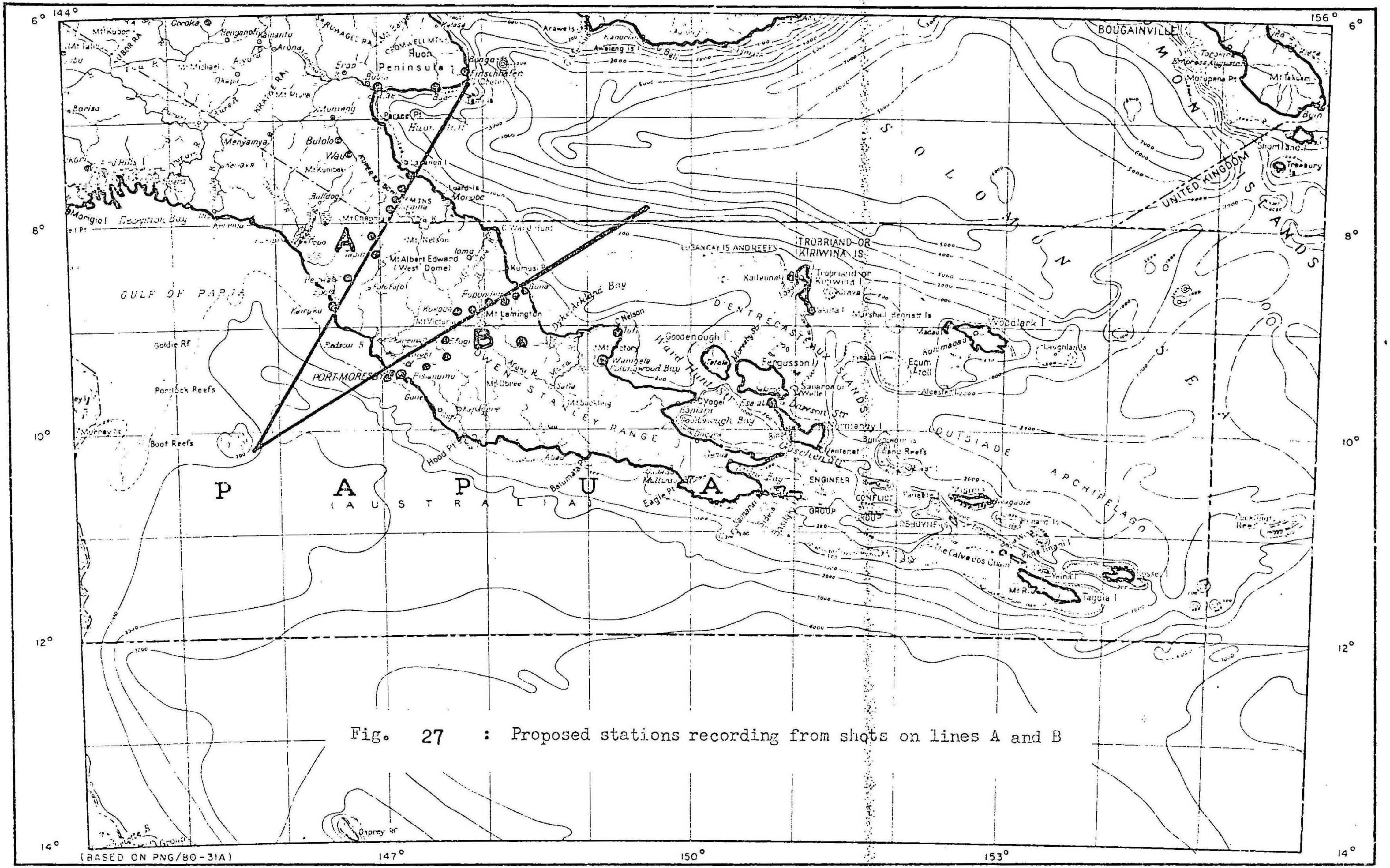


Fig. 27 : Proposed stations recording from shots on lines A and B

