DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

BULLETIN 157

Marine Geology of the Arafura Sea

D. JONGSMA

AUSTRALIAN GOVERNMENT PUBLISHING SERVICE
CANBERRA, 1974

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DEPARTMENT OF MINERALS AND ENERGY

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Published for The Bureau of Mineral Resources, Geology and Geophysics by The Australian Government Publishing Service

ISBN 0 642 00720 9

MANUSCRIPT RECEIVED: FEBRUARY 1972.

REVISED MANUSCRIPT RECEIVED: APRIL 1972.

ISSUED: SEPTEMBER 1974.

PRINTED BY MERCURY-WALCH PTY LTD, 5-7 BOWEN ROAD, MOONAH, TASMANIA

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SUMMARY

The Arafura Sea covers about 650 000 km^2 between West Irian and the Australian continent. The continental shelf in this region adjoins the stable Australian craton to the south and is bordered on the northwest by the Tertiary orogenic belt of the Banda Arc, with its deep troughs and volcanic arcs. To the north is a Tertiary geosyncline and to the northeast a thickly covered alluvial plain. To the east lies the graben structure of the Gulf of Carpentaria. The marine geology of the Australian part of the Arafura Shelf south of 8°S latitude was investigated by the Bureau of Mineral Resources (BMR) in 1969 by 4420 km of shallow seismic reflection profiles, echo-sounding, 400 dredge samples, 16 gravity cores, and three submarine dives.

The continental shelf is broad and has generally low relief except in the far southwest, where there are some small banks, and in the northeast, where extensive dissection has been caused by subaerial erosion. The shelf edge follows the arcuate trend of the Banda Arcs in the western part of the region and swings abruptly north-south at the head of the Arafura Depression at about the 133°E meridian.

Seismic profiling has revealed a series of unconformities in the top few hundred metres of section. There is a regional unconformity at the base of the Mesozoic, which overlies the Precambrian. Palaeozoic sediments have not been delineated but may be present in a graben in the Money Shoal area and north of Melville Island. A basal Tertiary horizon has been traced in the profiles. Another well displayed unconformity has been correlated with a regional Mio-Pliocene surface encountered in Ashmore Reef No. 1 well, and several others, corresponding to later Cainozoic orogenies, have been observed. All these surfaces dip to the northwest in the Arafura Sea and shallow eastwards towards a structural high north of the Wessel Islands in pre-Mesozoic rocks. Except for the basal Mesozoic unconformity, the surfaces have very low relief and are locally conformable in the southern and western parts of the area. The locus of sedimentation during the post-Mesozoic was north of Melville Island and the maximum thickness of Pliocene to Recent sediments seen in the profiles is 300 m about 328 km north of Melville Island.

Near the Aru Islands the post-Mesozoic section is thin or absent as a result of uplift and erosion associated with the active orogenic belts to the north. A structural ridge trends west-northwest and forms a sill separating the Timor and Aru Troughs.

Recent terrigenous sediments are mainly restricted to the inner part of the shelf. Sedimentation rates since the last Pleistocene low sea-level stand are about 2 m/1000 years 20 km north of Melville Island and about 10 cm/1000 years 100 km north of Melville Island. The surface sediments in the Arafura Sea are transgressive on the inner part of the shelf, with coarse shelly quartz sand grading seawards into silty clay. The outer part of the shelf is dominated by Pleistocene relict sediments which are extensively glauconitized, and deposition is negligible. Close to outcrops of the Mio-Pliocene unconformity phosphatic nodules and sharks' teeth were formed and deposited respectively on this surface of non-deposition or were derived from exposed Miocene sediments. Phosphate values of the bulked sediments are extremely low. Some of the surface sediments, especially in the northeast, are derived from eroded calcareous quartz-rich Tertiary sediments.

Brown concretionary carbonate pellets in the surface sediments along a belt following the 70-m bathymetric contour are probably of subaerial origin and point to a previous strandline at about -80 m.

Further evidence of eustatic sea-level changes in the Arafura Sea is widespread and features interpreted as submerged strandlines were identified at eight separate depths between -200 m and -120 m. Beach rock and shallow-water corals collected by submarine at 200 m water depths were dated as older than 170 000 years B.P. and indicate an extremely low eustatic sea level stillstand during a glacial period preceding the Wisconsin. Other dates suggest that at 14 000 years B.P., at an early stage during the Holocene transgression, sea level stood at about -100 m.

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INTRODUCTION

This Bulletin presents the results of a marine geological survey carried out by BMR in the Arafura Sea in 1969 as part of a program of regional geological reconnaissance mapping of the Australian continental shelf. It is a continuation of work in the Timor Sea and northwest shelf (van Andel & Veevers, 1967; Jones, 1968, 1970). The area surveyed is the northern Australian continental shelf between longitudes 130° and 136°E and between latitudes 8° and 12°S (Fig. 1), an area of about 240 000 km². From 2 to 25 May the Japanese research submersible *Yomiuri* and its mothership, the converted deepsea tug *Yamato,* were made available. The major part of the survey lasted from 21 September to 6 December 1969, using the chartered oil-rig supply vessel *San Pedro Sound* as a platform.

The sediments were sampled with gravity corers and with dredges designed to minimize washing of the sediment during recovery; 415 stations were occupied and 16 gravity cores and 399 surface sediment samples were recovered. Station localities shown in Figure 2 are listed with other data in the Appendix. Traverses were run at a spacing of 18 to 28 km in a north-south direction, and the interval between sample stations along the traverse lines was about 18 km.

Figure 1. Location map of the Arafura Sea.

Continuous seismic reflection profiles totalling 4420 line-kilometres were obtained with a 1000-joule 3-electrode Sparkarray source and a single-channel hydrophone streamer, and recorded with an Ocean Sonics GDR-T recorder. Reference is made to geophysical surveys carried out by oil companies under the Petroleum Search Subsidy Acts and to the survey by United Geophysical Corporation under contract to BMR in 1967.

The opportunity to observe directly certain sea-bed features, and to carry out controlled sampling, was provided by the Japanese submersible *Yomiuri,* in which three dives were made.

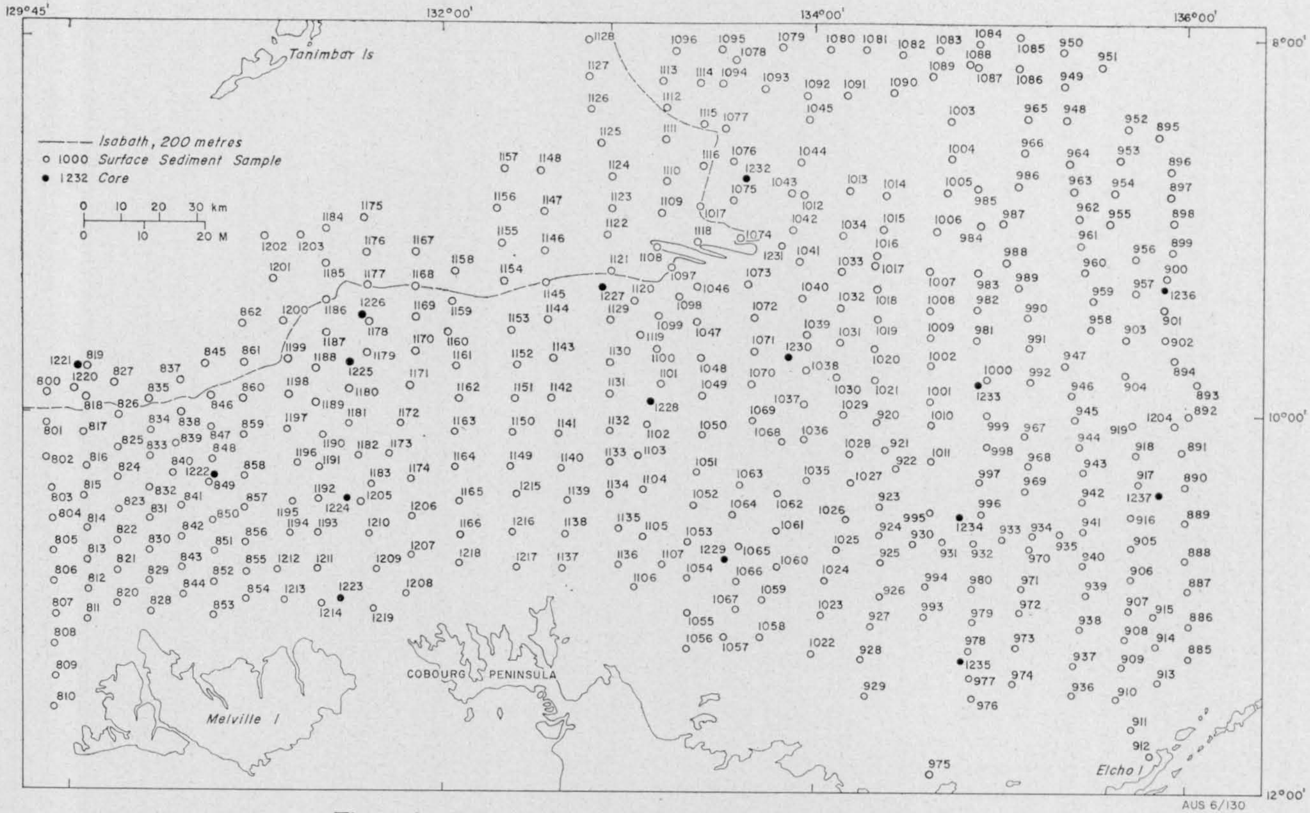

Figure 2. Location of sampling stations in the Arafura Sea.

Navigation and positioning

Conventional methods of celestial navigation and dead-reckoning were used to determine the locations of the stations at sea, and near-shore stations were positioned by radar. Whenever possible, accurate star fixes were obtained at dawn and dusk, and position lines from the sun at frequent intervals during the day. The five categories of position accuracy adopted and tabulated with other station data in the Appendix are as follows:

A. Accuracy within 2 km: fix by visual or radar cross-bearings on landmarks, or top-class celestial fix (at least 4 good observations);

B. Accuracy within 5 km: short dead-reckoning run from A class fix, or good celestial fix (3 good observations);

C. Accuracy within 9 km: short dead-reckoning run from B class fix, standard celestial fix (often only 2 sights), or moderate to long dead-reckoning run from last fix supported by position lines only;

D. Accuracy within 18 km: up to 12 hours since last fix and drift not shown with certainty;

E. Position unknown, error may be more than 18 km.

Most sample-station positions fall within category C, and the sparker profiles run at night normally had B or C fixes at each end.

Limits of Arafura Sea and Arafura Shelf

According to Tjia (1966), the Arafura Sea is bordered by the Outer Banda Arc and West Irian on the north; Torres Strait on the east; the Gulf of Carpentaria and the Australian mainland on the south; and the 130°E meridian on the west. The International Hydrographic Bureau (1953) included the Gulf of Carpentaria in the Arafura Sea, but for the purposes of this Bulletin the Gulf of Carpentaria is regarded as a separate entity. Using this definition the Arafura Sea has an area of 650 000 km^2.

Contrasting opinions are held about the oceanic affinity of the Arafura Sea. The Murchison Committee of the Royal Geographical Society (London) of 1845 (Murchison, 1893) regarded it as part of the Pacific Ocean. The International Hydrographic Bureau (1953) and workers such as Kossina (1921) hold the same view. Many geologists (Fairbridge, 1966; Nicol, 1970) follow Schott's (1935) recommendation to include the Arafura Sea in the Indian Ocean, since oceanographically there is no definite eastern boundary of Indian Ocean water in the Timor and Arafura Seas. The latter recommendation has been followed in this Bulletin and the Arafura Sea is regarded as part of the Indian Ocean.

The Arafura Shelf (named by Krummel, 1897) covers the shallow part of the Arafura Sea between West Irian and Australia, an area of about 600 000 km^2. Early writers used the term Sahul Shelf (named by Earl, 1845) to describe the whole of the continental shelf of north and northwest Australia from North West Cape to Torres Strait, including the Gulf of Carpentaria (Molengraaf & Weber, 1919; Kuenen, 1935; van Bemmelen, 1949). However, in modern usage the Sahul Shelf is restricted to the Australian shelf in the Timor Sea west of about 130°E (Fairbridge, 1953).

Previous investigations

Marine sediments from the Arafura Shelf were collected during the Challenger expedition (1872-1876) between Torres Strait and Aru Island. On the later

Snellius expedition (1929-1930) several marine sediment samples were recovered from near the edge of the Arafura Shelf and the Aru Trough (Kuenen & Neeb, 1943). Van Bemmelen (1949) briefly discussed the relationship of the Arafura Shelf to the surrounding land areas. A more comprehensive account of the morphology, geological relations, and significance of the bottom samples from the Challenger and Snellius expeditions was given by Fairbridge (1951, 1953). In a report on the petroleum prospects of West Irian, Visser & Hermes (1962) discussed aspects of the stratigraphy of the Arafura Shelf, and its regional setting has been described by Boutakoff (1963) and Phipps (1967).

In recent years, the region has been investigated in more detail by oil companies and by BMR. This work includes systematic sediment sampling of the continental shelf southwest of the Arafura Sea (van Andel & Veevers, 1967; Jones, 1968, 1970). Geophysical exploration and drilling of oil wells have provided further knowledge of the stratigraphy and structure of the Australian continental margin in the northwest (Jones 1969; Veevers, 1971; Caye, 1968) and in the Arafura Sea (Nicol, 1970). Unpublished results of subsidized marine geophysical work by petroleum companies on the Arafura Shelf are referred to in later sections. Observations on the earlier part of this survey in the *Yamato* have been recorded by Trail & Jones (1969) and Jongsma (1970).

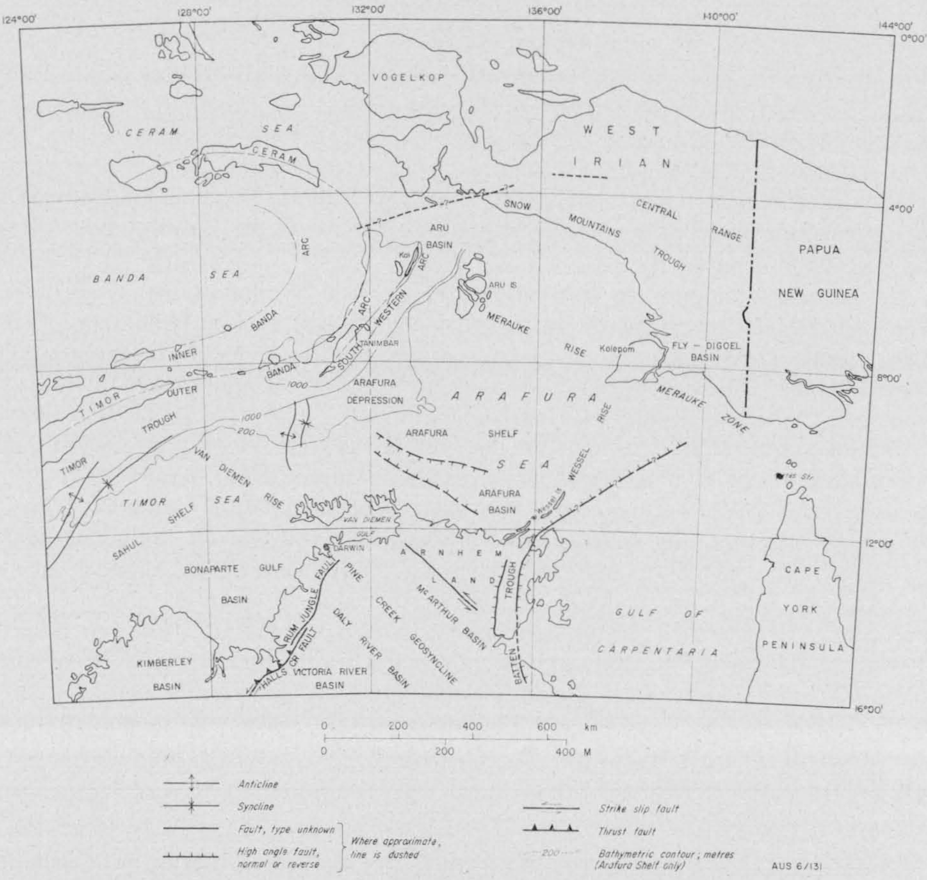

Figure 3. Regional tectonic setting of the Arafura Sea.

Some aspects of the physical and chemical oceanography of the Arafura Sea were investigated by van Riel et al. (1950), Rochford (1962, 1967), and Wyrtki (1962). A summary of the geology and oceanography of the Arafura Sea was given by Tjia (1966).

Regional tectonic framework

The Arafura Shelf, which is an extension of the stable northern Australian shield area, reflects some of the movements which have occurred in the tectonically active Tertiary orogenic belts of the Banda Arcs, Timor, and New Guinea, bordering the Arafura Sea on the north and northwest (Fig. 3). In terms of the theory of plate tectonics the Arafura Shelf can be thought of as a submerged part of the Australian continental crust which is bounded by an extinct accreting plate margin. The volcanic Banda Arc and the Aru Basin are expressions of an existing consuming plate margin bordering the area to the northwest, across which a slip vector of 4.9 cm per year has been calculated.

The Arafura Shelf contains several tectonic rises and depressions. Its western margin north of Cape Van Diemen is situated on the flanks of the Van Diemen Rise, and its southeastern margin coincides with the Wessel Rise. From the Aru Islands the Merauke Rise crosses the Arafura Shelf to Frederik Hendrik Island and beyond, forming the western part of the Merauke Zone of van Bemmelen

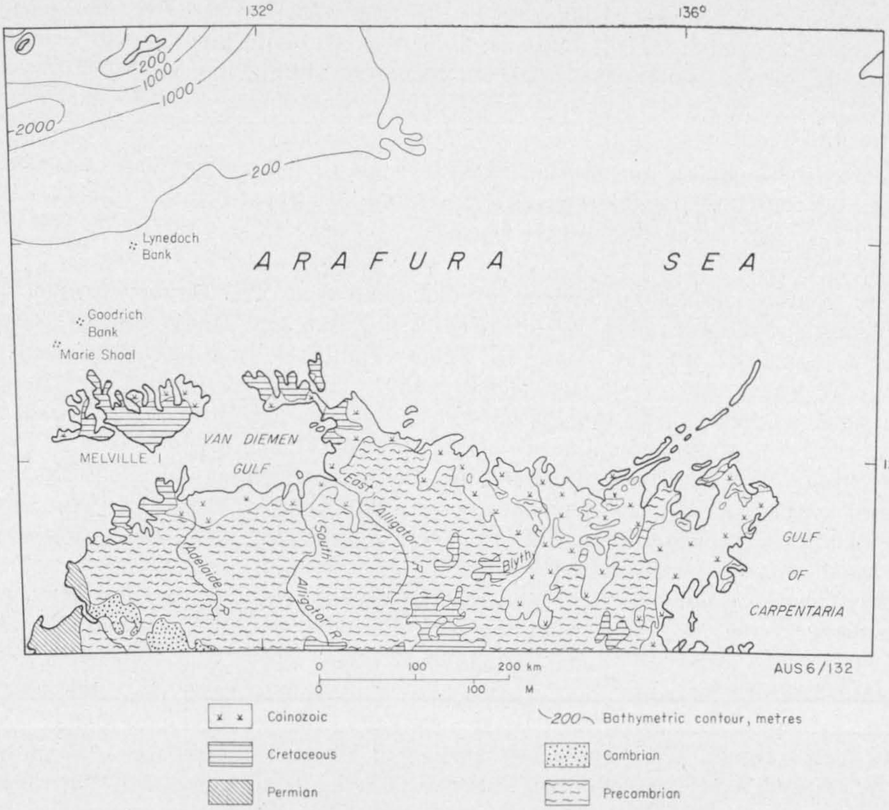

Figure 4. Generalized geology of the northern part of the Northern Territory and adjacent islands.

(1949, p. 721), who suggested that the zone represents the margin of the Australian continent. The rises are extensions of mobile zones on land (Fairbridge, 1953; van Andel & Veevers, 1967; Phipps, 1967), and the intervening depressions correspond to onshore basins.

Rises and depressions opposite corresponding tectonic features onshore are evident on other parts of the Australian continental shelf (Phipps, 1967), and in the Arafura Shelf the following correspondences are recognized (Fig. 3):

On the Shelf	*Onshore*
Van Diemen Rise	Pine Creek Geosyncline
Arafura Depression	Arafura Basin
Wessel Rise	Batten Trough
Merauke Rise	Merauke Zone
Snow Mountains Trough	Fly-Digoel Basin

Summary of onshore geology

The northern part of the Northern Territory forms part of the Australian Precambrian shield and contains rocks of Archaean to Cainozoic age (Fig. 4). Palaeozoic rocks have not been found in the region west of the Bonaparte Gulf and Daly River Basins and it has been a stable area since the middle of the Proterozoic (Walpole et al., 1968). Upper Proterozoic sediments were deposited in broad, mainly shallow basins early in this long period of stability, and vertical movements accompanied by injection of high-level granite plutons also occurred during this period. Later epicratonic sedimentation during the Mesozoic (mainly in the Cretaceous) and Cainozoic resulted in a thin veneer of both marine and continental sediments.

The Aru Islands on the Arafura Shelf form part of the Australian continental block and consist of possible Precambrian granitic basement beneath Mio-Pliocene limestones (van Bemmelen 1949; Fairbridge, 1951, 1953; Visser & Hermes, 1962).

The Arafura and Sahul Shelves are separated from the Tertiary geosyncline of Timor and East Celebes by the deep Aru Basin and Timor Trough. These troughs, together with the islands of Timor, Tanimbar, and Kai, form part of the Outer Banda Arc of van Bemmelen (1949). The islands of the Outer Banda Arc were uplifted during the Pleistocene and the area is still characterized by high negative isostatic anomalies of over 100 mGal (Vening Meinesz et al., 1934). The oldest rocks on Timor consist of pre-Permian allochthonous sediments and volcanics which have undergone low-grade metamorphism. From the Permian to the Pleistocene, calcareous marine sediments interbedded with some tuffs were deposited. Four separate periods of folding have been recognized on Timor by Audley-Charles (1968): Lower Triassic, Middle Jurassic, Eocene, and Miocene. The effects of the two Tertiary fold periods, the lower Eocene Timorean Orogeny and the middle Miocene Ramalauean Orogeny, are strongly in evidence in the Arafura Shelf region.

The geological history of West Irian is similar to that of the Outer Banda Arc. Folded geosynclinal sediments of Palaeozoic to Upper Tertiary age are exposed in the central West Irian ranges (Visser & Hermes, 1962). South of the ranges the plains of southern New Guinea form part of the Australian craton and are structurally continuous with the Arafura Shelf (van Bemmelen, 1949). Lower

Mesozoic rocks resting on Cambrian or Precambrian basement in this area are overlain by almost horizontal Mesozoic and Cainozoic marine sediments (Visser & Hermes, 1962).

Geomorphology of coastal areas

Four old land surfaces, the Ashburton, Tennant Creek, Wave Hill, and Koolpinyah Surfaces, have been recognized in the Northern Territory by Hays (1968), but only the Wave Hill and Koolpinyah Surfaces are extensive in the coastal region south of the Arafura Sea. The Ashburton Surface in the southern part of the Northern Territory is thought to be a relic of a pre-Cretaceous surface reduced by the processes of pedimentation and scarp retreat to a large number of residuals on the later pediplaned Tennant Creek Surface. The Tennant Creek Surface is associated with widespread lateritization; its age is postulated as middle to late Cretaceous in the central part of the Northern Territory, becoming younger northwards, and it is early Tertiary (probable pre-Miocene) on Bathurst and Melville Islands. A second period of pediplanation resulted in the formation of the Wave Hill Surface, about 33 m below the Tennant Creek Surface, which was also modified. Both the Tennant Creek and Wave Hill Surfaces were then warped into gentle ridges and shallow basins. Subsequent multicyclic erosion produced the Koolpinyah Surface, which is at present being formed in the coastal areas.

Identification of these surfaces is made possible by the presence of two lateritic profiles, one of which probably developed during Upper Cretaceous to Middle Tertiary time, and the other, later Quaternary incipient stage developed on the Koolpinyah Surface. Associated with the laterite are the Gove Peninsula and Wessel Islands bauxite deposits.

Three physiographic zones, the Main Plateau, the Dissected Margin, and the Northern Plains, are recognized. The Northern Plains zone includes the coastal plain proper and is almost 150 km wide southeast of Darwin; on the north coast of Arnhem Land it rarely exceeds 30 km, and is less than 2 km wide in places. It ranges in elevation up to about 75 m inland and in general relief is extremely small. Streams wind slowly across the coastal plain to the sea with their meanders locally incised to depths of 6 to 10 m, but generally lose themselves in swamps near the coast (Hays, 1968). The Northern Plains zone was subjected to repeated submergence, during which the mouths of major rivers were drowned and estuarine sediments accumulated. A recent fall in sea level was postulated by Christian & Stewart (1953) to account for the raised beaches, wave-cut benches, and extensive alluviations above present base level in drowned valleys in the Darwin and Ord-Victoria region. This fall in sea level was questioned by Russell (1963), who found no supporting evidence on the northwest coast.

The geomorphology of the coastline bordering the Arafura Sea on the south is complex. Bathurst and Melville Islands and Cobourg Peninsula are cuestas 130 m high and composed of Cretaceous and Tertiary sediments dipping gently northwards with short scarp-faces along their southern edge. In Arnhem Land tidal flats and sand dunes border the coastal plain, and extensive wave-cut platforms have developed locally (Dunnet, 1965). On the Wessel Islands resistant Upper Proterozoic sandstones dip northwest at 1.5° to 3° and form prominent cliffs up to 110 m high on the southeastern sides of the islands.

The Aru Islands consist of slightly undulating plateaux, rarely more than 18 m above sea level (Fairbridge, 1951). On their west sides they are bounded by low cliffs, and on the east the plateaux descend into swampy terrain, offshore islets, and coral reefs; Fairbridge suggested that this is the result of tilting. A striking feature of the islands is the presence of *sungis,* narrow channel-like straits, which are as much as 100 m deep and are related to Quaternary low sea-level stands.

Climate and oceanography

From April to September the Arafura Sea is affected by the southeast trade winds, which are constant in both strength and direction for most of this period. Wind strengths of force 4 to force 6 on the Beaufort scale are usual. In December the northwest monsoon spreads across the Timor and Arafura Seas, reaching Darwin by early January. Wind strengths of force 1 to force 4 on the Beaufort scale prevail during the northwest monsoon season (December to March), and squalls, frequently associated with thunderstorms, are common. In the transition periods between the southeast trade and the northwest monsoon seasons, light variable winds prevail and land and sea breezes are dominant in the coastal belts. The survey party experienced optimum conditions with clear skies and slight seas during October and November.

Temperatures in the Arafura Sea are very high; it is one of the hottest maritime climates in the world. At Darwin, the average maximum day temperature is 33°C in November and the average minimum is 20°C in July. Rainfall in the Arafura Sea is high (1500 - 2000 mm). Most rain falls between November and April. During the dry season, especially in July and August, rainfall is negligible.

Surface currents, according to *Australia Pilot,* Vol. 5, have no constant direction during the northwest monsoon season, when the South Equatorial Current is absent east of 115° to 120°E and does not affect the Arafura Sea. In the southwest and southeast parts of the Sea, currents are directed outwards into the Indian Ocean and Coral Sea respectively. A third system, revolving counter-clockwise around 10°S and 136°E (Tjia, 1966), has current speeds of less than 0.5 knot. During the remainder of the year, April to November, the South Equatorial Current causes a westerly set with a maximum rate of 1 to 2 knots.

Tides in the Arafura Sea are semidiurnal, with a well marked diurnal inequality typical of tropical waters. Variations in range and phase are a result of the enclosure of the Sea. The mean spring range varies from 1.47 m at Cape Don to 4.15 m at Arnhem Bay (Easton, 1970). Tidal currents of less than 1 knot occur near the Australian coast; during flood they set eastward and southward and at ebb they set westward and northward (*Australia Pilot,* Vol. 5).

Upwelling from the Indian Ocean takes place along the shelf and slope region of the Western Arafura Sea according to van Riel et al. (1950) and Rochford (1962), and relatively high inorganic phosphate and low oxygen values have been reported in the surface water. Extensive slicks of microscopic planktonic algae seen in these waters during the survey are suggestive of high productivity, but fish and bird populations do not appear to be particularly high.

Regional bathymetry

Fairbridge (1953) put the edge of the Sahul Shelf at a depth of 550 m, where there is a marked increase in slope. Although this large change in slope is present over most of the Arafura Sea, bathymetric contours (Fig. 5) show that the break in slope indicating the present shelf edge occurs at about 120 to 180 m. On the edge of the shelf and on the upper slope, submarine terraces down to 200 m have been observed in sounding profiles taken during this survey. Shallow banks rising from the upper slope, such as occur in the Timor Sea to the west, are not found in the survey area. Over much of the northern part of the shelf a drowned fluvial drainage pattern related to Pleistocene low sea levels can be recognized (Fairbridge, 1951). A prominent feature of this system is the channel extending from near Cape Wessel west-northwest across the shelf to link with the Arafura Depression, a distance of over 400 km. However, Fairbridge believes that the Arafura Depression is of structural rather than erosional origin.

STRUCTURE AND STRATIGRAPHY

Previous geophysical investigations

The earliest geophysical information over the area was obtained by Adastra Hunting Geophysics Pty Ltd (Shell Development, 1965) during an aerial magnetic survey of the adjoining northern part of Arnhem Land and Melville Island, which indicated a gradual deepening of magnetic basement to the north and northwest. Earlier onshore seismic work on Bathurst Island (Oil Development, 1962) also indicated a northwest-dipping refractor presumed to be lower Proterozoic, at a depth between 450 m and 950 m.

The first marine seismic work in the area, a short reflection program in Dundas Strait by Anacapa Corporation (1965), indicated a regional northerly dip. In the same year Burmah Oil Company of Australia Ltd (1965) carried out a reconnaissance reflection survey north of Bathurst Island, where a strong reflection was recorded at the same level as the Proterozoic refractor on Bathurst Island. Between New Year Island and Cape Wessel another reconnaissance line run by Geophysical Associates for BMR showed an unconformity rising from 0.45 second near New Year Island to 0.15 second in the central part of the line, after which its depth remained constant to near the end of the traverse, where a gentle easterly dip was apparent near Cape Wessel. The unconformity was correlated with the base of the Mesozoic by extrapolation from onshore. In December 1965 Shell Development Ltd carried out a seismic reconnaissance survey of the whole area using reflection techniques combined with velocity probes (Shell Development, 1966). A regional thickening of the Mesozoic and Tertiary section towards the northwest was again indicated. The intensity of geophysical exploration in the Arafura Sea increased in more recent years and since 1965 Shell Development Ltd has carried out four more surveys: Lynedoch Bank (1967a), Money Shoal (1967b), Arafura D-1 (1968), and Arafura D-2 (1969). During this period Australian Aquitaine Petroleum Pty Ltd completed two surveys in the southeastern part of the Arafura Sea: Volsella Shoal (1967) and New Year Island (1968). The results of these marine seismic surveys and velocity probes made it possible to map three main horizons, A, B, and C. Horizon C was found to be a prominent unconformity, and although it is shallow near the Australian coast and to the east, it deepens rapidly to the north and west to a probable depth of 6000 m north of Melville Island. In the east this unconformity is identified as basal Mesozoic from correlation with onshore geology, and overlies folded Proterozoic strata. A graben structure affecting Horizon C occurs in the Money Shoal area. Above

Horizon C the section is apparently conformable and undeformed. Within this sequence Horizon B is believed to be a Mesozoic reflector of possibly Late Triassic or Early Jurassic age, and Horizon A is correlated with the base of the Tertiary. A very shallow horizon A was seen in sparker profiles taken in the area. West of Bathurst Island a marine seismic survey near Parry Shoal (Longreach Oil Ltd, 1969) also indicated the presence of the basal Mesozoic reflector (Horizon 2), below which a strong unconformity (Horizon 3) presumed to be Proterozoic was mapped. Palaeozoic sediments may occur between the two reflectors in this area, as they do in Petrel No. 1 well 200 km to the southwest. The shallowest reflector mapped during the Parry Shoal survey was a northwest-dipping horizon thought to correspond to an Oligocene transgression.

