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TROPICAL AND TEMPERATE CARBONATE ENVIRONMENTS: THE EFFECTS OF SEA LEVEL, CLIMATE AND TECTONICS ON FACIES DEVELOPMENT

BY

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TROPICAL AND TEMPERATE CARBONATE ENVIRONMENTS: THE EFFECTS OF SEA LEVEL, CLIMATE AND TECTONICS ON FACIES DEVELOPMENT

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Phase 1

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EXECUTIVE SUMMARY

Cruise 105 was the first of three cruises planned for the BMR-JNOC joint research program aimed at understanding the effects of sea level, climate and tectonics on facies development in tropical and temperate carbonates. The program objectives are:

- to define the sediment facies distribution on the shelf and upper slope to a depth of 1000m;
- to define the three dimensional facies geometry;
- to define the principal factors affecting facies distribution;
- to relate facies geometry particularly to sea level change;
- to determine the effect of climate and sea level change on the position of the East Australia Current and to determine the chemical fingerprint of this specific watermass in the sediments;
- to understand and model the changes in climate and sea level in the past 500,000 years and to relate sea level change to facies geometry, and,
- to understand the diagenesis of temperate and tropical carbonates.

Cruise 105 left Sydney at 2215hrs on Monday 14th October and arrived in Cairns at 0800hrs Tuesday 12th November. Two areas had been chosen for detailed study (Figure 1):

(i) off Noosa Heads between latitudes 26°10'S and 26°40'S,
(ii) off Fraser Island between latitudes 24° 50'S and 25° 20'S.

Data collected during the cruise included 900km of multichannel high resolution seismic data, 350km of boomer data, 50km of sidescan data, and, of equal relevance, 49 camera stations, 25 dredge stations, 36 gravity core stations, 25 vibrocore stations and 103 grab sample stations. Ninety three metres of core were collected. The results obtained are summarised below.

Area 1 - Noosa Heads

Preliminary interpretation of the high resolution seismic data has defined 14 seismic sequences interpreted as sea level-related packages relating to the development of the margin since its likely flooding in the Oligocene (Davies and others, 1989). However the character of the sequence boundaries, particularly those in the upper half of the sections, suggest that processes of erosion other than conventional shore-related erosion have been of major significance. The sequence boundaries frequently change from erosional beneath the outer shelf to conformable westwards towards the coastline. We believe that these boundaries are produced when storm wave base and boundary

current transport coincide such that sediments are suspended and transported. This condition can occur as a consequence of a fall in sea level. However, the unconformity will not relate to a downward shift in coastal onlap, but rather to the accumulative effect of erosion in a depth zone bordering on a hundred metres of water. This is of major significance for the interpretation of seismic sequences and their use as direct sea level indicators.

Studies of the surface sediments have identified a major warm temperate to sub-tropical carbonate facies in the mid to outer shelf comprised principally of coralline algae which form both thick crusts and lithified and unlithified rhodoliths, together with bivalves, bryozoans, serpulid tubes, barnacles and benthonic forams; corals are limited to the shallow water parts of the bank. This biosedimentary association forms a biohermal build-up covering substantial parts of the middle and outer shelf, and bottom photographs show clearly the cross shelf variation in its biological and sedimentary composition.

Area 2 - Fraser Island

Seismic data collected allows the identification of hitherto undiscovered carbonate platforms forming the mid to outer shelf and upper slope terrace (Figure 26). All seismic sections show a 9km wide platform beneath the upper slope terrace, exhibiting poor reflection characteristics and truncated seawards by a steep slope often in excess of 30°. Changes in reflection character allow the differentiation of an outer and inner zone of poor reflection (Platforms 1 and 2), dipping reflectors in front of the inner non-reflecting zone (Platform 2), and the progradation of a strongly reflecting bedded upper section over the outer non-reflecting zone (Platform 1). The sequence is covered in the mid shelf by a third non-reflecting sequence (Platform 3), which interdigitates with three bedded sequences which are both truncated, and downlap onto the non-bedded and bedded parts of Platforms 1 and 2. The sediments of platforms 1 and 2 are at least 450m thick, and appear in seismic character to represent a section similar to that which occurs on the Marion Plateau (Davies and others, 1991), further to the north.

Dredging of the upper slope terrace (Platform 1) provides clues to both its composition and age. Samples from the base of the slope are pale yellow to pale brown packstones and grainstones comprised of benthonic foraminifera, planktonic foraminifera, bryozoans and pteropods, suggestive of a deep outer shelf depositional environment. Samples from the mid slope area are pale yellow rhodolith/large foram/molluscan packstones and grainstones of late Early Miocene to Middle Miocene age (to be confirmed). Samples from the top of the slope are pale yellow rhodolith/coral/

foraminifera grainstones, packstones and floatstones. Large rhodoliths, *Lepidocyclina* spp. and articulated coralline algae are a feature of the rocks dredged. In addition, bryozoans and benthonic foraminifera are particularly important constituents of mid and upper slope floatstones and wackestones.The age of the mid slope dredged limestones are considered to be Early and Middle Miocene, identical to those on the Marion Plateau. We interpret the seismic and dredge results to indicate the growth of an Early Miocene and early mid Miocene subtropical buildup growing in a generally rising sea level,which was subsequently exposed during the substantial mid Miocene fall in sea level. Exposure is indicated by the erosional unconformity seen in the seismic data and the meteoric diagenesis seen in thin sections.

Platform 3 is the youngest of the platforms. It is at least 150m thick and has backstepped some 9km, from the inner edge of Platform 1, to the west. However, in this position it still overlies the inner western part of Platform 2, and is seen at the shelf surface today as Gardner Bank. Sidescan data along its eastern margin show two major biosedimentary facies, a coralline algal/coral facies in 110m of water at the base of the cliff forming the eastern margin and a massive encrusting coralline algal facies forming the cliff itself. Nannofossil evidence indicate that these limestones are mid to late Pleistocene in age. Gardner Bank is today dominated by encrusting coralline algae and corals although other sediment contributors include bivalves, larger foraminifera, *Halimeda*, bryozoans, gastropods, echinoids, barnacles and articulated coralline algae; large areas of the bank are strewn with rhodoliths and covered by seagrass. Platform 3 is, therefore, a composite buildup formed during sea level oscillations in a marginal tropical or subtropical environment.

Studies in both Areas 1 and 2 demonstrate the potential for temperate and sub-tropical carbonates to form substantial buildups on passive continental margins.

INTRODUCTION

Carbonate sediments, through their dominantly biological composition are extremely sensitive indicators of the environment in which they have lived: sea level and climatic changes are faithfully recorded in the skeletons which dominate the composition of the sediments deposited in such environments. However, the strongest signals of environmental change will be encapsulated in the sediments deposited in the marginal climatic environments, i.e. in the subtropical and warm-temperate regions. In addition, such thick and widespread carbonate accumulations in many parts of the world have been shown to contain almost 50 percent of global oil and gas reserves, although almost all research has concentrated on sediments of tropical affinities, ignoring the facies relations, build-ups and potential plays in their subtropical and temperate counterparts. Eastern Australia, mantled by tropical and temperate carbonate sediments, therefore, defines the essential model for exploration applicable to both other parts of Australia and many parts of the world, and is, in addition, a prime focus for understanding the history and mechanisms of climate change in the past half million years.

The passive continental margin of northeast Australia extends for 2500 km from the tropics to temperate latitudes. It comprises the largest area of carbonate sediments deposited on a passive margin anywhere in the world, and includes both the Great Barrier Reef and the lesser known temperate build-ups of southern Queensland and northern New South Wales. It's architecture has been primarily defined by Late Cretaceous rifting and it's sedimentary evolution owes much to the northward plate motion of Australia in the Cainozoic from temperate to tropical latitudes (Symonds and others, 1983; Davies and others, 1987, 1989). The Great Barrier Reef represents the major feature on the margin, extending for 2000km and comprised of 2500 individual reefs. It is widest in the central-south area around latitude 21°S where coral reefs and *Halimeda*-rich packstones dominate the outer shelf. To the south, the reefs and *Halimeda* packstones diminish, and the sediments on the shelf comprise coralline algal boundstones, bryozoan/foraminifera grainstones and packstones, and rhodolith dominated buildups, bioclastic in nature and dominated by calcite rather than unstable aragonite. The facies and porosity/permeability attributes clearly reflect the change from tropical warm water to temperate cold water (Marshall and Davies, 1978; Davies and others, 1989). Studies on temperate carbonates in the Australian region are few, in spite of such sediments mantling the shelves surrounding half the continent (Jones and Davies, 1983; Marshall and Davies, 1978; Marshall, 1980; Rao, 1981; Collins, 1988; James and Bone, 1991; Conolly and von der Borch, 1967; Wass and others, 1970;

von der Borch, 1970). As part of the overall BMR/JNOC program, scientists from both organisations have visited the coastal outcrops of Tertiary limestones in the Torquay area of Victoria, and have collected the principal facies in order to effect a comparison with the offshore facies to be collected off northeast Australia.

Cruise Objectives

The principal objectives of the cruise were:

- To define the facies distribution on the shelf and upper slope in the two selected areas of the southern Queensland margin to a depth of approximately 1000m.
- To define the three dimensional facies geometry.
- To define the principal factors effecting facies distribution:
- To relate facies geometry to the above factors, particularly to sea level change.
- To define both the effect of climate and sea level change on the physical position of the East Australian Current and the chemical fingerprint of this specific watermass in the sediments.
- To understand and model the changes in climate and sea level particularly in the past 500,000 years, and to relate sea level change to facies geometry.
- To understand the post depositional factors affecting the physical make-up of the sediments and in particular to define and understand the differences in process and products in warm water and cold water carbonates limestones.

Previous Work

The main geological features of the region have been deduced from geological (Davies, 1979, 1983; Davies and Hopley, 1983; Marshall and Davies, 1978; Marshall, 1977, 1980; Stephens, 1982) and geophysical studies (Davies and others, 1989; Symonds and others, 1983; Marshall, 1979; Nunn, 1982; and Searle, 1983). Plate tectonics, climate, subsidence, oceanography and sea level have all contributed significantly to the distribution of facies.

Previous studies of the margin between latitudes 20° and 28°S have been fragmentary, covering only parts of the area and only some aspects of the Holocene evolution of the reefs (Davies, 1983; Davies and Hopley, 1983), the mapping of surface sediments (Marshall, 1977, 1980), and the intermediate to deep geological structure (Davies and

others, 1989; Hill and others, 1990). With the exception of ODP Leg 133 further north (Davies and others, 1991), little attempt has been made to thoroughly understand the factors affecting the evolution of the sediments or to use the record in the sediments as a library of past environmental change. Only Harris and others (1990) have attempted to relate sediment composition and distribution to causal mechanisms, although much of the ODP related research further north has provided the most important leap in understanding the relevance of the region to studies of climate change and passive margin evolution. The astonishing conclusion that parts of the Great Barrier Reef are less than one million years old and possibly as young as 500,000 years suggests that the environmental record it encapsulates is of the highest known resolution anywhere in the world, and a priceless statement of natural global climate change and the mechanisms driving modern climate change. Further, the extreme youth of the system raises crucial scientific questions about its biological evolution and the dogmas assumed in this evolution, and provides a priceless asset in model generation for energy exploration elsewhere.

The joint BMR-JNOC program will study the outer shelf and upper slope sedimentary facies of the northeast Australian margin along critical and contrasting latitudinal transects in 1991, 1992 and 1993.

Our summary of previous work concentrates on two aspects, i.e. facies distribution and seismic data.

Facies Distribution

The bathymetry in the study areas is shown in Figure 1. The distribution of samples previously collected in the area, together with the grainsize and calcium carbonate content are shown on large format maps prepared as part of the cruise proposal (Tsuji and others, 1991).

Very close correlation occurs between the areal distribution of large grainsize sediments and the high carbonate content sediments. Those sediments which are relatively coarse and have a high carbonate content are, in general, distributed on the outer shelf and upper slope, whereas relatively finer sediments with low carbonate content tend to be distributed on the inner shelf. As an exception, the shelf between 26°S to 26.5°S shows a reverse distribution, with coarse sediments rich in carbonate on the inner shelf and fine grained sediments low in carbonate content on the outer shelf to upper

slope. Corals and coralline algae are documented from the outer shelf, whereas the dominant carbonate grains on the inner shelf sediments are mainly mollusc fragments.

One drill hole occurs in the area off the northern end of Fraser Island (GSQ-Sandy Cape 1-3R; Grimes, 1982), the summary log for which is shown in Figure 2. This shows 420m of late Tertiary and Quaternary sandy marine shelf deposits, 172m of mid-Tertiary interbedded basaltic volcanics, and marine, deltaic and fluvial sediments. These sequences are correlated with the Oligocene and younger rocks in Wreck Island 1, and the Capricorn 1A and Aquarius 1 wells in the Capricorn Basin, further to the north.

Distribution of Seismic Data

The following seismic data has previously been collected in the areas under consideration for study:

BMR continental margin data collected in the early 1970s (Symonds, 1973).

BMR shelf mapping sparker data also collected in the early 1970s (Marshall, 1977).

Sonne 15 airgun data collected off Fraser island during 1980 (e.g. Jones and others, 1982).

Gulf and Shell seismic lines collected in the mid 1960s (unpublished data).

Study Transects

Two study areas (1 and 2 in Figures 1, and also Figures 3 and 4) have been chosen for detailed study on the following bases:

1. The distribution of carbonate sediments.
2. The expected distribution of various types of carbonate sedimentary facies in relation to the expected current conditions, water depth, bathymetry,etc In particular the distribution of rhodoliths is relevant because of the importance of this facies in the Ryukyus and because of its apparent significance as a warm temperate to sub-tropical indicator.
3. Sedimentation rates and outer shelf/upper slope morphology in the way they effect accessibility to the stratigraphic record.
4. The effects of currents on the distribution and characteristics of carbonate sedimentary facies.