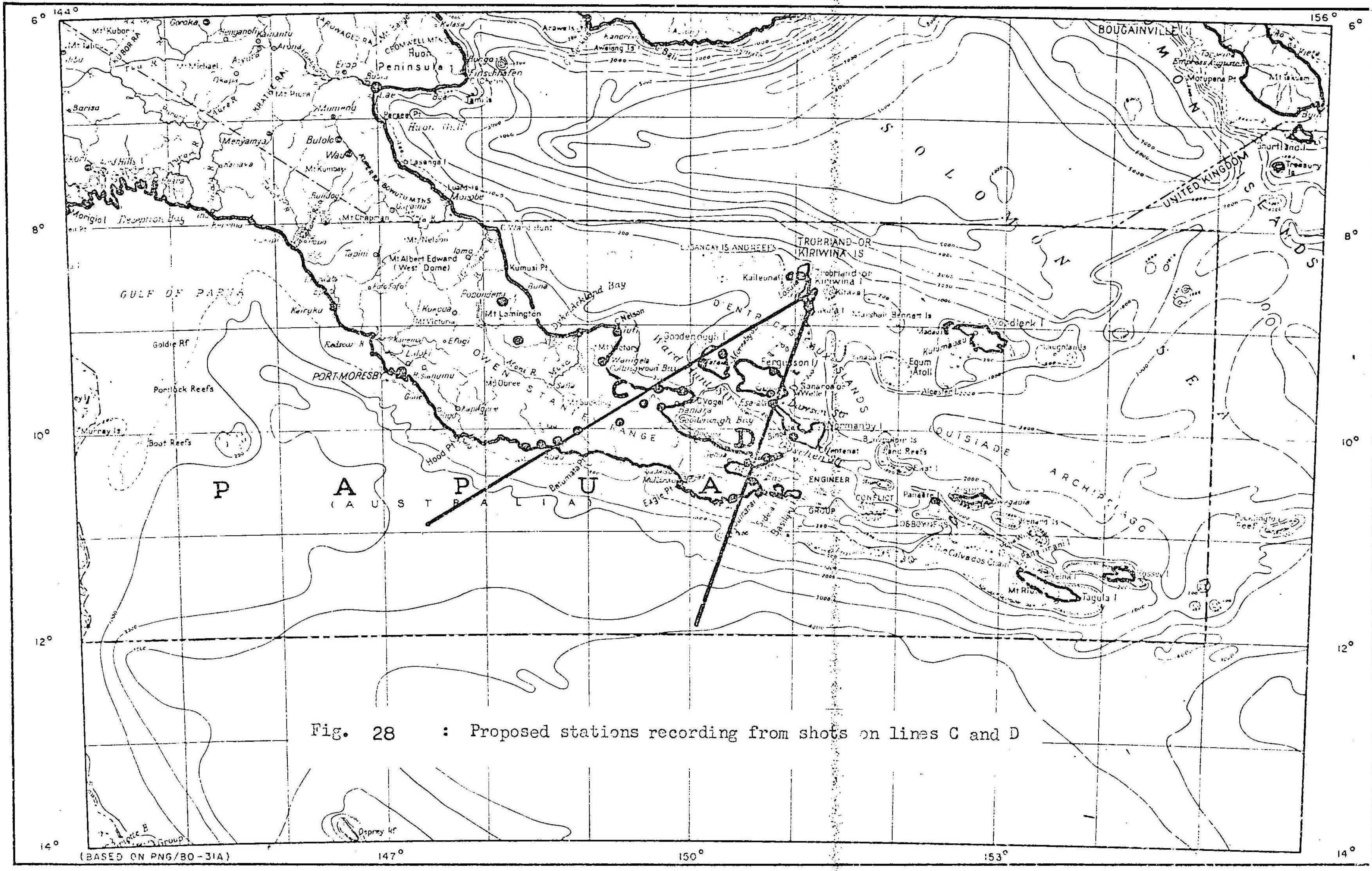


Fig. 28 : Proposed stations recording from shots on lines C and D