In 1967 a marine geophysical survey of the Timor Sea carried out under contract to BMR by United Geophysical Corporation (Jones, 1969) extended east to 132°E and overlapped the region described in this Bulletin. In a study of the shallow seismic profiles obtained during the survey, Veevers (1971) identified four unconformities termed S1, S2, S3, and S4. The S1 and S2 surfaces were thought to represent the Plio-Pleistocene fold periods which affected Timor and New Guinea; the deeper S3 surface was correlated with the late Miocene-lower Pliocene Ramelauean Orogeny of Timor, and S4 with the early lower Miocene Matabian Unconformity.

Marine seismic coverage by oil companies in 1965-69 is shown in Figure 6, and correlation of the various reflectors mapped is given in Table 1.

Description of the shallow seismic profiles

The shallow seismic reflection profiles run during the BMR 1969 survey were obtained with a 1000-joule Sparkarray energy source which normally gave penetration of 0.4 to 0.7 second (two-way time) and resolution of 10 to 20 milliseconds. The quality of the records was often downgraded by ringing effects and multiples caused by subhorizontal layers with strong acoustic contrast in the upper near-surface part of the section (Pl. 1). Deconvolution was not possible as magnetic tape recordings were not made. Traverses were run at night at speeds of 5 to 6 knots and it has been assumed that the ship travelled in a straight line and at a constant speed between the fixes taken at the beginning and end of each traverse where intermediate positioning was not possible. Within each traverse, positions are fixed by the time-marks shown on the records, which also give an indication of the horizontal scale. Location of the traverses is shown in Figure 7.

On the original records a 1-second sweep was normally used and the vertical-scale exaggeration was about 8 times. In the line interpretations (Figs. 8-16) the horizontal scale has been further compressed resulting in vertical-scale exaggeration of about 66 times. A sound velocity of 1500 m/s has been assumed throughout. Time-marks on the original records occur every 5 minutes along the record and are indicated by breaks in the scale-lines, which themselves are 50 milliseconds apart. The direct wave form (about 10-20 milliseconds in duration) has its top at 0.01 second on most records, corresponding to the 15-m separation between the sparker source and the receiver. Line drawings of the records are shown in Figures 8 to 16, in which spurious reflectors have been omitted. Reference to slope angles in the figure descriptions refer to the attitude of reflectors as they appear in the drawings and not to the true angles.

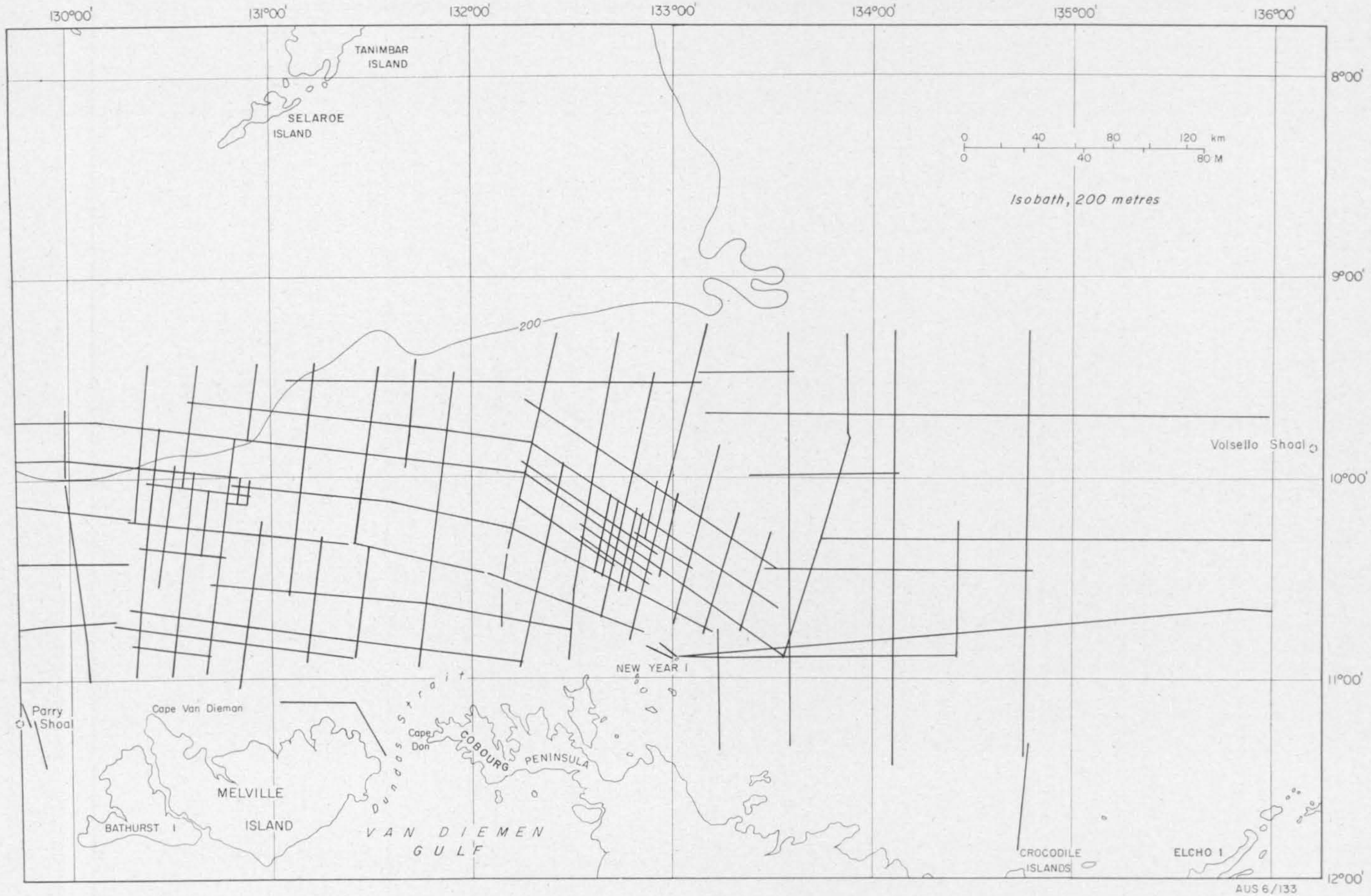

Figure 6. Marine seismic coverage by petroleum exploration companies between 1965 and 1969.

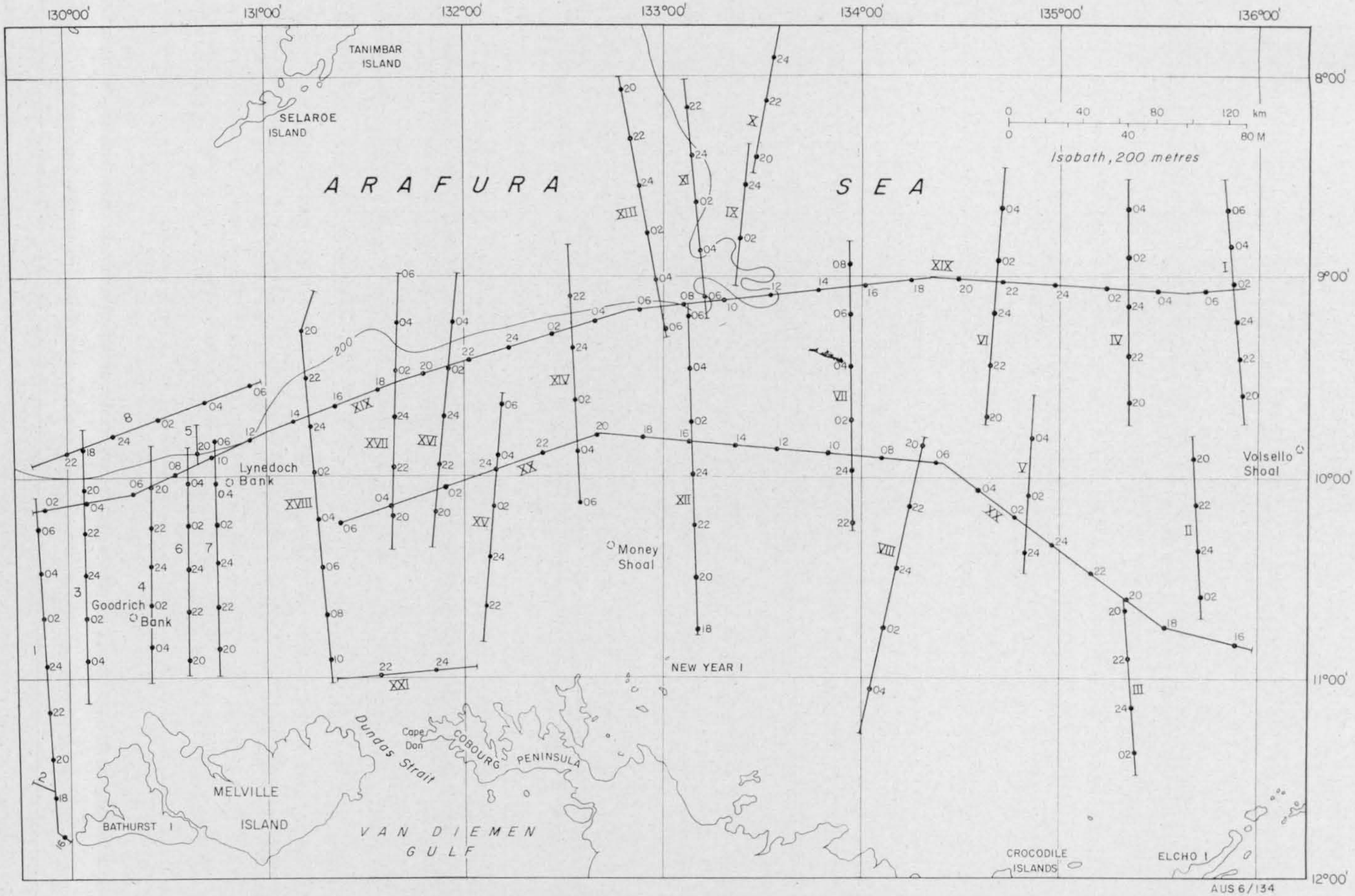

Figure 7. Location of shallow seismic reflection profiles showing traverse numbers and 2-hour intervals.

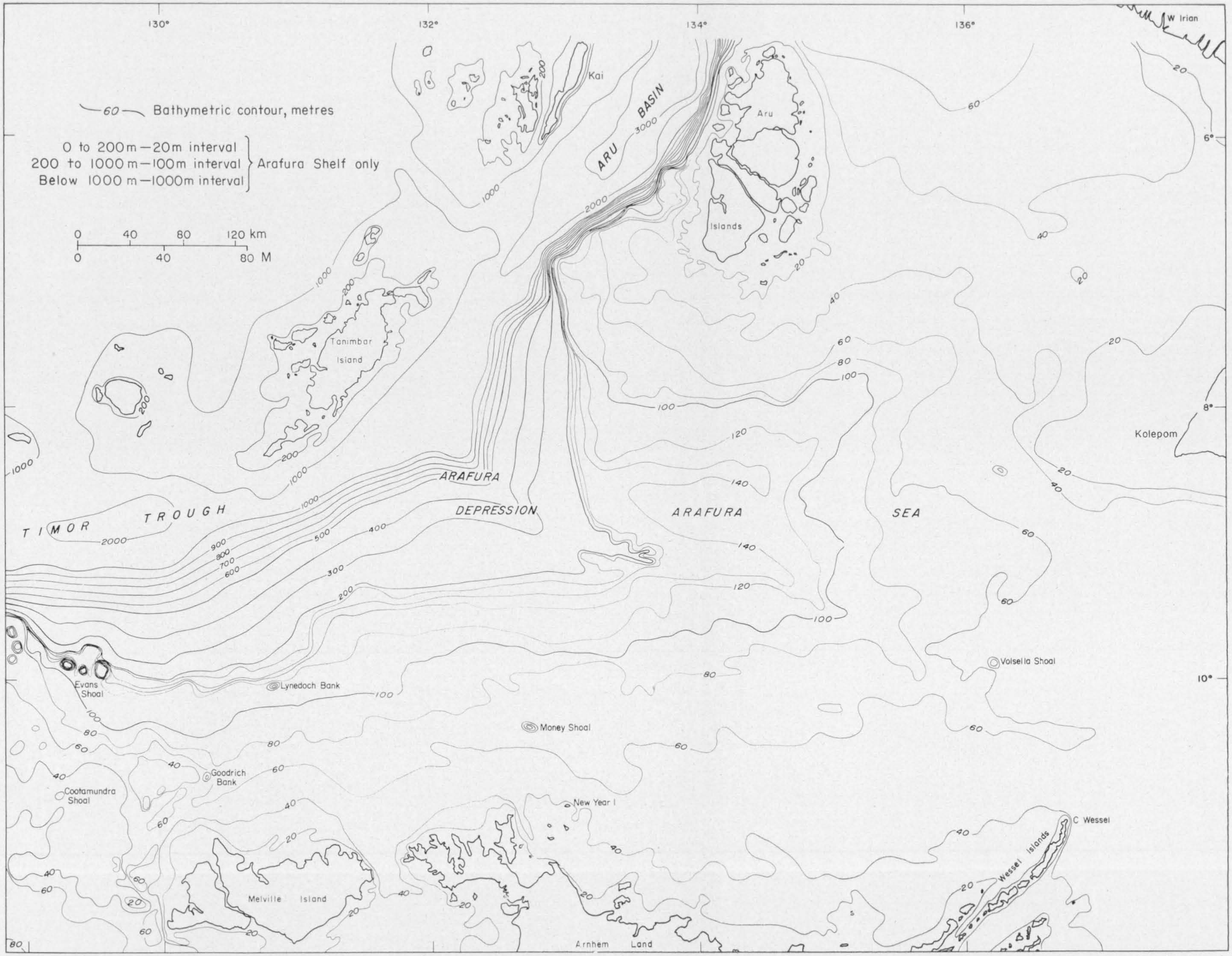

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Figure 5. Generalized bathymetry of the Arafura Sea.

TABLE 1. CORRELATION OF SEISMIC REFLECTORS MAPPED IN THE ARAFURA SEA

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
								SH	Holocene
							S1	S1	Pleistocene
							S2	S2	Pliocene
	Horizon A	Horizon 1					S3	S3	late Miocene-early Pliocene
							S4		lower Miocene
	Horizon A			Horizon A	Horizon A	Horizon 1		S4	basal Tertiary
				Horizon X					
	Horizon B	Horizon 2	Horizon 2	Horizon B	Horizon B				top Triassic
				Horizon Y					
				Horizon Z					
'Base Mesozoic'	Horizon C	Horizon 3	Horizon 3	Horizon C	Horizon C	Horizon 2		S5	basal Mesozoic
			Horizon 4	Horizon D					
			Horizon 5	Horizon E					
					Horizon F	Horizon 3			top of Proterozoic

1. Shell Development (1966)
2. Shell Development (1967a)
3. Australian Aquitaine Petroleum (1967)
4. Australian Aquitaine Petroleum (1968)
5. Shell Development (1968)
6. Shell Development (1969)
7. Longreach Oil (1969)
8. Veevers (1971)
9. Present survey
10. Possible age

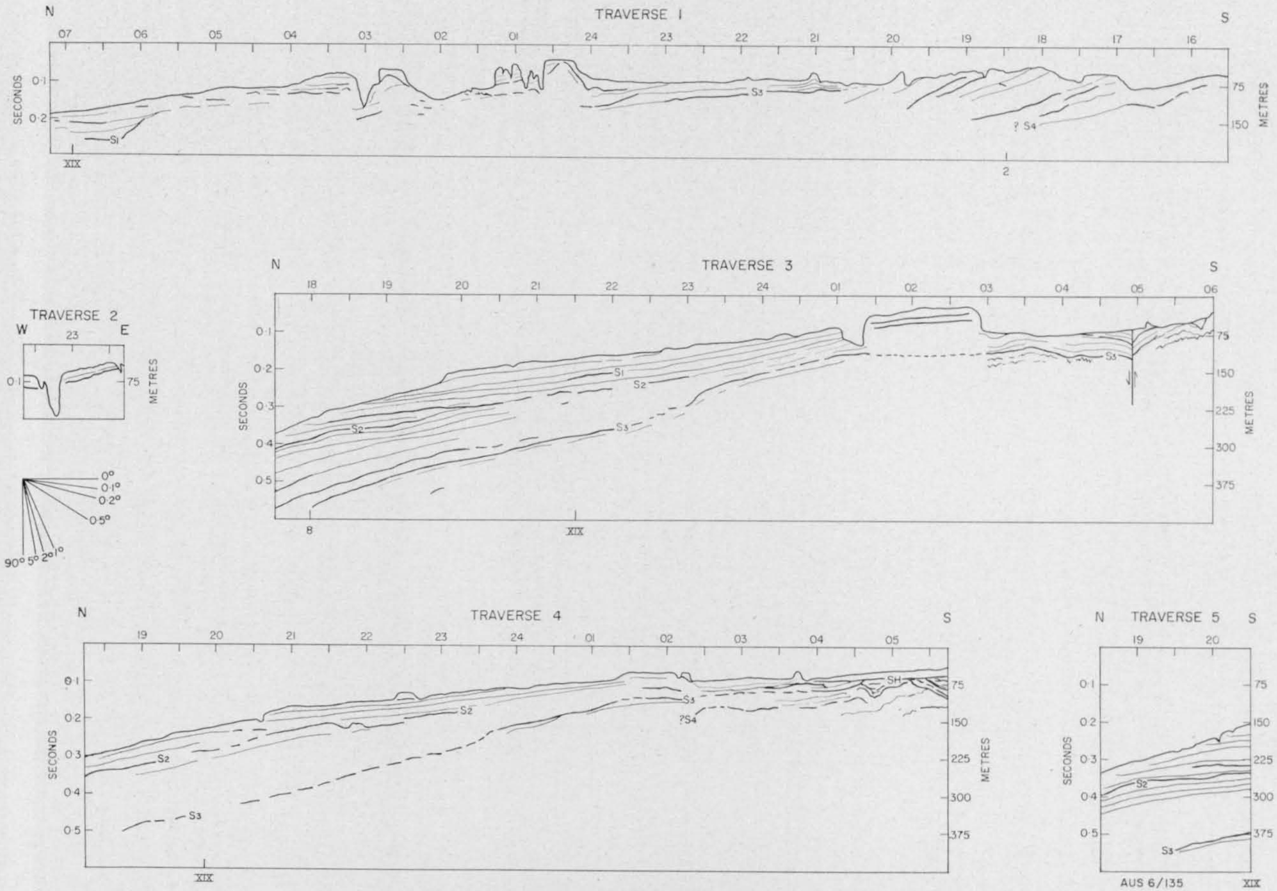

Figure 8. Interpretations of Traverses 1-5, near Bathurst Island.

Traverses near Bathurst Island.

Traverse 1. S2, S3, and perhaps S4 are present. The sequence above S4 dips northwards at a moderate angle. S3, identified between 2030 and 2300 hours, is a smooth gently dipping horizon. A bank at 2100 hours appears to be a constructional feature whereas the larger banks and troughs between 2400 hours and 0400 hours seem to have been formed by erosion of the post-S3 sequence. The sharp change in slope of S2 at 0615 hours at 0.25 second depth probably marks an ancient strandline.

Traverse 2. A short traverse across a silled trough west of Bathurst Island. Horizons are truncated at the channel walls, indicating an erosional origin.

Traverse 3. S1, S2, and S3 are present. The sequence between S3 and S2 thickens steadily seawards but the sequence above S2 is thickest at about 2100 hours, several kilometres south of the present shelf edge. The change in slope of S3 at 2300 hours probably marks the edge of a previous shelf. A deep erosional channel occurs on the north side of Goodrich Bank at 0100 hours. The sequence below this bank is obscured by multiples, but S3 appears again at 0300 hours. Some warping of the sequence above S3 can be seen between 2300 and 0500 hours and a fault with a throw of about 15 m occurs at 0500 hours. Irregular reflectors below S3 in this region may be from early Tertiary sediments which appear to crop out at the end of the traverse.

Traverse 4. SH, S2, S3, and possibly S4 are seen. Notches are present at 2030 and at 2230 hours in depths of 147 m and 100 m respectively. The sequence above S2 is well stratified. S2 is clearly an erosional surface at 2145 hours. A former shelf break in S3 occurs at 2330 hours, and at 0430 hours this surface becomes highly irregular and marks a strong unconformity.

Traverse 5. S2 and S3 are present in this traverse on the edge of the shelf. Upbuilding and outbuilding are visible. Two notches at 2000 and 2015 hours in depths of 183 m and 165 m respectively register low sea-level stands during the Pleistocene.

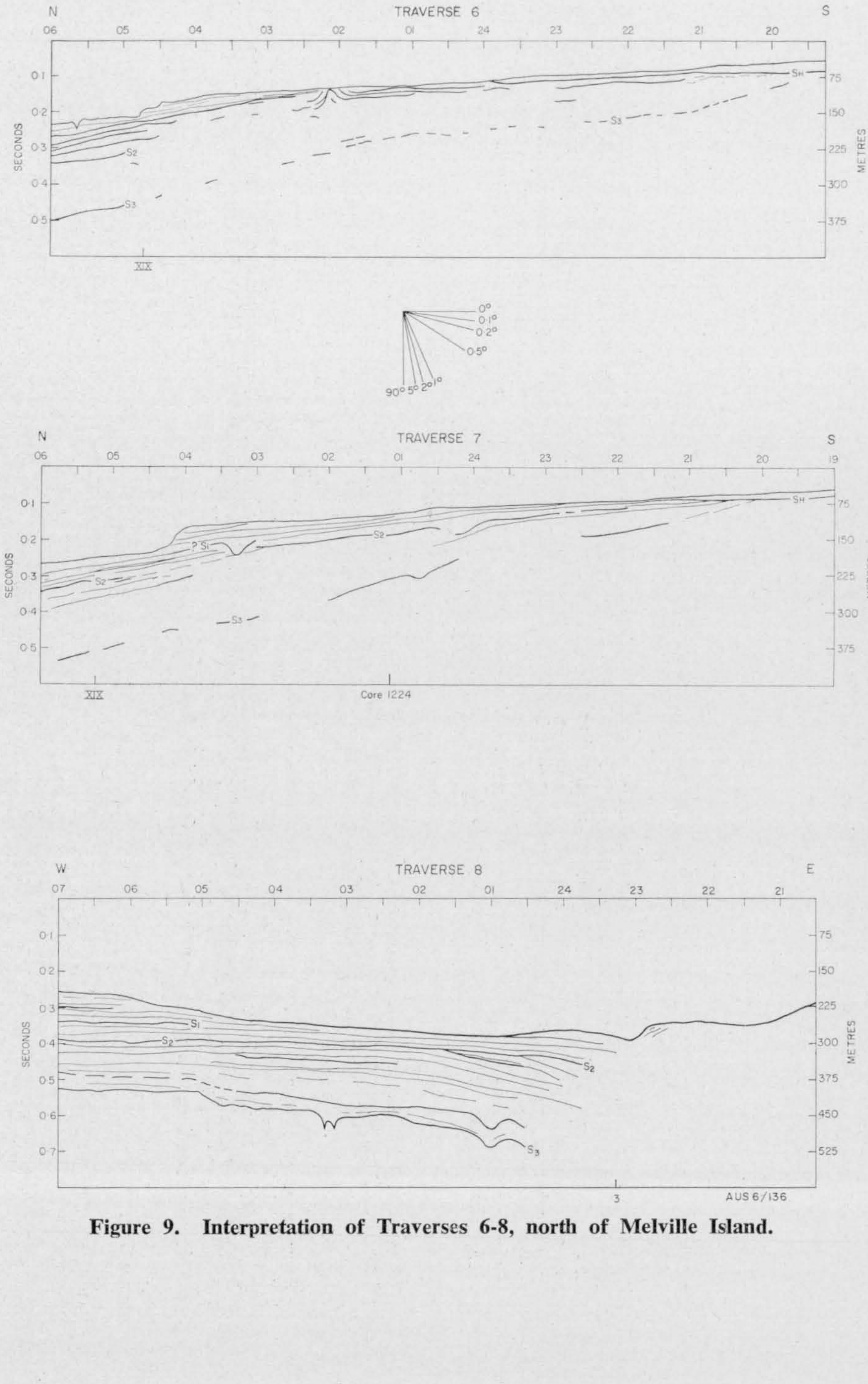

Figure 9. Interpretation of Traverses 6-8, north of Melville Island.

Traverses north of Melville Island.

Traverse 6. SH, S2, and S3 are faintly discernible. The sequence above S2 is well stratified but few reflectors are present below S2. Erosional notches and scarps in the sea floor occur at 0540 hours (-76 m), at 0445 hours (-154 m), and at 0430 hours (-128 m). A buried reef occurs at 0210 hours and a change in slope in S3 is present at 0100 hours. The flat horizon SH at 2330 hours is overlain by a wedge of acoustically transparent Recent sediments thickening towards Melville Island.

Traverse 7. SH, S1, S2, and S3 are present. A scarp in the sea floor between 161 and 136 m at 0415 hours is erosional. A gully occurs in a reflector which may be S1 at 0315 hours. Another gully occurs in S2 at 0030 hours. Reflections are not observed between S2 and S3. S3 shows an inflection at 0045 hours at a depth of 0.3 second and merges with SH at 2000 hours.

Traverse 8. This traverse runs parallel to the shelf edge on the upper continental slope. S1, S2, and S3 are seen in the western part of the traverse. High noise level owing to a following sea obscures the reflections in the early part of the record. S3 is clearly an unconformable erosional surface, but the overlying sequence appears mainly conformable throughout.

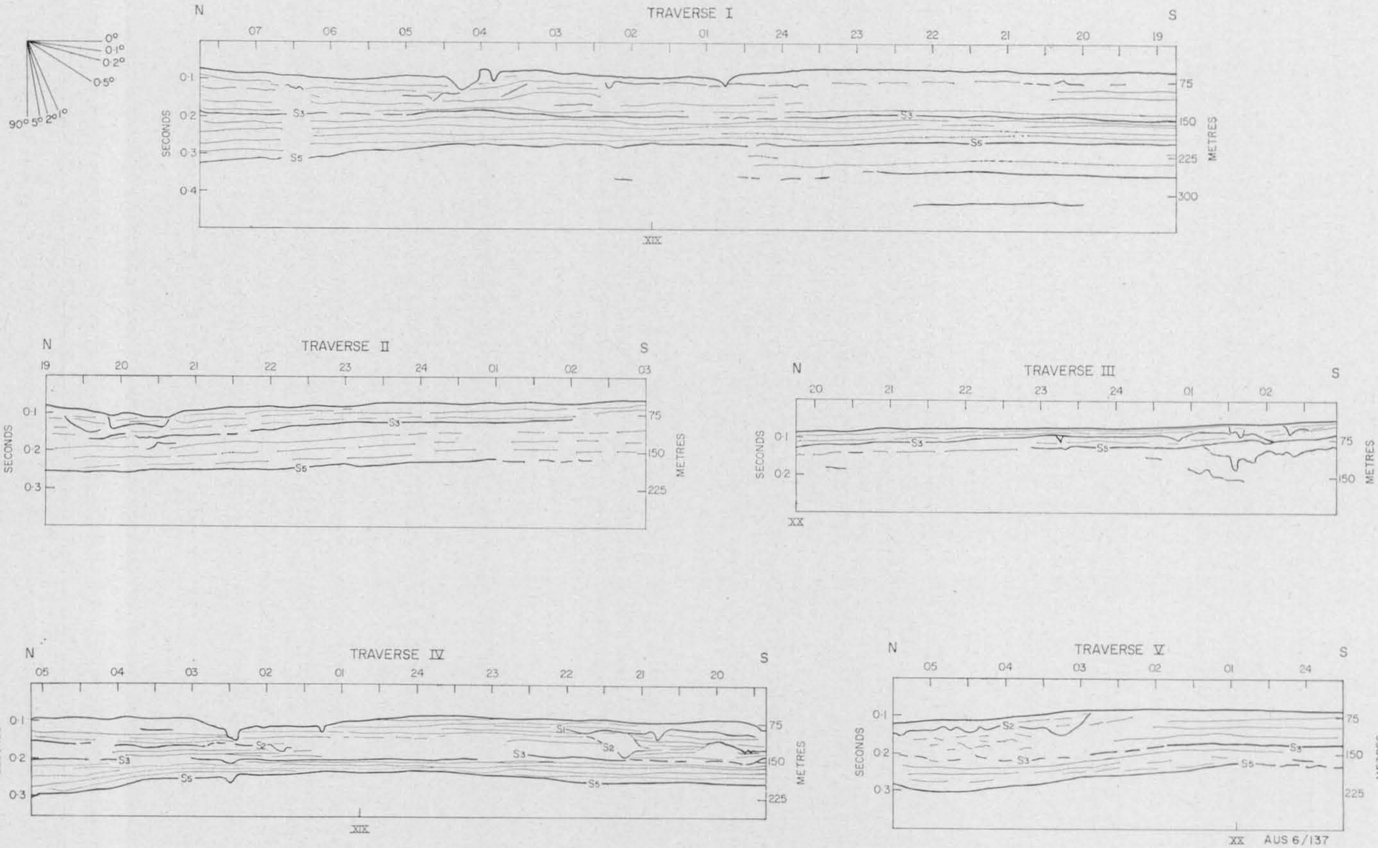

Figure 10. Interpretation of Traverses 1-V, north of Wessel Islands.

Traverses north of Wessel Islands.

Traverse I. S3 and S5 are present. S5 shows only minor relief. Erosional channels occur at 0415 hours (-95 m), at 0350 hours (-75 m), and at 0045 hours (-75 m). At 0630 hours an irregular reflector about 0.03 second (20 m) below the sea bottom obscures the section below. This acoustically impenetrable reflector may be a buried reef.

Traverse II. S3 and S5 are present. An infilled erosional channel in the post-S3 sequence occurs at 2000 hours, but otherwise the profile shows no evidence of unconformities.

Traverse III. S3, S5, and an irregular reflector below S5 are present. S3 lies at shallow depths and there are indications of channelling in the overlying sequence at the southern end of the traverses. At 0200 hours it dips down and merges with S5. An irregular reflector between 0100 and 0255 hours is present below S5.

Traverse IV. S1, S2, S3, and S5 are present. Erosional channels occur at 0230 hours (-110 m) and at 0115 hours (-90 m). Large parts of the post-S3 sequence are acoustically transparent.

Traverse V. S2, S3, and S5 are present. S2 is strongly erosional and meets the sea floor at 0300 hours. The sequence between S2 and S3 is chaotic, and S3 is not clearly defined.