The characteristics of each of the two selected study areas are defined below:

Area 1 (Noosa Heads) - Figure 3.

- Carbonate sedimentary facies are expected to extend from the inner shelf to the outer shelf.
- Grainsize distribution patterns show a normal equilibrium condition, i.e. a gradient from coarser sediment on the inner shelf to finer sediment on the outer shelf.
- Living coral is documented on a bank in the area (Barwon Bank). The biological association and the associated development of the carbonate sediments presents an interesting mid-shelf association.
- Planktonic foraminifera dominate the fine sedimentary facies on the outer shelf deeper than 70m, in distinction to the Ryukyus where such facies occur deeper than 200m.
- The change in topography from shelf to upper slope is very gentle: prograding sedimentary patterns are observed in the seismic sections.

Area 2 (Fraser Island) - Figure 4.

- In this area, the southward flowing East Australian Current impinges on the outer shelf.
- Biologic generation of substantial carbonate sedimentary facies is expected at the shelf edge.
- Grain size distribution patterns show the reverse pattern to that observed in Area 1, i.e. the coarse sediments occur on the outer shelf.
- The Rhodolith Facies, one of the most characteristic carbonate facies in the Ryukyus, is expected to occur in this area.
- The change of topography from shelf to upper slope is very steep and areas of low sedimentation rates and exposure of older formations, through shelf edge erosion, is expected on the shelf/slope. Dredge sampling from such slopes is expected to provide information on the age and sedimentary facies of older formations identified in the seismic sections.

CRUISE RESULTS

Area 1 - Noosa Heads

Seismic Stratigraphy

The position of seismic data collected in Area 1 is shown in Figure 5 and the seismic way points in Table1. The sequence stratigraphic interpretation of high resolution seismic data collected from Area 1 are shown in Figures 6-11, and summarised in Tables 2 and 3. The ages of the sequences are, at this stage, unknown. No attempt has been made to place the sequence stratigraphic and related eustatic controls within a regional or global time framework.

Line 105/01 (Figure 6)
This line begins at 26°20'S, 153°09.5'E, and ends at 26°20'S, 153°57.5'E. Water depth in the west is 35m and in the east is 2648m. The line is 77km in length. Interpretation of the monitor section prior to processing has defined eleven seismic sequences:

Sequence 1
This forms the outer shelf and upper slope surface throughout the section. It is uniformly 40msecs thick, parallel bedded with little internal structure.

Sequence 2
This sequence has parallel bedding as the only internal structure. It onlaps and downlaps onto the sequence boundary below. It is uniformly 20-30msecs below the shelf.

Sequence 3
This sequence is distributed below the outer shelf and upper slope to the east of 2220 hours. It onlaps to the west and pinches out at 2220. Its maximum thickness is 30msecs at 2221 hours.

Sequence 4
This is widely distributed below the shelf. It exhibits parallel bedding as its internal structure. The sequence onlaps and downlaps onto the sequence boundary below

and is truncated by the sequence boundary above at 2220 to 2221 hours. It averages 20msecs in thickness and is thickest (30msecs) at 2218 hours.

Sequence 5

This is distributed below the shelf edge and upper slope to the east of 2218 hours. The sequence onlaps onto the sequence boundary below. It is interpreted as a transgressive and still-stand prograding sequence at low sea level. Its maximum thickness is 50 msecs.

Sequence 6

This onlaps the sequence boundary below and is truncated by the upper sequence boundary, which is flat and continuous to the west of 2217 hours. This sequence is normally thin (20msecs) but is thickest (30msecs) at 2221 hours. It is a transgressive sequence.

Sequence 7

This sequence downlaps onto the sequence boundary below and is toplapped by the upper sequence boundary. It pinches out to the west at 2204 hours; it is thickest (40msecs) at 2218 hours.

Sequence 8

This sequence occurs between 2209 and 2222 hours. It onlaps and downlaps the lower sequence boundary and is truncated by the upper sequence boundary. The sequence is thickest (70msecs) at 2216 hours. It is thought to represent a prograding sequence, the foresets of which are truncated by an erosional surface.

Sequence 9

This is a thin (20msecs) sequence which occurs west of 2211 hours. The sequence onlaps the lower sequence boundary to the west, suggesting that the sequence is transgressive.

Sequence 10

This occurs to the west of 2210 hours. The internal structure of the sequence shows parallel bedding which downlaps on to the lower sequence boundary and is truncated by the upper one. To the west of 2200 hours this sequence has a uniform thickness of 50 msecs. It is very thin, less than 20msecs, from 2201 to 2205 hours, because of the mound like topography of the lower sequence boundary. Most of the

lower part of this sequence is covered by multiple where processing is needed for a precise interpretation.

Sequence 11

Internally, this sequence exhibits both mounding and parallel bedding. It is truncated by the upper sequence boundary which is irregular, suggesting erosion. Most of this sequence is covered by the multiple.

Line 105/05 (Figure 7)

This line is approximately 50km in length and begins at 26°25'S, 153°23.5'E, and ends at 26°25'S, 153°54.5'E. Water depths are 1332m in the east, and 51m in the west. Eleven seismic sequences have been recognised based on the interpretation of the fast monitor section prior to processing:

Sequence 1

This sequence occurs between the sea floor and a depth of 45msecs, forming the shelf and slope surface throughout the line. It is parallel bedded with very minor eastward progradation and westward onlapping. The basal reflection of Sequence 1 slightly truncates the underlying Sequence 2. The truncation is well shown between 0030 hours (174m) and 0040 hours (216m) around the present day shelf edge.

Sequence 2

This sequence is thinnest at around 0030 hours (174m) where it measures 20msecs. It thickens toward both east and west. In the east, it is thickest at around 0040 (216m) and 0020 (145m) where it measures 46msecs. Further west, it gradually decreases in thickness. In the eastern part of the area near the present day shelf edge, the sequence mainly consists of parallel reflectors onlapping a palaeoshelf edge to the west. Eastwards progradation is also seen here. In the west, it comprises parallel reflectors onlapping a palaeohigh at 0015 hours (137m) from the west. Sequence 2 is clearly transgressive. The sequence boundary between Sequences 2 and 6 is an erosional unconformity which has its shallowest part at 0020 hours and gradually merges westwards and eastwards. The basal reflection of Sequence 2 truncates the underlying three Sequences 3, 4, and 5.

The following three Sequences (Sequences, 3, 4, and 5) are small scale prograding packages separated by truncation surfaces.

Sequence 3.

The sequence is thickest at 0042 hours (242m) measuring 60msecs, and rapidly thinning out both up slope and down slope. It consists of foresets downlapping on the lower sequence boundary and truncated at their tops. The sequence boundary between Sequences 3 and 6 is an erosional unconformity. The prograding sequence may represent deposition during low sea level.

Sequence 4

This progradative sequence is very similar to Sequence 3. It is thickest (40msecs) at 0039 (206m) and thins out rapidly to zero both to the west and to the east. The reflectors are downlapping on the lower sequence boundary and truncated at the tops. This prograding sequence may represent deposition during low sea level.

Sequence 5

The thickness of this sequence is around 32msecs, and rapidly thins out to zero up slope and down slope. The sequence also resembles sequences 3 and 4. It onlaps and downlaps the lower sequence boundary and may have formed at the initial stage of low sea level.

Sequence 6

The sequence is thickest (75msecs) at around 0029 hours (171m) and thins to the west and to the east due to the erosion at the sequence boundary 5/6. The progradative sequence is truncated at the top and downlaps on to the lower sequence boundary. The lower surface is erosional and has eroded out the lower sequence at 0029 hours (171m). The bathymetric low is filled with deposits starting at the beginning of Sequence 6. It may be transgressive.

Sequence 7

This sequence is relatively uniform in its thickness (30msecs) to the west of 0029 (171m). To the east of 0029 it substantially changes its thickness due to the development of banks in Sequence 8. Sequence 7 is aggradative and eroded at the top. At 0040hours (216m) downlapping reflectors are seen. Between 0029 hours (171m) and 0034 hours (187m), the reflectors are onlapping the lower lying banks. To the east of 0025 hours (158m), they are prograding onto the sequence boundary between Sequences 7 and 9.

Sequence 8

This sequence averages 20msecs thick but thickens to 40msecs at the banks and thins out to zero to the west at 0029 hours (171m). This progradative sequence is characterised by the banks in the upper part of the sequence which are located between 0029 hours (171m) and 0034 (187m). The sequence boundary between Sequences 8 and 9 is a truncation surface.

Sequence 9

This sequence is bounded top and bottom by truncation surfaces. It shows relatively constant thickness (45msecs) and thins downdip. The parallel reflectors are relatively uniformly low dipping and slightly progradative. The sequence may represent deposition during high sea level.

Sequence 10

This progradative sequence is very similar to Sequence 9. It shows no drastic change in thickness (22-34msecs). Due to the multiples, detailed structures are invisible to the west of 0026 hours (163m). The sequence may represent deposition during high sea level.

Sequence 11

This progradative sequence is also similar to Sequences 9 and 10. The thickness gradually increases eastwards (60-100msecs). The parallel reflectors are onlapping the lower surface. The sequence may represent deposition during high or a transgressive sea level.

Line 105/06 (Figure 8)

This line begins at 26°30'S, 153°53'E, and ends at 26°29.5'S, 153°22'E. Water depth in the east is 831m and in the west 53m. The line is 52km in length.

Interpretation of the monitor section prior to processing has defined seven seismic sequences:

Sequence 1

This sequence occurs between the sea floor and a depth of 70 msecs, East of 0330 hours (831m) the sequence is truncated by the sea floor and therefore comprises the seafloor throughout much of the area westwards to a depth of approximately 100m; westwards of this it probably still mantles the shelf. It is almost certainly composed

of a series of eastward prograding and onlapping reflectors formed during a succession of sea level oscillations. The basal reflector of Sequence 1 markedly truncates the underlying sequence. The truncation is particularly well seen between 0435hours (216m) and 0455 hours (174m) representing the position of the present day upper slope.

Sequence 2

This is thickest west of 0415 hours (309m) where it measures 250msecs. It is comprised of parallel reflectors onlapping a palaeoshelf edge but which parallel the palaeoshelf surface, with gentle feather edging westwards (as seen at 0455 hours (174m)). Sequence 2 is clearly transgressive. It is exposed at the seafloor in water depths between 830 and 1000m. The sequence boundary between Sequences 2 and 3 is an erosional unconformity which merges westwards with the unconformity between Sequences 1 and 2.

Sequence 3

This is thickest (120 msecs) between 0440 hours (202m) and 0450 hours (182m). Westwards it rapidly thins due to erosion at the 2/3 unconformity. Although comprised largely of parallel reflectors, it loses this characteristic in places and exhibits a mounded appearance. It may slightly prograde with downlapping seen between 0442 hours (197m) and 0446 hours (189m). The sequence may therefore represent deposition during high sea level, the progradation representing stillstand deposition.

Sequence 4

This sequence is 120msecs thick at 0500 hours (176m) and is comprised of parallel onlapping reflectors which thin westwards and are truncated by the Sequence 3/4 boundary. Massive truncation occurs along a palaeoslope at 0412 hours (324m). Eastwards, the sequence thins dramatically.

Sequence 5

This is the thickest sequence identified; it is 400 msecs close to 0412 hours (324m). West of 0500 hours (176m), the sequence is very clearly progradative while eastwards, correlative reflectors aggrade. A series of progradative and onlapping units probably comprise the sequence but processing is needed to decipher the detail.

Sequence 6

This is clearly progradational as seen at 0520 hours (146m). It is 100 msecs thick, but thins westwards onto a rising basement.

Sequence 7

This is over 200 msecs thick at 0518 hours (148m). It overlies basement and may therefore represent the first transgression of the margin. It is comprised of at least two facies:

(i) a mounded, partly prograding and partly lagoonal (?), probably shallow water facies, immediately above basement,

(ii) an onlapping facies onto both basement and the mounded/prograding facies.

This sequence is therefore both progradative and transgressive. The above defined relationships are best seen between 0515 hours (151m) and 0530 hours (136m).

Line 105/08 (Figure 9)

This line is approximately 44km in length and extends from 26°35.0'S, 153°22.5'E to 26°35.0'S, 153°46.4'E. Water depths vary from 54 to 563m.

Twelve sequences have been identified in this section:

Sequence 1

This sequence forms the shelf and upper slope surface throughout the section. It is uniformly 50msecs thick, parallel bedded with little internal structure. It onlaps the lower sequence boundary. The sequence is transgressive.

Sequence 2

This sequence exhibits parallel bedding.with prograding to the east onlapping and downlapping the sequence boundary beneath. In addition it is truncated by the sequence boundary above. The thickness is 5msecs below the shelf becoming much thicker from 1605 hours seaward. Its maximum thickness is 80msecs at 1600 hours. The sequence is transgressive.

Sequence 3

This sequence shows sigmoidal bedding from 1600 to 1610 hours and parallel bedding from 1610 to the east. It appears to define a shelf edge system of deposition. It onlaps the sequence boundary below. The maximum thickness of the

sequence is 80msecs as seen at 1606 hours. The sequence may be transgressive and high stand.

Sequence 4

The sequence shows sigmoidal bedding between 1606 to 1607 and parallel bedding from 1607 to the east. It onlaps and downlaps the lower sequence boundary below and is truncated by the sequence boundary above. The sequence is very thin (less than 10msecs) to the west of 1550 hours, and thickest (100msecs) at 1622 hours. The sequence is both transgressive and high stand.

Sequence 5

This sequence shows parallel bedding. It onlaps and downlaps the lower sequence boundary. The sequence boundary above this shows a massive unconformity which truncates Sequence 7. The maximum thickness of this sequence is 40msecs at 1600 hours. It is a stillstand prograding sequence.

Sequence 6

This sequence is parallel bedded to 1600 hours and mounded at 1602 hours. It onlaps and downlaps the lower sequence boundary and is truncated by the sequence boundary above. It onlaps at 1605. Maximum thickness of the sequence is 40msecs at 1555 hours. This is a transgressive sequence.