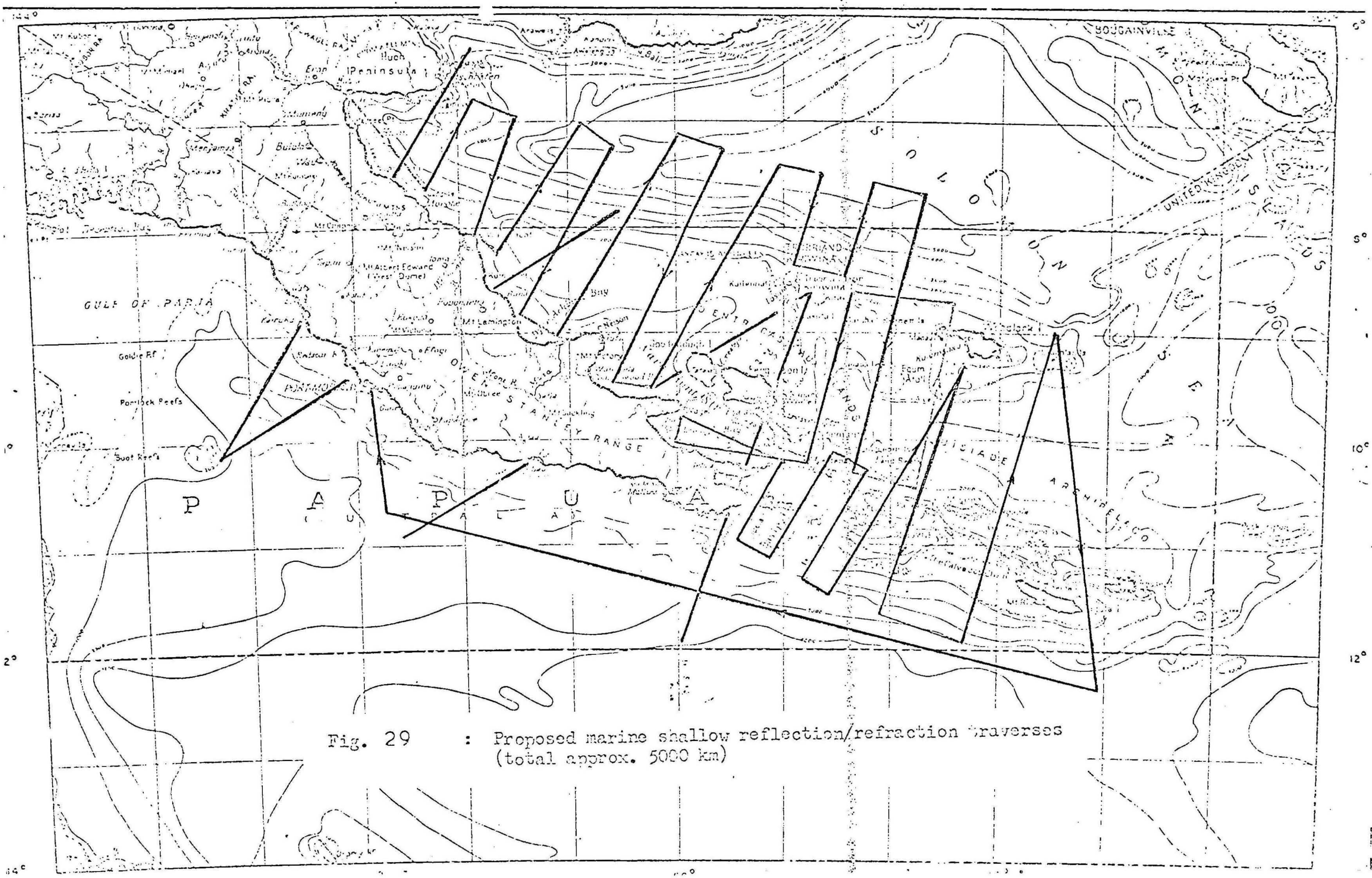


Fig. 29 : Proposed marine shallow reflection/refraction traverses (total approx. 5000 km)