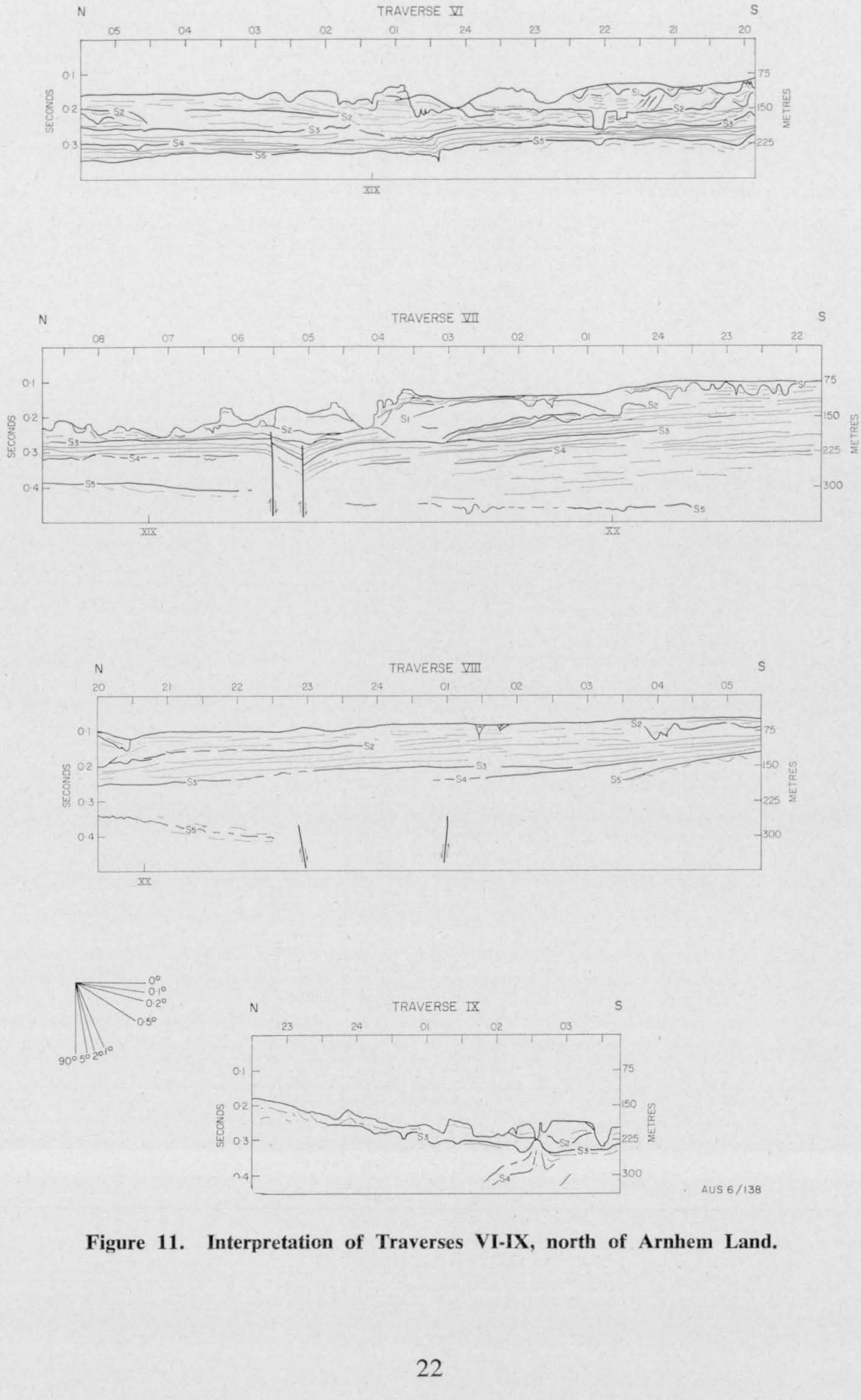

Figure 11. Interpretation of Traverses VI-IX, north of Arnhem Land.

Traverses north of Arnhem Land.

Traverse VI. S1-5 are present. The sea floor and S1-2 show evidence of extensive erosional dissection. S1 extends from 2000 hours and is overlain mainly by acoustically transparent sediments. The sequence between S1 and S2 includes foreset bedding at 2130 hours. A deep erosional channel in S2 at 2200 hours cuts through the entire sequence between S2 and S3 and is floored by S3. S4 is visible only between 0400 and 0530 hours. S5 has some erosional relief at 0030 hours.

Traverse VII. S1-5 are present. As in Traverse VI the sea floor and S1-2 are extensively dissected. Much of the sequence above S2 is acoustically transparent. The sequence below S2 is faulted between 0500 and 0540 hours. S5 is considerably deeper than in Traverse VI.

Traverse VIII. S2, S3, S4, and S5 are present. Erosional channels occur in the near-surface reflector S2, but the sea floor itself has little or no relief. S3 merges with S4 at 0315 hours and S4 in turn merges with S5. S5 is not visible in the centre of the record and this coincides with the intersection of a graben in the Money Shoal area.

Traverse IX. S2-4 are present at the southern end of this traverse. S3 crops out at 2315 hours. The pinnacle on the sea floor at 0235 hours looks like an erosion residual similar to the other larger features nearby. The steep-sided ridge in S4 at 0230 hours is probably a reef, and the overlying reflectors, including S3, are draped over it.

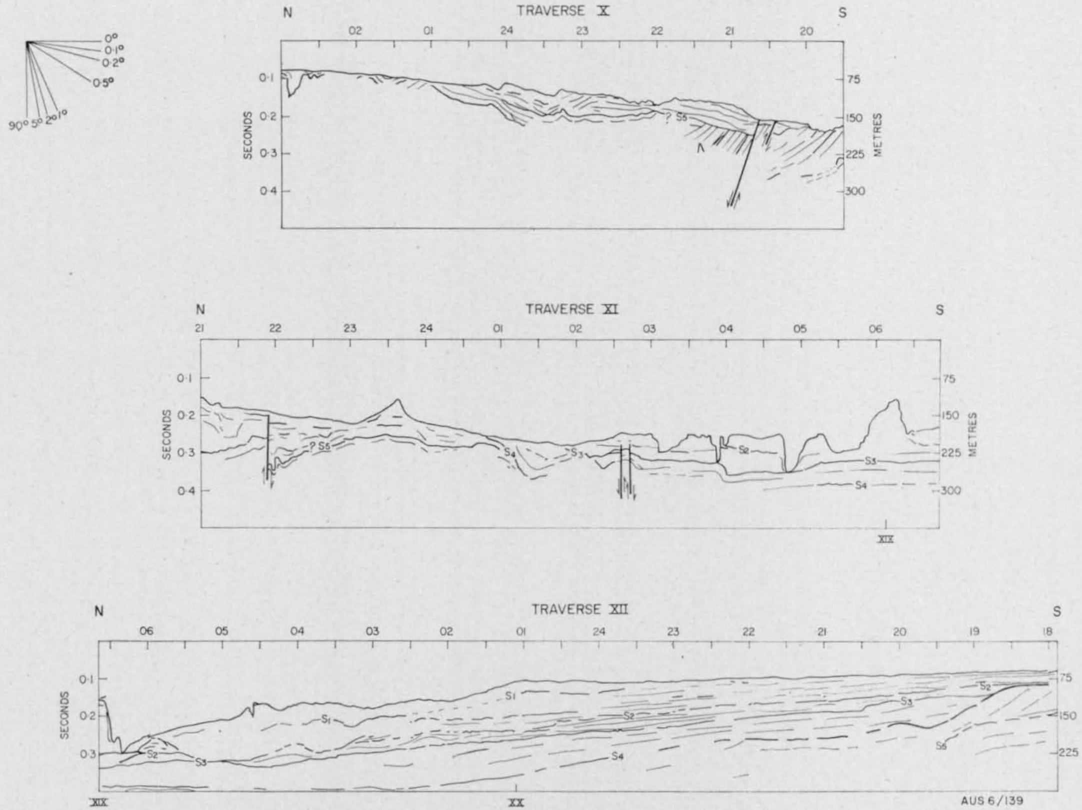

Figure 12. Interpretation of Traverses X-XII, between New Year and Aru Islands.

Traverses between New Year and Aru Islands.

Traverse X. S5 is close to the surface and possibly crops out towards the northern end of the traverse, where little penetration was achieved. S5 also crops out at the extreme southern end of the traverse; in this area faulting is evident and S5 is a high-angle unconformity.

Traverse XI. S2, S3, S4, and possibly S5 are present. The start of the traverse shows a deformed faulted sequence with S5 showing high relief. S4 comes close to the surface and crops out at 0045 hours, while S3 crops out at 0145 hours. The sequence above S3 is acoustically transparent except for one faint reflector which is S2. Deep erosional channels in the sea floor occur at 0350 and at 0450 hours. At 0400 hours S3 and underlying reflectors appear to be deformed by gentle folding. The deformation in S3 is not present in the sediments above S3.

Traverse XII. S1-5 are present. The bank at the northern end of the traverse at 0630 hours is probably the same feature as that crossed at 0600 hours in Traverse XI. It is flanked on the southern side by a trough at a depth of 225 m. All reflectors dip gently northwards towards the edge of the shelf. The relief in S2 and S1 is probably erosional. The sequence above S3 between 0630 and 0300 hours is acoustically transparent. Between 1800 and 1900 hours weak reflectors above S5 suggest foreset bedding between S3 and S5.

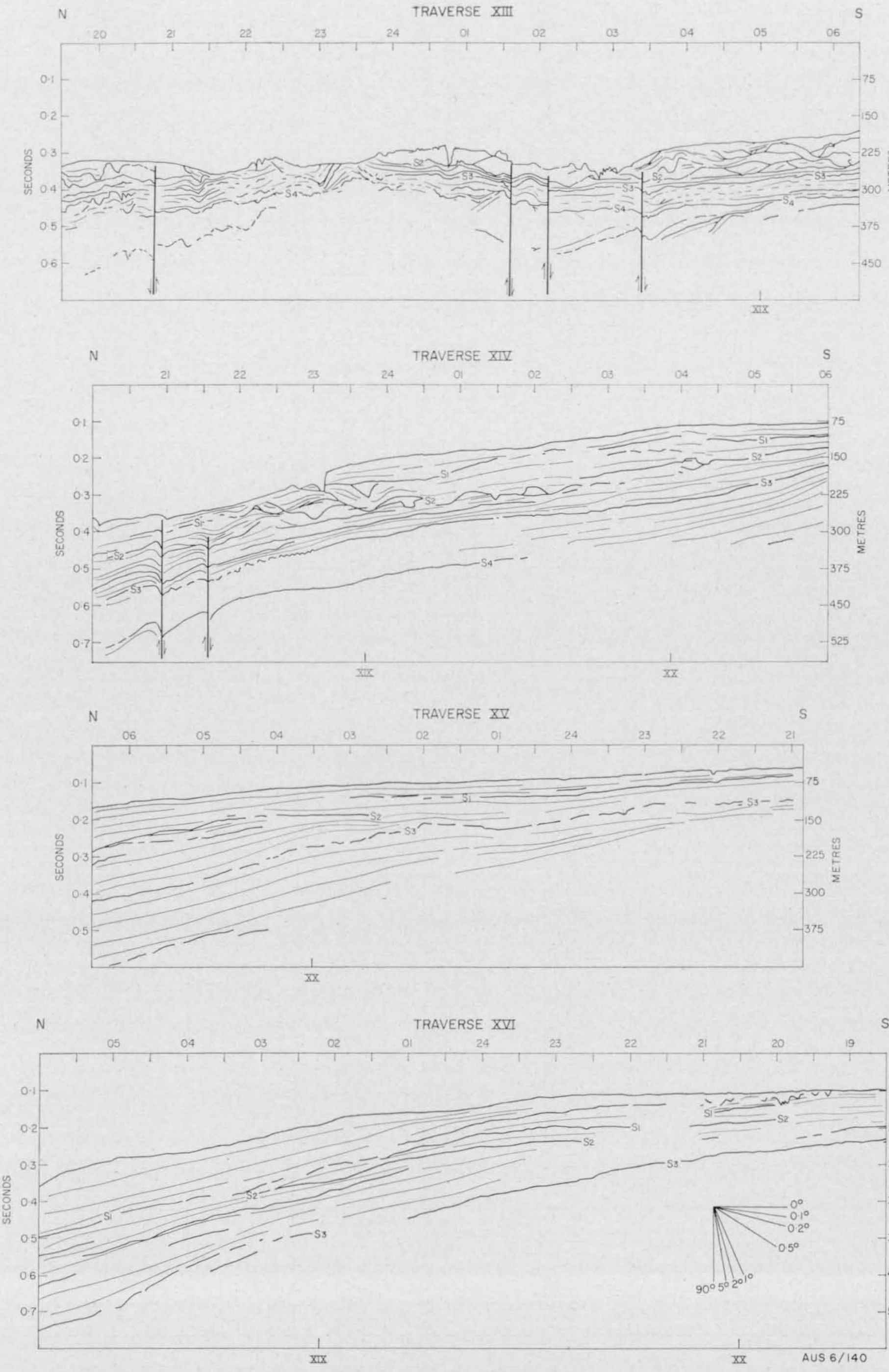

Figure 13. Interpretation of Traverses XIII-XVI, north of Cobourg Peninsula.

Traverses north of Cobourg Peninsula.

Traverse XIII. S2, S3, and S4 are present. At the start of the traverse the strata are much disturbed. S4 is the only surface traceable throughout this profile. A broad anticlinal horst has its crest at 2300 hours where S3 crops out. Deep erosional channels in the sea floor cut into S2 at 0045 and 0240 hours. Reflectors above S3 in the southern part of the record are also disturbed, but the sequence between S3 and S4 is essentially undeformed.

Traverse XIV. S1-4 occur in this profile. Faulting and minor warping affect the sediments underlying the upper continental slope at the northern end of the traverse, but as in Traverse XIII deformation decreases southwards. An erosional scarp related to an ancient shoreline is well displayed at 2300 hours; the trough at the foot of this feature is at -210 m (Pl. 2, fig. 1).

Traverse XV. S1-3 are present. S3 shows some irregularities but in general the reflectors indicate conformability and thickening of all sequences northwards. The sea floor is smooth except for a small notch at 2100 hours at a depth of 60 m.

Traverse XVI. S1, S2, and S3 are present. A change in slope of the otherwise smooth sea floor can be observed at 0200 hours at a depth of 130 m. As in Traverse XV the sequences appear well stratified, semiconformable, and thicken seawards. Between 1900 and 2100 hours erosional channels occur in a surface above S1.

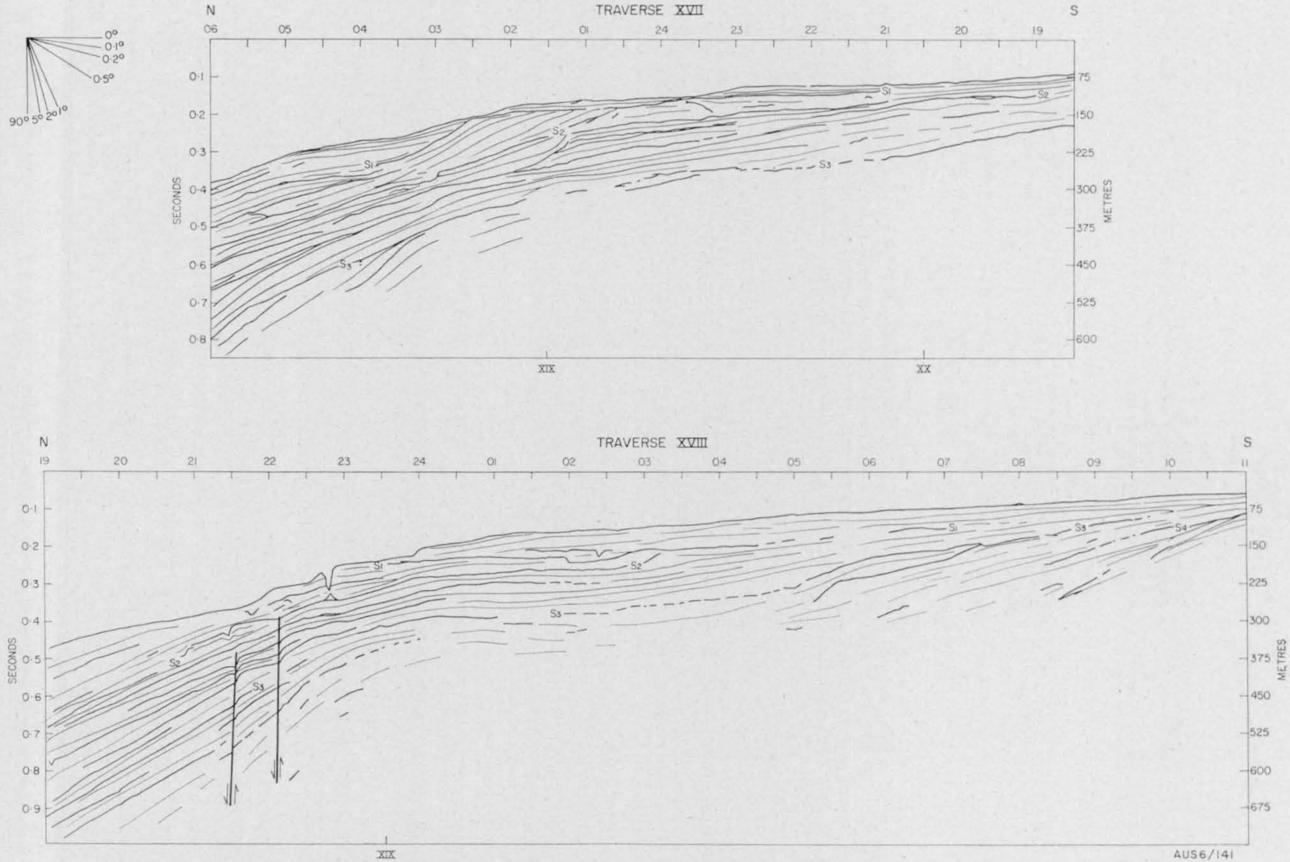

Figure 14. Interpretation of Traverses XVII and XVIII, north of Dundas Strait.

Traverses north of Dundas Strait.

Traverse XVII. S1-3 are present. This profile across the outer shelf and upper slope shows a well bedded, semiconformable sequence, thickening northwards. Several periods of erosion, followed by renewed upward and outward building of the edge of the shelf, are suggested.

Traverse XVIII. S1-4 are present. As in Traverse XVII, a thick and essentially undeformed prism of sediments underlies the shelf-edge region, but here the edge of the shelf is more clearly defined and two small normal faults occur under the upper continental slope.

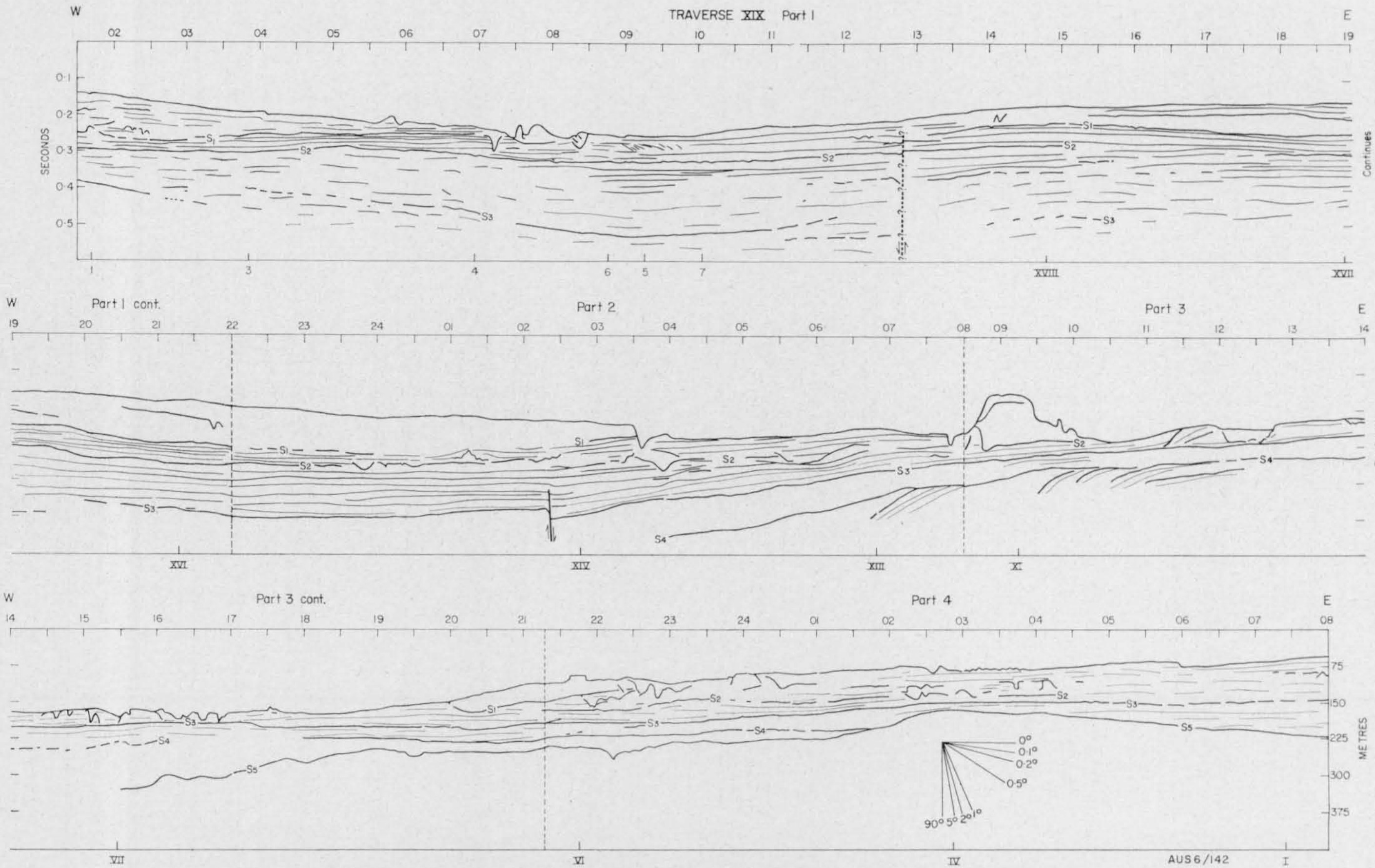

Figure 15. Interpretation of the tie-in traverse near the edge of the shelf.

Tie-in traverse near the edge of the shelf.

Traverse XIX. This long traverse runs in a general easterly direction along the outer part of the continental shelf parallel to the continental margin throughout Parts 1 and 2. Parts 3 and 4 continue eastwards across the shelf, the edge of which swings to the north at the beginning of Part 3.

Parts 1 and 2. S3 is the deepest reflector visible throughout most of this section and is faint and discontinuous in Part 1. Reflectors are essentially flat-lying throughout and much of the sequence overlying S1 in the eastern part of the section is acoustically transparent. A small normal fault downthrown to the east disrupts S3 and part of the S2-3 sequence at 0230 hours (Part 2).

Parts 3 and 4. Seaward-dipping reflectors underlying S4 appear at the beginning of Part 3, where the shelf swings to the north at right angles to the traverse direction. The profile crosses the erosional channel system feeding into the Arafura Depression at 1600 hours (Part 3). Highly disturbed reflectors in the upper part of the sequence at the beginning of Part 4 are probably erosional features.

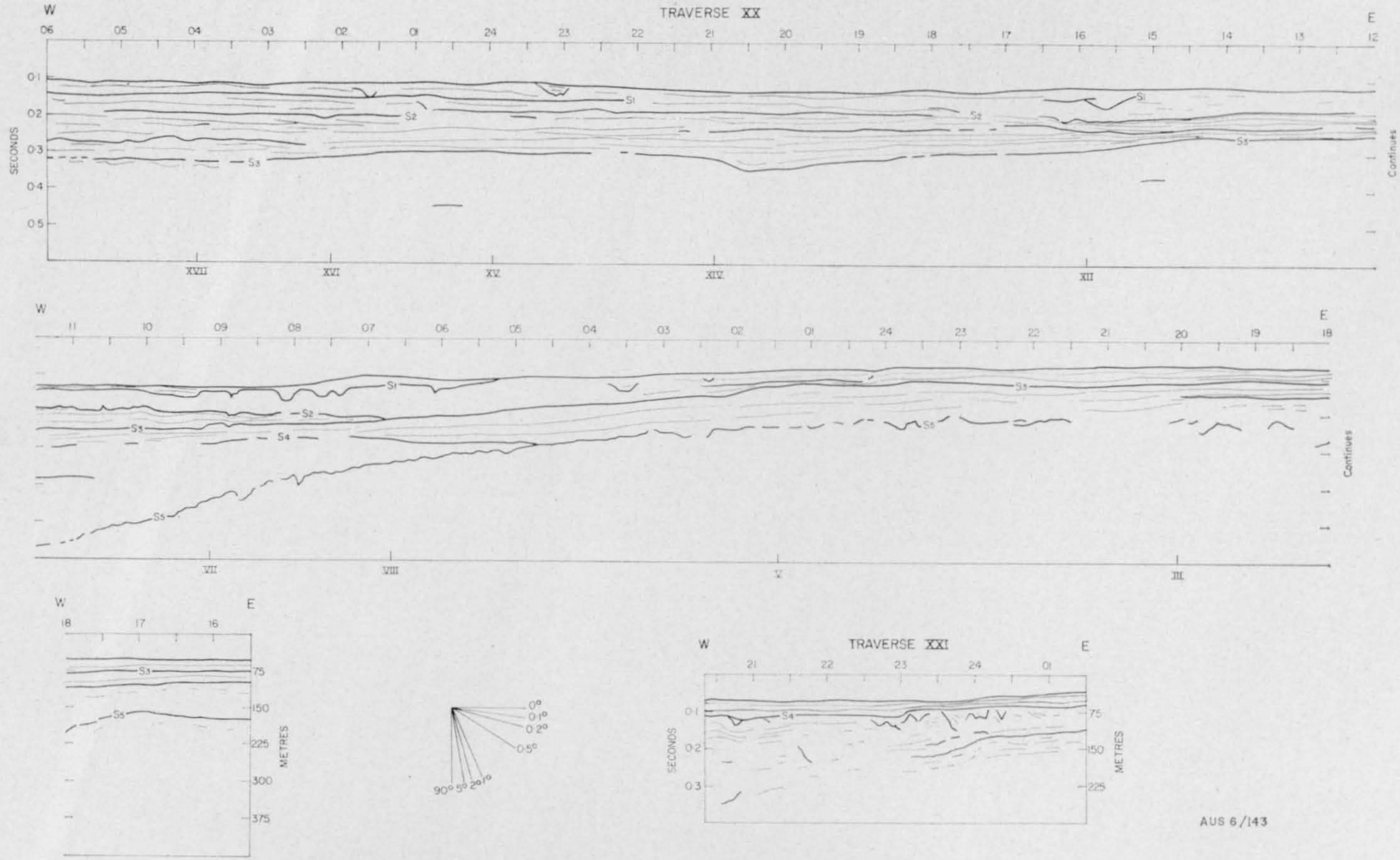

Figure 16. Interpretation of the tie-in traverse across the middle shelf.

Tie-in traverses across the middle shelf.

Traverse XX. This profile runs in general westerly direction along the middle shelf from north of Elcho Island to north of Melville Island. Reflectors are subhorizontal throughout, except for irregularities in surfaces of erosion. These are particularly evident in S1 in the middle part of the profile and in S5 in the eastern half.

Traverse XXI. This short profile runs from west to east, north of Cobourg Peninsula. Highly disturbed reflectors occur under a strong reflector correlated with S4. S5 may be present at the eastern end of the profile.

Stratigraphic interpretation

The deepest reflector identified in the shallow seismic profiles, S5, is recognizable only in traverses east of 133°E. However, it can be correlated with the widespread basal Mesozoic horizon delineated in the Arafura Sea by the subsidized seismic surveys by oil companies, and extrapolation of S5 landwards from the ends of Traverses III, VIII, XII, and XX confirms that it represents the unconformity on the Proterozoic. This would normally be expected to be the base of the Mesozoic, but is possibly at the base of the Tertiary in the region of Melville and Elcho Islands where the Tertiary rests directly on the Proterozoic. The surface has a regional dip to the north in the western part of the Arafura Sea, and to the west in the eastern part (Fig. 17). It is affected by a graben trending east-west in the Money Shoal area crossed by Traverse VIII (Fig. 11), and forms an extensive prominent high centred on 9°20'S, 135°30'E.

A regional northwesterly dip is also displayed by S4 which is postulated to be an unconformity or disconformity at the base of the Tertiary (Fig. 18). It is equivalent to Horizon A of Shell Development (1967a, 1968, 1969). S4 is present at the start of Traverse 1 (Fig. 8), 1.5 km west of Cape Fourcroy on Bathurst Island where Upper Cretaceous rocks crop out. S4 also occurs in Traverses XVIII (Fig. 14) and XXI (Fig. 16) 20 km from Melville Island and Cobourg Peninsula, where Cretaceous sediments crop out or are overlain by a thin veneer of Cainozoic. This surface dips less steeply to the north and west than does the underlying S5, indicating a general thickening of the Mesozoic sequence in this direction. The maximum thickness seen in the shallow seismic profiles is about 225 m (Traverse XX, Fig. 16). S4 is not recognizable in the southeastern part of the area and crops out on the sea floor in the area 8°S, 133°E (Fig. 18). Minor erosional relief is generally absent on this surface, but tectonic deformation by folding and faulting is apparent south of Aru Island (Traverse XI, Fig. 12; Traverse XIII, Fig. 13). There is at least one disconformity between S4 and S5, and the disconformity in Traverse XIII (Fig. 13) and Traverse XIX Part 2 (Fig. 15) may be equivalent to a possible Triassic reflector mapped during earlier oil company surveys in the area (Shell Development 1968, 1969; Nicol, 1970, Horizon B).

S3 is a strong persistent reflector present in nearly all seismic profiles. It is equivalent to the prominent reflector in the Timor Sea correlated by Veevers (1971) with the late Miocene to early Pliocene unconformity in Ashmore Reef No. 1 well, and can be traced over much of the Northwest Shelf (Jones, 1971). It marks the break in sedimentation caused by the late middle Miocene orogeny which affected most of New Guinea and the Indonesian Archipelago (the Ramalauean Orogeny of Timor). The very strong acoustic contrast between this reflector and the overlying sequence, which causes ringing in many of the seismic sections, suggests that S3 is strongly indurated. In the western part of the area it has been dissected, but in general it lacks any relief, and slopes gently to the north and west sub-parallel to the underlying S4 and to the continental slope (Fig. 19). Local irregularities occur where it has been structurally deformed near the present edge of the shelf (Traverses X, XI, Fig. 12; Traverse XIII, Fig. 13), and north of Melville Island, where there is a marked change in gradient and an associated trough at a depth of 0.3 second. This is also possibly fault-controlled. The surface becomes shallower towards the Wessel Rise in the east,

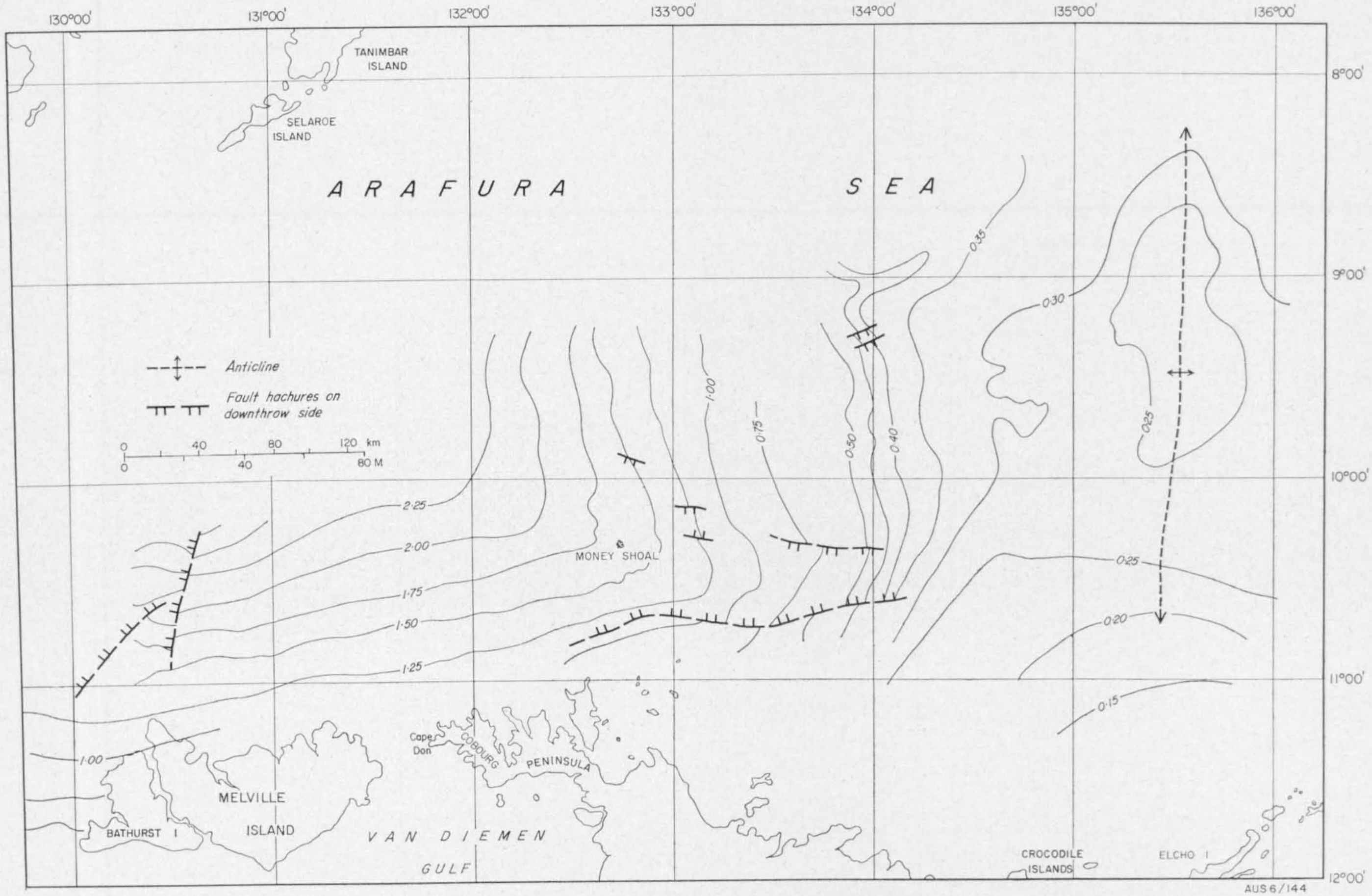

Figure 17. Isochrons on S5 (seismic basement); intervals 0.05 and 0.25 second.