Sequence 7

The sequence shows sigmoidal and parallel bedding. It onlaps the sequence boundary below and is truncated by the sequence boundary above. Its maximum thickness is 90msecs at 1555 hours. This is a transgressive and stillstand progradative sequence.

Sequence 8

This sequence is mounded at 1520 to 1540 hours; prograding from 1540 to 1555 and parallel bedded from 1555 to the east. It both downlaps and onlaps the lower sequence boundary and is truncated by the sequence boundary above which shows an irregular erosional surface at 1539 to 1548 hours. The maximum thickness is 100msecs at 1559 hours. This sequence is a still stand progradative sequence.

Sequence 9

The sequence is parallel bedded. It onlaps the sequence boundary below and is truncated by the irregular sequence boundary above at 1538 to 1548. Although this

sequence is thin (20-40 msecs) to the west of 1603 hours, it becomes thicker to the east from 1605 hours., and thickest (120msecs) at 1624 hours.

Sequence 10

The sequence shows parallel bedding throughout the section, but is mounded from 1526 to 1535 hours. It onlaps and downlaps the lower sequence boundary. The section varies in thickness from 80-200msecs.

Sequence 11

This is a prograding sequence with mounded structures at 1522 to 1531 hours. It onlaps and downlaps the lower sequence boundary. This sequence shows the rise in sea level and following stillstand. It varies in thickness from 100 to 180msecs.

Sequence 12

This sequence shows an eastward prograding shelf-edge structure at 1555 to 1605 hours and parallel bedding downlapping eastward to the west of 1555 hours. It onlaps and downlaps the basement surface which is characterised by an irregular erosional surface. The sequence is thickest (100msecs) at 1609 hours and terminated at 1605 hours.

Line 105/09 (Figure 10)

This line is approximately 18km in length and extends from 26°36.9'S, 153°46.7'E to 26°36.8'S, 153°39.3'E. Water depths vary from 891m to 163m.

Sequence 1

This sequence forms the shelf and slope surface throughout the section. It is uniformly 80msecs thick, parallel bedded with little internal structure.

Sequence 2

Thinly bedded transgressive sequence 25msecs thick.

The following three sequences are distinct prograding packages separated by erosional unconformities.

Sequence 3

A prograding sequence with foresets truncated at the top while the same foresets downlap on the lower sequence boundary. The sequence is thickest (25msecs) at

1806 hours (279m). The lower surface is erosional. Downslope, Sequence 3 is uniformly thick at around 50msecs but thins up slope to zero to the west of 1820 hours (226m).

Sequence 4

A progradative sequence similar to Sequence 3 and thickest (100msecs) at the junction of the foresets and topsets at 1912 hours (147m). The sequence thins both to the west and to the east. Substantial erosion has affected the upper sequence boundary to the east.

Sequence 5

A progradative sequence which is thickest (60 msecs) at around 1912 hours (147m). Substantial truncation has occurred along the top of the foresets, whereas basinwards the bottomsets are thin and conformable and exhibit little erosion.

Sequence 6

Bounded top and bottom by unconformities the sequence is comprised of relatively uniformly low dipping reflectors. The sequence is thinnest where it has been eroded at 1805hours (286m) and thickest down slope at 1742 hours (584m) where it exhibits both mounding and erosion within the sequence.

Sequence 7

At least 100msecs thick, Sequence 7 is comprised of uniformly dipping reflectors which onlap the lower sequence boundary east of 1750 hours (468m).

Sequence 8

Of unknown total thickness, Sequence 8 is clearly progradational with its upper boundary characterised by substantial erosion. The steep foreset slope east of 1750 hours (468m) appears to represent an original depositional slope, i.e. an original prograding shelf edge and slope.

Line 105/10 (Figure 11)

This tie line is a strike section approximately 18km in length. It extends from 26°37.0'S, 153°45.5'E to 26°30.0'S, 153°49.0'E. Water depths vary from approximately 170 to 300m. Twelve seismic sequences have been identified:

Sequence 1

A blanket sequence throughout the section, it is approximately 60msecs thick at 0220hours, but as thin as 40 msecs at 0120hours along the southern part of the line. Many sequences below Sequence 1 appear to prograde from both the north and the south towards a depocentre at around 0210 hours.

Sequence 2

Thickest in the depocentre where it is 20msecs, it onlaps its lower sequence boundary. It is therefore similar in character to Sequence 1 in that it forms a blanket, probably partly transgressive sequence, However unlike Sequence 1, it occupies only the centre of the depocentre and its northern shoulder. It has suffered erosion to the south.

Sequence 3

A prograding sequence truncated by the Sequence 2/3 boundary, it is 45msecs thick in the centre of the depocentre, but absent or very thin along both the northern and southern shoulders.

Sequence 4

A composite prograding/transgressive sequence, it likely represents more than one sea level oscillation. It is thickest along the southern shoulder where it measures 90msecs at 0155hours.

Sequence 5

Eroded above and below, Sequence 5 is nowhere more than 40msecs thick along the southern shoulder, thinning into the depocentre but expanding to 70msecs thick along the northern shoulder.

Sequence 6

Occurs along the southern shoulder where it is bounded by erosional unconformities above and below. It is 60msecs thick at 0145hours.

Sequence 7

Bounded by erosional surfaces above and below, Sequence 7 thickens to the north. It has been substantially eroded along the Sequence 6/7 boundary in the basin centre. It is progradational along the edge of the southern shoulder but is flat lying to the

north. The erosion in boundary 6/7 time has strongly emphasised the channel between the northern and southern parts of the section.

Sequence 8
Progradational along the southern shoulder, where it is 90msecs thick, it thins to the depocentre due to erosion. However, further north it is flat lying and approximately 80msecs thick.

Sequence 9
Identified only along the southern shoulder, it is 15msecs thick and bounded by erosional unconformities.

Sequence 10
Thickening towards the basin, it is 140msecs thick along the southern shoulder and greater than 200msces thick along the northern flank.

Sequence 11
Prograding to the north, but now uniformly thick at approximately 120msecs, it is bounded top and bottom by erosional unconformities.

Sequence 12
Infilling topographic relief in what may be basement in the area, Sequence 12 is also at least partly progradational. It is in places 200msecs thick (e.g.. 0125hours).

Correlation of the Seismic Sequences

Using the tie line, 105/10 (Fig. 11), correlation of the seismic sequences in all the dip sections has been attempted and is shown in Table 2 and 3. The sequences may be interpreted as sea level related packages in the conventional manner as shown in Table 2 and 3. However, one important character of the sequence boundaries deserves comment; the frequency with which most sequence boundaries change from clearly erosional in the east to conformable westwards, i.e. towards the shoreline. Within a eustatic interpretation how do sequence boundaries become conformable westwards when a falling sea level progressively exposes eastwards? A possible explanation lies with the mechanisms of erosion producing the eroded parts of the sequence boundaries. Erosion will occur on the outer shelf when storm wave base and boundary current transport coincide, such that sediments are suspended and transported. This will occur

as a consequence of a fall in sea level, but the unconformity will not be a subaerial unconformity; it will relate to an outer shelf condition, not a shoreline condition.

Sedimentology

The location of sediments collected from the shelf off Noosa in southern Queensland are shown in Figure 12. Facies variations in the sediments have been defined on the basis of carbonate content (Figure 13), bioconstituents (Figure 14) and grainsize (Figure 15). The position of bottom photographs of sedimentary environments on the shelf are shown in Figure 17 and the photographs themselves in Appendix 2. Descriptions of all samples collected are shown in Appendix 3.

On the continental margin off Noosa, four facies have been defined (Figure 16):

1. Inner Shelf Fine Sand Facies

This occupies the inner shelf between the shoreline and approximately 60m water depth and is composed of sub-rounded to rounded, generally well sorted quartz, felspar and lithic fragments as observed in samples GS/010, 011, 034, 035, 036, 037, 038, 039, 060. The carbonate content may vary up to 40% but is usually much lower and may be as low as 5%. The carbonate constituents are bivalves, brachiopods, barnacles, serpulids, benthonic forams and gastropods.

The cores collected in this facies are VC/011, VC/012, VC/013, and VC/019. The sediments which comprise the cores, vary in texture and composition upwards from very fine- to medium-grained, moderately sorted grey quartzose sand, containing planktonic foraminifera, to fine- to medium-grained, well to moderately sorted olive grey or grey quartzose sand, and fine- to coarse-grained brown quartzose sand at the surface. The whole sequence can be observed in VC/012, although a shelly unit which can be observed in some cores at the bottom of the middle fine- to medium-grained sand cannot be observed in this core. The lowermost plankton bearing unit is not observed in VC/011, and the uppermost unit is only seen in VC/012. The succession indicates a shoaling upward sequence, beginning with an open marine environment (as indicated by the plankton), changing to an inner shelf environment, and reflecting coastline progradation.

2. Medium- to Coarse-Grained Sand Facies

This facies occurs within the depth range 60-80m, except in the south where it extends to around 160m. The facies is characterised by two sub-facies. (1) A low carbonate sub-facies, occurring between the fine sand facies and Barwon Bank and its northern extension, dominated by moderate to well sorted and well rounded quartz, with lithic fragments and glauconite(?) sometimes present; the low carbonate content, usually around 10%, is composed of bivalves and large benthonic forams; as observed in samples GS/007, 008, 009, 012, 013, 031, 032, 033, 040, 041, 042, 043, 057, 058. (2) A high carbonate sub-facies, immediately adjacent to and the south of Barwon Bank, with a carbonate content of 30-100%; the quartz in these sediments is identical to that found elsewhere in the facies. The carbonate is essentially bioclastic and composed of bivalves, brachiopods, serpulids, and large benthonic forams. Samples from this sub-facies are GS/002, 003, 014, 020, 044, 045, 052, 053, 056.

Cores collected in this facies are VC/010, VC/023 and VC/024. Core VC/010, collected from the low carbonate sub-facies, is 56cm long, and is composed, in ascending order, of medium to very coarse sand, shelly muddy very coarse sand, and shelly sandy granules. The other two cores, VC/023 and VC/024 were collected from the high carbonate sub-facies. VC/023 is 56cm long, and is comprised of muddy fine to coarse sand, gravelly (shelly) coarse to very coarse sand, fine to medium sand, coarse to very coarse sand, and muddy fine to coarse sand in ascending order. VC/024 is 44cm long and consist of four units, gravel, muddy sand, medium to coarse sand, and fine to medium sand, in ascending order. The carbonate content of the units varies from 15% at the base to 40% at the top, suggesting a clear upward increase in carbonate producing biological activity. This succession may show a deepening upward sequence.

3. Very Coarse Sand and Gravel Facies

This facies occurs in the vicinity of Barwon Bank in water depths of 30-80m. Samples from this facies are GS/004, 005, 006, 015, 016, 017, 018, 029, 030, 055. It is typically a biohermal facies with carbonate content varying from <30 to 100%. The terrigenous components include rounded and well sorted quartz, lithic fragments and felspar. The principal carbonate components include bivalves, bryozoans, serpulid tubes, barnacles, benthonic forams with rarer corals and planktonic forams. However, the most distinctive component of the facies is coralline algae in the form of crusts on most fragments and as rhodoliths, especially in the southern part of the bank in water depths shallower than 60m. Sea bottom photographs show some living coral development, but also extensive seagrass beds (Figure 17 and Appendix 2).

Dredged samples from Barwon Bank (DR/012, DR/013, DR/014, DR/015, DR/017) are comprised of calcareous sandstone and/or sandy limestone, corals, molluscan shells including oysters, and rhodoliths. Some of them are encrusted by red coralline algae and/or barnacles. The calcareous sandstone and/or sandy limestones show thin parallel bedding and exhibit boring by sponges or molluscs. Encrusting coralline algae first cover the sandstones, and are succeeded by barnacles or encrusting corals. The degree of cementation in the sandstone changes according to the bedding; vugs or borings are often arranged parallel to the bedding. A thin section of a sandy limestone from DR/013 showed it to be a well sorted grainstone to packstone, composed of sand-sized articulated coralline algal segments, quartz, feldspar, and other biotic grains. Pore fillings include acicular isopachous cement, drusy mosaic, equant cement and bladed to fibrous needle cement. The acicular isopachous cement and the bladed to fibrous needle cement suggest submarine cementation while the drusy mosaic equant cement suggests cementation in the meteoric environment. However, some bioclasts are very fresh and do not show evidence of meteoric diagenesis.

Conglomerates composed of the algal coated well rounded calcareous sandstone pebbles were also dredged. The matrix of the conglomerate is a well consolidated, poorly sorted sandstone in which the intergranular pores are filled by white lime mud. The matrix is composed of fine to very coarse sand-size grains of quartz, benthonic foraminifera, and other unidentified grains. Platey living and dead corals (*Montipora* sp mainly) were also dredged.

VC/022 is a core collected in this facies. It is 13cm in length, made of moderately sorted quartzose coarse sand, and contains 40% carbonate consisting of benthonic forams, molluscan shell fragments and echinoid spines.

4. Outer Shelf/Upper Slope Fine Sand Facies

This facies occurs generally in water depths greater than 80-100m and mainly occupies the upper continental slope. The samples are GS/001, 021, 022, 023, 024, 025, 026, 027, 046, 047, 048, 049, 050, 051. Large variations in carbonate content, from 30-90 percent, typify this facies. The terrigenous component, dominantly quartz, is well sorted and moderately rounded. The carbonate component is bioclastic and comprised of bivalves, bryozoans, benthonic forams and barnacles as major contributors, while corals, pteropods and planktonic forams are minor constituents.

Rocks from DR/011 are rhodolith limestones coated by living coralline algae on one side. The rhodoliths are 1-6cm in diameter, and some have coral as nuclei. The matrix varies from a coarse grainstone to a wackestone. Limestone fragments consisting of coralline algae and benthonic forams were recovered from GC/018.

Cores collected in this facies are VC/013, VC/015, VC/016, VC/017, VC/018, and VC/025, and consist of four units: fine sand, shells and granules, fine to medium sand, and very fine to medium sand in ascending order. The nannofossil analysis of VC/014 suggests, from the rare occurrence of *Emiliania huxleyi*, that the lowermost fine sand is older than 60,000 years. The upper three units, which show an upward fining sequence, were probably deposited during a late Quaternary transgression. The shell and granule deposit is probably the early transgressive unit, the fine to medium sand the middle transgressive unit, and the uppermost very fine to medium sand the late transgressive/highstand unit. This whole sequence is observed also in VC/015, 016, 017, and 018. VC/025 shows the upper two sequences in a 183cm core.

Summary

The sediment distribution of Area 1 is summarised as follows:

(1) Inner shelf fine sand facies extends from the shoreline to approximately 60m water depth. Cores suggest a shoaling upward regressive sequence.

(2) Medium to coarse grained sand facies occurs within the depth range 60-80m except in the south where it extends to around 160m.

(3) Very coarse sand and gravel facies, which is typically a biohermal facies characterised by coralline algae, corals, and barnacles, occurs in the vicinity of Barwon Bank in water depths of 30-80m.

(4) Outer shelf/upper slope fine sand facies occurs deeper than 80 to 100m. Limestones are exposed on the outer shelf in the northern part of the survey area.

Calcareous Nannofossil Biostratigraphy

Microscopy was conducted at a magnification of 1,500, using both smear slides and slides prepared by the method introduced by Stradner and Papp (1961). Most samples taken by vibrocorer and dredge are composed of sand, so Stradner and Papp's technique was necessary for the concentration of calcareous nannofossils. To correlate zonal schemes with radiometric ages, the scheme of Sato and Takayama (1990) was used in this paper (Figure 18). Age, core length and water depth are summarised in Table 4.

Overall abundance

Abundant: > 100 specimens/observation field (x 1500)
Common :10-100 specimens/observation field (x 1500)
Few : 1- 10 specimens/observation field (x 1500)
Rare : < 1 specimens/observation field (x 1500)

Relative Abundance

Abundant: > 32%
Common : 32-8%
Few : 8-2%
Rare : 2-0.5%
Very Rare: < 0.5%

1. Core Sample Analysis (Tables 5 and 6)

A total of 31 samples collected from the core catchers (16 gravity cores and 15 vibrocores) were examined for their calcareous nannofossils assemblages. The results are shown in Table 5 and 6.

Correlation of the above samples to the CN Zones of Okada and Bukry (1980; Fig.18) and to the zonal scheme given by Sato and Takayama (1990; Fig.18) are summarised as follows:

GC/014; CN-14b Subzone (Okada and Bukry, 1980),
between biodatum 2 and 3 (0.24-0.39 Ma; Sato and Takayama, 1990)).
GC/015; CN-11 Zone or older, below biodatum 16 (older than 3.56 Ma).
GC/017; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/019; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/020; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/021; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/022; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/023; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/024; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/025; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/026; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/027; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/029; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/030; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/031; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).

GC/032; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/006; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/007; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/010; CN-14b-CN-15 Zone, between present and biodatum 3 (0-0.39 Ma).
VC/011; CN-14b-CN-15 Zone, between present and biodatum 3 (0-0.39 Ma).
VC/012; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/013; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/014; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/015; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/016; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/017; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/018; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/019; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/023; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/024; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
VC/025; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).

Most samples (GC/019, 020, 021, 022, 023, 024, 025, 026, 027, 029, 030, 031, 032, 033; VC/007, 012, 013, 016, 017, 018, 019, 023, 025) can be correlated to the age between 0.07 Ma and present. At least, it can be safely said that their age should be younger than 0.24 Ma.

Sample GC/015cc includes many nannofossil species which characterise a mid Pliocene age. The age of sample GC/014 is assigned to between 0.39 Ma and 0.24 Ma.
Three samples (VC/014, 015, 024) are dated between 0.24 Ma and 0.07 Ma; however, due to the poor preservation state of the fossils, SEM examination will be necessary to obtain a more definite age determination.

For GC/017 and VC/006, it can only be said that their age is younger than 0.24 Ma and for VC/010 and 011, younger than 0.39 Ma.

The rare occurrence of *Sphenolithus* spp. in five samples (GC/022, VC/014, 019, 023, 024) is thought to indicate reworking from older strata.

In sample GC/014 the calcareous nannofossil assemblage is characterised by a flood of *Gephyrocapsa* group. Almost 95% of the flora consists of *Gephyrocapsa* spp. (*Gephyrocapsa caribbeanica, Gephyrocapsa oceanica, Gephyrocapsa parallela, Gephyrocapsa* spp.(small forms) with well preserved central bridges. The absence of

Pseudoemiliania lacunosa/Emiliania huxleyi indicates that this sample should be placed between biodatum 3 and biodatum 2 (0.39 Ma-0.24 Ma; Sato and Takayama, 1990) and the CN14b Subzone of Okada and Bukry (1980). In addition to the *Gephyrocapsa* group, few to rare occurrence of the following species was recorded; *Crenalithus doronicoides, Helicosphaera carteri, Discolithina* spp., *Calcidiscus leptoporus*, and *Rhabdosphaera clavigera.*

In sample GC/015 two samples from the core catcher and top of this 108cm core were analysed for their nannofloras. Both samples consist of dark olive clay and are dominated by small placoliths which make up 95% of the assemblage. The presence of *Sphenolithus abies* in the lower sample and the absence of this species in the upper sample suggests that biodatum 16 (3.56 Ma; Sato and Takayama, 1990) is located within this 108cm core. In the lower sample, *Discoaster asymmetricus* is one of the common species among the discoaster group, which is thought to indicate that the lower sample should be correlated with the CN-11 Zone. The occurrence of *Discoaster tamalis* in the upper sample indicates that the age of this sample is older than 2.75 Ma (biodatum 15 of Sato and Takayama, 1990). The core GC/015, therefore, ranges in age from latest early Pliocene to earliest late Pliocene. The other important constituent in these samples are *Pseudoemiliania lacunosa, Helicosphaera carteri, Helicosphaera* cf.*sellii, Discolithina japonica, Discolithina multipora, Discolithina* spp., *Calcidiscus leptoporus, Calcidiscus macintyrei, Coccolithus pelagicus, Rhabdosphaera clavigera, Scapholithus fossilis, Crenalithus productus, Discoaster brouweri, Discoaster pentaradiatus, Discoaster tribrachiatus*, and *Braarudosphaera bigelowii.*

In sample GC/017, two samples (dark grey, slightly fine sandy mud from the core catcher and dark olive, slightly muddy fine sand from the top of core) were analysed. The relative abundance of *Emiliania huxleyi* in both samples is "few", which may indicate that the age of the whole of core GC/017 lies between 0.24 Ma and 0.07 Ma (between biodatum 2 and the bottom of the acme of the *Emiliania huxleyi* biohorizon (Gartner,1977). The few occurrences of *Emiliania huxleyi*, however, may be attributed to a temporary fluctuation in nannofloral composition and/or the selective removal of small-sized *Emiliania huxleyi* from the assemblage by dissolution. The moderate to poor preservation state of nannofossils in these samples may suggest that the latter has occurred and changed the original floral composition. The assemblages themselves are very similar in both samples, and consist mainly of *Gephyrocapsa caribbeanica, Gephyrocapsa oceanica, Gephyrocapsa* spp.(small forms), and *Crenalithus doronicoides.*

In sample VC/006, two samples of similar lithology (olive muddy fine sand), one from the core catcher and the other from 60cm above the core bottom, were examined. The relative abundance of *Emiliania huxleyi* is around 25% in the lower sample, whereas it attains nearly 90% in the upper sample, which may show that the bottom of the acme of the *Emiliania huxleyi* biohorizon (0.07Ma; Gartner,1977) occurs between 0-60cm from the bottom. Judging from the good preservation state of the flora, selective dissolution of *Emiliania huxleyi* is unlikely to have changed the original floral composition in the lower sample. However, there still remains the possibility that the shift in relative abundance of *Emiliania huxleyi* is due to a temporary floral fluctuation caused by a change in marine conditions. *Gephyrocapsa caribbeanica, Gephyrocapsa oceanica, Gephyrocapsa parallela, Gephyrocapsa* spp.(small forms), *Crenalithus doronicoides, Helicosphaera carteri, Discolithina* spp., *Calcidiscus leptoporus*, and *Rhabdosphaera clavigera* constitute the other important species of these samples.

In sample VC/010, VC/011 olive medium-grained sand (VC/010, core catcher) and brown calcareous medium-grained sand (VC/011, core catcher) produce only moderately-poorly preserved nannofossils. The assemblages of both samples are mainly composed of small placoliths (ca.90%), but *Emiliania huxleyi* was not identifiable due to poor preservation state. *Gephyrocapsa* is one of the most dominant genera in the assemblage. The absence of *Pseudoemiliania lacunosa* indicates these samples may be correlated to a time above biodatum 3 (0.39 Ma) and to the CN-14b - CN-15 Zones.

In samples from VC/014, VC/015 and VC/024 the floral contents are very similar to one another; VC0/14 core catcher--dark olive fine to medium-grained sand; VC/015 core catcher--dark grey muddy fine to medium-grained sand, and VC/024 core catcher--olive very coarse-grained sand. The flora consist of *Crenalithus doronicoides, Gephyrocapsa caribbeanica, Gephyrocapsa oceanica, Gephyrocapsa* spp.(small forms), and *Emiliania huxleyi*. The relative abundance of *Emiliania huxleyi* is relatively low in all three samples (VC/014; 13%, VC/015; 18%, VC/024; 17%) when compared with that of other cores of the equivalent intervals (50-90%). Therefore, these three cores may reach in time below the bottom of the acme of the *Emiliania huxleyi* biohorizon (0.07 Ma). As discussed above, there still remain the two problems of selective dissolution and a temporary floral change which may affect this conclusion. However, it is clear that the age of the bottom of these cores is younger than 0.24 Ma (Biodatum 2).

The core catcher samples from GC/019, 020, 021, 022, 023, 024, 025, 026, 027, 029, 030, 031, 032 and VC/007, 012, 013, 016, 017, 018, 019, 023, 025 were examined. Although some differences may occur in the overall abundance and preservation state of nannofossils among the captioned samples, all of them have the same character in floral composition; i.e. the dominance of *Emiliania huxleyi* (50-90%). These samples are, therefore, correlated to a time above the bottom of the acme of the *Emiliania huxleyi* biohorizon (0.07 Ma). However, because of problem of the two factors which may affect floral composition discussed above, it is difficult at present to strictly limit their age to between 0.07 Ma and the present. Other species of importance in these samples are *Gephyrocapsa caribbeanica*, *Gephyrocapsa oceanica*, *Gephyrocapsa parallela*, *Gephyrocapsa* spp.(small forms), *Crenalithus doronicoides*, *Crenalithus productus*, *Helicosphaera carteri*, *Discolithina japonica*, *Discolithina multipora*, *Discolithina* spp., *Calcidiscus leptoporus*, *Ceratolithus cristatus*, *Rhabdosphaera clavigera*, and *Braarudosphaera bigelowii*.

Reworked specimens in the core catchers from GC/022, VC/014, VC/019, VC/023, and VC/024 included very rare occurrences of *Sphenolithus abies*, *Sphenolithus moriformis*, and *Sphenolithus neoabies*, all of which are judged to be reworked from underlying pre-early Pliocene strata.

2. Surface Samples (Table 7)

Sediment samples (DR/012--olive medium sand, DR/013--light brown coarse sand, DR/014--grey very coarse sand, DR/015--brown shelly very coarse sand, and DR/016 -- brown to light olive fine sand with bivalve shells) collected by pipe dredge were examined for their calcareous nannofossils. They all include abundant *Emiliania huxleyi* (50-70%), which may indicate their age to be younger than 0.07 Ma (bottom of the acme of the *Emiliania huxleyi* biohorizon of Gartner, 1977). At least it can be safely said that the age is not older than 0.24 Ma (biodatum 2 of Sato and Takayama, 1990). No specimen considered to be a product of reworking was detected in spite of extensive examination.

3. Limestone Rock Samples in Dredges (Table 7)

A small quantity of rock powder was scraped with a knife from the matrix part of the rhodolith limestones and calcareous sandstones collected by the chain dredge. Seven limestone samples picked from DR/011 and DR/014 were observed under the microscope and five samples included nannofossils. Two samples (DR/014-02, DR/014-05; calcareous sandstone) yielded no age diagnostic species. Two samples (DR/011-02 - from the rhodolith limestone and DR/014-01- from the calcareous

sandstone) showed the rare occurrence of poorly preserved calcareous nannofossils; however, the presence of *Gephyrocapsa caribbeanica* indicates an age younger than 1.66 Ma (Biodatum 11 of Sato and Takayama, 1990). Overall abundance was too low to confirm the absence of *Pseudoemiliania lacunosa* which has its last appearance datum at 0.39 Ma. In sample DR/014-06 (calcareous sandstone) poorly preserved calcareous nannofossils were detected. They include *Gephyrocapsa caribbeanica* and *Gephyrocapsa oceanica*, indicating an age younger than biodatum 10 (1.57 Ma; Sato and Takayama, 1990). Further, the absence of *Pseudoemiliania lacunosa* and the presence of *Gephyrocapsa caribbeanica/Gephyrocapsa oceanica* indicates an age younger than 0.39 Ma (biodatum 3).

Area 2 - Fraser Island

Seismic Stratigraphy

The position of seismic data collected in Area 2, to the east of Fraser Island, is shown in Figure 19 and the seismic way points in Table 8. The sequence stratigraphic interpretation of high resolution seismic data collected from Area 2 is shown in Figures 20-25 and the stratigraphy has been divided into three units. The ages of these units are, at this stage, unknown. A preliminary description of each east-west line is presented below.