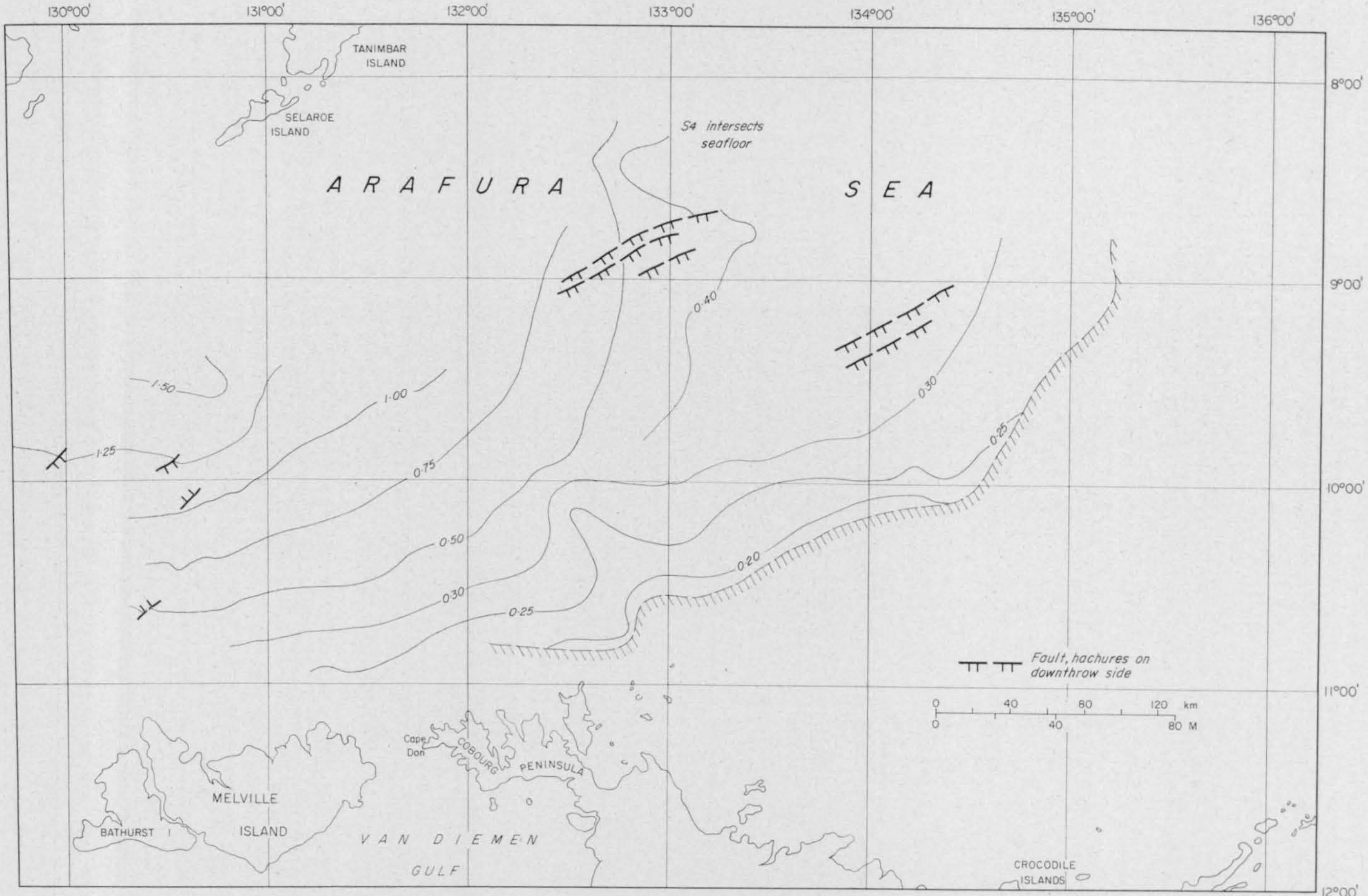

Figure 18. Isochrons on S4 (base of Tertiary); intervals 0.05, 0.10, and 0.25 second.

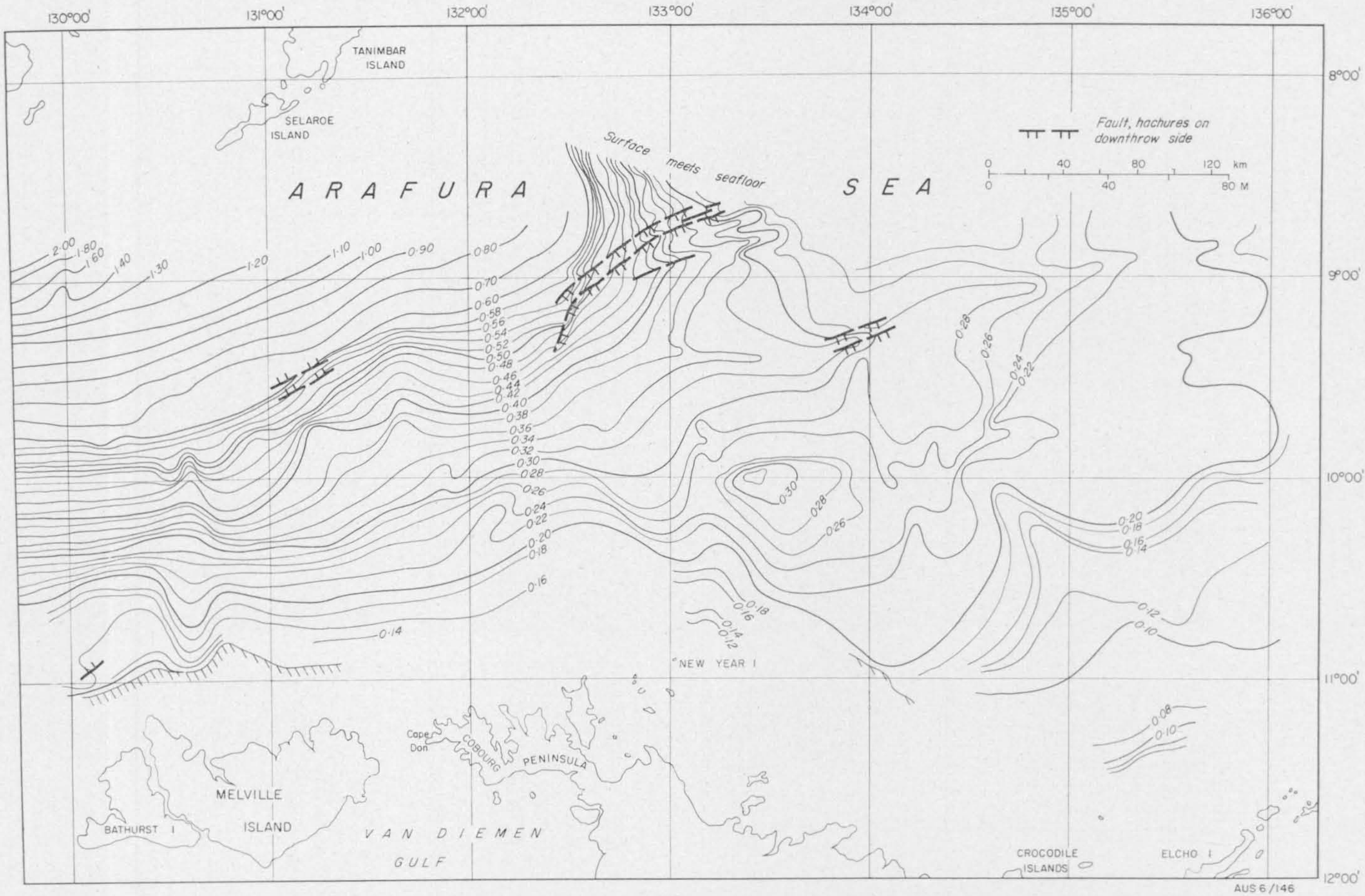

Figure 19. Isochrons on S3 (Plio-Miocene); intervals 0.02 and 0.10 second.

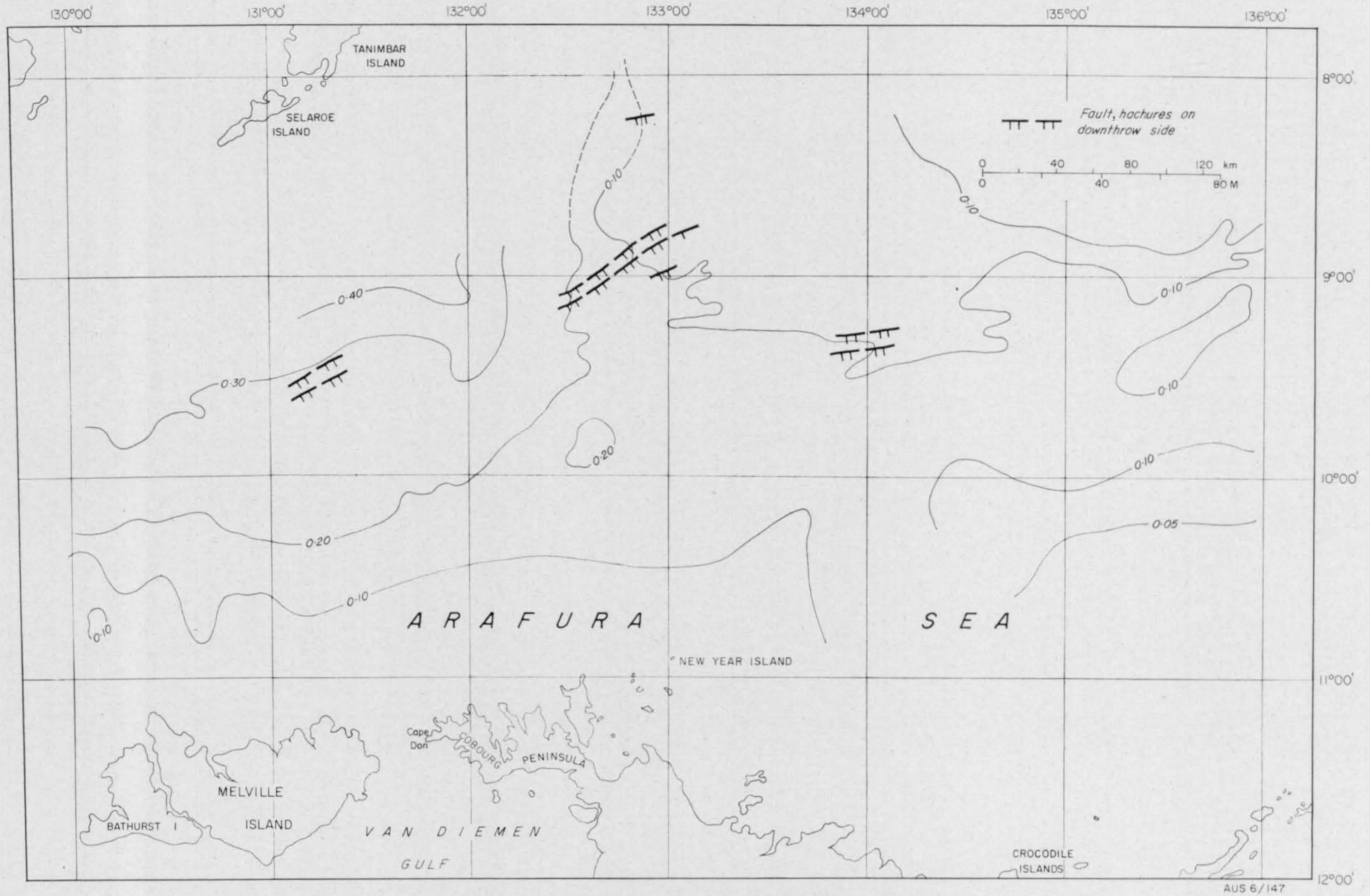

Figure 20. Pliocene to Recent (post-S3) isopachs; intervals 0.05 and 0.1 second.

but there appears to be a local deepening at the offshore margin of Arafura Basin (Traverse III, Fig. 10; Fig. 19). North of New Year Island S3 merges with the underlying S5 and it crops out on the sea floor near the margin of the Arafura Depression at about 8°30′S.

The lower Miocene-Eocene sequence between S3 and S4 averages less than 100 m in thickness over that part of the Arafura Shelf covered by the shallow seismic profiles, but appears to thicken to at least 150 m west of Bathurst Island (Traverse 1, Fig. 8).

Three shallow unconformities occur in the Pliocene-Quaternary section overlying S3, which as a whole thickens slowly and somewhat irregularly towards the Timor Trough and Aru Basin (Fig. 20). The two lower surfaces, S1 and S2, which are equivalent to the S1 and S2 of Veevers (1971), are probably the result of Plio-Pleistocene fold movements in Timor and New Guinea. The youngest surface, SH, is believed to represent a late Pleistocene eustatic low sea-level erosional period. S2 is recognizable throughout most of the Arafura Shelf, but merges with S3 landwards. It crops out near 9°S, 133°30′E, where it forms an irregular surface. In the central and northeastern part of the area in particular, it is clearly an erosional surface dissected by numerous channels which in some places have cut down to below S3 (Traverse VI, Fig. 11). The sequence between S2 and S3, which must be mainly, if not entirely, Pliocene, has a maximum thickness observable in the shallow seismic records of about 190 m, although the average thickness under the shelf is about 75 m. Regional thinning of the sequence overlying S3 to the south and east is shown in Figure 20.

A maximum of 100 m of Plio-Pleistocene sediments occurs between unconformities S1 and S2 on the upper continental slope north of Melville Island. This sequence thins southwards and pinches out under the shelf where S1 and S2 merge. S1 is usually a rather weak reflector underlying the acoustically transparent superficial sediments. It crops out in several places near the edge of the shelf and is commonly exposed in channels and areas of sea-floor scour. In several places S1 displays a sharp break in slope overlain by prograding sedimentary units in the region of the present-day shelf margin, indicating a previous cycle of erosion and deposition.

The youngest surface recognizable in the shallow seismic profiles (SH) appears at the southern end of Traverses 4, 6, and 7 north of Melville Island (Figs 8 and 9), and is overlain by a maximum of 22 m of acoustically transparent superficial sediments. SH is undoubtedly present over wide areas where it is too close to the sea floor to be resolved in seismic sections. A gravity core taken on the outer shelf (0100 hours, Traverse 7, Fig. 9) recovered 1.3 m of soft green clay overlying a fossil soil horizon containing wood which gave a radiocarbon date of 14 500 ± 700 years B.P. (Jongsma, 1970). Although the wood was possibly transported, it is believed that the fossil soil was formed before the transgression caused by the Holocene rise in sea level, and the SH represents the subaerial surface exposed during the last Pleistocene eustatic low sea-level stillstand.

MORPHOLOGY AND QUATERNARY GEOLOGICAL HISTORY

Bathymetric contours shown on the 1 : 1 000 000 continental shelf sediments map and in Figure 5 were compiled from published and unpublished R.A.N. Hydrographic Office data, oil company surveys, and echo-sounding traverses run during the BMR 1969 marine geological survey. The density of soundings is uneven, being much less in deeper waters beyond the edge of the shelf, and on the shelf itself in the eastern part of the area north of 9°80′S, than it is elsewhere.

Continental shelf

The Arafura Shelf south of 8°S can be divided on morphological grounds into two areas: south of 10°S it is undissected and almost flat except where it approaches the Van Diemen Rise near its western margin. However, north of 10°S and east of 133°E there are many channels, terraces, and ridges, and a subaerial drainage pattern is discernible. Van Diemen Rise has an intricate relief of banks, terraces, and channels superimposed on the regional topography. The banks are closely spaced and are separated by narrow, somewhat sinuous channels. The tops of the banks are quite flat; the slopes are steep (7 to 19°) and in some places are interrupted by terraces. According to van Andel & Veevers (1967, p. 32), the deepest parts of the channels occur where they cut through the highest part of the Rise. All channels shoal towards the edge of the shelf at a depth of 100 to 110 m and are clearly erosional. Bank tops at 55 m and 33 m are crossed in Traverses 1, 2, 3, and 4 (Fig. 8). The similarity of these features to the topography of Bathurst and Melville Islands led van Andel & Veevers (1967) to conclude that the Van Diemen Rise may represent a submerged continuation of the same landscape. There is also a striking similarity between the topography of the Van Diemen Rise and that of the Aru Islands to the northeast.

The central and southern parts of the Arafura Shelf are undissected, flat, and mainly featureless. Two banks are present: Lyndoch Bank, near the shelf edge, rises from 110 to 11 m, and Money Shoal in the middle of the shelf farther east rises from 60 to 6 m.

In the northeastern part of the Arafura Shelf between 8°S and 10°S and east of 133°E is a highly irregular surface similar to that of the Van Diemen Rise. Channels and banks are aligned in a southeast direction and the highest relief occurs at the head of the Arafura Depression. Two shallow banks, Volsella Shoal and Duddel Shoal, rise from a depth of 60 m in the middle of the shelf close to the 136°E meridian.

The erosional origin of the channels is clearly demonstrated in the seismic profiles by the truncation of subsurface reflectors at the channel sides. This fact, combined with the general similarity of the shelf morphology to the present-day subaerial landscapes, strongly suggests that the regional morphological pattern is the result of subaerial erosion, although some extension and modification of the banks and terraces by reef growth may have taken place since submergence.

According to van Bemmelen (1949), Fairbridge (1953), and van Andel & Veevers (1967), the northern Australian continental shelf was affected by slow epeirogenic movements in response to the orogenic disturbances of the bordering geosynclines of the Timor/New Guinea region. This slow deformation started in the early Precambrian and followed the same structural trends throughout its history (Fairbridge, 1953). The erosional topography at the head of the Arafura Depression may thus be a result of the differential movement between the depression and the Merauke Rise to the north. This slow movement coupled with the presence of an old river system, during low sea-level stands in the Pleistocene, gave rise to the dissected topography now seen at the head of the Arafura Depression.

In contrast, the flat featureless floor in the more stable region in the central and southern parts of the Arafura Shelf south of 10°S indicates the absence of surface drainage during Pleistocene low sea-level stands; although breaks in deposition must have occurred during glacial epochs, on the whole the area has been one of continuous sedimentation during the Cainozoic.

Continental slope

The continental slope in the Arafura Sea near the Arafura Depression is inclined at a very gentle angle, about 0.2°, down to -550 m, at which depth there is a marked increase in gradient to about 0.75°. These gradients are much less than those of typical continental slopes in other parts of the world, which average about 4° for the first 2000 m (Shepard, 1963, p. 298). To the north and west the slope increases considerably. The twofold division of the continental slope of northern Australia into a relatively steep lower part and a gently inclined upper part has been noted by other workers (Kuenen, 1935; Fairbridge, 1953; Veevers, 1971); the upper part has been variously described as an outer shelf (Fairbridge) and an upper slope (Veevers), and a somewhat similar feature on the northwest Australian continental margin between the shelf and the slope proper has been termed a marginal plateau by Jones (1973). In this survey several seismic profiles were run across the upper slope in the southwestern part of the Arafura Sea. Except near the head of the Arafura Depression, where the subaerial drainage pattern crossing the shelf extends down onto the upper slope, the profiles indicate that the upper slope has a generally smooth surface. Canyons dissecting the continental slope are not known, but data are sparse in the deeper water.

Shelf-edge features in relation to eustatic sea-level changes

Several notches, terraces, and scarps believed to be related to Pleistocene low sea levels have been noted at the edge of the shelf and on the upper continental slope in the Arafura Sea. The complexity of these features and their apparent discontinuity, which may be partly attributable to the sparsity of data and the lack of resolution of the sounding equipment, make it difficult to obtain a clear picture of their inter-relationships and origin. They occur at depths ranging from 122 to 250 m and are grouped at or around the following eight separate levels: 122 m, 134 m, 147 m, 154 m, 163 m, 174 m, 181 m, and 225 m.

The shallowest notches, terraces and changes in slope, between 122 and 134 m, may record evidence of the late Pleistocene low sea-level stand reported from various parts of the globe and dated at about 15 000 years B.P. Dating of a possible subaerial surface in the Arafura Sea also supports lowering of sea level at about this time. As mentioned earlier, at the base of a core 130 cm long in a water depth of 99 m, wood which possibly formed part of an ancient soil horizon was dated at 14 500 ± 700 years B.P. (Table 2).

The difficulty of correlating terraces in this area is demonstrated by the next series of terraces and notches between 147 m and 181 m. For instance, in Traverses 6 and 7 (Fig. 9), which are less than 13 km apart, a scarp is present on the shelf edge; in Traverse 6 it is divided into two steps with terraces at 157 and at 151 m, and the combined height of the two scarps is 15 m; on the other hand, in Traverse 7 the scarp is continuous, 25 m in height, and the terrace at the base of the scarp is at 161 m. An echo-sounder profile near a bank near the head of the Arafura Depression at the site of the third submersible dive (9°14′S, 133°24′E) shows four terraces between 122 and 180 m on the side of the bank; the terraces and notches between 147 and 183 m would require closely controlled sampling and dating to allow correlation with individual eustatic sea levels. A similar situation is reported in other parts of the continental shelf of Australia off Sydney (Phipps, 1967) and on the Great Barrier Reef (Maxwell, 1968; Veeh & Veevers, 1970). Veeh & Veevers, from dating of shallow-water fossils at 175 m, postulated that these terraces were formed during successive stillstands between 17 000 years and 13 600 years B.P. Beach rock dredged from a depth of 130 to 175 m in the Arafura Sea gave a radiocarbon age of 18 700 ± 350 years B.P., close to the older limit of this range (Table 3).

TABLE 2. ISOTOPIC DATES OF ARAFURA SEA SAMPLES.

Station No.	Location: Latitude south	Location: Longitude east	Depth (m)	Age B.P. (years)	Material
1231	9°07′	133°52′	130-175	18 700 ± 350[1]	Beach rock
Dive II	9°55′	130°03′	210-200	170 000[2]	Coral
1225	9°44′	131°00′	117	30 000[1]	Shells, base of 125-cm core
1222	10°20′	130°46′	90	14 500 ± 700[1]	Wood, base of 130-cm core

[1] Radiocarbon dates by the Department of Nuclear and Radiation Chemistry, University of New South Wales, Sydney.

[2] Uranium series date by H. H. Veeh, Australian National University, Canberra.

The deepest notch occurs in the upper continental slope at depths of 200 to 250 m (Pl. 2). A similar feature at about -200 m has been recorded on other parts of the Australian continental margin by Conolly (1969), and in both Australian and Californian waters by Dill (1969). In the Arafura Sea the notch was observed during two dives in the submersible *Yomiuri,* when it was found that the trough was floored by mud, and the cliff on its landward side was composed of dead coral and beach rock (Pl. 3, figs. 1 and 2). A sample taken from the base of the cliff with the mechanical arm of the submersible consisted of algal material, bryozoans, mollusc shells, and shallow-water corals. The coral, which was not recrystallized, had a minimum age of 170 000 years B.P. when dated by the uranium/thorium method. This indicated that it was formed during one of the earlier glacial stages, possibly the Riss, which Donn et al. (1962) suggested brought about the maximum eustatic lowering of sea level.

One other date on material from a short core bears on the late Quaternary geological history of the Arafura Sea. A core on the central shelf north of Melville Island in 117 m of water bottomed in a shelly layer 125 cm below the surface. Abraded shells from this layer gave a radiocarbon age older than 30 000 years B.P. This worn shelly material may not be a littoral deposit, but even if it is the shells may significantly antedate the transgression which resulted in the deposition of the overlying sediments.

Age dating and shelf-edge morphology indicate the following sequence of eustatic events:

(1) A very low eustatic sea-level stillstand at about 200 m before 170 000 years B.P.;
(2) A transgression before 30 000 years B.P.;
(3) A subsequent lowering of sea level after 30 000 years B.P., which appears to have fluctuated, forming terraces and notches between -180 and -120 m;
(4) A transgression from about -120 m which reached half-way across the present-day shelf by 14 500 years B.P.

Quaternary sedimentation

There is no direct evidence about the nature of the subsurface Quaternary sediments, which must have been extensively reworked during transgressions and regressions. Coral reef development apparently continued during glacial maxima. During interstadial periods of high sea level it is likely that conditions similar to those on the present-day shelf prevailed, with terrigenous sand near shore and silt and clay on the middle shelf, and a general increase in carbonate content seawards. On the outermost shelf coarse relict shelly sediments predominate and further evidence of non-deposition is provided by the abundance of glauconite. Fine-grained pelagic sediments are found on the upper slope, where deposition was uninterrupted during the Quaternary.

Some indication of rates of sedimentation since the Holocene transgression is provided by the radiocarbon date on a core and by interpretation of the shallow seismic sections. They suggest that on the middle shelf fine-grained sediment has accumulated at a rate of a little under 10 cm per 1000 years, while inshore coarser-grained sediments have been laid down at about 2 m per 1000 years. Extensive winnowing and some erosion have taken place over wide areas near the edge of the shelf, but there has been no deposition in these areas.

SURFACE SEDIMENTS

Methods of treatment

Sediment colour was determined on the fresh samples on board ship. Textural analysis in the laboratory involved wet-sieving to separate the gravel (+2 mm) from the sand (2.0 to 0.063 mm) and the silt plus clay (-0.063 mm). The relative proportions of silt and clay were determined by the pipette method.

Chemical determination of CO_2 and P_2O_5 was carried out by the Australian Mineral Development Laboratories. Mineralogical and biogenic composition were determined by thin-section petrography and unconsolidated material was examined under the binocular microscope. Heavy-mineral separations were carried out on all samples by conventional techniques and selected samples were statistically analysed. The distribution of the sample stations is shown in Figure 2, and station data and basic sediment characteristics are tabulated in the Appendix.

Colour

The colour of the surface sediments was determined at the time of recovery by reference to the Rock-Color Chart (Geological Society of America, 1959). Colour determinations were not made on samples collected on the *Yamato* (Nos. 800 to 862). Of the 311 colour determinations, 75 percent of the samples were either dusky yellow-green (5 GY 5/2, 41 percent) or greyish green (10 GY 5/2, 34 percent). Figure 21 shows sediment colour distribution in the Arafura Sea. The greenish hues are mainly due to the presence of glauconite. An increase in carbonate sand-size or gravel-size particles imparts a lighter more yellowish colour to the sediment. Compared with the colour of the Timor Sea sediments (van Andel & Veevers, 1967) there is a similar predominance of dusky yellow-green (5 GY 5/2) sediment, but the range of colour in the Arafura Sea appears to be smaller.

Texture

Shepard's (1954) sand-silt-clay diagram (Fig. 22) was used to describe the regional textural distribution of the Arafura Sea sediments. The end members in this classification have a purely textural significance, as intended by Shepard. Arafura Sea sediments are dominantly calcareous and hence the names of the end members should, strictly speaking, be calcarenite, calcisiltite, and calcilutite (Pettijohn, 1957). Shepard's classification refers only to the fraction finer than 2 mm. Material coarser than 2 mm has been expressed as a percentage of the total sample and is plotted as a distribution map in Figure 23 and as an overprint on Plate 6.

The sediments of the Arafura Sea are low in silt-size particles and are chiefly coarse-grained. The textures of the samples range between sand and silty clay. The highest proportion (25 percent) of the samples lies in the sand-silt-clay range with a slightly higher clay than silt content. Sand and clayey sand comprise 24 percent and 22 percent respectively, and 18.2 percent of the samples are silty clays. The remaining samples are divided between sandy clay (4.9 percent), silty sand (3.1 percent), and clayey silt (2.6 percent). Only one sample on the diagram plots as a clay and one as sandy silt.

The distribution of the various textural groups is shown in Figure 24. Sand or calcarenite covers the edge of the shelf in the eastern part of the survey area, and occurs close inshore east of Bathurst Island. Narrow bands of clayey sand or sand-silt-clay separate the sand from a broad band of fine silty clay covering the middle of the shelf. Towards the southeast corner, near Arnhem Land, sand-silt-clay and clayey sand predominate. In the northeast corner the dissected bottom topography is covered by sand, silty sand, or clayey sand. Sands on the edge of the shelf grade into clayey sand and sandy clay as depth increases west of 132°E, but otherwise there is little correlation between sediment texture and water depth.

The distribution of material coarser than 2 mm is shown in Figure 24. The gravel component of samples near the Arnhem Land coast is of terrigenous origin and consists of ferruginous siltstone and sandstone fragments. On the edge of the shelf, and in the northwestern part of the survey area, the gravel component is largely shelly material and consists of relict shallow-water forms deposited during Pleistocene low sea-level periods (Pl. 4, fig. 1). This zone is too far from present-day sources of sediment supply to be buried by Recent fine-grained detritus.

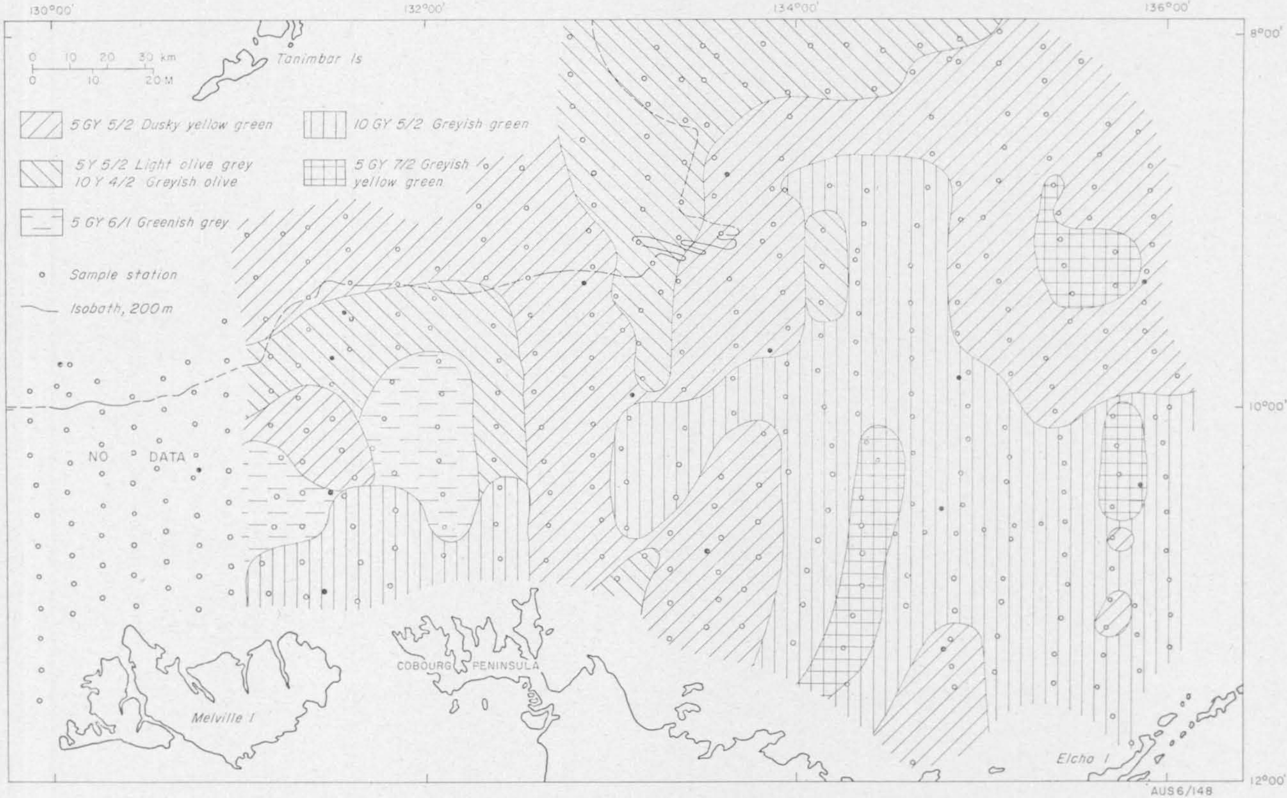

Figure 21. Colour of surface sediments. Less than 5 per cent of the samples have colours falling outside the groupings shown.