Line 105/17 - Latitude 24°49.0'S (Figure 20)
The morphology of the shelf is divisible into three parts, a relatively flat surface to a depth of 60m, a change of slope to a depth of 100m starting at 0100 hours and developing into a 9km wide terrace to a depth of 250m, with the shelf break at a depth of approximately 240m as seen at 0220 hours. This morphology reflects the underlying stratigraphic development and can be seen throughout Area 2.

The repeated multiples in water depths shallow than 60m make sub-bottom interpretation difficult. This preliminary interpretation therefore concentrates mainly on the section above the multiples. Three seismic sedimentary units may be identified (Figure 20).

Unit 1.

In water depths greater than 100m, Unit 1 is defined as extending from the seafloor to a depth of approximately 100msecs and downlapping to the east onto a unit boundary which is flat lying eastwards, but which is clearly eroded in water depths of 100m. Unit 1 is comprised of at least three seismic sequences (Sequences 1, 2 & 3 in Figures 20-25) identified through downlap and onlap terminations. The unit changes facies to the west from a distinctly bedded unit to a massive poorly reflecting unit, this change in facies coinciding with a marked change in shelf morphology between 60 and 100m.

Unit 2.

In this unit only the upper sequence boundary is visible so that the thickness of the unit is unknown. It equates with the carbonate platforms and intervening lagoonal sediments beneath the upper slope terrace. The unit shows a change in facies from west to east. Between 0100 and 0150 hours, the unit is roughly bedded but eastwards it loses all reflection characteristics. The upper sequence boundary is flat lying beneath the outer deeper terrace and forms a cliff like upper slope with an angle of 30°.

Unit 3.

This is comprised of a slope sequence to the east of, and forming the continental slope in water depths greater than 500m. Bedding reflectors are well seen around 0250 hours but slumping appears to be a characteristic of the sequence.

Line 105/19 - Latitude 24°55.0'S (Figure 21)

This section is remarkably similar to that shot at 105/17 with the same shelf morphology and seismic units clearly visible (Figure 21).

Unit 1.

This is formed by a series of downlapping reflectors between the sea floor and the lower boundary some 850 msecs deeper in the section. The downlapping is well seen between 0840 and 0810 hours with a distinct feather edge to the east at around 0810 hours. Westwards the reflectors lose their characteristics with the unit having a "chattery" appearance, representing a facies change from bedded to the east becoming less well bedded, approaching massive to the west below water depths of 60-100m. At least three seismic sequences can be recognised which in descending thicknesses are 80msecs, 40msecs and 60msecs thick. The boundaries between the sequences are erosional unconformities.

Unit 2.

This occurs below the deeper outer shelf terrace at a depth of around 214m with a sharp break of slope separating outer shelf terrace and upper slope at 245m. The seismic characteristics of the Unit are comparable to those described for line 105/17 and may be divided into an an easterly non-reflecting section between 0755 and 0740 hours and a western part showing strong reflection characteristics between 0755 and 0830 hours. The multiples make it impossible to trace the upper unit boundary to the west beneath the outer shelf terrace; however, beneath the outer terrace it is a flat lying almost planar reflector which when projected westwards to the inner shelf coincides with an erosion unconformity comprising the base of the shelf sequence.

Unit 3.

This is made up of a slope sequence showing bedding, chaotic terminations, erosion and slumping.

Line 105/21 - Latitude 25°00.5'S (Figure 22)

The seismic character of this section is very similar to the previously described sections. Unit 1 is comprised of three sequences, the upper sequence feather-edging eastwards in 250m of water. Unit 2 shows a non reflecting character with a slope along its eastern side of 30°, while Unit 3 is a slope facies beginning in a depth of 657m.

Line 105/23 - Latitude 25°05.5'S (Figure 23)

The same three units are recognisable as in the sections already described. In addition the following characters are important: the top of Unit 2 can be extended westwards to coincide with a prominent and eroded reflector beneath the inner shelf. The seismic characteristics of Unit 2 show the progradation of the bedded part of Unit 2 eastwards over the non reflective massive facies particularly between 2330 and 2255 hours. This section is also different in that the continental slope is uninterruptedly steep to a depth of at least 1300m.

Line 105/25 - Latitude 25°10.5'S (Figure 24)

The seismic structures seen along this line are similar to those described above with the facies differentiation within Unit 2 particularly well seen. The bedded prograding upper part of Unit 2 feather edges eastwards over the massive facies. However, a difference in this section is that the upper surface of Unit 2 is eroded as seen at 1320 hours. In addition, the continental slope is now no longer steep, the scarp of more northerly sections having been largely obliterated by a depositional slope sequence.

Line 105/27 - Latitude 25°14.5'S (Figure 25)

This line is very similar to Line 105/25 in that the scarp slope has been almost entirely obliterated and buried beneath a depositional slope sequence. However, differences in the reflection characters of Unit 2 allow the differentiation of an outer and inner zone of poor reflection, dipping reflectors in front of the inner non-reflecting zone and the progradation of the strongly reflecting upper section over the outer non-reflecting zone. The interpretation of this section is shown in Figure 26.

Without the benefit of migration and stacking of the seismic data, it is difficult to make a definitive interpretation of the seismic data. However our preliminary synthesis is shown in Figure 27 and summarised below. Three points need to be emphasised:

1. Build up of a carbonate platform (Platform 1) on the shelf edge with a steep seaward facing slope. Leewards (westwards) from this platform, "lagoonal" sediments were deposited while leewards of these again, a lagoonal platform (Platform 2) developed. This sequence appears to have been deposited during a slowly rising sea level as indicated by the upward and outward progradation of the bedded and lagoonal facies over Platform 1. The seismic data provides no clues as to the age of these platforms or its temperate or tropical character. However, by analogy with the Queensland and Marion Plateaus (Davies and others, 1991), it is probably Early or Middle Miocene in age.

2. Exposure of the platforms with the probable development of karsting and fluviatile erosion further to the west. The steep slope of the margin probably related to erosion at this time. By analogy with the Queensland and Marion Plateaus, the exposure and erosion is likely to have resulted from the Middle Miocene sea level fall (Davies and others, 1991).

3. Flooding of the earlier platforms and growth of a new platform (Platform 3) in the mid to outer shelf, which is directly below the present day sub-tropical platform. Immediately in front of the new platform, three sea level related bedded sequences downlap the older Miocene(?) platform. The age of the younger platform is unknown, but its likely multiple growth is probably related to major sea level oscillations of Late Miocene to Pleistocene age.

Sedimentology

The sediments collected from the shelf off Fraser Island (Figure 28) are Holocene to Miocene in age. Sediment distribution (Figures 29, 30) is dependent upon the variation of the major constituents, *Halimeda* (Figure 31), corals and algae (Figure 32), planktonic foraminifera and pteropods (Figure 33), carbonate rock fragments (Figure 34) and quartz (Figure 35). Petrographic descriptions of all samples collected are contained in Appendix 3. The location of bottom photographs are shown in Figure 36 while photographs of all principal environments are in Appendix 2. The distribution of sediment types is related to the morphology of the shelf.

1. Nearshore Part of Shallow Shelf Terrace

On the nearshore part of the shelf terrace, fine sands, rich in quartz (almost 90%) predominate (samples GS/063, 073, 074, 088, 089, 096, 103). This is the quartz dominant fine sand facies of Figure 30. Associated grains include lithic fragments and bioclasts. The quartz grains are subrounded and very well sorted. Bioclastic grains are fine- to medium-sand size and consist of shell fragments and benthonic foraminifera. The sedimentology is strongly influenced by the quartz sand supplied by longshore drift along the eastern edge of Fraser Island. This dominantly clastic facies extends from the shoreline to a depth of 50m.

2. Rhodolith-dominated Bank

This occurs in water depths of 24 to 110m and is approximately 15km wide. A sidescan traverse of the bank is shown in Figure 38. On the inner side of the bank, coarse to very coarse carbonate sands with subordinate coarse quartz sand dominate, as observed in samples GS/062, 064, 075, 076, 077, 078, 087, and 094. This is the carbonate coarse-sand facies of Figure 30. The carbonate sand is made of benthonic foraminifera, carbonate rock or calcareous sandstone, shell fragments, and other unidentified bioclastic grains. The sediments also include biogenic gravels composed of larger benthonic foraminifera like *Marginopora* and *Operculina* (?), and pelecypods, gastropods, bryozoans, barnacles, and echinoid spines. Some gravels are rounded to subrounded sandy limestone or calcareous sandstone.

The rhodolith-coral gravelly facies is the main facies of the bank (Figure 30). This facies is developed particularly on the outer eastern side of the bank, the width of the facies belt varying from 10km at the centre of the survey area to 3km in the south and north; water depths of 30 to 50m predominate. The rhodoliths and corals form biogenic

gravels and coarse to very coarse sand. In addition to the coralline algae and the corals, other characteristic constituents of the facies include pelecypods, larger foraminifera (*Operculina* ?), *Halimeda*, bryozoans, gastropods, echinoid spines, barnacles, and articulated coralline algae.

Rhodoliths, comprised principally of encrusting coralline algae with encrusting foraminifera, are pebble- to cobble-sized, and red coloured in living modern forms and white in dead forms. Some living rhodoliths have smooth surfaces, but some have pinnacles on their surface.The nuclei of the rhodoliths are corals, benthonic foraminifera, or other bioclasts. The rhodoliths show the typical concentric structure and are frequently extensively bored. Platey and small massive living corals, notably *Montipora* and *Goniopora* sps. occur on the bank. Dead corals dredged are pebble- to boulder-size and coated by living coralline algae, encrusting bryozoans and worm tubes. Some of the dead corals have been extensively bored by sponges. Some boulders show repeated alternations of coral and coralline algae, as seen in samples from dredge DR/018. Larger foraminifera are 2cm in maximum diameter and less than 2mm in thickness. *Halimeda* plates as large as 2cm in diameter occur in living form; in these samples the calcification is low. Bryozoans occur in a variety of forms including net, branching, and encrusting habits. An encrusting form of bryozoan that coats seaweed, would be fossilised as hollow tube-bryozoans after the decomposition of the algae.

In one example, coral pebbles coated by coralline algae, rhodoliths, and sand size grains are aggregated by organic matter instead of carbonate cement (sample GS/071). Limestones, comprised of rhodolith rudstone to floatstone with grainstone or packstone matrix were collected in DR/001 and DR/002. The rhodoliths are 1 to 4cms in diameter, concentric in structure, with bored surfaces as seen in modern rhodoliths. The age of deposition of the limestone is unknown. Such rocks occur extensively in this environment.

In some locations, the eastern edge of the bank forms a cliff (Figure 39) dredges from which (DR/021 and DR/023 in water depths of 110m) comprised algal boundstone and coral blocks. Living encrusting coralline algae cover one side of the limestones suggesting that they are exposed at the sea bottom, a conclusion substantiated by bottom photography (Appendix 2). The algal boundstone shows extensive development of encrusting algae, frequently encrusting *Millepora*. Such an association often occurs in reef flat environments. Some corals appear fresh although the encrusting algal

limestone is a yellow to brown colour suggesting oxidisation. Included nannofossils suggest that the limestones are Pleistocene.

3. Upper Slope Terrace

On the upper slope terrace, in water depths of 110 to 300m, fine to medium sands composed of biogenic carbonate sand and subordinate quartz sands with little mud make up the majority of the samples (GS/066, 067, 068, 069, 081, 082, 083, 084, 085, 090, 091, 098, 099, and 100). This is the carbonate dominant fine sand facies (Fig. 30). The carbonate grains are mainly benthonic foraminifera, molluscs, bryozoans, and unidentified bioclastics. Abundant planktonic foraminifera and pteropod fragments are the characteristic constituents on the deeper shelf terrace. The sediments also include granule size brown coloured carbonate lithic grains, which suggest either re-working of sediments from the bank and/or limestones outcropping on the outer shelf.

4. The Slope

This environment begins at the major break in slope around 300m and extends to depths greater than 1000m. In the northern part of the area the slope is steep and largely uncovered with sediment (Figures 20 and 21) while in the south it is sediment draped (Figure 25). The environment was sampled by dredging and coring. Dredge samples DR/009 and DR/010 from the uppermost slope (250-450m) are pale yellow rhodolith/ coral/ foraminifera grainstones, packstones and floatstones. The rhodoliths are 0.5-3cm in diameter while some *Lepidocyclina* sp. are also 0.5-1cm in diameter and sometimes coated by coralline algae. Articulated coralline algae are a feature of rocks from the upper slope where they form well cemented grainstones and packstones. Tight yellow to black wackestones include benthonic foraminifera and bryozoans as important constituents. The larger foraminifera (*Lepidocyclina* sp.) indicate a Miocene age (to be confirmed). Diagenetic fabrics include isopachous micritic or fibrous cements, bladed sparry calcite, and equant spar. These suggest that cementation has occurred in both marine and meteoric environments.

Rocks dredged from the upper slope (DR/005) are also pale yellow rhodolith/large foram/ molluscan packstones and grainstones. Tight yellow to black floatstone/wackestones include benthonic foraminifera and bryozoans as important constituents. The large foram, *Lepidocyclina* sp., suggest a late Early Miocene to early Middle Miocene age. Undated limestones (DR/006), also from the upper slope, are pale yellow to pale brown packstones and grainstones comprised of benthonic foraminifera, planktonic foraminifera, bryozoans and pteropods suggesting an outer shelf

depositional environment. The deepest dredged sample (DR/003), from a depth of 600m, is a very dense hard mudstone of unknown age. It may be very much older than the carbonates described above.

Gravity coring conducted on the upper continental slope, below the exposed limestones, define the sediments as dominantly pale olive, muds, sands, and gravels, composed of planktonic foraminifera, pteropod spines, shell fragments, benthonic foraminifera, bryozoans, molluscan shells, and solitary corals. Nannofossil dating suggest that most of these sediments are late Quaternary in age. However one core showed an early Pliocene age at a depth of 3.5m.

Summary

The sedimentary distribution and its relation to morphology of the shelf is summarised as follows:

1). The quartz dominant fine sand facies (Fig. 30) extends from the shoreline to a depth of about 45m.

2). The carbonate coarse sand facies (Fig. 30) occurs seaward of the quartz dominant fine sand facies in water depths greater than 45 to 50m.

3). The rhodolith-coral gravelly facies (Fig. 30) covers most of the rhodolith dominated bank in water depths of 24 to 110m. At the eastern end of the area covered by this facies, where water depths are about 100m, rhodolith limestones, encrusting algal - coral limestones outcrop on the sea bottom.

4). Carbonate dominant fine sand facies (Fig. 30) occurs on the deeper shelf terrace at depths ranging from 120 to 280m.

5). Sediments on the upper continental slope are characterised by two types:

- limestones and mudstone of probable Miocene age outcropping above 700m.
- carbonate muds, planktonic foraminifera, and bryozoans, which mantle the deep slope.

Sidescan Survey

A 50km grid of good quality sidescan was run over the central to northern part of Gardner Bank and the boundary of the Rhodolith Bank and the Upper Slope Terrace to the east (Figure 37). Some of the more spectacular results are shown in Figures 38 and 39.

Figure 38 shows the sidescan image across Gardner Bank from west to east. The western and eastern sediment aprons are clearly visible as are the lineated highly reflecting rock dominated outcrops of the bank itself. The water depth over the top of the bank is about 24m. The boundary between the eastern edge and the sediment apron is particularly distinctive.

Figure 39 shows the steep slope and cliff separating the Rhodolith Bank and the Upper Slope Terrace. The cliff and the area immediately east of the cliff is rock dominated while further east the feather edge of a sediment body is clearly seen. Dredging at this location shows the cliff and the area immediately to the east to be a part of a coralline algal-coral build-up of undetermined age. The north to south linear features on the sidescan in front of the cliff are interpreted as low sea level en echelon reef patches. Integration of this data with the seismic data from Lines 105/19 and 21 (Figures 21 and 22) defines the coralline algal-coral build-up as the upper part of Platform 3. The cliff may have formed as a consequence of one, or a number of sea level changes, and represents a smaller version of the cliff which occurs at the top of the continental slope and proposed as mid Miocene age.

Calcareous Nannofossil Biostratigraphy

1. Core Sample Analysis (Table 10)

Eight samples in the core catchers can be correlated to the CN zones of Okada and Bukry (1980) and to the zonal scheme given by Sato and Takayama (1990) as follows:

GC/001; CN-15 Zone (Okada & Bukry,1980),
between present and biodatum 2 (0-0.24 Ma; Sato and Takayama,1990).
GC/002; CN-15 Zone, between present and biodatum 2 (0-0.24 Ma).
GC/003; CN-14a Subzone, between biodatum 3 and biodatum 6 ((0.39-0.89 Ma).
GC/004; CN-14b Subzone, between biodatum 2 and biodatum 3 (0.24-0.39 Ma).
GC/008; CN-11 Zone or older, below biodatum 16 (older than 3.56Ma).
GC/009; CN-14b Subzone, between biodatum 2 and biodatum 3 (0.24-0.39 Ma).
GC/010; CN-11 Zone, below biodatum 16 (older than 3.56 Ma).
GC/013; CN-14b Subzone, between biodatum 2 and biodatum 3 (0.24-0.39 Ma).

Core GC/001 is 40cm long and is a foram/nanno ooze. The calcareous nannofossil flora of the sample taken from the core catcher is characterised by the abundant occurrence of *Emiliania huxleyi*, indicating that the sample should be correlated to CN-15 Zone of Okada and Bukry (1980) and to above the biodatum 2 of Sato and

Takayama (1990). Judging from the high percentage of *Emiliania huxleyi*, this sample, may be further assigned to above the bottom of the acme of the *Emiliania huxleyi* biohorizon (0.07 Ma; Gartner, 1977). The assemblage also consists of *Gephyrocapsa caribbeanica*, *Gephyrocapsa oceanica*, *Gephyrocapsa* spp. (small forms), *Crenalithus doronicoides*, and associated with *Helicosphaera carteri*, *Discolithina japonica*, *Calcidiscus leptoporus*, *Rhabdosphaera clavigera*, *Scapholithus fossilis*, and *Ceratolithus cristatus*.

Core GC/002 was only 3cm long but two samples were examined for their calcareous nannofossil assemblage. One was taken from slightly consolidated coarse grained sandstone and the other from overlying nanno ooze. Nannos are few in the sand sample and abundant in the ooze sample. Both assemblages are however, similar to one another. *Emiliania huxleyi* is overwhelmingly dominant and *Gephyrocapsa caribbeanica*, *Gephyrocapsa oceanica*, Gephyrocapsa spp. (small forms) and *Crenalithus doronicoides* are the next species in dominance. *Helicosphaera carteri*, *Calcidiscus leptoporus*, *Rhabdosphaera clavigera*, *Scapholithus fossilis*, and *Discolithina* spp. comprise around 1% of the assemblage respectively. The rare occurrence of *Gephyrocapsa parallela* was recorded in both samples. Only one specimen of *Braarudosphaera bigelowii* was detected from the nanno ooze sample. The dominance of *Emiliania huxleyi* may indicate these two samples to be located above the bottom of the acme of the *Emiliania huxleyi* biohorizon (0.07Ma; Gartner,1977). The samples are correlated to CN-15 Zone and to above biohorizon 2 (0.24Ma).

Core GC/003 is 350cm long and composed of foram/nanno ooze; the core catcher yielded abundant and moderately preserved nannoflora. The co-occurrence of *Pseudoemiliania lacunosa* and *Gephyrocapsa oceanica* shows that this sample is clearly assigned to CN-13b/CN-14a Subzones. The presence of *Gephyrocapsa parallela* indicates the sample is younger than 0.89 Ma (biohorizon 6 of Sato and Takayama, 1990). The age of this sample therefore lies between 0.89 Ma (biodatum 6) and 0.39 Ma (biodatum 3). The absence of *Reticulofenestra* sp. A (Takayama and Sato, 1987) also supports the above conclusion.

Small placoliths which are difficult to identify under the light microscope are the most dominant species in the sample. The other species of importance are *Gephyrocapsa caribbeanica*, *Gephyrocapsa* spp.(small forms), *Crenalithus doronicoides*, *Helicosphaera carteri*, *Calcidiscus leptoporus*, and *Discolithina* spp.

In core GC/004 only 18cm core was recovered. Nannofossil studies were carried out on the slightly consolidated medium-grained sand in the core catcher. Overall abundance is common and preservation state is moderate to poor. The absence of both *Pseudoemiliania lacunosa* and *Emiliania huxleyi*, and the presence of *Gephyrocapsa oceanica /Gephyrocapsa caribbeanica* suggest that the sample correlates to the CN-14b Subzone, between biodatums 3 and 2 (0.39Ma-0.24Ma). The rare occurrence of species which are conferrable to *Emiliania huxleyi*, however, may suggest an age slightly younger than 0.24Ma. However, due to the moderate to poor preservation state, scanning microscopy will be essential for the identification of the above mentioned *Emiliania* cf. *huxleyi*. In addition to *Gephyrocapsa* spp.(small forms), the occurrence of the following species are recorded in this sample; *Crenalithus doronicoides*, *Crenalithus productus*, *Helicosphaera carteri*, *Calcidiscus leptoporus*, and *Rhabdosphaera clavigera*.

Core GC/008 is 35cm long. Four samples from the bottom to top of the core were analysed. Mixed calcareous nannofossil assemblages of pre-Pliocene and Pleistocene age were detected in the same sample. The pre-Pliocene flora are thought to be reworked from underlying sediments. The sandy mud sample at the bottom of the core includes only pre-Pliocene nannoflora. The second sample about 10cm above the bottom includes 90% of pre-Pliocene and 10% of Pleistocene flora. The third one approximately 20cm above the bottom includes 10% of pre-Pliocene and 90% of Pleistocene nannoflora. The sample at the top of core yields 50% of pre-Pliocene and 50% of Pleistocene calcareous nannofossil assemblage. The Pliocene calcareous nannofossil assemblage is mainly composed of *Sphenolithus abies*, indicating an age older than 3.56 Ma (biodatum 16 of Sato and Takayama, 1990) and correlated to the CN-11 Zone or older. The Pleistocene assemblage is characterised by the occurrence of *Gephyrocapsa caribbeanica* and *Gephyrocapsa oceanica*. The absence of *Pseudoemiliania lacunosa* indicates an age younger than 0.39 Ma (biodatum 3). Identification of *Emiliania huxleyi* is difficult because of the poor preservation state of the specimens. Few to rare examples of *Coccolithus pelagicus* were recorded in all four samples.

Core GC/009 is 378cm long; nanno ooze in the core catcher was examined. The overall abundance of nannofossils is high and preservation is good. The absence of *Pseudoemiliania lacunosa /Emiliania huxleyi* and the presence of *Gephyrocapsa caribbeanica /Gephyrocapsa oceanica* suggests that the age of the sample is between 0.39 Ma and 0.24 Ma (between biodatums 3 and 2, CN-14b Subzone). *Gephyrocapsa* spp.(small forms) and *Crenalithus* spp. are the most dominant. Rare to very rare

occurrence of *Helicosphaera carteri*, *Discolithina* spp., *Calcidiscus leptoporus*, and *Rhabdosphaera clavigera* was also recorded.

Core GC/010 is 430cm. One nanno ooze sample in the core catcher was analysed for calcareous nannofossils. Overall abundance is abundant and the state of preservation is moderate. The nannoflora consists mainly of *Sphenolithus abies* and *Reticulofenestra pseudoumbilica*, which indicates an age older than 3.56 Ma (biodatum 16, CN-11 Zone or older). *Discoaster asymmetricus* is one of the common species in the *Discoaster* group, which indicates the sample is assigned to the CN-11 Zone. *Pseudoemiliania lacunosa*, *Discolithina multipora*, *Calcidiscus macintyrei*, *Calcidiscus leptoporus*, *Coccolithus pelagicus*, *Rhabdosphaera clavigera*, *Discoaster brouweri*, *Discoaster pentaradiatus*, and *Discoaster variabilis* are detected in this sample. It should be noted that both cores GC/008 and GC/010 are correlated to the lower Pliocene or lower, but that the calcareous nannofossil assemblages are completely different in the two cores. Common discoasters were found in GC/010, whereas no specimen of discoaster was detected from GC/008.

Core GC/013 is 406cm long; a white to grey coloured nanno ooze in the core catcher was examined. The sample includes abundant well-preserved calcareous nannofossils. The *Gephyrocapsa* group comprises almost 99% of the assemblage; *Gephyrocapsa caribbeanica*, *Gephyrocapsa oceanica* and *Gephyrocapsa parallela* are important species for age determination. The absence of *Pseudoemiliania lacunosa* /*Emiliania huxleyi* indicates the age of this sample to lie between 0.39 Ma and 0.24 Ma (biodatums 3 and 2, CN-14b Subzone). The rare to very rare occurrence of the following species was recorded; *Helicosphaera carteri*, *Discolithina japonica*, *Discolithina* spp., *Calcidiscus leptoporus*, *Coccolithus pelagicus*, *Rhabdosphaera clavigera*, and *Scapholithus fossilis*.

2. Surface Samples (Table 11)

Calcareous nannofossils were detected from the following nine samples collected near the sea bottom surface. The samples are not however necessarily undisturbed.

Sample	Overall abundance	Preservation state	Lithology
GC/011	Common	Good	fine grained sand
VC/003	Rare	Moderate	coarse grained sand
GS/068	Rare	Good	f-m grained sand
GS/069	Rare	Good	muddy c-grained sand
DR/001	Very Rare	Good	very coarse grained sand
DR/005-10C5	Few	Poor	mud in the cavity of limestone cobble
DR/009-00	Common	Good	slightly sandy mud
DR/010-Bulk	Rare	Good	coarse grained sand
DR/021-09B	Common	Good	mud filling cavity of algal limestone

Although there may occur some changes in overall abundance and preservation state among the samples listed above, all of the samples include *Emiliania huxleyi* of which the first appearance datum is 0.24 Ma (biodatum 2 of Sato and Takayama, 1990). The age of the nine samples are therefore younger than 0.24Ma. *Emiliania huxleyi* is the most dominant species in the following 7 samples; GC/011, GS/068, GS/069, DR/001, DR/009-00, DR/010-Bulk, DR/021-09B. These seven samples may be correlated to above the bottom of the acme of the *Emiliania huxleyi* biohorizon which dates 0.07 Ma (Gartner,1977). No reworked specimens were found in any of the samples.

3. Limestone Blocks in Grabs and Dredges (Table 12)

A total of 48 limestone samples were recovered from 9 locations and analysed for nannoflora; four samples yielded calcareous nannofossils.

In sample GS/071 a small quantity of rock powder was scraped with a knife from the matrix (foraminiferal grainstone) of a limestone cobble. The overall abundance of nannofossils is rare and the preservation is poor to moderate. The presence of *Gephyrocapsa caribbeanica /Gephyrocapsa oceanica* and the absence of *Pseudoemiliania lacunosa* indicates an age younger than 0.39 Ma (biodatum 3 of Sato and Takayama,1990). Scanning electron microscopy will be necessary for the

identification of *Emiliania huxleyi* because the preservation state is not good enough to identify using the light microscope. *Gephyrocapsa* spp.(small form), *Crenalithus doronicoides*, *Discolithina* spp., *Calcidiscus leptoporus* were also detected in this sample.

In sample DR/006, a smear slide prepared from the matrix of a rhodolith limestone cobble yielded very rare and poorly preserved nannoflora. However, due to strong overgrowth, most specimens were difficult to identify. Many small placoliths which were classified into the *Gephyrocapsa* group indicate an age younger than late Pliocene. Several specimens which may be conferrable to *Gephyrocapsa caribbeanica* were detected, but SEM examination will be required for the detailed observation of their central structure.