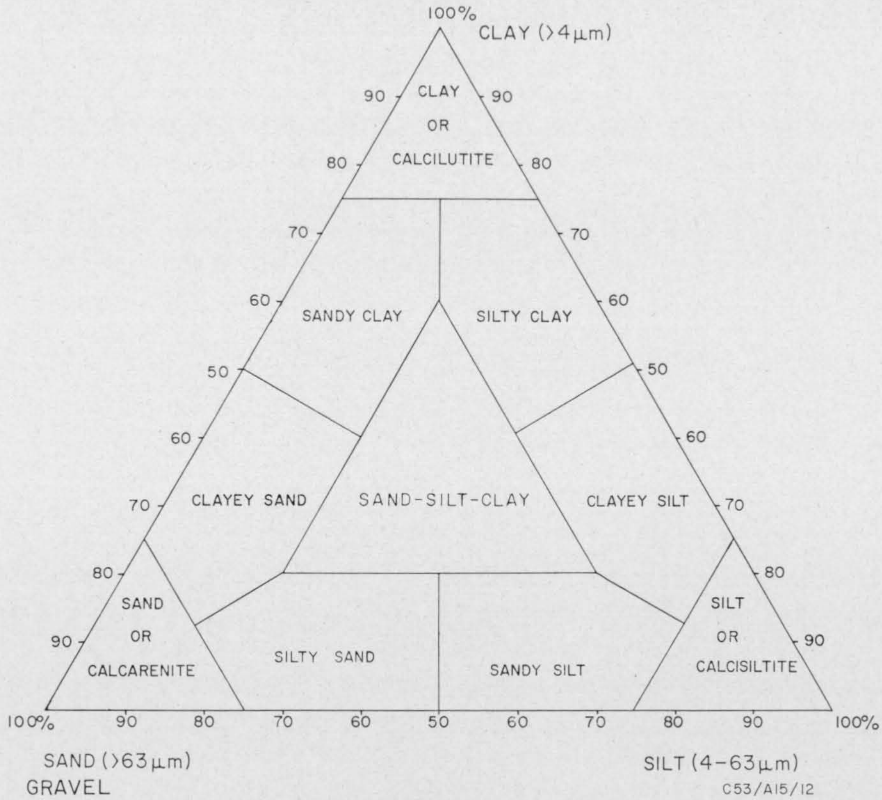

Figure 22. Sand-silt-clay diagram (after Shepard, 1954) used in textural classification.

Carbonate

All the Arafura Shelf sediments are calcareous, and values for total carbonate range from 8 to 100 percent. A strong positive correlation between grainsize and carbonate content is superimposed on the regional increase in carbonate away from sources of terrigeneous sediment. On the edge of the shelf, where coarser sediments are present, the carbonate content is over 50 percent (Fig. 25). A wide band of almost pure calcarenite is found on the edge of the shelf north of Bathurst and Melville Islands, where very little terrigenous material is present. Abundant benthonic and planktonic Foraminifera, together with relict mollusc shells, are present in this area and also in the highly calcareous sediments of the northwestern part of the shelf.

A small tongue of low-carbonate material occurs opposite the mouth of the Liverpool River and immediately north of New Year Island, and the wide area of fine-grained sediment with less than 40 percent carbonate which covers the middle shelf reflects the influence of terrigenous sediments originating from Dundas Strait.

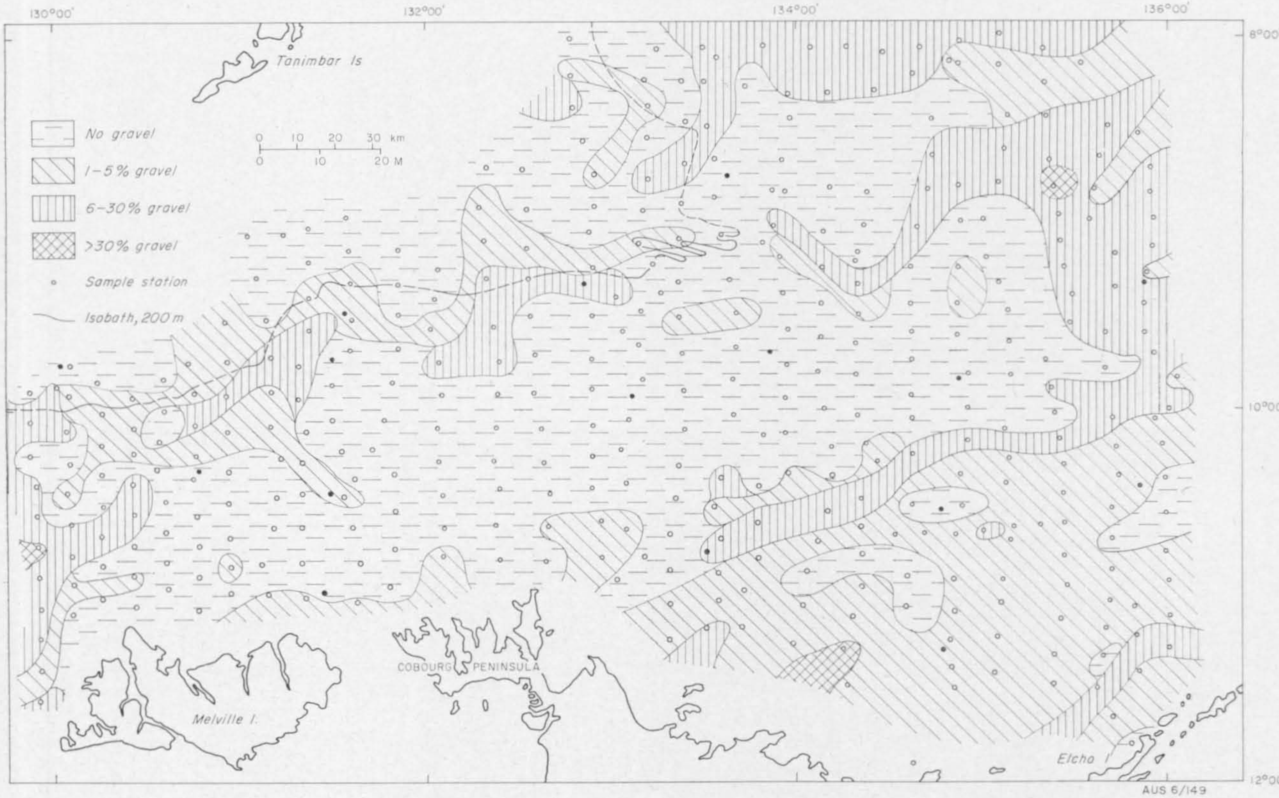

Figure 23. Gravel (greater than 2 mm) content of surface sediments.

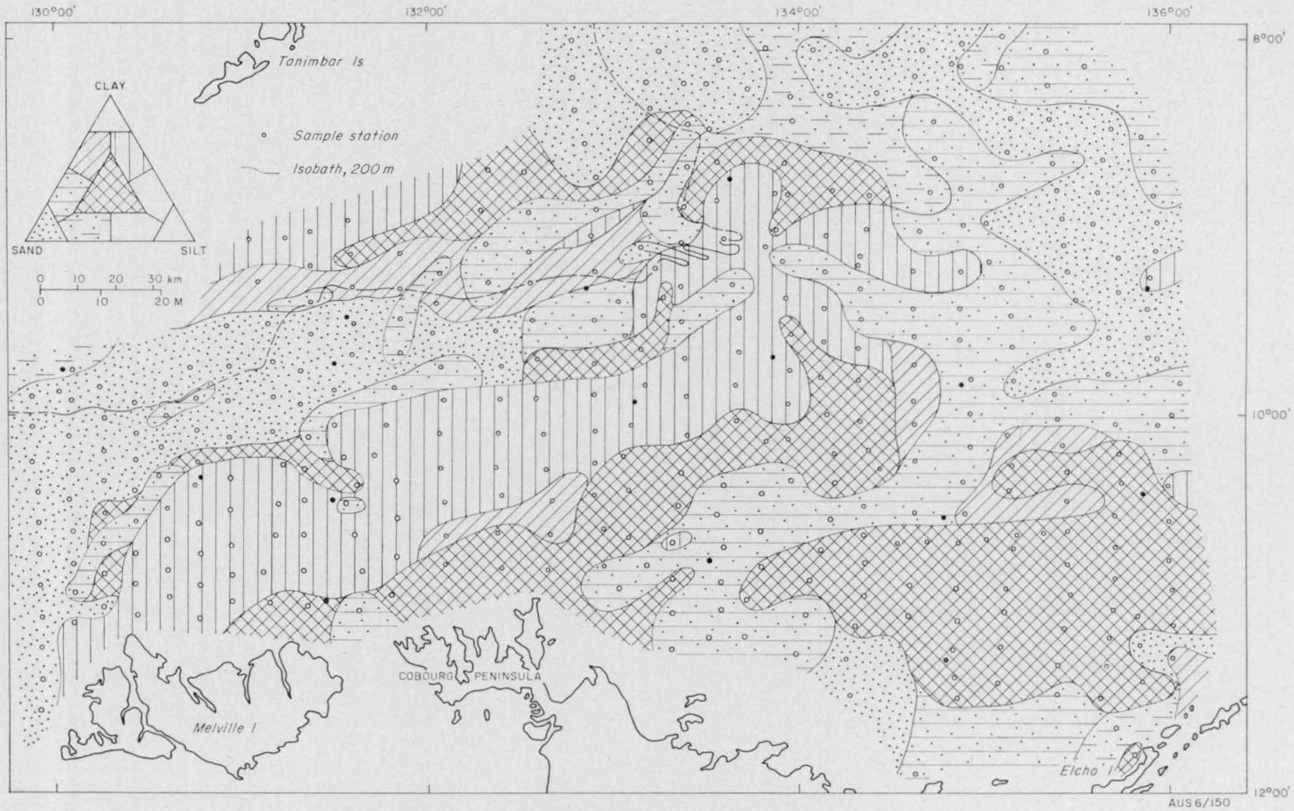

Figure 24. Textural distribution of surface sediments.

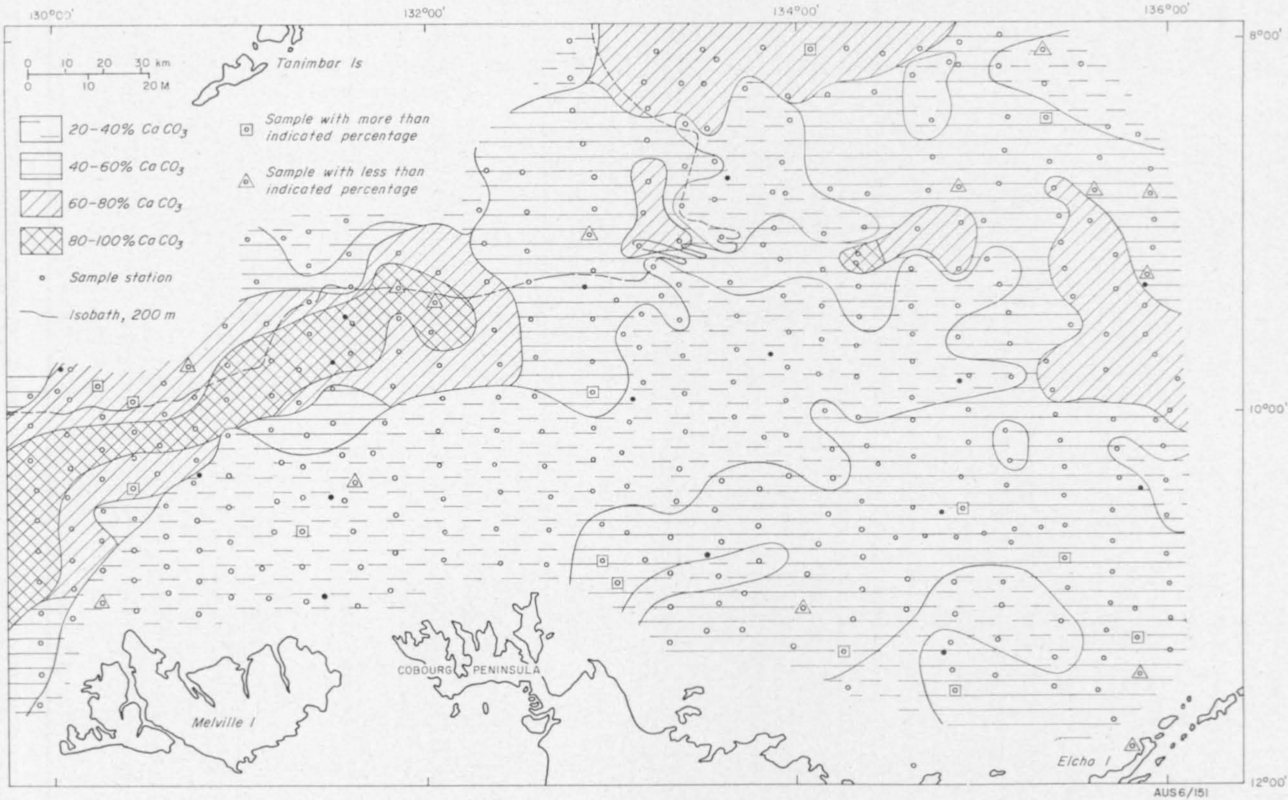

Figure 25. Calcium carbonate content of surface sediments.

On the upper slope in water more than 2000 m deep the carbonate content decreases towards the Timor Trough as a result of an increase in clay content. Van Andel & Veevers (1967) found a similar decrease in carbonate towards the Timor Trough in the area to the west. Timor sea sediments in general have a carbonate distribution similar to that of the Arafura Sea with a belt of low-carbonate fine sediments in the Timor Trough and upper slope, a band of pure calcarenites on the edge of the shelf, and a complex zone of mixed sediments on the shelf itself.

Phosphate

The sediments of the continental shelf are uniformly low in phosphate; a few samples from near the edge of the shelf contain 0.4 to 0.6 percent P_2O_5, but the great majority contains less than 0.4 percent, and a signficant number of inshore samples contain less than 0.2 percent (Fig. 26). On the upper slope in the northern part of the area in water depths of 225 to 254 m the phosphate content of the sediment is slightly higher; the maximum value recorded was 1.7 percent P_2O_5. This sample (Station 1126) contained shark's teeth, glauconite pellets, and many small pebbles of rock consisting of black limestone, quartz, and feldspar in a calcareous cement. Continuous seismic profiles show that there is very little Recent sediment cover in this area and in places channels are eroded down into a probable Miocene unconformity. The phosphatic material is probably derived from these older sediments. Somewhat similar phosphatic gravels, for which a Miocene age has been postulated, have been described by von der Borch (1970) and Marshall (1971) from the east coast of Australia near Nambucca Heads. Marine phosphorites of the Californian borderland (Dietz et al., 1942), the Chatham Rise (Norris, 1964), and the northwest African continental margin (Summerhayes et al., 1971) are also believed to be mainly Miocene.

In the Arafura Sea the phosphate content is usually highest in the coarser samples and is associated with glauconite. Under the microscope the phosphate appears to be included in the glauconite pellets as collophane and in some cases it is incorporated in sharks' teeth.

Quartz

Quartz is a minor constituent in most samples, but quartz content (Fig. 27) increases towards sources of terrigenous supply, as expected. Quartz content was determined by visual estimation in thin section and there is likely to be additional quartz too fine to be resolved under the microscope in the silt and clay fractions.

Samples taken near shore and particularly in the area north of Bathurst and Melville Islands contain an appreciable quantity of quartz. The quartz is sub-angular to rounded and commonly fractured, suggesting a long history of abrasion; it is probably the result of reworking of older sediments.

Near the northeast margin of the survey area subrounded quartz is abundant and widespread (Pl. 4, fig. 2), and in many places is very fine-grained. It was probably derived from Tertiary sediments underlying the shelf, which was extensively dissected during periods of lowered sea level. The heavy-mineral assemblage suggests an original derivation from the Arnhem Land Block.

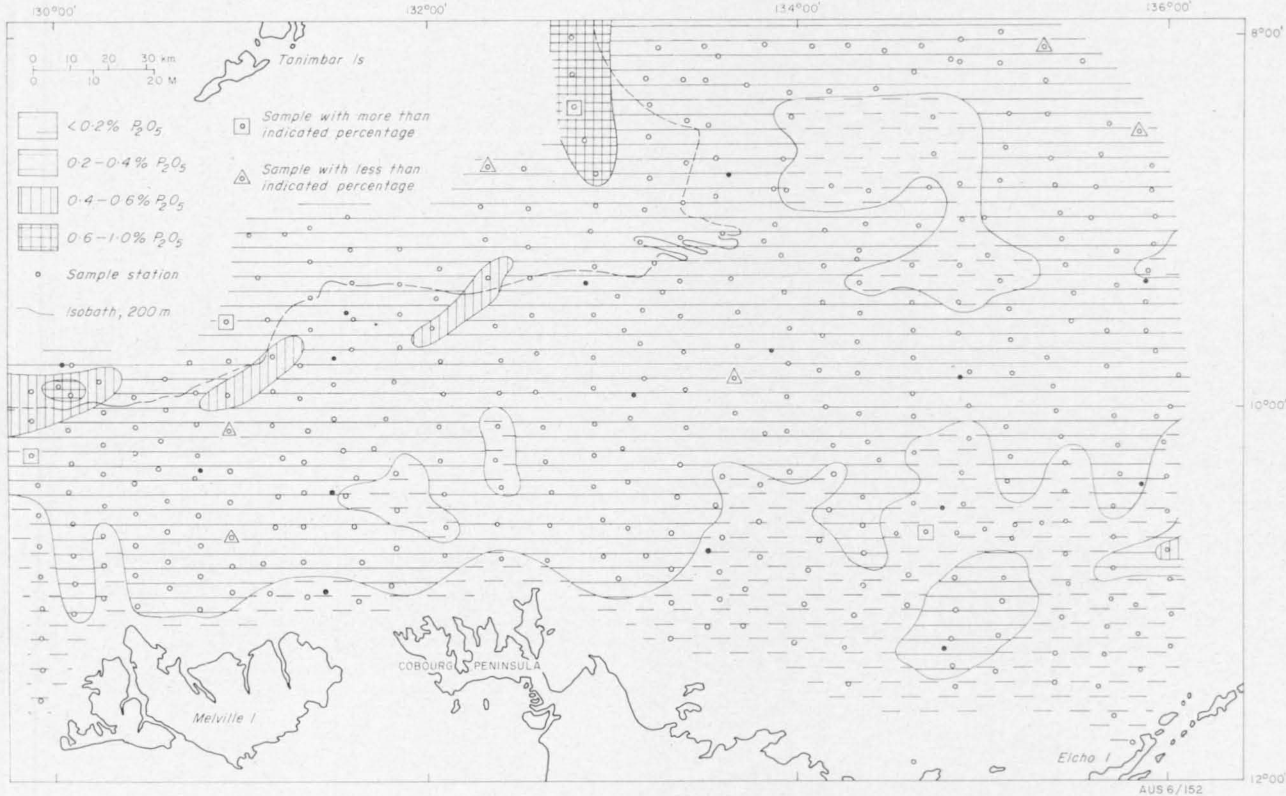

Figure 26. Phosphate (P_2O_5) contents of surface sediments.

Biogenic component

The benthonic organisms in the sediments deposited in the Arafura Sea include Foraminifera, molluscs, bryozoans, echinoids, pteropods, calcareous algae, and coral.

Near shore and over a wide area of shelf south of 10°S and east of 134°E benthonic material forms the bulk of the sediments. Thick-walled Foraminifera and bryozoans are also abundant along the northern margin of the area near Aru Island. On the middle and outer parts of the shelf the benthonic component decreases, but is still fairly well represented. Some local patches of winnowed sediment with mollusc shells occur on the edge of the shelf in deeper water. On the continental slope the benthonic component is absent and the sediment contains mostly planktonic Foraminifera.

Planktonic Foraminifera are abundant in the deeper water of the Arafura Sea and on the outer shelf, but are rare or absent in near-shore samples (Fig. 28; Pl. 5, fig. 1). Foraminiferal identification of samples taken on the *Yamato* by Professor H. Niino of Tokyo has shown that the most abundant planktonic species are *Globigerinoides ruber, Globoquadrina dutertrei, Globorotalia menardii,* and *Globigerinita glutinata.* Planktonic Foraminifera increase in number offshore. Benthonic Foraminifera, according to Professor Niino, are plentiful in samples taken between depths of 80 and 130 m, where organic remains are most abundant. Miliolidae and *Textularia* are common in sandy samples, whereas muddy facies support the growth of *Ammonia.*

Glauconite

The term 'glauconite' is used as a general name for green fine-grained authigenic minerals, and specific identification has not been attempted. According to Cloud (1955) and Burst (1958) glauconite is formed where little or no clastic sediment is being deposited, and Porrenga (1967) suggested that it is formed at depths of 30 to 2000 m and at temperatures lower than about 15°C.

Glauconite in the Arafura Sea occurs as bright green pellets and as greenish material filling gastropod and foraminiferal shells. On the Arafura Shelf glauconite is widespread, and is abundant in the northern and northeastern areas, where sedimentation is slow or absent (Fig. 29).

Van Andel & Veevers (1967) reported that glauconite pellets were most abundant in the Sahul Shelf in water shallower than 80 m. This is not the case in the Arafura Sea, where in the area near the embayment in the shelf in water depths over 200 m glauconite forms almost 30 percent of the total sediment. The pellets are bright green and glauconite is found replacing foraminiferal and molluscan tests. More rarely, bryozoan material is invaded by glauconite. The pellets range between 0.1 and 0.5 mm in maximum diameter and have an irregular ellipsoidal shape and a smooth waxy surface (Pl. 5, fig. 2). In places they occur in irregular masses of finely crystalline material. The infilling of tests by glauconite is in some instances at an advanced stage and the walls of the tests themselves are partly replaced by glauconite.

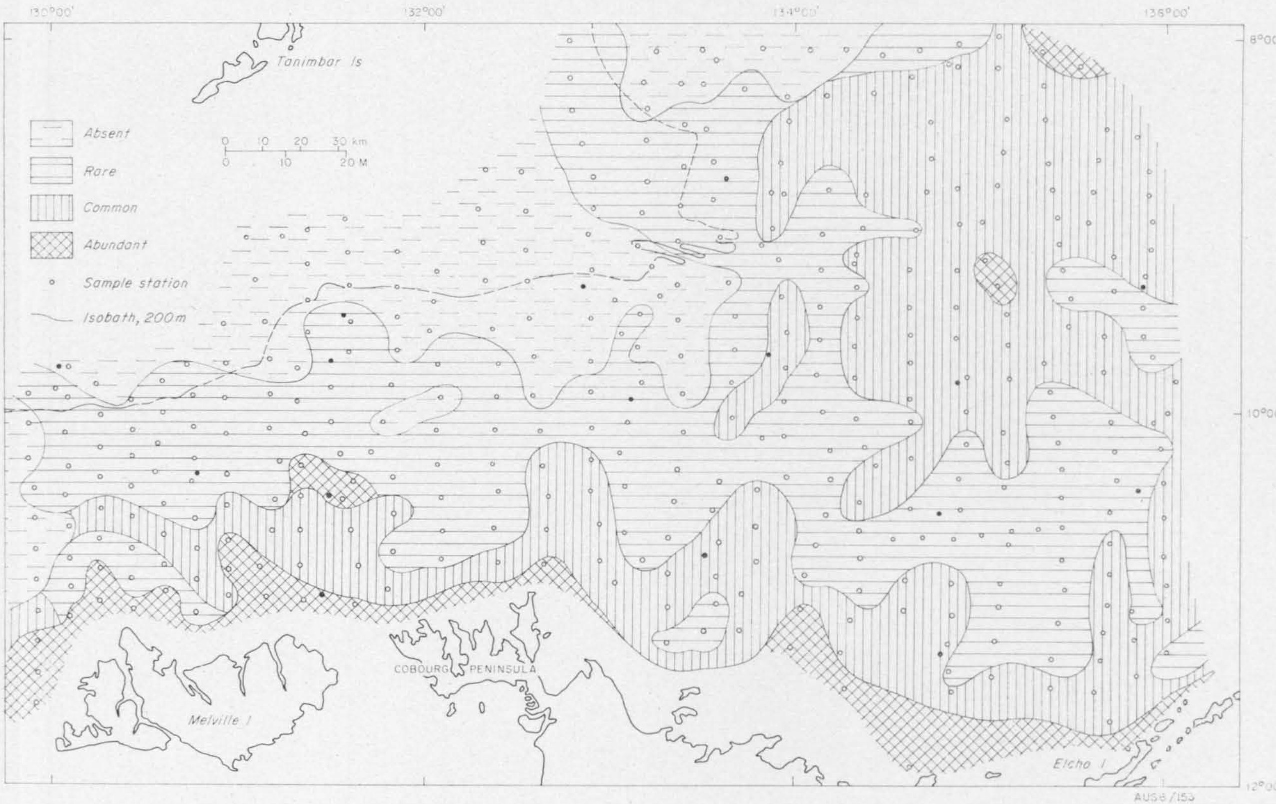

Figure 27. Distribution of quartz in surface sediments.

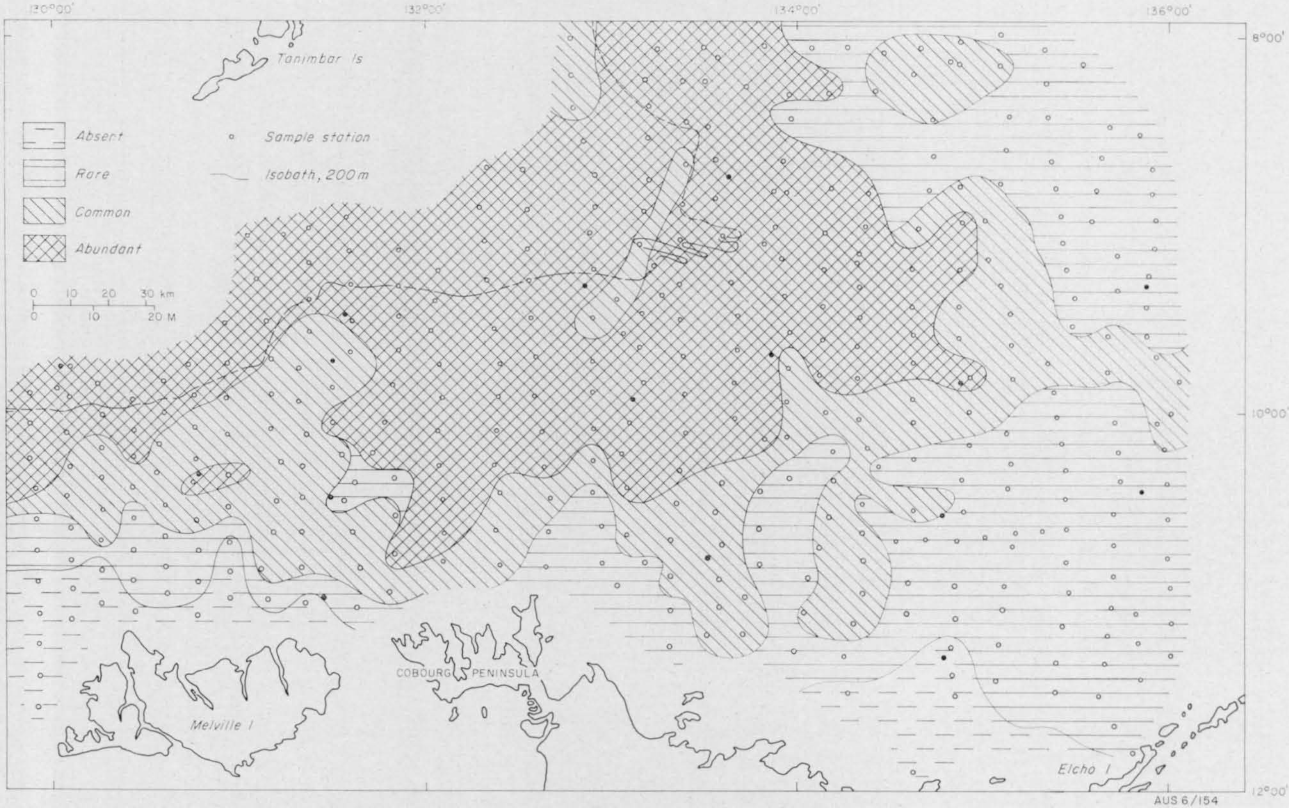

Figure 28. Distribution of planktonic Foraminifera in surface sediments.

Calcareous nodules and oolites

Brown calcareous nodules with diameters ranging from 2 to 10 mm are abundant in restricted zones. They are smooth, with rounded or irregular shapes, and usually brown or yellow with lustrous surfaces. They are identical with the pellets described by van Andel & Veevers (1967) on the Sahul Shelf and are composed of turbid micrite and may include very fine grains of quartz, small Foraminifera, and veins of sparry calcite.

The pellets are formed only in shallow water, as on the Sahul Shelf, and are most abundant between 40 and 80 m. According to van Andel & Veevers (1967, p. 80) they are similar to the concretionary nodules found in kunkar soils of southwestern Australia and in caliche soils of North America. They indicate a different Pleistocene climate during a low sea-level stand and may have formed in situ during the Wisconsin Regression.

On the Arafura Shelf the close control of depth on the distribution of the calcareous nodules is evident (Fig. 30), and this strongly suggests that their orgin is related to an ancient low sea-level stillstand during which they formed in a narrow littoral zone.

Oolites are rare on the Arafura Shelf and those which have been observed consist of structureless micritic pellets with thin concentric carbonate envelopes. Well developed oolite textures have not been seen in any of the samples.

Heavy-mineral provinces

Heavy minerals in the Arafura Sea sediments are common only in near-shore samples which contain a significant amount of terrigenous material. Separation of heavy minerals was completed for all samples; grain counts were carried out on 19 samples (Table 3) and visual estimates of the heavy-mineral suites were made on the rest of the samples.

Two distinct heavy-mineral provinces can be recognized (Fig. 31). One region north of Melville Island and Cobourg Peninsula is characterized by a very high content of opaques (mainly ilmenite), abundant zircon and tourmaline, and little or no amphibole. The assemblage is similar to that of the Darwin Province described by von der Borch (1965), and is in accordance with the tectonic stability of the depositional basin and its low, ancient, deeply weathered hinterland. The absence of unstable minerals is probably due to single-cycle maturation by lateritic weathering (van Andel & Veevers, 1967). The terrestrial component in the western part of the Arafura Sea is probably derived from the Mary, Adelaide, and Alligator Rivers, and to some extent the Daly River, which drain the partly lateritized Lower Proterozoic Pine Creek Geosyncline.

The eastern part of the Arafura Sea, north of Arnhem Land, is characterized by an assemblage rich in amphiboles and pyroxenes and relatively poor in opaques. The relative instability of this mineral suite in an area of tectonic stability is puzzling. The source terrain for the terrestrial component of these sediments is the Proterozoic rocks, which also have been extensively lateritized, and the survival of the amphiboles is difficult to explain. However, this lack of correlation between heavy-mineral assemblages and the general composition and degree of maturity of the source area is not uncommon elsewhere, according to van Andel (1960).