In dredge samples DR/021-011A-01 and DR/021-011A-03 calcareous nannofossils were found in the matrix of an algal limestone cobble. The overall abundance is poor, as is also the preservation state. Most specimens are strongly overgrown and difficult to identify. The presence of *Gephyrocapsa caribbeanica* indicates that the age of part of the matrix is no older than 1.66 Ma (biodatum 11 of Sato and Takayama, 1990). The absence of *Pseudoemiliania lacunosa* cannot be confirmed due to the rare occurrence of the nannofossils and the poor preservation state.

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Appendix 1

Cruise 105 Station Data

Sample Number	Time	Position Latitude	Longitude	Water depth (metres)	Sample /Photo Core length
105/CM/001	302.0101	25 04.5	153.24.6	28	Y
2	302.0354	25 05.0	153 31.4	43	Y
3	302.0433	25 04.6	153 33.4	42	Y
4	302.0519	25 04.5	153 35.3	50	Y
5	302.0602	25 04.6	153 37.3	64	Y
6	302.1601	25 04.7	153 38.5	123	Y
7	302.1808	25 04.6	153 39.0	110	N
8	302.1911	25 04.7	153 41.3	237	N
9	302.1956	25 04.8	153 43.3	276	Y
10	302.2109	25 05.2	153 44.4	620	N
11	303.2349	25 05.0	153 45.3	1050	Y
12	303.1951	26 20.0	153 53.0	684	N
13	303.2139	26 20.0	153 51.5	281	N
14	303.2339	26 20.0	153 51.1	221	N
15	304.0132	26 20.0	153 51.0	206	Y
16	304.0431	26 20.0	153 50.9	178	Y
17	304.0756	26 20.0	153 49.2	112	Y
18	304.0936	26 14.8	153 49.7	97	Y
19	304.1247	26 19.7	153 36.0	62	Y
20	304.1911	26 25.1	153 34.6	56	Y
21	305.0325	26 20.1	153 32.7	68	Y
22	305.0506	26 20.0	153 22.0	51	Y
23	305.0753	26 20.0	153 12.0	42	Y
24	305.1125	26 30.0	153 24.0	42	Y
25	305.1725	26 29.9	153 31.9	31	Y
26	305.2011	26 30.1	153 49.5	362	Y
27	306.1311	26 35.0	153 43.6	298	Y
28	306.1513	26 35.0	153 44.6	420	Y
29	306.1558	26 35.1	153 45.7	510	Y
30	306.1754	26 35.3	153 51.2	1083	Y
31	307.0913	26 35.0	153 25.6	49	Y
32	307.1141	26 34.9	153 31.6	68	Y
33	307.1304	26 35.0	153 33.6	100	Y
34	307.1535	26 35.0	153 37.8	130	Y
35	307.1817	26 30.0	153 38.5	119	Y
36	307.1915	26 30.0	153 41.8	137	Y
37	307.2026	26 30.0	153 45.7	185	Y
38	307.2134	26 30.0	153 51.6	629	Y
39	307.2243	26 30.2	153 53.6	1006	Y
40	308.0054	26 25.0	153 53.4	204	Y
41	308.0849	26 24.9	153 46.1	127	Y

42	309.0316	26 35.0	153 30.4	40	Y
43	310.0405	25 03.0	153 30.8	50	Y
44	310.1935	25 03.0	153 31.3	41	N
45	310.2054	25 03.0	153 31.4	37	N
46	310.2203	25 03.0	153 32.2	25	N
47	311.1022	24 54.5	153 26.0	48	Y
48	311.1119	24 59.4	153 26.0	31	N
49	311.1237	25 01.5	153 26.4	83	Y
105/DR/001	299.1943	25 14.0	153 40.9	100	
2	300.1611	25 04.8	153 34.9	52	Y
3	300.1331	25 04.5	153 43.8	600	Y
4	300.1553	25 04.5	153 45.0	1040	N
5	300.2231	24 59.2	153 42.9	592	Y
6	301.0335	24 54.5	153 37.5	420	Y
7	301.1758	24 54.5	153 32.5	43	Y
8	301.1951	24 54.5	153 30.0	28	Y
9	302.0925	24 59.5	153 42.6	271	Y
10	302.1157	24 59.5	153 42.8	438	Y
11	303.0308	26 15.0	153 52.5	1200	Y
12	304.1335	26 20.1	153 37.1	71	Y
13	304.1601	26 20.1	153 36.1	59	Y
14	304.1821	26 25.0	153 28.1	66	Y
15	305.1509	26 30.0	153 32.8	48	
16	306.1355	26 35.0	153 43.6	298	Y
17	308.1202	26 35.0	153 29.9	41	Y
18	309.2152	25 09.5	153 38.8	60	Y
19	309.2311	25 09.7	153 37.2	54	Y
20	310.0029	25 09.5	153 34.3	45	Y
21				92	Y
22	311.0555	21 01.5	153 36.8	107	
23	311.1455	25 01.5	153 36.6	93	Y
105/GC/001	299.1208	25 20.0	153 51.1	546	0.41
2	299.1326	25 20.0	153 53.4	810	0.03
3	299.1532	25 15.5	153 49.1	542	3.50.
4	299.1703	25 14.5	153 45.1	264	0.18
5	299.1809	25 14.5	153 43.3	190	0.00.
6	299.1842	25 14.5	153 41.5	114	0.01
7	300.2001	25 04.5	153 45.0	1023	0.00.
8	301.0128	24 54.5	153 40.6		0.35
9	301.0235	24 54.3	153 41.2	818	3.78
10	301.1211	24 54.7	153 43.3	1171	4.30.
11	301.1508	24 54.7	153 35.9	209	0.00.
12	301.1604	24 54.5	153 35.9	219	0.00.
13	303.0345	25 15.3	153 52.5	1200	4.06
14	303.1253	26 20.1	153 54.5	1475	6.20.
15	303.1552	26 20.0	153 53.8	1623	1.08
16	303.1821	26 20.1	153 53.0	690	0.00.
17	303.2241	26 20.0	153 51.5	259	1.27
18	304.0733	26 20.0	153 49.2	113	0.00.
19	305.2115	26 30.0	153 49.5	353	3.58
20	305.2335	26 30.1	153 49.5	355	3.86
21	306.0053	26 30.2	153 49.9	413	3.43
22	306.0219	26 29.9	153 51.6	621	3.30.

23	306.0348	26 30.0	153 52.9	842	3.38
24		26 30.0	153 53.6	1080	2.85
25	306.0832	26 35.1	153 51.1	1022	4.02
26	306.0957	26 35.1	153 47.7	719	3.20.
27	306.1111	26 35.0	153 45.6	496	2.96
28	306.1206	26 34.9	153 43.5	276	0.00.
29	308.0311	26 25.0	153 53.7	1020	3.06
30	308.0504	26 25.0	153 51.6	361	5.25
31	308.0551	26 25.0	153 51.4	311	5.24
32	308.0708	26 25.0	153 51.0	356	5.17
33	312.1013	23 30.0	152 20.0	292	3.34
34	312.1117	23 30.0	152 20.0	291	3.37
35	312.1218	23 30.0	152 16.9	230	0.49
36	312.1328	23 30.0	152 17.4	251	3.10.
105/GS/001	290.0642	26 35.0	153 39.8	155	Y
2	290.0802	26 35.0	153 35.9	118	Y
3	290.0858	26 35.0	153 33.2	100	Y
4	290.0937	26 35.0	153 30.9	55	Y
5	290.1041	26 35.0	153 30.2	40	Y
6	290.1111	26 35.0	153 29.6	40	Y
7	290.1153	26 35.0	153 27.2	50	Y
8	290.1236	26 35.0	153 24.1	60	Y
9	290.1408	26 35.0	153 23.2	60	Y
10	290.1437	26 30.0	153 22.8	55	Y
11	290.1515	26 30.0	153 23.7	56	Y
12	290.1607	26 30.0	153 26.4	55	Y
13	290.1631	26 30.0	153 30.3	54	Y
14	290.1656	26 30.0	153 31.2	42	Y
15	290.1727	26 30.0	153 32.0	27	Y
16	290.1747	26 30.0	153 33.6	53	Y
17	290.1814	26 30.0	153 34.0	71	Y
18	290.1828	26 30.0	153 34.6	82	Y
19	290.1908	26 30.0	153 36.7	86	Y
20	290.2001	26 30.0	153 40.0	109	Y
21	290.2048	26 30.0	153 43.7	127	Y
22	290.2152	26 30.0	153 47.7	156	Y
23	290.2329	26 29.8	153 48.9	237	Y
24	291.0025	26 25.0	153 45.1	142	Y
25	291.0025	26 25.0	153 40.0	121	Y
26	291.0114	26 25.0	153 38.1	111	Y
27	291.0140.	26 25.0	153 27.4	90	Y
28	291.0219	26 25.0	153 34.8	91	Y
29	291.0308	26 25.0	153 34.8	58	Y
30	291.0331	26 25.0	153 34.0	62	Y
31	291.0351	26 25.0	153 33.2	59	Y
32	291.0413	26 25.0	153 32.5	58	Y
33	291.0442	26 25.0	153 30.0	56	Y
34	291.0511	26 25.0	153 27.0	56	Y
35	291.0546	26 25.0	153 24.0	53	Y
36	291.0643	26 20.0	153 24.1	53	Y
37	291.0719	26 20.0	153 20.0	54	Y
38	291.0806	26 20.0	153 14.9	54	Y
39	291.0932	26 15.0	153 24.1	53	Y

40	291.1007	26 15.0	153 27.2	53	Y
41	291.1039	26 15.0	153 30.0	55	Y
42	291.1323	26 15.0	153 33.0	59	Y
43	291.140.	26 15.0	153 36.4	63	Y
44	291.1445	26 15.0	153 40.0	67	Y
45	291.1505	26 15.0	153 40.6	67	Y
46	291.1537	26 15.0	153 43.9	81	Y
47	291.1614	26 15.0	153 47.1	87	Y
48	291.1646	26 15.0	153 49.1	96	Y
49	291.2020.	26 20.0	153 49.5	120	Y
50	291.2104	26 20.0	153 43.5	110	Y
51	291.2146	26 20.0	153 42.5	91	Y
52	291.2221	26 20.0	153 40.0	86	Y
53	291.2252	26 20.0	153 37.2	71	Y
54	291.2308	26 20.0	153 36.7	66	Y
55	291.2325	26 20.0	153 35.8	66	Y
56	292.2344	26 20.0	153 35.0	66	Y
57	292.0014	26 20.0	153 32.8	60	Y
58	292.0043	26 20.0	153 30.0	58	Y
59	292.0109	26 20.0	153 27.5	56	Y
60	292.0312	26 20.0	153 09.7	35	Y
61	299.2301	25 14.5	153 38.0	50	Y
62	299.2348	25 14.5	153 32.8	50	Y
63	300.0105	25 14.4	153 27.5	44	Y
64	300.0257	25 04.5	153 29.3	48	Y
65	300.0950.	25 04.7	153 38.3	119	Y
66	300.1015	25 04.5	153 39.6	182	Y
67	300.1125	25 04.6	153 40.7	222	Y
68	301.1421	24 54.6	153 35.9	215	Y
69	301.1442	24 54.6	153 34.6	149	Y
70	301.1715	24 54.5	153 33.7	106	Y
71	301.2120.	24 54.4	153 29.0	28	Y
72	301.2124	24 54.4	153 29.0	28	Y
73	301.2156	24 54.4	153 24.5		Y
74	309.1334	25 20.0	153 27.6	47	Y
75	309.1405	25 20.0	153 30.0	50	Y
76	309.1436	25 20.0	153 32.6	57	Y
77	309.1511	25 20.0	153 35.5	56	Y
78	309.1541	25 20.0	153 38.0	55	Y
79	309.1614	25 20.0	153 41.0		Y
80	309.1638	25 20.0	153 42.5		Y
81	309.1702	25 20.0	153 44.0		Y
82	309.1727	25 20.0	153 45.5		Y
83	309.1910.	25 09.5	153 43.0	244	Y
84	309.1940.	25 09.5	153 41.5	179	Y
85	309.2010.	25 09.5	153 39.7	94	Y
86	309.2028	25 09.5	153 39.0	68	Y
87	310.0124	25 09.5	153 32.5	52	
88	310.0210.	25 09.5	153 27.0	37	
89	310.0301	25 04.7	153 27.0	40	Y
90	310.2331	24 59.6	153 29.6	251	Y
91	311.0621	24 59.6	153 37.1	117	Y
92	311.0127	24 59.5	153 35.0	57	Y

93	311.0735	24 59.5	153 32.5	46	Y
94	311.0813	24 59.5	153 29.0	42	Y
95	311.0813	24 59.5	153 26.0	31	Y
96	311.0954	24 54.6	153 26.0	58	Y
97	311.1620.	25 01.6	153 36.5	87	Y
98	311.1843	24 49.1	153 33.3	211	Y
99	311.1905	24 49.1	153 32.0	233	Y
100	311.1925	24 49.1	153 31.0	104	Y
101	311.1945	24 49.1	153 30.0	46	Y
102	311.2027	24 49.0	153 27.0	43	Y
103	311.2048	24 49.0	153 25.0	40	Y
105/PD/001	300.0450.	25 04.7	153 33.0	43	Y
2	300.0910.	25.04.7	153 37.0	94	Y
105/VC/001	299.2301	25 14.0	153 38.0	50	0.01
2	300.0019	25 14.5	153 32.9	52	0.01
3	300.0125	25 14.4	153 27.5	44	0.01
4	300.0326	25 04.5	153 29.3	48	0.00.
5	300.1115	25 04.8	153 39.9		0.00.
6	304.0021	26 20.0	153 51.2	222	2.67
7	304.0308	26 20.0	153 51.0	205	3.40.
8	304.0526	26 20.0	153 50.9	183	0.00.
9	304.0000.	26 20.1	153 49.2	113	0.00.
10	305.0255	26 20.0	153 32.8	62	0.57
11	305.0533	26 20.0	153 22.0	52	0.76
12	305.0833	26 20.0	153 12.0	42	1.32
13	305.1030.	26 30.0	153 23.8	54	0.64
14	306.2316	26 30.0	153 45.7	185	1.46
15	307.0032	26 30.0	153 45.7	180	1.56
16	307.0231	26 30.0	153 41.8	237	0.83
17	307.0437	26 30.0	153 41.8	136	0.72
18	307.0557	26 30.0	153 38.9	118	0.92
19	307.0830.	26 30.0	153 33.8	53	0.59
20	307.0944	26 35.0	153 25.6	49	0.00.
21	307.0945	26 35.0	153 26.0	49	0.00.
22	307.0000.	26 35.0	153 31.5	70	0.13
23	307.1402	26 35.0	153 33.6	99	0.56
24	307.1624	26 35.0	153 37.8	130	0.44
25	308.0921	26 25.0	153 46.0	127	1.83

Appendix 2

Photographic characterisation of shelf environments

Survey data regarding position and water depth at all camera sites are given in Appendix 1.