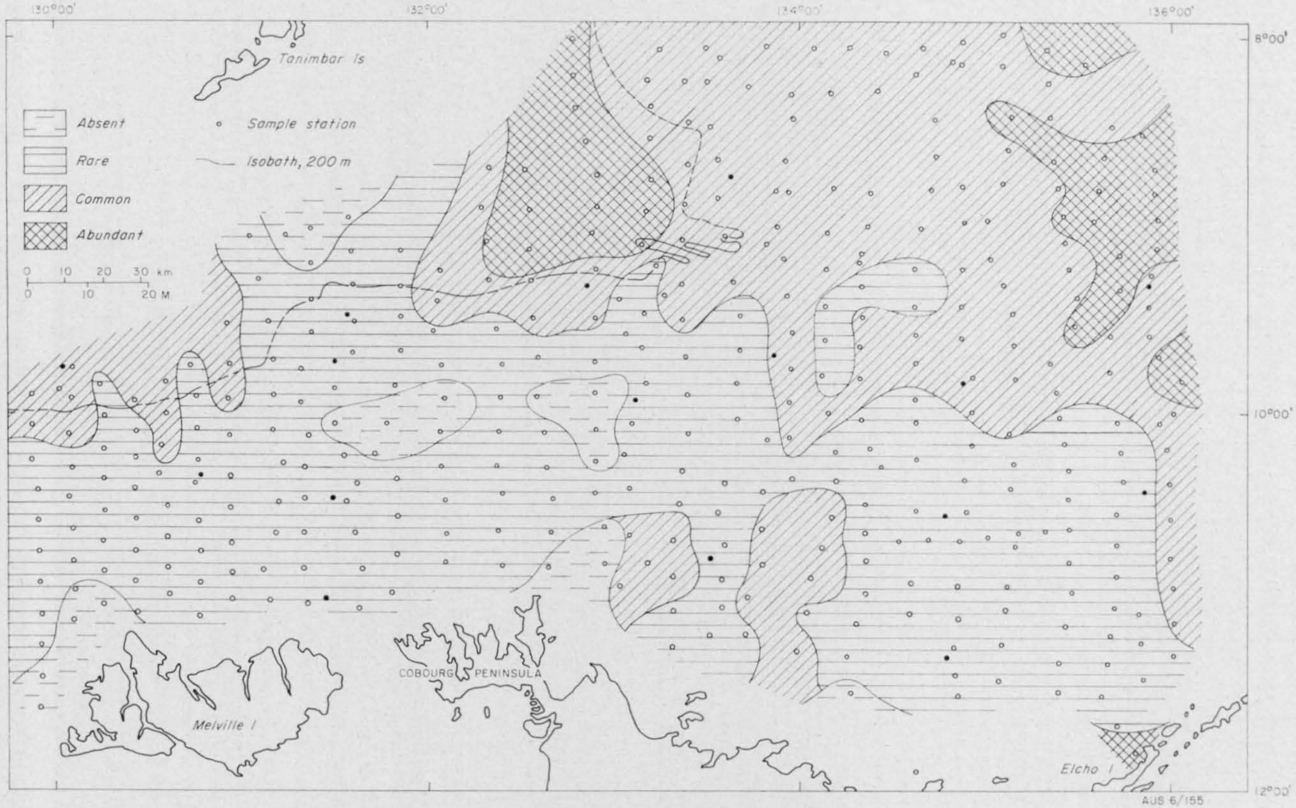

Figure 29. Distribution of glauconite in surface sediments.

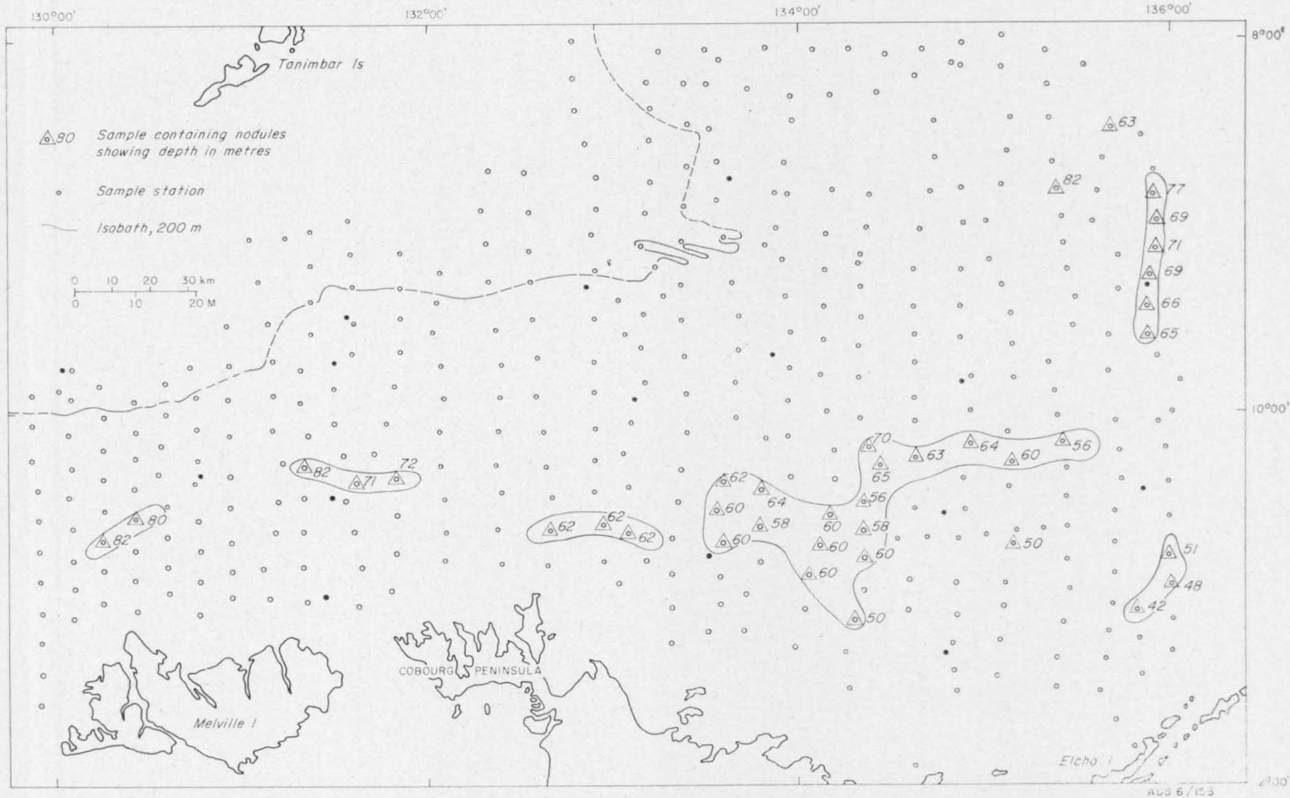

Figure 30. Distribution of concretionary calcareous nodules in surface sediments.

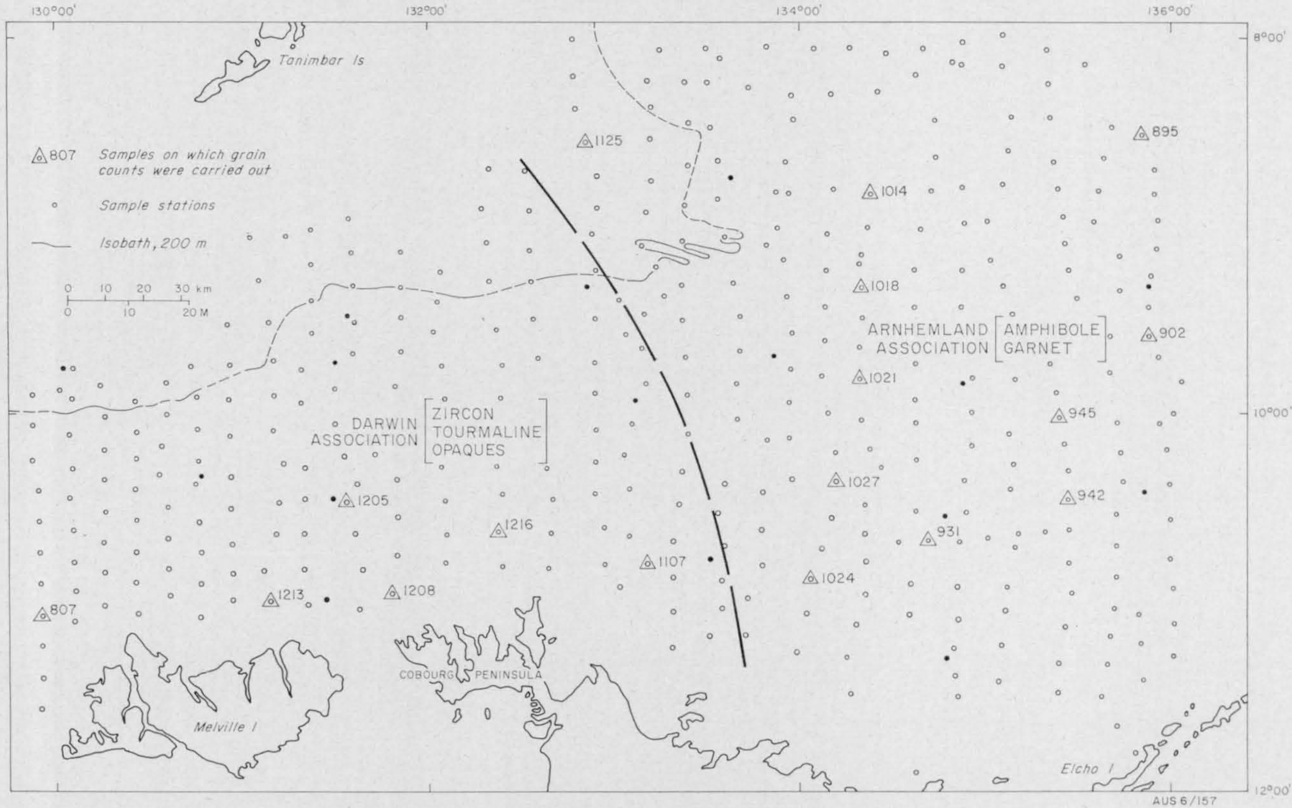

Figure 31. Heavy-mineral provinces in the Arafura Sea.

TABLE 3. HEAVY-MINERAL ASSEMBLAGES

Station Number	*Zircon*	*Tour-maline*	*Garnet*	*Stauro-lite*	*Kyanite*	*Epidote*	*Amphi-bole*	*Augite*	*Hypers-thene*	*Titan-ite*	*Opaques*	*Others*	
807	4	25	—	3	5	—	—	—	—	—	45	6	
1213	5	4	—	12	—	—	2	—	—	—	72	4	DARWIN
1205	2	4	—	5	—	1	—	—	—	—	83	5	ASSOCI-
1208	4	1	—	2	—	—	—	—	—	—	79	9	
1216	10	9	4	—	—	1	—	1	—	—	61	3	ATION
1107	23	1	1	1	—	1	—	—	—	—	60	10	
1125	—	—	4	—	1	1	38	9	3	—	18	22	
1024	12	9	3	—	—	3	3	—	2	—	42	9	
1027	5	7	3	2	1	4	31	—	1	—	23	14	
1021	5	2	11	1	—	1	18	—	1	—	35	15	ARNHEM
1018	5	2	10	—	—	—	17	—	—	—	45	—	
1014	3	6	6	—	—	4	9	—	4	—	43	12	LAND
1000	3	6	7	—	—	1	30	4	—	—	25	12	
931	6	2	6	—	—	3	14	2	6	—	49	12	ASSOCI-
942	9	3	10	2	—	1	25	—	—	—	24	12	
945	6	2	7	—	—	1	42	—	—	—	20	14	ATION
902	3	4	10	—	—	3	36	—	—	—	24	16	
895	1	1	8	—	—	—	43	4	6	—	28	9	
911	13	14	5	—	—	—	1	—	2	—	51	11	

Point Counts by W. Burgis on 100 grains.

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APPENDIX

STATION DATA, TEXTURAL DESCRIPTION, CARBONATE AND PHOSPHATE CONTENT

Sample No.	*Location S Latitude*	*Location E Longitude*	*Fix Category*	*Depth (m)*	*Sampling* Method*	*Date (1969) day/month*	*Time (CST)*	*Colour*	*Gravel %*	*Sand & Gravel %*	*Silt %*	*Clay %*	*Textural Description*	*Carbonate %*	*P_2O_5 %*
Y69-800	09°53.4′	129°53.5′		220	Condred	3/5	0900						Sand	59.6	0.5
Y69-801	10°03′	129°53.5′		150	„	3/5	1030		11	88	4	8	Sand	66.9	0.4
Y69-802	10°14′	129°53′		114	„	3/5	1200		11	90	3	7	Sand	90.4	0.7
Y69-803	10°24′	129°55′		88	„	3/5	1320		16	87	7	6	Sand	84.4	0.25
Y69-804	10°34′	129°55′		57	„	3/5	1430		8	92	3	5	Sand	91.3	0.15
Y69-805	10°44′	129°56′		34	„	3/5	1540		35	100	0	0	Sand	92.0	0.15
Y69-806	10°54′	129°55′		37	„	3/5	1650		9	95	2	3	Sand	95.5	0.1
Y69-807	11°04′	129°56′		78	„	3/5	1750		12	91	4	5	Sand	43.9	0.1
Y69-808	11°14′	129°56′		85	„	3/5	1910		24	83	8	9	Sand	41.2	0.15
Y69-809	11°22.5′	129°54′		50	„	3/5	2020		3	93	3	4	Sand	49.2	0.1
Y69-810	11°34′	129°56′		42	„	3/5	2200		29	89	5	6	Sand	30.4	0.15
Y69-811	11°06′	130°06′		24	„	4/5	0610		0	0	49	51	Silty clay	23.7	0.25
Y69-812	10°57′	130°06′		62	„	4/5	0720		4	53	16	31	Clayey sand	64.6	0.2
Y69-813	10°47′	130°06′		80	„	4/5	0830		8	80	7	13	Sand	78.0	0.2
Y69-814	10°37′	130°06′		55	„	4/5	0942		8	72	10	18	Clayey sand	76.4	0.2
Y69-815	10°27′	130°05′		94	„	4/5	1052		2	83	7	10	Sand	79.8	0.2
Y69-816	10°16.8′	130°06′		122	„	4/5	1201		0	81	8	11	Sand	83.3	0.4
Y69-817	10°06′	130°04.8′		156	„	4/5	1315		8	77	12	11	Sand	83.5	0.3
Y69-818	9°55′	130°05.5′		226	„	4/5	1505		4	85	7	8	Sand	78.2	0.65
Y69-819	9°45′	130°05.5′		298	„	4/5	1625		0	60	21	19	Silty sand	70.4	0.3
Y69-820	11°01′	130°16′		35	„	5/5	0735		0	84	6	10	Sand	8.1	0.1
Y69-821	10°51′	130°16′		67	„	5/5	0847		1	28	25	47	Sand-silt-clay	28.5	0.15
Y69-822	10°41′	130°16′		82	„	5/5	0955		7	61	15	24	Clayey sand	74.5	0.15
Y69-823	10°31′	130°16′		86	„	5/5	1100		0	28	27	45	Sand-silt-clay	51.1	0.25
Y69-824	10°21′	130°15.5′		114	„	5/5	1210		0	72	11	17	Clayey sand	71.1	0.25
Y69-825	10°11′	130°15.5′		128	„	5/5	1325		6	93	3	4	Sand	92.7	0.35
Y69-826	10°01′	130°15.5′		200	„	5/5	1445		3	71	10	19	Clayey sand	74.0	0.3
Y69-827	9°50′	130°15′		249	„	5/5	1600		0	80	8	12	Sand	80.9	0.5
Y69-828	11°04′	130°26′		36	„	6/5	0600		0	0	29	71	Silty clay	21.2	0.2
Y69-829	10°54′	130°26′		57	„	6/5	0710		2	5	23	72	Silty clay	23.9	0.2
Y69-830	10°44′	130°26′		69	„	6/5	0820		0	0	28	72	Silty clay	31.1	0.25
Y69-831	10°34′	130°26′		80	„	6/5	0930		9	42	17	41	Clayey sand	57.3	0.3
Y69-832	10°24′	130°26′		88	„	6/5	1040		24	84	6	10	Sand	84.9	0.35
Y69-833	10°14′	130°26′		114	„	6/5	1155		5	76	11	13	Sand	76.8	0.3

* Condred: small conical dredge. Boxdred: heavy box-section rock dredge. Tridred: triangular-section rock dredge.
Bigcore: 8-foot-barrel gravity corer. Fix category: see INTRODUCTION.

Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbonate %	P_2O_5 %
Y69-834	10°05′	130°26′		160	Condred	6/5	1305		2	83	5	12	Sand	81.0	0.3
Y69-835	9°55′	130°26′		208	„	6/5	1427		2	78	11	11	Sand	81.4	0.35
Y69-836	9°45′	130°26′		272	„	6/5	1542								
Y69-837	9°50′	130°36′		216	„	8/5	0730								
Y69-838	10°00′	130°36′		158	„	8/5	0950		0	65	16	19	Clayey sand	67.0	0.3
Y69-839	10°10′	130°34′		107	„	8/5	1100		0	91	5	4	Sand	87.6	0.25
Y69-840	10°20′	130°33′		100	„	8/5	1215		0	61	18	21	Clayey sand	71.0	0.25
Y69-841	10°30′	130°36′		86	„	8/5	1330		0	6	31	63	Silty clay	33.8	0.3
Y69-842	10°40′	130°36′		73	„	8/5	1445		0	0	36	64	Silty clay	29.0	0.25
Y69-843	10°50′	130°36′		60	„	8/5	1605		0	0	66	34	Clayey silt	26.0	0.25
Y69-844	10°59′	130°35.5′		46	„	8/5	1720		0	2	33	65	Silty clay	24.2	0.25
Y69-845	9°45′	130°44′		222	„	9/5	0705		3	91	4	5	Sand	27.4	0.15
Y69-846	9°55′	130°46′		174	„	9/5	0835		2	70	13	17	Clayey sand	78.2	0.35
Y69-847	10°05′	130°46′		110	„	9/5	1000		20	93	3	4	Sand	92.2	0.3
Y69-848	10°15′	130°46′		104	„	9/5	1115		4	50	25	25	Sand-silt-clay	69.7	0.25
Y69-849	10°23.3′	130°45′		92	„	9/5	1230		0	5	37	58	Silty clay	38.4	0.3
Y69-850	10°35′	130°46′		75	„	9/5	1355		0	14	32	54	Silty clay	36.3	0.35
Y69-851	10°45′	130°47′		60	„	9/5	1515		0	5	26	69	Silty clay	31.1	0.25
Y69-852	10°55′	138°46′		50	„	9/5	1635		0	4	35	61	Silty clay	26.4	0.25
Y69-853	11°05′	130°46′		34	„	9/5	1750		0	7	28	65	Silty clay	28.8	0.25
Y69-854	11°00′	130°56′		38	„	10/5	0910		0	16	29	55	Silty clay	36.1	0.25
Y69-855	10°49′	130°56′		49	„	10/5	1025		1	43	17	40	Clayey sand	31.1	0.2
Y69-856	10°40′	130°56′		54	„	10/5	1145		2	26	24	50	Sand-silt-clay	27.6	0.15
Y69-857	10°30′	130°56′		80	„	10/5	1310		0	2	28	70	Silty clay	28.3	0.2
Y69-858	10°20′	130°56′		92	„	10/5	1430		0	6	34	60	Silty clay	38.9	0.2
Y69-859	10°08′	130°56′		102	„	10/5	1453		5	85	8	7	Sand	33.8	0.1
Y69-860	9°56′	130°56′		126	„	10/5	1715		8	88	5	7	Sand	83.5	0.4
Y69-861	9°44′	130°57′		158	„	10/5	1830		2	79	9	12	Sand	91.3	0.25
Y69-862	9°32′	130°58′		210	„	10/5	1950		3	77	9	14	Sand	79.8	0.4
P69-885	11°17′	136°02′	C	42	„	1/10	0800	10 GY 5/2	7	33	18	49	Sandy clay	43.0	0.15
P69-886	11°07′	136°02′	D	44	„	1/10	0910	10 GY 5/2	3	32	22	46	Sand-silt-clay	45.3	0.15
P69-887	10°50′	136°02′	C	48	„	1/10	1018	10 GY 5/2	3	33	29	38	Sand-silt-clay	46.0	0.15
P69-888	10°46′	136°00′	C	51	„	1/10	1123	10 GY 5/2	4	36	26	38	Sand-silt-clay	45.3	0.45
P69-889	10°34′	136°00′	C	55	„	1/10	1235	10 GY 5/2	1	26	25	49	Sand-silt-clay	38.4	0.15
P69-890	10°23′	136°00′	C	59	„	1/10	1347	10 GY 5/2	0	10	30	60	Silty clay	28.5	0.15
P69-891	10°12′	135°59′	C	66	„	1/10	1453	10 GY 5/2	5	53	15	32	Clayey sand	58.0	0.15
P69-892	10°01.5′	136°01′	D	69	„	1/10	1601	10 GY 5/2	18	66	16	18	Clayey sand	63.3	0.2
P69-893	9°50′	136°03.5′	C	64	„	1/10	1707	5 GY 5/2	3	72	10	18	Clayey sand	60.0	0.2
P69-894	9°42.5′	135°56.5′	C	64	„	1/10	1814	5 GY 5/2	8	78	10	12	Sand	64.2	0.2
P69-895	8°31′	135°51′	C	64	„	2/10	0750	5 GY 5/2	5	69	6	25	Clayey sand	33.6	0.15

Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbonate %	P_2O_5 %
P69-896	8°42′	135°55′	D	77	Condred	2/10	0910	5 GY 5/2	20	69	9	22	Clayey sand	48.5	0.2
P69-897	8°50′	135°55′	C	77	,,	2/10	1025	5 GY 5/2	12	39	19	42	Sandy clay	31.5	0.25
P69-898	8°58′	135°56′	C	69	,,	2/10	1135	5 GY 5/2	13	78	4	18	Sand	54.5	0.2
P69-899	9°07′	135°55′	C	71	,,	2/10	1244	5 GY 5/2	17	75	14	11	Sand	57.0	0.2
P69-900	9°16′	135°54′	C	69	,,	2/10	1353	5 GY 5/2	1	19	37	44	Silty clay	31.7	0.15
P69-901	9°26.5′	135°52.5′	C	66	,,	2/10	1504	5 GY 5/2	24	81	8	11	Sand	78.7	0.2
P69-902	9°36′	135°53.5′	D	65	,,	2/10	1615	5 GY 5/2	6	82	8	10	Sand	70.4	0.25
P69-903	9°36′	135°40.5′	C	66	,,	2/10	1725	5 GY 5/2	7	84	6	10	Sand	70.2	0.25
P69-904	9°48′	135°40′	C	69	,,	2/10	1837	5 GY 5/2	0	81	11	8	Sand	62.8	0.25
P69-905	10°42′	135°43	C	57	,,	3/10	0540	5 GY 5/2	1	26	28	46	Sand-silt-clay	42.3	0.15
P69-906	10°52′	135°42′	C	54	,,	3/10	0719	10 GY 5/2	5	36	24	40	Sand-silt-clay	43.5	0.2
P69-907	11°02′	135°42′	D	54	,,	3/10	0828	5 GY 5/2	6	33	30	37	Sand-silt-clay	42.3	0.15
P69-908	11°32′	135°41′	C	49	,,	3/10	0937	5 GY 5/2	5	42	27	31	Sand-silt-clay	48.8	0.15
P69-909	11°20.5′	135°40′	B	44	,,	3/10	1047	10 GY 5/2	0	40	38	22	Sand-silt-clay	41.6	0.15
P69-910	11°31′	135°38′	A	39	,,	3/10	1155	10 GY 5/2	20	44	30	26	Sand-silt-clay	42.3	0.15
P69-911	11°41′	135°41.5′	A	36	,,	3/10	1330	10 GY 5/2	2	52	32	16	Silty sand	42.8	0.15
P69-912	11°48.5′	135°49.5′	A	11	,,	3/10	1430	10 GY 5/2	0	43	32	25	Sand-silt-clay	30.4	0.15
P69-913	11°25′	135°50′	B	35	,,	4/10	0820	10 GY 5/2	1	27	43	30	Sand-silt-clay	36.1	0.15
P69-914	11°13′	135°49′	B	42	,,	4/10	0935	10 GY 5/2	27	87	8	5	Sand	78.2	0.15
P69-915	11°03′	135°50′	C	42	,,	4/10	1042	10 GY 5/2	6	45	27	28	Sand-silt-clay	47.8	0.15
P69-916	10°32′	135°43′	C	51	,,	4/10	1430	5 GY 7/2	1	30	25	45	Sand-silt-clay	40.3	0.25
P69-917	10°22.5′	135°45.5′	D	59	,,	4/10	1536	5 GY 7/2	3	31	22	47	Sand-silt-clay	42.3	0.2
P69-918	10°12.5′	135°44.5	C	59	,,	4/10	1643	5 GY 7/2	0	23	25	52	Sand-silt-clay	33.1	0.2
P69-919	10°02.5′	135°44′	C	70	,,	4/10	1752	5 GY 7/2	13	54	13	33	Clayey sand	51.8	0.2
P69-920	10°02.5′	134°19.5′	B	72	,,	5/10	0615	10 GY 5/2	0	33	22	45	Sand-silt-clay	34.7	0.2
P69-921	10°11.5′	134°22′	C	70	,,	5/10	0730	5 GY 5/2	2	35	24	41	Sand-silt-clay	43.7	0.2
P69-922	10°21′	134°26′	C	65	,,	5/10	0840	5 GY 7/2	3	43	28	29	Sand-silt-clay	48.3	0.2
P69-923	10°29.5′	134°21′	C	56	,,	5/10	0945	5 GY 7/2	7	58	20	22	Clayey sand	57.2	0.2
P69-924	10°38.5′	134°21′	C	58	,,	5/10	1050	5 GY 7/2	5	41	30	29	Sand-silt-clay	49.2	0.25
P69-925	10°47.5′	134°20.5′	C	60	,,	5/10	1158	5 GY 7/2	0	46	25	29	Sand-silt-clay	50.1	0.2
P69-926	10°57′	134°20.5′	C	53	,,	5/10	1309	5 GY 7/2	3	50	23	27	Sand-silt-clay	53.0	0.15
P69-927	11°08′	134°18.5′	D	50	,,	5/10	1418	5 GY 7/2	2	47	29	24	Sand-silt-clay	45.1	0.15
P69-928	11°18.5′	134°15.5′	D	48	,,	5/10	1527	5 GY 6/1	37	91	6	3	Sand	73.4	0.15
P69-929	11°30′	134°16.5′	C	38	,,	5/10	1637	10 GY 5/2	4	86	9	5	Sand	29.9	0.1
P69-930	10°41.5′	134°32′	C	53	,,	11/10	1345	10 GY 5/2	2	33	28	39	Sand-silt-clay	42.5	0.15
P69-931	10°40.5′	134°41′	C	55	,,	11/10	1455	10 GY 5/2	3	40	29	31	Sand-silt-clay	49.2	0.2
P69-932	10°40′	134°52′	C	50	,,	11/10	1605	10 GY 5/2	5	42	26	32	Sand-silt-clay	47.4	0.15
P69-933	10°39′	135°01′	C	60	,,	11/10	1710	10 GY 5/2	7	49	27	24	Sand-silt-clay	54.1	0.15
P69-934	10°38′	135°11′	C	55	,,	11/10	1818	10 GY 5/2	3	34	25	41	Sand-silt-clay	45.5	0.15
P69-935	10°37.5′	135°20′	C	55	,,	11/10	1925	10 GY 5/2	3	30	24	46	Sand-silt-clay	41.8	0.15

Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbonate %	P_2O_5 %
P69-936	11°29′	135°24′	A	33	Condred	12/10	0610	10 GY 5/2	2	55	20	25	Clayey sand	55.2	0.15
P69-937	11°19.5′	135°23.5′	D	46	,,	12/10	0730	10 GY 5/2	4	34	29	37	Sand-silt-clay	38.9	0.15
P69-938	11°08′	135°26.5′	C	49	,,	12/10	0837	10 GY 5/2	3	26	35	49	Sand-silt-clay	39.3	0.15
P69-939	10°57.5′	135°28′	C	51	,,	12/10	0945	10 GY 5/2	4	32	23	45	Sand-silt-clay	42.3	0.15
P69-940	10°48′	135°27′	C	51	,,	12/10	1055	10 GY 5/2	2	25	25	50	Sand-silt-clay	87.9	0.15
P69-941	10°37′	135°27.5′	B	53	,,	12/10	1204	10 GY 5/2	3	28	22	50	Sand-silt-clay	41.2	0.15
P69-942	10°27.5′	135°27′	C	53	,,	12/10	1318	10 GY 5/2	5	36	20	44	Sandy clay	49.0	0.15
P69-943	10°18′	135°27′	C	53	,,	12/10	1425	10 GY 5/2	3	29	21	50	Sand-silt-clay	42.8	0.15
P69-944	10°10′	135°26′	C	56	,,	12/10	1532	10 GY 5/2	11	36	16	48	Sandy clay	42.1	0.2
P69-945	10°01′	135°25′	C	63	,,	12/10	1640	5 GY 5/2	0	54	12	34	Clayey sand	50.4	0.25
P69-946	9°53′	135°23.5′	C	82	,,	12/10	1747	5 GY 5/2	18	74	7	19	Clayey sand	64.6	0.3
P69-947	9°44′	135°22′	D	82	,,	12/10	1858	5 GY 5/2	0	79	5	16	Sand	64.1	0.3
P69-948	8°26′	135°22′	B	75	,,	13/10	0610	5 GY 5/2	28	83	6	11	Sand	64.1	0.2
P69-949	8°15′	135°20′	C	81	,,	13/10	0724	5 GY 5/2	5	62	12	26	Clayey sand	32.9	0.2
P69-950	8°04′	135°25.5	C	86	,,	13/10	0833	5 GY 5/2	7	70	11	19	Clayey sand	17.5	0.15
P69-951	8°09′	135°32.5′	C	66	,,	13/10	1013	5 GY 5/2	4	68	7	25	Clayey sand	32.9	0.2
P69-952	8°29′	135°41′	C	63	,,	14/10	1300	5 GY 5/2	7	76	5	19	Sand	39.8	0.25
P69-953	8°39′	135°39′	D	63	,,	14/10	1410	5 GY 5/2	21	84	4	12	Sand	58.9	0.25
P69-954	8°50′	135°37′	D	66	,,	14/10	1518	5 GY 5/2	3	83	5	12	Sand	38.9	0.25
P69-955	9°01′	133°35′	D	64	,,	14/10	1625	5 GY 5/2	15	81	5	14	Sand	66.7	0.25
P69-956	9°11′	135°43′	C	70	,,	14/10	1734	5 GY 7/2	14	76	7	17	Sand	62.3	0.25
P69-957	9°21′	135°43′	C	60	,,	14/10	1843	5 GY 7/2	22	84	6	10	Sand	77.9	0.2
P69-958	9°33′	135°30′	C	73	,,	15/10	0800	5 GY 5/2	7	73	10	17	Clayey sand	59.3	0.2
P69-959	9°24′	135°30′	C	64	,,	15/10	0910	5 GY 7/2	16	80	7	13	Sand	73.6	0.2
P69-960	9°14′	135°27′	C	68	,,	15/10	1020	5 GY 7/2	22	84	6	10	Sand	66.7	0.2
P69-961	9°05′	135°26.9′	C	64	,,	15/10	1130	5 GY 7/2	22	75	12	13	Sand	70.2	0.2
P69-962	8°56′	135°25′	C	73	,,	15/10	1240	5 GY 5/2	15	85	5	10	Sand	59.6	0.25
P69-963	8°48′	135°23′	C	82	,,	15/10	1325	5 GY 7/2	46	91	3	6	Sand	72.5	0.35
P69-964	8°39′	135°21′	B	65	,,	15/10	1505	5 GY 5/2	6	69	9	22	Clayey sand	57.5	0.2
P69-965	8°25′	135°08′	C	88	,,	15/10	1715	5 GY 5/2	6	77	6	17	Sand	46.5	0.2
P69-966	8°36′	135°08′	B	82	,,	15/10	1860	5 GY 5/2	10	78	6	16	Sand	46.9	0.2
P69-967	10°07′	135°08′	B	67	,,	16/10	0550	10 GY 5/2	1	34	19	47	Sandy clay	39.1	0.2
P69-968	10°16′	135°09′	C	60	,,	16/10	0701	10 GY 5/2	2	30	22	48	Sand-silt-clay	37.5	0.2
P69-969	10°25′	135°10′	C	59	,,	16/10	0807	10 GY 5/2	2	30	20	50	Sand-silt-clay	41.6	0.25
P69-970	10°43′	135°08′	D	53	,,	16/10	1015	10 GY 5/2	5	40	20	40	Sand-silt-clay	46.5	0.25
P69-971	10°51′	135°08′	D	53	,,	16/10	1123	10 GY 5/2	5	32	24	44	Sand-silt-clay	39.8	0.2
P69-972	11°02.5′	135°07′	C	48	,,	16/10	1235	10 GY 5/2	3	32	25	43	Sand-silt-clay	40.0	0.2
P69-973	11°14′	135°05.5′	D	45	,,	16/10	1338	10 GY 5/2	0	9	33	58	Silty clay	23.5	0.2
P69-974	11°25.5′	135°5′	C	40	,,	16/10	1440	10 GY 5/2	5	37	26	37	Sand-silt-clay	42.5	0.15
P69-975	11°54.5′	134°38′	A	10	,,	17/10	1130	5 GY 5/2	4	73	11	16	Clayey sand	21.6	0.15

Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbonate %	P_2O_5 %
P69-976	11°31′	134°51′	C	34	Condred	17/10	1415	5 GY 5/2	4	46	23	31	Sand-silt-clay	98.9	0.15
P69-977	11°23.5′	134°50′	D	41	„	17/10	1525	5 GY 5/2	4	42	24	34	Sand-silt-clay	44.8	0.2
P69-978	11°15′	134°49′	C	48	„	17/10	1631	5 GY 5/2	7	45	20	35	Clayey sand	49.5	0.2
P69-979	11°06′	134°51.5′	B	55	„	17/10	1737	10 GY 5/2	1	36	24	40	Sand-silt-clay	39.1	0.2
P69-980	10°56′	134°51′	C	54	„	17/10	1846	10 GY 5/2	5	41	22	37	Sand-silt-clay	48.5	0.2
P69-981	9°35′	134°52.5	C	94	„	18/10	0535	5 GY 5/2	0	71	6	23	Clayey sand	47.8	0.2
P69-982	9°25′	134°53′	C	115	„	18/10	0702	5 GY 5/2	2	45	23	32	Sand-silt-clay	35.4	0.15
P69-983	9°14′	134°53′	D	122	„	18/10	0809	5 GY 5/2	2	16	35	49	Silty clay	64.8	0.15
P69-984	8°59′	134°54′	D	94	„	18/10	0935	5 GY 5/2	0	51	13	36	Clayey sand	72.5	0.15
P69-985	8°48′	134°53′	C	100	„	18/10	1048	5 GY 5/2	0	71	8	21	Clayey sand	39.5	0.15
P69-986	8°47′	135°05′	C	82	„	18/10	1223	5 GY 5/2	14	72	9	19	Clayey sand	51.7	0.25
P69-987	8°59′	135°01′	C	86	„	18/10	1334	5 GY 5/2	0	77	7	16	Sand	43.5	0.2
P69-988	9°10′	135°02′	D	91	„	18/10	1444	5 GY 5/2	0	73	8	19	Clayey sand	35.6	0.15
P69-989	9°20′	135°06′	D	88	„	18/10	1554	5 GY 5/2	0	53	15	32	Clayey sand	34.7	0.15
P69-990	9°28′	135°09′	D	86	„	18/10	1701	5 GY 5/2	0	68	9	23	Clayey sand	45.1	0.2
P69-991	9°38′	135°10′	C	70	„	18/10	1810	5 GY 5/2	0	59	18	23	Clayey sand	40.2	0.2
P69-992	9°49′	135°10′	C	80	„	18/10	1919	5 GY 5/2	0	81	4	15	Sand	36.3	0.2
P69-993	11°04′	134°35′	B	50	„	19/10	0615	10 GY 5/2	0	47	21	32	Sand-silt-clay	44.6	0.15
P69-994	10°54′	134°36′	C	55	„	19/10	0730	10 GY 5/2	0	43	25	32	Sand-silt-clay	47.1	0.15
P69-995	10°26′	134°38′	D	54	„	19/10	0950	10 GY 5/2	0	47	19	34	Clayey sand	50.8	0.15
P69-996	10°31′	134°54′	C	52	„	19/10	1135	10 GY 5/2	0	38	15	47	Sandy clay	80.2	0.15
P69-997	10°21′	134°54′	C	60	„	19/10	1245	10 GY 5/2	3	42	18	40	Clayey sand	40.3	0.15
P69-998	10°10′	134°55′	D	64	„	19/10	1352	10 GY 5/2	10	45	15	40	Clayey sand	48.1	0.15
P69-999	10°00′	134°55′	D	70	„	19/10	1500	10 GY 5/2	0	45	11	44	Clayey sand	42.1	0.2
P69-1000	9°49′	134°55′	C	72	„	19/10	1610	10 GY 5/2	0	45	12	43	Clayey sand	36.8	0.2
P69-1001	9°56′	134°38′	C	70	„	19/10	1820	10 GY 5/2	0	26	8	66	Sandy clay	34.0	0.2
P69-1002	9°44′	134°38′	B	80	„	19/10	1925	10 GY 5/2	0	33	11	56	Sandy clay	30.8	0.2
P69-1003	8°26′	134°44′	B	120	„	20/10	0540	5 GY 5/2	0	65	16	19	Clayey sand	30.1	0.15
P69-1004	8°38′	134°44′	C	115	„	20/10	0717	5 GY 5/2	7	67	11	22	Clayey sand	47.4	0.15
P69-1005	8°50′	134°43′	C	113	„	20/10	0850	10 GY 5/2	7	68	20	12	Silty sand	56.6	0.2
P69-1006	9°02′	134°40′	C	95	„	20/10	1003	10 GY 5/2	13	78	8	14	Sand	72.0	0.2
P69-1007	9°13.5′	134°38′	C	135	„	20/10	1122	10 GY 5/2	0	13	53	34	Clayey silt	26.5	0.15
P69-1008	9°27′	134°38′	D	128	„	20/10	1236	10 GY 5/2	0	39	13	48	Sandy clay	30.8	0.2
P69-1009	9°35′	134°38′	C	93	„	20/10	1330	10 GY 5/2	0	53	13	34	Clayey sand	38.9	0.2
P69-1010	10°02′	134°38′	C	68	„	20/10	1645	10 GY 5/2	0	37	20	43	Sandy clay	41.4	0.2
P69-1011	10°14′	134°38′	D	63	„	20/10	1805	10 GY 5/2	7	48	17	35	Clayey sand	51.5	0.15
P69-1012	8°49′	133°57′	C	168	„	21/10	0851	10 GY 5/2	0	20	41	39	Clayey silt	26.0	0.15
P69-1013	8°49′	134°12′	D	155	„	21/10	1028	10 GY 5/2	0	38	26	36	Sand-silt-clay	45.8	0.15
P69-1014	8°50′	134°23′	C	142	„	21/10	1140	10 GY 5/2	0	30	25	45	Sand-silt-clay	25.3	0.15
P69-1015	9°00′	134°22′	C	130	„	21/10	1252	10 GY 5/2	0	8	20	72	Silty clay	26.9	0.2

Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbonate %	P_2O_5 %
P69-1016	9°09′	134°29′	C	100	Boxdred	21/10	1350							80.5	0.35
P69-1017	9°11′	134°21′	C	117	Condred	21/10	1435	10 GY 5/2	0	0	28	72	Silty clay	100	0.2
P69-1018	9°19′	134°21′	D	91	,,	21/10	1554	10 GY 5/2	7	61	14	25	Clayey sand	57.5	0.15
P69-1019	9°29′	134°20′	D	119	,,	21/10	1703	10 GY 5/2	5	58	12	30	Clayey sand	56.4	0.2
P69-1020	9°38′	134°20′	C	79	,,	21/10	1819	10 GY 5/2	0	13	21	66	Silty clay	23.2	0.2
P69-1021	9°49′	134°20′	D	66	,,	21/10	1930	10 GY 5/2	0	21	23	56	Sand-silt-clay	31.0	0.2
P69-1022	11°15′	134°00′	B	48	,,	22/10	0555	10 GY 5/2	4	61	16	23	Clayey sand	44.2	0.1
P69-1023	11°05′	134°02.5′	C	55	,,	22/10	0710	10 GY 5/2	3	64	12	24	Clayey sand	33.1	0.1
P69-1024	10°54′	134°05′	C	60	,,	22/10	0820	10 GY 5/2	0	41	23	36	Sand-silt-clay	40.1	0.15
P69-1025	10°46′	134°07.5′	C	60	,,	22/10	0930	10 GY 5/2	3	43	21	36	Sand-silt-clay	47.8	0.15
P69-1026	10°33′	134°10′	C	60	,,	22/10	1040	10 GY 5/2	7	53	19	28	Clayey sand	54.0	0.25
P69-1027	10°22′	134°11.5′	D	70	,,	22/10	1150	10 GY 5/2	0	34	22	44	Sand-silt-clay	38.6	0.15
P69-1028	10°12′	134°11′	C	71	,,	22/10	1300	10 GY 5/2	0	27	24	49	Sand-silt-clay	32.2	0.2
P69-1029	10°00′	134°09′	C	86	,,	22/10	1408	10 GY 5/2	0	37	17	46	Sandy clay	40.5	0.2
P69-1030	9°48′	134°07′	D	82	,,	22/10	1517	10 GY 5/2	0	21	24	55	Sand-silt-clay	28.7	0.2
P69-1031	9°37′	134°08′	D	91	,,	22/10	1628	10 GY 5/2	0	17	20	63	Silty clay	25.3	0.2
P69-1032	9°26′	134°08′	C	124	,,	22/10	1737	10 Y 6/2	0	6	24	70	Silty clay	23.2	0.2
P69-1033	9°14′	134°08′	C	109	,,	22/10	1845	10 Y 6/2	7	54	10	36	Clayey sand	59.3	0.2
P69-1034	9°03′	134°08′	C	157	,,	22/10	1954	10 Y 6/2	0	8	43	49	Silty clay	27.3	0.2
P69-1035	10°21′	133°58′	B	60	,,	23/10	0615	10 GY 5/2	3	50	19	31	Clayey sand	47.6	0.2
P69-1036	10°08′	133°57.5′	C	65	,,	23/10	0730	10 GY 5/2	0	36	21	43	Sand-silt-clay	35.4	0.2
P69-1037	9°57′	133°58′	C	70	,,	23/10	0840	10 GY 5/2	0	9	24	67	Silty clay	23.0	0.2
P69-1038	9°46′	133°58.5′	C	95	,,	23/10	0950	10 GY 5/2	0	13	28	59	Silty clay	27.3	0.2
P69-1039	9°35′	133°59′	D	98	,,	23/10	1100	5 GY 5/2	0	22	23	55	Sand-silt-clay	25.5	0.2
P69-1040	9°23.5′	133°57′	C	168	,,	23/10	1212	5 GY 5/2	0	5	47	48	Silty clay	21.8	0.2
P69-1041	9°12′	133°50′	C	130	,,	23/10	1325	5 GY 5/2	4	56	17	27	Clayey sand	57.1	0.2
P69-1042	9°01.5′	133°54′	C	166	,,	23/10	1436	5 GY 5/2	7	30	24	46	Sand-silt-clay	41.2	0.3
P69-1043	8°50′	133°54′	D	189	,,	23/10	1554	5 GY 5/2	0	8	37	55	Silty clay	30.8	0.2
P69-1044	8°40′	133°56′	C	175	,,	23/10	1745	5 GY 5/2	0	30	36	34	Sand-silt-clay	20.0	0.2
P69-1045	8°26.5′	133°59′	B	164	,,	23/10	1900	5 GY 5/2	0	72	19	9	Silty sand	38.2	0.15
P69-1046	9°19′	133°22′	B	140	,,	24/10	0610	5 GY 5/2	0	5	24	71	Silty clay	25.3	0.2
P69-1047	9°30′	133°22′	C	122	,,	24/10	0730	5 GY 5/2	4	42	17	41	Clayey sand	51.7	0.2
P69-1048	9°42′	133°23′	C	98	,,	24/10	0842	5 GY 5/2	0	3	23	74	Silty clay	22.3	0.2
P69-1049	9°54′	133°24′	C	75	,,	24/10	0952	5 GY 5/2	0	3	48	49	Silty clay	25.3	0.2
P69-1050	10°06′	133°24′	D	75	,,	24/10	1102	10 GY 5/2	0	14	37	49	Silty clay	30.1	0.2
P69-1051	10°18′	133°22.5′	C	70	,,	24/10	1215	10 GY 5/2	0	26	35	39	Sand-silt-clay	36.3	0.2
P69-1052	10°29′	133°21′	C	68	,,	24/10	1325	10 GY 5/2	0	30	29	41	Sand-silt-clay	38.9	0.2
P69-1053	10°41′	133°19′	D	64	,,	24/10	1432	5 GY 5/2	0	4	39	57	Silty clay	44.2	0.2
P69-1054	10°52′	133°19′	D	58	,,	24/10	1540	10 G 4/2	0	38	28	34	Sand-silt-clay	36.6	0.2
P69-1055	11°03′	133°19′	D	47	,,	24/10	1646	5 GY 5/2	3	58	17	25	Clayey sand	46.2	0.15

Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbonate %	P_2O_5 %
P69-1056	11°14′	133°19′	B	37	Condred	24/10	1756	5 GY 5/2	2	65	13	22	Clayey sand	50.4	0.15
P69-1057	11°10.5′	133°31′	B	44	„	31/10	0725	5 GY 5/2	7	65	15	20	Clayey sand	59.1	0.15
P69-1058	11°10.5′	133°43′	C	47	„	31/10	0840	5 GY 5/2	2	57	18	25	Clayey sand	45.5	0.15
P69-1059	10°59.5′	133°43′	C	47	„	31/10	0950	5 GY 5/2	3	47	22	31	Sand-silt-clay	49.0	0.15
P69-1060	10°48.5′	133°48′	D	60	„	31/10	1100	5 GY 5/2	1	50	22	28	Sand-silt-clay	37.9	0.15
P69-1061	10°37′	133°48′	C	58	„	31/10	1210	5 GY 5/2	10	57	17	26	Clayey sand	52.9	0.15
P69-1062	10°25′	133°48′	C	64	„	31/10	1330	5 GY 5/2							
P69-1063	10°23′	133°36′	C	62	„	31/10	1530	5 GY 5/2	9	43	22	35	Sand-silt-clay	50.6	0.15
P69-1064	10°32′	133°34′	C	60	„	31/10	1642	5 GY 5/2	4	51	20	29	Clayey sand	53.1	0.2
P69-1065	10°42′	133°36′	C	58	„	31/10	1752	5 GY 5/2	7	53	19	28	Clayey sand	52.0	0.15
P69-1066	10°53′	133°35′	C	56	„	31/10	1915	5 GY 5/2	2	50	17	33	Clayey sand	38.6	0.15
P69-1067	11°02′	133°35′	D	52	„	31/10	2015	5 GY 5/2	6	62	12	26	Clayey sand	59.8	0.15
P69-1068	10°08.5′	133°50′	C	73	„	1/11	0615	5 GY 5/2	0	34	24	42	Sand-silt-clay	37.5	0.2
P69-1069	10°01.5′	133°40′	D	77	„	1/11	0800	10 GY 5/2	0	22	26	52	Sand-silt-clay	31.3	0.2
P69-1070	9°50′	133°46′	D	82	„	1/11	0910	10 GY 5/2	0	3	31	66	Silty clay	22.7	0.15
P69-1071	9°39.5′	133°41′	D	112	„	1/11	1025	5 GY 5/2	0	12	24	64	Silty clay	24.6	0.3
P69-1072	9°28.5′	133°41′	D	110	„	1/11	1138	5 GY 5/2	0	17	22	61	Silty clay	28.7	0.3
P69-1073	9°18′	133°38′	D	135	„	1/11	1310	5 GY 5/2	3	48	11	41	Clayey sand	52.2	0.3
P69-1074	9°03′	133°36′	C	170	„	1/11	1420	5 GY 5/2	0	10	30	60	Silty clay	25.8	0.3
P69-1075	8°51′	133°34′	D	187	„	1/11	1540	5 GY 5/2	0	7	27	66	Silty clay	28.5	0.3
P69-1076	8°39′	133°34′	D	192	„	1/11	1655	5 GY 5/2	0	39	29	32	Sand-silt-clay	49.9	0.3
P69-1077	8°28′	133°31′	C	164	„	1/11	1825	5 Y 5/2	29	80	10	10	Sand	64.8	0.3
P69-1078	8°06′	133°35′	C	113	„	2/11	0610	10 Y 4/2	11	79	13	8	Sand	67.6	0.2
P69-1079	8°02′	133°50′	C	108	„	2/11	0753	10 Y 4/2	11	60	34	6	Silty sand	70.2	0.2
P69-1080	8°03′	134°05′	C	91	„	2/11	0920	10 Y 4/2	15	87	7	6	Sand	84.4	0.3
P69-1081	8°04′	134°16′	D	110	„	2/11	1045	10 Y 4/2	13	66	28	6	Silty sand	70.1	0.2
P69-1082	8°05′	134°28′	D	105	„	2/11	1207	5 Y 5/2	11	86	7	7	Sand	80.0	0.2
P69-1083	8°03′	134°40′	C	109	„	2/11	1337	10 Y 4/2	18	78	9	13	Sand	71.3	0.2
P69-1084	8°01′	134°53′	C	104	„	2/11	1510	10 Y 4/2	7	76	11	13	Sand	57.0	0.2
P69-1085	7°59′	135°06′	C	92	„	2/11	1700	5 GY 5/2	8	63	25	12	Silty sand	50.8	0.3
P69-1086	8°09′	135°06′	C	94	„	2/11	1812	5 GY 5/2	6	68	11	21	Clayey sand	34.5	0.3
P69-1087	8°09′	134°53′	D	110	„	2/11	1940	5 GY 5/2	4	58	30	12	Silty sand	43.0	0.2
P69-1088	8°09′	134°50′	C	115	„	3/11	0630	5 GY 5/2	2	79	8	13	Sand	35.2	0.2
P69-1089	8°12′	134°37′	C	121	„	3/11	0805	5 GY 5/2	15	76	9	15	Sand	32.6	0.2
P69-1090	8°17′	134°25′	D	130	„	3/11	0945	10 Y 4/2	8	87	5	8	Sand	48.8	0.2
P69-1091	8°18′	134°11′	D	141	„	3/11	1110	10 Y 4/2	9	76	9	15	Sand	52.7	0.2
P69-1092	8°18′	133°58′	C	132	„	3/11	1242	10 Y 4/2	10	71	16	13	Silty sand	62.3	0.2
P69-1093	8°16′	133°44′	C	112	„	3/11	1508	10 Y 4/2	0	76	13	11	Sand	31.1	0.2
P69-1094	8°14′	133°30.8′	D	118	„	3/11	1645	5 Y 5/2	7	84	9	7	Sand	70.8	0.2
P69-1095	8°03.5′	133°30′	B	88	„	3/11	1825	5 Y 5/2	14	88	7	5	Sand	78.4	0.2

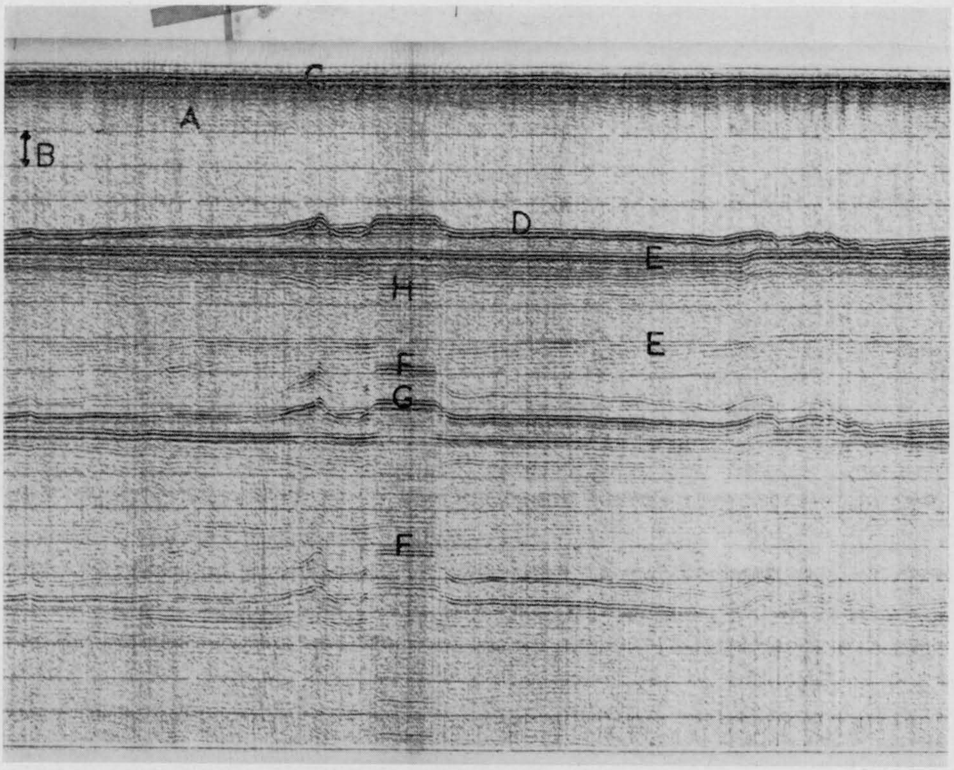
Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/ month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbon-ate %	P_2O_5 %
P69-1096	8°03.5′	133°15′	D	100	Condred	3/11	1950	5 Y 5/2	0	86	7	7	Sand	80.5	0.3
P69-1097	9°12.5′	133°14′	C	168	,,	4/11	0654	10 GY 5/2	0	0	23	77	Clay	22.5	0.3
P69-1098	9°22.5′	133°16′	C	122	,,	4/11	0816	10 Y 4/2	0	35	24	41	Sand-silt-clay	43.5	0.2
P69-1099	9°28.5′	133°10′	C	130	,,	4/11	0930	10 Y 4/2	0	12	45	43	Clayey silt	26.9	0.3
P69-1100	9°39′	133°10′	D	137	,,	4/11	1040	10 Y 4/2	0	23	27	50	Sand-silt-clay	36.1	0.2
P69-1101	9°50′	133°10.5′	C	73	,,	4/11	1155	10 Y 4/2	0	5	36	59	Clayey silt	26.7	0.2
P69-1102	10°03′	133°06′	D	75	,,	4/11	1302	10 GY 5/2	0	14	31	55	Silty clay	28.7	0.2
P69-1103	10°13′	133°03′	C	68	,,	4/11	1418	10 GY 5/2	0	28	27	45	Sand-silt-clay	35.4	0.2
P69-1104	10°25′	133°05′	C	66	,,	4/11	1527	10 GY 5/2	0	32	31	37	Sand-silt-clay	38.4	0.2
P69-1105	10°39′	133°05′	B	62	,,	4/11	1640	10 GY 5/2	4	43	25	32	Sand-silt-clay	44.6	0.2
P69-1106	10°55′	133°03′	A	30	,,	5/11	1550	5 Y 5/2	0	61	14	25	Clayey sand	63.7	0.3
P69-1107	10°48′	133°10′	B	62	,,	5/11	1720	5 Y 5/2	0	50	15	35	Clayey sand	46.5	0.2
P69-1108	9°06′	133°09′	C	119	,,	6/11	0630	10 YR 8/6	5	91	3	6	Sand	82.3	0.2
P69-1109	8°55′	133°11′	D	220	,,	6/11	0745	5 Y 5/2							
P69-1110	8°41′	133°12′	C	196	,,	6/11	0902	10 Y 4/2	9	71	12	17	Clayey sand	67.2	0.3
P69-1111	8°32′	133°12′	D	220	,,	6/11	1030	10 Y 4/2	0	60	20	20	Sand-silt-clay	44.2	0.2
P69-1112	8°22′	133°12	D	180	,,	6/11	1145	5 Y 7/2	5	87	6	7	Sand	79.3	0.2
P69-1113	8°13′	133°11′	C	162	,,	6/11	1256	5 Y 5/2	0	87	7	6	Sand	80.7	0.2
P69-1114	8°14′	133°23′	D	125	,,	6/11	1415	5 Y 5/2							
P69-1115	8°27′	133°24′	C	146	,,	6/11	1600	5 Y 5/2	0	69	15	16	Clayey sand	39.6	0.2
P69-1116	8°40.5′	133°23′	D	182	,,	6/11	1715	5 Y 5/2	9	67	22	11	Silty sand	49.0	0.2
P69-1117	8°53′	133°23′	C	227	,,	6/11	1830	5 Y 5/2	0	26	35	39	Sand-silt-clay	36.3	0.2
P69-1118	9°05′	133°22′	D	165	,,	6/11	1950	5 Y 5/2	4	34	56	10	Sandy silt	67.4	0.15
P69-1119	9°35′	133°04′	C	126	,,	7/11	0605	5 GY 5/2	0	65	7	28	Clayey sand	38.9	0.2
P69-1120	9°24′	133°02′	C	125	,,	7/11	0720	10 Y 6/2	7	45	11	44	Clayey sand	55.9	0.2
P69-1121	9°14′	132°54′	C	145	,,	7/11	0840	5 GY 5/2	3	34	18	48	Sandy clay	44.8	0.2
P69-1122	9°02.5′	132°53′	B	205	,,	7/11	1000	5 GY 5/2	0	3	23	74	Silty clay	26.5	0.3
P69-1123	8°54′	132°54′	C	208	,,	7/11	1115	5 Y 5/2	0	56	15	29	Clayey sand	50.1	0.3
P69-1124	8°44′	132°54.5′	C	240	,,	7/11	1230	5 Y 5/2	4	86	4	10	Sand	59.3	0.6
P69-1125	8°33′	132°51′	C	225	,,	7/11	1410	5 Y 5/2	0	77	10	13	Sand	59.8	0.7
P69-1126	8°22′	132°48′	D	254	,,	7/11	1525	5 Y 5/2	26	82	8	10	Sand	54.3	1.7
P69-1127	8°11′	132°47.5′	D	245	,,	7/11	1710	5 Y 5/2	5	82	8	10	Sand	37.3	0.6
P69-1128	8°00′	132°48′	D	243	,,	7/11	1828	5 Y 5/2	0	100	0	0	Sand	43.0	0.6
P69-1129	9°30′	132°54′	C	140	,,	8/11	0745	5 GY 5/2	0	48	18	34	Clayey sand	57.3	0.2
P69-1130	9°43′	132°54′	C	114	,,	8/11	0905	5 GY 5/2	0	29	21	50	Sand-silt-clay	42.8	0.3
P69-1131	9°54′	132°54′	D	72	,,	8/11	1015	5 GY 5/2	0	3	45	52	Silty clay	85.5	0.3
P69-1132	10°05′	132°54′	C	75	,,	8/11	1125	5 GY 5/2	0	8	37	55	Silty clay	29.9	0.2
P69-1133	10°15′	132°54′	C	70	,,	8/11	1235	5 GY 5/2	0	17	36	47	Silty clay	31.5	0.2
P69-1134	10°25′	132°54′	C	66	,,	8/11	1345	5 GY 5/2	0	28	28	44	Sand-silt-clay	36.1	0.2
P69-1135	10°36′	132°56.5′	A	62	,,	8/11	1510	5 GY 5/2	2	43	24	33	Sand-silt-clay	46.0	0.2

Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbonate %	P_2O_5 %
P69-1136	10°48′	132°56.5′	A	53	Condred	8/11	1617	5 GY 5/2	6	70	14	16	Clayey sand	60.7	0.2
P69-1137	10°49′	132°38.5′	A	51	,,	8/11	1800	5 GY 5/2	0	28	24	48	Sand-silt-clay	33.6	0.2
P69-1138	10°38′	132°39.5′	C	62	,,	9/11	0615	5 GY 5/2	4	31	15	54	Sandy clay	35.9	0.2
P69-1139	10°27′	132°41′	C	60	,,	9/11	0723	5 GY 5/2	0	25	6	69	Sandy clay	33.4	0.2
P69-1140	10°17′	132°38′	C	65	,,	9/11	0838	5 GY 5/2	0	15	35	50	Silty clay	32.2	0.2
P69-1141	10°06′	132°37′	C	75	,,	9/11	0958	5 GY 5/2	0	6	41	53	Silty clay	27.6	0.2
P69-1142	9°55′	132°35′	D	78	,,	9/11	1107	5 GY 5/2	0	6	36	58	Silty clay	30.8	0.3
P69-1143	9°42′	132°36′	C	100	,,	9/11	1216	5 GY 5/2	0	35	20	45	Sand-silt-clay	44.8	0.3
P69-1144	9°30′	132°34′	C	124	,,	9/11	1230	5 GY 5/2	0	47	16	37	Clayey sand	57.0	0.3
P69-1145	9°18′	132°34′	D	146	,,	9/11	1452	5 GY 5/2	6	37	19	44	Sandy clay	51.7	0.2
P69-1146	9°07′	132°33′	D	218	,,	9/11	1022	5 GY 5/2	3	49	18	33	Clayey sand	52.0	0.25
P69-1147	8°55′	132°33′	D	256	,,	9/11	1724	5 GY 5/2	0	42	16	42	Clayey sand	45.5	0.25
P69-1148	8°42′	132°31′	C	267	,,	9/11	1900	5 GY 5/2	0	32	22	46	Sand-silt-clay	43.7	0.2
P69-1149	10°16′	132°22′	C	70	,,	10/11	0745	5 GY 5/2	0	13	44	43	Clayey silt	32.2	0.15
P69-1150	10°05.5′	132°23′	C	74	,,	10/11	0900	5 GY 5/2	0	4	36	60	Silty clay	30.1	0.15
P69-1151	9°55′	132°23′	C	85	,,	10/11	1010	5 GY 5/2	0	12	35	53	Silty clay	32.9	0.2
P69-1152	9°44′	132°24′	C	100	,,	10/11	1121	5 GY 5/2	13	81	6	13	Sand	65.5	0.2
P69-1153	9°33′	132°24′	C	128	,,	10/11	1230	5 GY 6/4	6	85	5	10	Sand	88.1	0.3
P69-1154	9°17.5′	132°20′	C	168	,,	10/11	1355	5 GY 5/2	6	63	14	23	Clayey sand	64.6	0.5
P69-1155	9°09′	132°19′	D	168	,,	10/11	1530	5 GY 5/2	4	67	11	22	Clayey sand	58.9	0.2
P69-1156	8°54′	132°17′	D	236	,,	10/11	1645	5 GY 5/2	4	25	40	35	Sand-silt-clay	28.5	0.2
P69-1157	8°41′	132°20′	C	311	,,	10/11	1820	5 GY 5/2	0	41	22	37	Sand-silt-clay	50.8	0.15
P69-1158	9°14′	132°04′	C	210	,,	11/11	0500	5 GY 5/2	0	45	38	17	Silty sand	61.4	0.2
P69-1159	9°24′	132°03′	C	158	,,	11/11	0630	5 B 5/1	0	16	12	72	Sandy clay	28.5	0.2
P69-1160	9°34′	132°02′	D	120	,,	11/11	0745	5 Y 6/4	5	81	6	13	Sand	82.6	0.4
P69-1161	9°45′	132°04.5′	C	108	,,	11/11	0903	5 GY 6/1	10	56	15	29	Clayey sand	65.5	0.2
P69-1162	9°55′	132°06′	D	84	,,	11/11	1015	5 GY 6/1	0	8	35	57	Silty clay	33.6	0.2
P69-1163	10°05′	132°04′	D	78	,,	11/11	1130	5 GY 6/1	0	5	29	66	Silty clay	28.3	0.2
P69-1164	10°17′	132°04′	C	73	,,	11/11	1237	5 GY 6/1	0	11	37	52	Silty clay	30.0	0.2
P69-1165	10°28′	132°05.5′	D	64	,,	11/11	1345	5 GY 6/1	0	7	41	52	Silty clay	29.0	0.15
P69-1166	10°39′	132°06′	C	55	,,	11/11	1435	5 GY 6/1	0	17	14	69	Sandy clay	29.0	0.15
P69-1167	9°09′	131°51′	D	220	,,	13/11	0945	5 GY 5/2	1	31	18	51	Sandy clay	44.4	0.2
P69-1168	9°20′	131°51′	C	198	,,	13/11	1100	5 GY 5/2	0	21	10	69	Sandy clay	36.3	0.2
P69-1169	9°30′	131°51′	C	146	,,	13/11	1215	5 GY 5/2	0	69	17	14	Silty sand	79.4	0.3
P69-1170	9°41′	131°51′	D	119	,,	13/11	1331	5 Y 5/2	0	45	39	16	Silty sand	69.9	0.3
P69-1171	9°52′	131°49′	D	110	,,	13/11	1446	5 GY 6/1	0	63	9	28	Clayey sand	61.6	0.2
P69-1172	10°03′	131°46′	D	82	,,	13/11	1558	5 GY 6/1	0	8	30	62	Silty clay	34.7	0.2
P69-1173	10°14′	131°42′	D	80	,,	13/11	1710		0	6	33	61	Silty clay	29.0	0.2
P69-1174	10°21.5′	131°49′	D	72	,,	13/11	1820		0	21	32	47	Sand-silt-clay	31.5	0.15
P69-1175	8°58′	131°35′	C	340	,,	14/11	0810	5 GY 5/2	0	6	25	69	Silty clay	28.7	0.2

Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbonate %	P_2O_5 %
P69-1176	9°09′	131°35.5′	C	242	Condred	14/11	0945	5 GY 5/2	0	39	21	40	Sand-silt-clay	50.4	0.2
P69-1177	9°19.5′	131°36′	C	188	,,	14/11	1100	5 GY 5/2	3	39	18	43	Sandy clay	46.7	0.2
P69-1178	9°30′	131°36′	C	130	,,	14/11	1215	5 Y 6/4	3	77	9	14	Sand	81.7	0.25
P69-1179	9°41′	131°36′	C	119	,,	14/11	1337	5 Y 6/4	0	82	7	11	Sand	84.8	0.2
P69-1180	9°42′	131°30′	D	117	,,	14/11	1449	5 Y 6/1	0	80	7	13	Sand	48.1	0.2
P69-1181	10°03′	131°30′	D	112	,,	14/11	1600	5 GY 5/2	0	20	28	52	Sand-silt-clay	42.5	0.25
P69-1182	10°13′	131°33′	D	90	,,	14/11	1714	5 GY 5/2	0	8	31	61	Silty-clay	31.5	0.2
P69-1183	10°22.5′	131°37′	C	71	,,	14/11	1824	5 GY 5/2	0	31	22	47	Sand-silt-clay	16.7	0.2
P69-1184	9°01′	131°22′	C	358	,,	15/11	0840	5 GY 5/2	0	6	53	41	Clayey silt	30.8	0.2
P69-1185	9°12′	131°22′	C	280	,,	15/11	0957	5 GY 5/2	0	7	62	31	Clayey silt	31.9	0.2
P69-1186	9°23′	131°22′	C	215	,,	15/11	1115	5 GY 5/2	5	57	16	27	Clayey sand	64.4	0.25
P69-1187	9°34′	131°22′	C	135	,,	15/11	1237	5 Y 6/4	15	87	5	8	Sand	88.1	0.3
P69-1188	9°45.5′	131°19.5′	C	124	,,	15/11	1350	5 Y 6/4	10	84	8	8	Sand	83.9	0.25
P69-1189	9°56.5′	131°19′	D	117	,,	15/11	1500	5 GY 5/2	10	78	7	15	Sand	78.6	0.25
P69-1190	10°07′	131°21′	D	102	,,	15/11	1610	5 GY 5/2	0	59	13	28	Clayey sand	56.3	0.25
P69-1191	10°17′	131°20′	C	82	,,	15/11	1720	5 GY 5/2	3	43	24	33	Sand-silt-clay	22.7	0.25
P69-1192	10°27′	131°20′	C	75	,,	15/11	1830	5 GY 6/1	0	12	29	59	Silty clay	32.9	0.2
P69-1193	10°38′	131°20′	C	71	,,	15/11	1937	5 GY 6/1	0	13	34	53	Silty clay	71.5	0.2
P69-1194	10°38′	131°11′	C	74	,,	16/11	0600	5 GY 6/1	0	10	34	56	Silty clay	27.1	0.2
P69-1195	10°27′	131°12′	D	80	,,	16/11	0730	5 GY 6/1	0	6	31	63	Silty clay	34.5	0.2
P69-1196	10°16′	131°13.5′	C	90	,,	16/11	0840	5 GY 6/1	0	12	31	57	Silty clay	34.5	0.25
P69-1197	10°05′	131°10′	C	98	,,	16/11	0950	5 GY 5/2	3	77	7	16	Sand	47.8	0.2
P69-1198	9°54′	131°11′	C	120	,,	16/11	1100	5 Y 6/4	2	87	4	9	Sand	84.6	0.35
P69-1199	9°43′	131°05′	C	148	,,	15/11	1215		17	88	5	7	Sand	85.8	0.4
P69-1200	9°30′	131°08′	D	210	,,	16/11	1330	5 GY 5/2	0	82	6	12	Sand	78.9	0.25
P69-1201	9°17′	131°05′	D	305	,,	16/11	1450	5 GY 5/2	0	16	15	69	Sandy clay	41.4	0.3
P69-1202	9°03′	131°03′	D	421	,,	10/11	1030	5 GY 5/2	0	19	21	60	Silty clay	40.9	0.2
P69-1203	9°03′	131°14′	C	353	,,	10/11	1720	5 GY 5/2	0	12	17	71	Silty clay	36.3	0.2
P69-1204	10°03′	135°56′	B	64	,,	28/11	1430		5	67	14	19	Clayey sand	53.1	0.2
P69-1205	10°28.5′	131°33.5′	C	72	,,	1/12	0815	10 GY 5/2	3	48	13	39	Clayey sand	23.7	0.15
P69-1206	10°33′	131°50′	D	66	,,	1/12	0950	10 GY 5/2	0	5	30	65	Silty clay	29.2	0.15
P69-1207	10°45′	131°50′	C	56	,,	1/12	1108	10 GY 5/2	0	2	42	56	Silty clay	20.9	0.2
P69-1208	10°57.5′	131°49′	C	56	,,	1/12	1219	10 GY 5/2	0	21	27	52	Sand-silt-clay	29.4	0.2
P69-1209	10°50′	131°39′	D	60	,,	1/12	1350	10 GY 5/2	0	10	45	45	Silty clay	28.7	0.2
P69-1210	10°39′	131°37′	D	67	,,	1/12	1500	10 GY 5/2	0	9	43	48	Silty clay	26.7	0.2
P69-1211	10°50′	131°20′	D	64	,,	1/12	1640	10 GY 5/2	0	16	31	53	Silty clay	28.1	0.2
P69-1212	10°50′	131°06′	C	62	,,	1/12	1748	10 GY 5/2	0	13	38	49	Silty clay	28.3	0.2
P69-1213	11°00′	131°10′	B	46	,,	1/12	1900	10 GY 5/2	3	42	20	38	Sand-silt-clay	33.6	0.15
P69-1214	11°01′	131°21′	B	57	,,	1/12	2010	10 GY 5/2	2	52	20	28	Sand-silt-clay	33.4	0.15

Sample No.	Location S Latitude	Location E Longitude	Fix Category	Depth (m)	Sampling* Method	Date (1969) day/month	Time (CST)	Colour	Gravel %	Sand & Gravel %	Silt %	Clay %	Textural Description	Carbonate %	P_2O_5 %
P69-1215	10°25′	132°24′	B	65	Condred	2/12	0600	10 GY 5/2	0	19	45	36	Clayey silt	32.7	0.15
P69-1216	10°37′	132°23′	C	58	,,	2/12	0725	10 GY 5/2	0	21	43	36	Sand-silt-clay	37.9	0.2
P69-1217	10°49′	132°24′	A	48	,,	2/12	0840	10 GY 5/2	2	32	33	35	Sand-silt-clay	32.2	0.15
P69-1218	10°48′	132°06′	B	52	,,	2/12	1030	10 GY 5/2	1	22	39	39	Sand-silt-clay	32.9	0.2
P69-1219	11°02′	131°37′	A	55	,,	2/12	1322	10 GY 5/2	2	65	13	22	Clayey sand	37.0	0.15
P69-1220	9°53′	130°02′	B	205	Tridred	5/12	0915		7	80	7	13	Sand	69.1	0.7
P69-1221	9°45′	130°03′	C	252	Bigcore	5/12	1038								
P69-1222	10°20′	130°46′	B	99	,,	5/12	1800								
P69-1223	11°00′	131°27′	C	50	,,	6/12	0710								
P69-1224	10°27′	131°29′	C	72	,,	6/12	1100								
P69-1225	9°44′	131°30′	D	117	,,	6/12	1445								
P69-1226	9°29′	131°34′	D	130	,,	6/12	1645								
P69-1227	9°19′	132°51′	D	150	,,	7/12	0325								
P69-1228	9°56′	133°07′		77	,,	7/12	1300								
P69-1229	10°46′	133°31.5′	B	64	,,	7/12	1830								
P69-1230	9°37′	133°52′	B	102	,,	8/12	0545								
P69-1231	9°07′	133°52′	D	130	Tridred	8/12	0920								
P69-1232	8°49′	133°38′	C	201	Bigcore	8/12	1230								
P69-1233	9°50′	134°53′	B	72	,,	9/12	0530								
P69-1234	10°32′	134°47′	D	54	,,	9/12	1015								
P69-1235	11°18′	134°47′	C	40	,,	9/12	1430								
P69-1236	9°19′	135°54′	C	64	,,	10/12	0550								
P69-1237	10°30′	135°52′	C	53	,,	10/12	1215								

PLATE 1



Section of a seismic profile showing features common to most records. A—time marks at 5-minute intervals, equivalent to about 800 m, indicated by breaks in scale lines; B—interval between scale lines, here 50 m/s (1-second sweep); C—direct wave form 10-20 m/s in duration; D—sea bottom; E—sub-bottom reflections, here S3 and S4; F—sea-bottom multiples; G—spurious sea-bottom reflection generated by ringing between sub-bottom reflector and sea surface; H—spurious sea-bottom reflection generated by ringing between sea-bottom and sub-bottom reflector.

PLATE 2

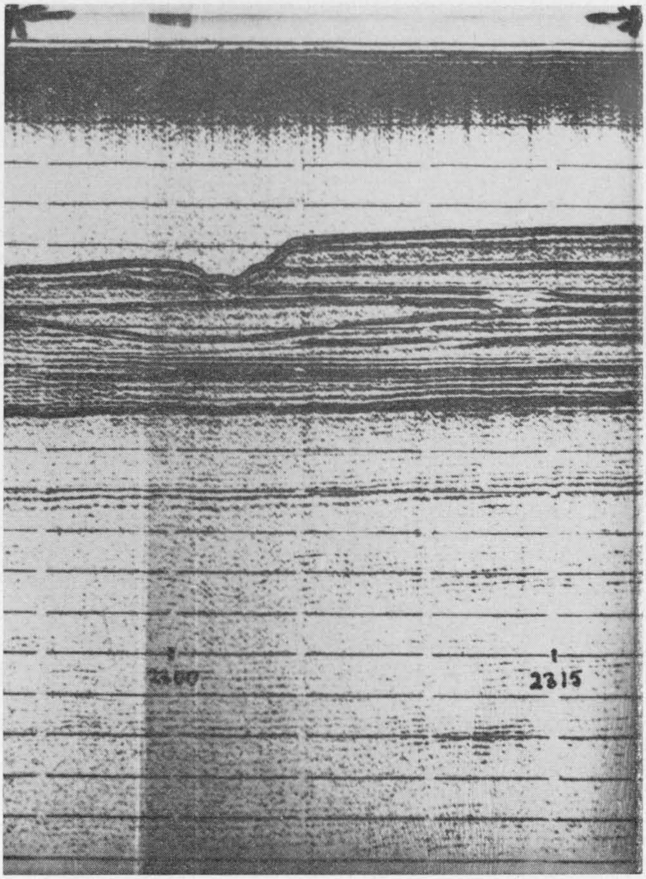


Figure 1. Part of Traverse XIV showing profile across the trough on the upper continental slope at 200 m depth. Reflectors have been emphasized by pencil marks. 1-second sweep, vertical exaggeration X 8.

PLATE 2

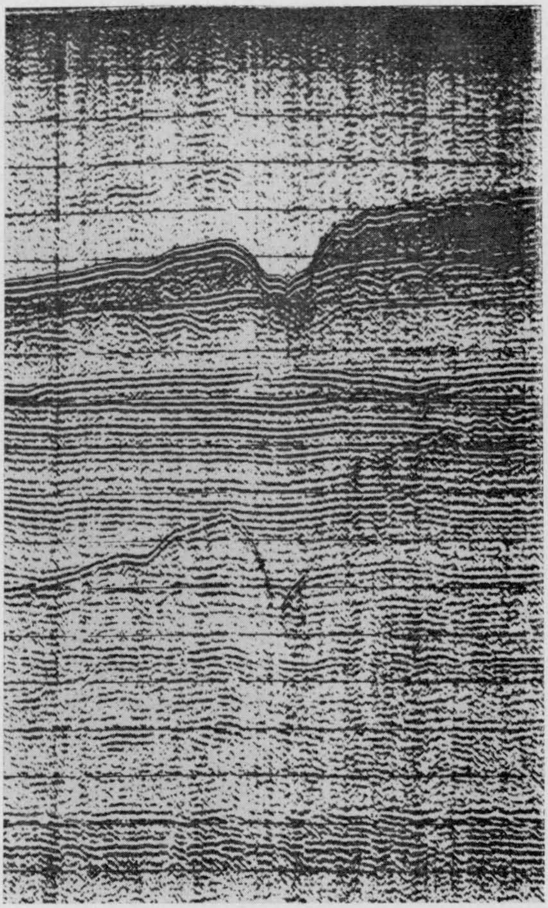


Figure 2. Profile across a similar feature in Capricorn Channel at 200 m depth. 1-second sweep, vertical exaggeration, X 8.

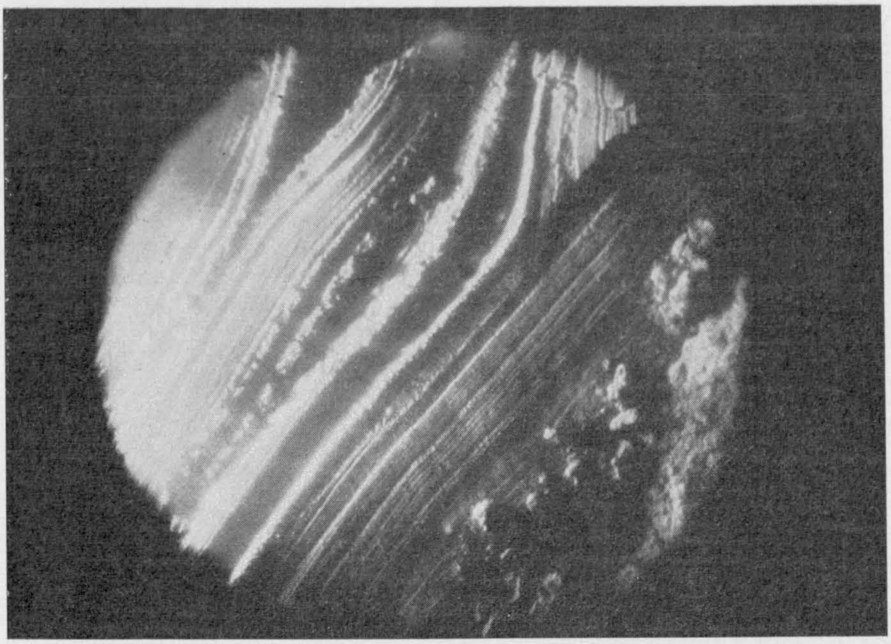


Figure 1. Mud flooring a trough at 200 m depth photographed through a lower observation port of the *Yomiuri* (dive 2). The scours were made by the hull scraping the bottom.

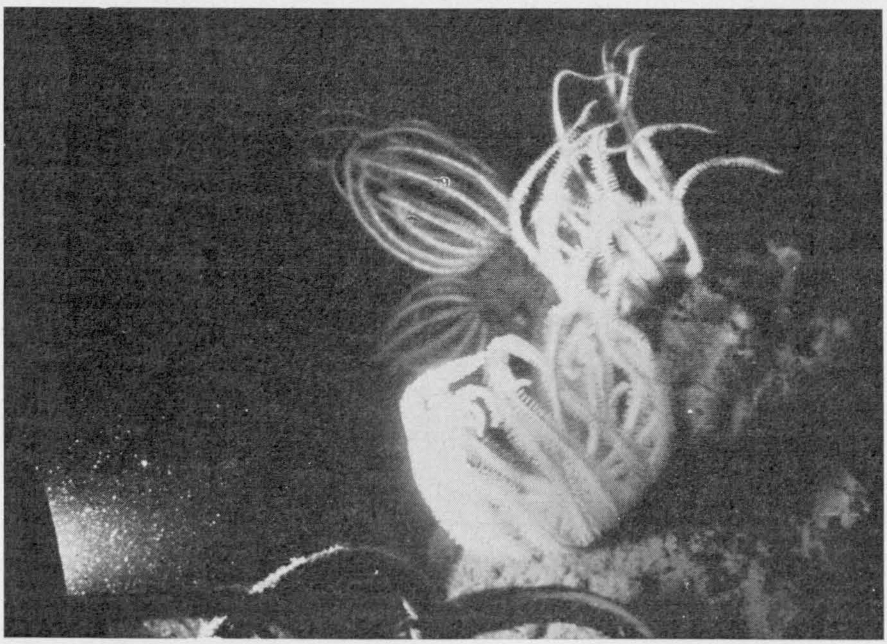


Figure 2. Gorgonian corals on a cliff face at 218 m depth. *Yomiuri,* dive 2.

PLATE 4

Figure 1. Shelly calcarenite photographed from the *Yomiuri* (dive 2). Depth 190 m. Field of view about 1 m^2.

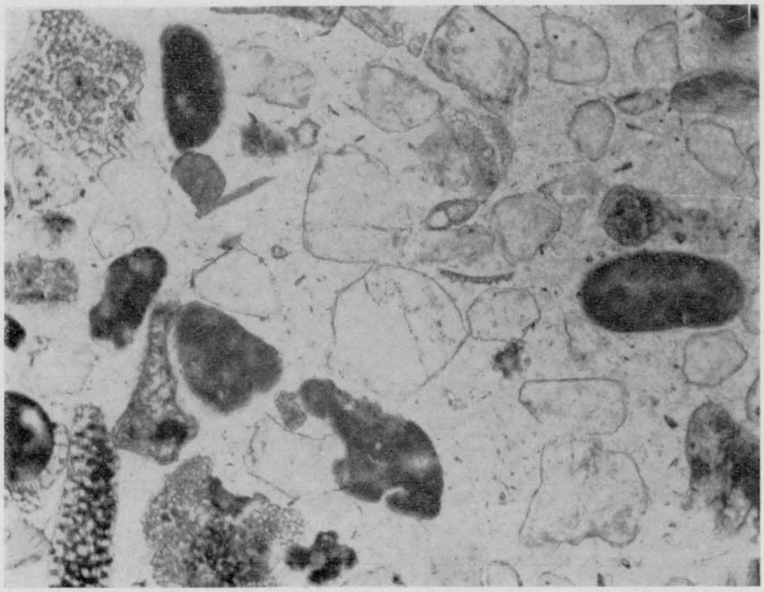


Figure 2. Fine-grained glauconitic shelly sand, consisting of subrounded quartz grains, glauconite pellets, and shell fragments. Station 987, depth 86 m. Ordinary light, X 55.

PLATE 5

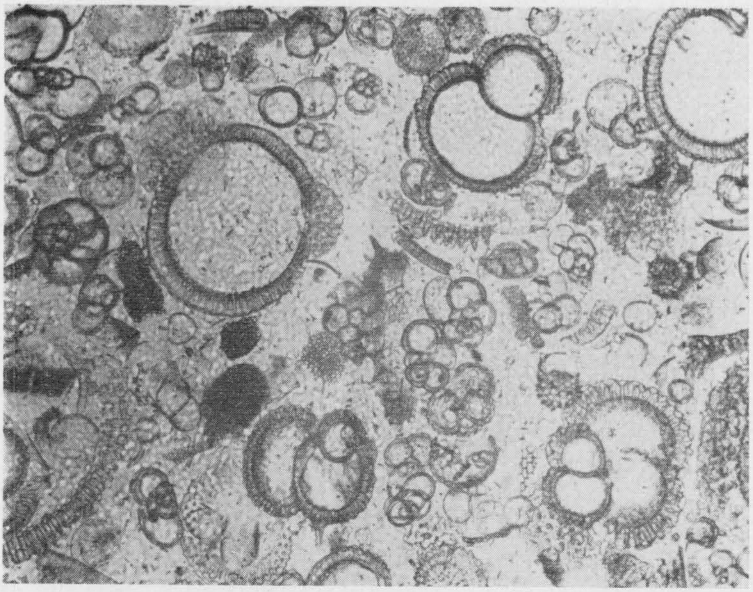


Figure 1. Shelly silty clay. The coarse fraction consists almost entirely of planktonic Foraminifera. Station 1175, depth 340 m. Ordinary light, X 55.

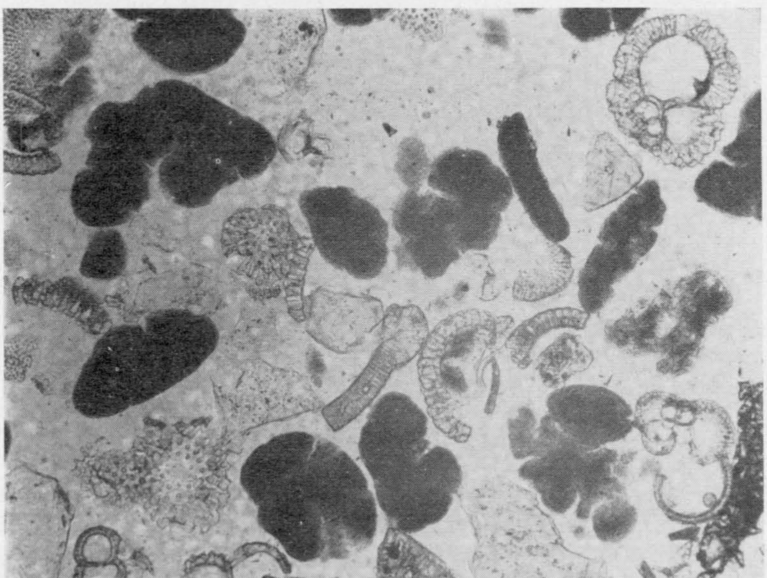
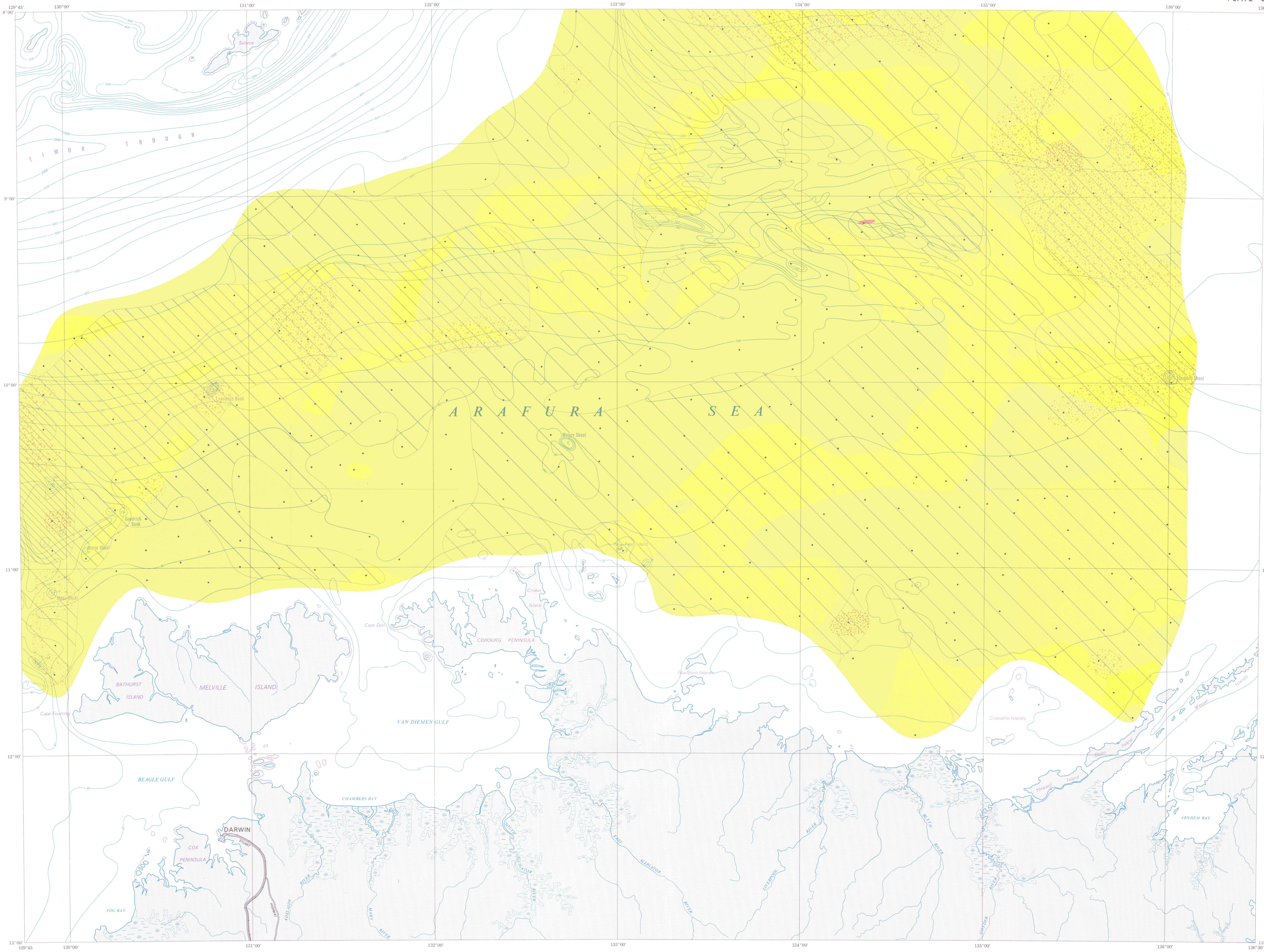
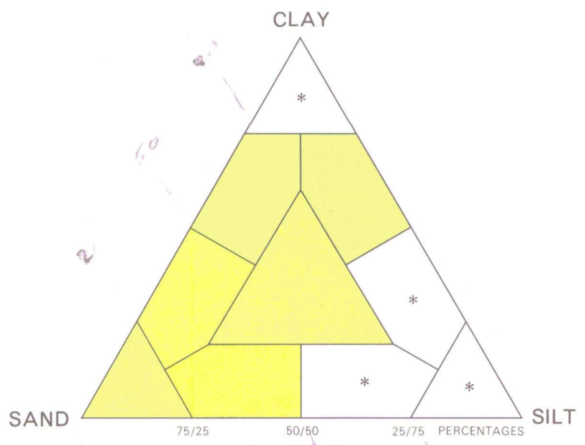


Figure 2. Fine-grained glauconitic calcarenite. Glauconite pellets, often recognizable as casts of shell chambers, form more than 50 per cent of the sediment. Station 1127, depth 245 m. Ordinary light, X 55.





SEDIMENT CLASSIFICATION

Note: The triangular diagram classifies the sediments according to the proportion of sand, silt-and clay-sized particles they contain. The Wentworth scale is used. The corners of the inner triangle represent 60/20/20 percentages

- *Sea bed sample station*
- 500 — *Bathymetric contour in metres. Contour intervals 20 m (0–200 m), 100 m (200–1000 m), 500 m (below 1000 m)*
- · 17 *Spot depth in metres*
- *Swamp*
- *Coral reef*
- *Highway, road*
- *Railway*

- *Sand*
- *Silty sand*
- *Silty clay*
- *Sandy clay*
- *Clayey sand*
- *Sand, silt, clay*
- *Rock*
- *30–90 % gravel*
- *10–30 % gravel*
- *>90 % carbonate*
- *60–90 % carbonate*
- *30–60 % carbonate*

CONTINENTAL SHELF SEDIMENTS

ARAFURA SEA

NORTHERN TERRITORY

1973

Scale 1 : 1 000 000

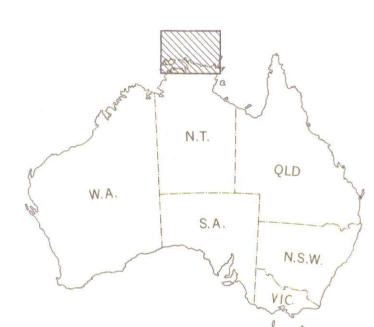
KILOMETRES 10 0 10 20 30 40 50 60 70 80
STATUTE MILES 10 0 10 20 30 40 50
NAUTICAL MILES 10 0 10 20 30 40 50

Lambert Conformal Conic Projection

Published by the Bureau of Mineral Resources, Geology and Geophysics, Department of Minerals and Energy. Issued under the authority of the Hon. R. F. X. Connor, M.P., Minister for Minerals and Energy.

Geology 1969 by D. Jongsma, H. A. Jones, D. S. Trail, R. Geijskes
Compiled 1971 by D. Jongsma
Cartography by Geological Branch, BMR
Drawn 1972 by M. R. Moffat
Printed by Mercury–Walch Pty Ltd., Hobart, Australia

Bibliographic reference: D. Jongsma 1974. Marine Geology of the Arafura Sea. Bureau of Mineral Resources, Geology and Geophysics. Australian Bulletin 157



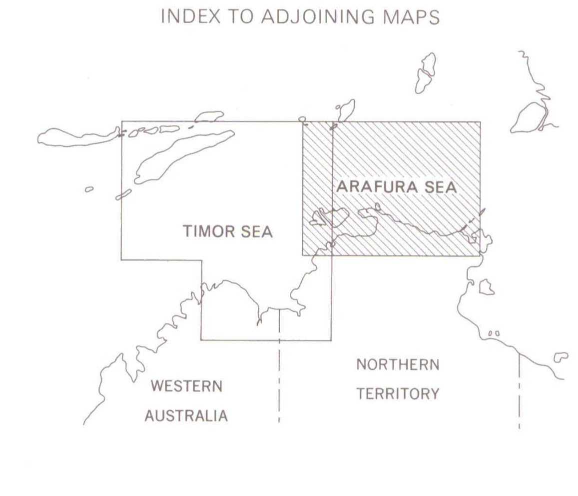
Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T.

Geological reliability: The distribution of sediments is based on analyses of sea bed samples from stations whose positions are marked. Extrapolation between stations, and outside the area sampled, has been guided by bathymetry and by sediment notations on British Admiralty and Australian charts

Bathymetric reliability: Bathymetric contours have been compiled from published and unpublished R.A.N. Hydrographic Service charts, from seismic profiles obtained by the Bureau of Mineral Resources in 1969, and from water depth data taken from subsidized petroleum search company reports.

NOT TO BE USED FOR NAVIGATION

INDEX TO ADJOINING MAPS



ARAFURA SEA