105/CM/001 is from the outer part of the inner shelf terrace. The bottom is characterised by evenly distributed sand and patchily distributed gravel sized shell fragments. Organics, presumably algae occur as laminar and dendritic branching forms. The disturbance caused by the trigger weight suggests a small amount of mud in the sands.

105/CM/002 represents the westernmost margin of Gardner Bank. The bottom is dominated by rubble with subordinate sand and appreciable organics. Mud appears to be absent. The bottom is rough and probably highly absorptive of reflectance energy.

105/CM/003 is from the middle of Gardner Bank. The bottom is dominated by various branching algae. Sand and gravel occur in patches. The trigger impact suggests that some mud may be present in the sands.

105/CM/004 is from the eastern part of the Gardner Bank and the outer part of the shallow shelf terrace. Two separate photographs show that the algae in this area are still present but are mainly ground cover which are being grazed by sea cucumbers. The algae are stabilising the sediments, which are dominantly sands and abundant gravel and cobble sized fragments.

105/CM/005 is located on the outer edge of the shallow shelf platform. Three separate photographs show a variety of features in this environment. (1) Low outcrops of rock which have been extensively bored by echinoids, with borings 5cm across; the rock outcrops are therefore being broken into various sized fragments, (2) sand patches some of which are (3) strewn with pebbles probably representing rhodoliths and approximately 2cm in size. This area is one of active encrustation on a large scale together with substantial erosion of rock substrates, and the production of sand. It is unknown whether submarine cementation is also occurring but it would appear that the production of the rocky platform may also be continuing at the present time.

105/CM/006 is from the western part of the deeper shelf terrace. The bottom is dominated by sand but with appreciable quantities of pebble-size fragments representing rhodoliths and some shell fragments.

105/CM/009 is on the extreme outer part of the deeper shelf terrace. The bottom appears to be a finer grained version of site 6. It is a fine sandy bottom with some 15% strewn with small pea-size pebbles.

105/CM/011 is representative of the continental slope environment. The sediments are clearly muddy but sand and gravel sized fragments still litter the surface. Active grazing is also occurring, as is burrowing with the burrows being surrounded by mole hills some 5cm across. Small whips and fans are stabilising the sediments.

105/CM/015 is representiative of the change in slope between the shelf and the slope. Fine sandy bottom containing a little mud and strewn with small gravel sized fragments and shells. The bottom is uniform throughout the photograph.

105/CM/016. A coarse sandy bottom strewn with gravel sized fragments and what appears to be a rock outcrop or lithified sand. Pebble sized fragments are more abundant than at Site 15. Small dark patches may represent low algal tufts. Fish may be grazers. Some burrowing is seen, while small echinoids may be grazing or in transit to sparse rock outcrops.

105/CM/017 is from the outer edge of the shelf terrace. The bottom is sandy, with some small gravel fragments visible on the surface (up to 2cm in size) and populated sparsely by whips and leafy algae. Echinoderms are grazing on and are partly buried in the sediments. The bottom is relatively flat with no micro or macro mounds produced by water motion or burrowers. The bottom is however being grazed by fish. Filamentous algae therefore must be stabilising sediment movement to a degree.

105/CM/018 marks the true edge of the shelf terrace at this latitude. The bottom appears either to be cemented or thickly covered with filamentous algae.Whips and leafy algae occur sparsely. The surface is lightly strewn with pea sized gravel fragments. The fact that the trigger weight has made little impression on the bottom suggests that it is hard and contains little mud.

105/CM/019 is from the northern extension of the Barwon Bank. The bottom is principally hard, irregular and the domain of whips, fleshy algae, fine branching organisms, crabs and single serpulid like worm projections. In places however, it is distinctly sandy with small shell fragments strewn across the surface and pock marked with roundish patches approximately 10cm in diameter. The sand contains some mud both of which are being stabilised by tufted algae. Echinoids are grazing the sediments.

105/CM/020. The bottom is both sandy and strewn with flat clasts and in one clear case a very large flat boulder nearly half a meter in size. Sponges, whips, sea squirts, echinoids and algal fronds are common. Echinoids and seastars are grazing on the sand which does not appear to contain much mud.

105/CM/021. Coarse sand and some gravel with little flora and fauna although burrowing is clearly visible. There appears to be little fine sand or mud in the sediments.

105/CM/022. Mottled bottom with few flora and fauna. Comprised of coarse sand with little gravel. The mottles are composed of fine sand as burrows. There is clearly a substantial turn-over of sediment.

105/CM/023. Heavily bioturbated mottled sandy bottom with no fauna/ flora visible and with little gravel. The mottling is caused by lighter coloured, probably finer sand, forming small mounds only 5cm across.

105/CM/024. Sandy bottom containing some fine sand overlying a gravelly surface seen close to the trigger weight where it is exposed. Small gravel fragments scattered over the bottom. Living and dead aborescent algae strewn on bottom.

105/CM/025. A collection of photographs from Barwon Bank showing a range of substrate and faunal/floral associations:

1. A coarse sand dominated bottom with abundant pebble to cobble sized fragments up to 5cm across with a few encrusted by living coralline algae. These grade into areas where there is more solid rock substrate with a clearly thin sediment layer on top.

2. Dominantly a coralline dominated bottom where the outlines of earlier living plate corals are totally encrusted with soft algae also occupying niches. The bottom is clearly layered, the layers being produced by encrusting coralline algae and plate corals growing slightly above the floor, which when they die, become encrusted with coralline algae and the space underneath filled with sediment.

3. Coral substrates dominated by large plates of *Montipora* sp. up to 1.5m across. The plates are, however,very low with less than 10-20cm space above the base surface. Other genera include *Goniopora* sp. and a more meandroid type coral. Echinoids are grazing on the substrates, particularly a long spiny variety (*Diadema* sp.?). Soft algae abound. Competition between coralline algae and corals appears to be intense.

105/CM/026.Coarse sand with a small amount of fines and abundant fine gravel littered over the bottom.

105/CM/027. Similar to Station 26 except that the surface is not so uniform, there being some evidence of burrowing and a covering of small gravel sized fragments littered over the surface.

105/CM/028. Similar to both Stations 26 and 27. Sandy bottom with some fine sand. Burrowed. Some gravel on the surface.

105/CM/029. Sandy bottom with less fine sand than at Station 28. Burrowed by shrimps which are clearly visible in the photograph.

105/CM/033.Coarse sand but appears to contain substantial mud judging by the cloud from the trigger weight. Gravel fragments litter surface. Browsing trails visible on the sand surface.

105/CM/034. Similar to the bottom at Station 33 with a mud cloud hanging in the water column after an earlier photograph. The sediment is medium to coarse sand with gravel littering the surface. Tracks visible on the surface - fairly active grazing population.

105/CM/035.Sandy bottom with some gravel on the surface. The surface is heavily imprinted and burrowed.

105/CM/036. Similar to the bottom at Station 35. Substantial imprinting of the bottom with small holes a centimetre across abundant in the centre of the photograph.

105/CM/037. The bottom has some relief which may be the result of rippling. Comprised of coarse sand with some fine sediment which is probably silt, seeing as the trail of a disturbance can be seen in one photograph. Gravel on the surface with some evidence of burrowing or disturbance by a ray or some such fish.

105/CM/038. Burrowed coarse sandy surface with some gravel fragments. Burrowing appears to be by a shrimp, some of which have come to the sediment surface when disturbed by the trigger weight. The mounds are small, some few centimetres across and one or two centimetres tall. Much larger holes may be burrows of larger fish or crabs.

105/CM/039. Similar to the bottom at Station 38 with substantial burrowing of fine to medium sand with gravel not abundant and distributed unevenly across the surface.

105/CM/040. Fine sand with abundant mud. The bottom has one large burrow with a hole 5-7cm across and several others. Little gravel on the surface.

105/CM/043. Gardner Bank. There are three points of substantial interest in the photographs,(1) the seagrass beds which are lush and very thick, (2) large plates of *Montipora* sp. growing on the bank tops, while massive *Goniopora* sp. are growing amongst the seagrasses, and (3) sandy-gravel environments littered with rhodoliths of all sizes.

105/CM/047. North Gardner Bank. Asymmetric oscillation interference ripples in sand with the sand being stabilised by seagrasses.

105/CM/049. A set of photographs was shot across the sidescan transect from west to east. Above the cliff the bottom is covered with evenly sized rhodoliths; in front of the cliff the bottom is an exposed, eroded and highly bored limestone while some few hundred metres east of the cliff the limestone surface is overlapped by sandy sediments containing little mud and which is faintly rippled.

Appendix 3:

Petrologic descriptions of grabs, dredges and cores

Survey data relevant to all samples collected and stations occupied during Rig Seismic cruise 105 are given in Appendix 1.

105/GS/001A
Description: 5YR 4.5/2 "reddish grey - dark reddish grey
Poorly sorted fine sand with rare granule sized pebbles and some silt.
The sand is composed of planktonic forams (25%),benthonic forams (25%) shell fragments, echinoid fragments, and pteropod fragments (10%), reddish brown grains approximately 1-2mm in size (30%). Glauconite infills benthonic forams & bryozoans. Pebbles are molluscan shells (less than 5%).

105/GS/001B
Description: 5Y 5/2 "olive grey"
Poorly sorted muddy fine to coarse sand containing pebbles (mainly molluscan shells, (less than 5%) and bryozoan nodules. The sand is comprised of benthonic forams, planktonic forams, rounded reddish stained grains (origin unknown) with rare glauconite filling.

105/GS/002
Description: 5Y 4/2 "olive grey"
Muddy, moderately sorted fine to very coarse sand with rare shells (molluscs), pebbles medium grained sand is dominant. The sand is composed of 90% carbonate, 10% quartz, 5% glauconite. Benthonic forams make up 30% and unidentified bioclastics 50% of the carbonate sand. Shell fragments are rare; echinoid spines or fragments are rare ; planktonic forams are rare. Few benthonic forams are glauconite filled.

105/GS/003
Description: 5Y 4/2 "olive grey"
Muddy, moderately sorted fine to very coarse sand with rare pebbles (few percent). Fine to medium sand is dominant. The sand is 60% carbonates, 40% quartz fine sand, and glauconite (total 5%). The carbonates are largely comprised of benthonic forams (10%), unidentified bioclastics (40%), and planktonic forams (rare).

105/GS/004
Description: 10YR 7-8/3 "very pale brown"
Coarse sand with 20% pebble - cobbles (~ 8cm). The sand is almost 100% carbonate.with rare quartz grains of medium to coarse size. The sand is composed of benthonic forams, shell fragments, unidentified bioclasts (some of them algae). The gravel is made up of molluscan shells - abundant bivalves (20%) coated by coralline algae, barnacles, branching coral or bryozoans, larger forams (some are like 10c coins), rhodoliths or algal nodules (abundant 50%), echinoid spines, bryozoans (10%), corals (rare).

105/GS/005
Description: 10YR 6/3-4 "pale brown - light yellowish brown"
Coarse sand to granules with 25% pebble - cobble. The sediment is 90% carbonate and 10% medium to coarse quartz sand.
The sand to granule fraction is composed of benthonic forams, shell fragments and coral fragments. The gravels as in 105/GS/004.

105-GS006A
Description: boulder 50cm x 30cm.
Quartz sandstone coated by barnacles, bryozoans, sponges and serpulids.

105/GS/006B
Description: 10YR 5/6 "yellowish brown"
Medium to coarse sand with 10% pebble - cobbles. The sand is 50% carbonate and 50% quartz. The carbonate is composed of unidentified bioclastics, molluscan shells and benthonic forams. The pebble - cobbles are composed of rounded quartz sandstone, algal coated, bored by molluscs and encrusted by bryozoans. The percentages of components in the pebble-cobble constituents are: algal coated (Sst), gravel 50%; molluscs 30% ; bryozoans, benthonic forams and corals 20% .

105/GS/007
Description- 10YR 5/6-8 "yellowish brown"
Well sorted medium to coarse sand with 1-5% gravel (pebble-size). The sand consists of 30% carbonate and 70% quartz with rare lithic fragments. The carbonate is composed of unidentified bioclastics and benthonic forams. The gravel is made up of brachiopods (30%), and the granule/pebbles by bivalves (40%) and gastropods, and benthonic forams (30%).

105/GS/008
Description: 5Y 5-4/3 "olive" - 4/2 "olive grey"
Well sorted fine to medium sand with 1-5% gravel. The sand is 40% carbonate and 60% quartz sand with rare lithoclasts. The carbonate is made up of unidentified bioclastics and benthonic forams. The gravel is composed of granule- and pebble-size fragments of bivalves (60%), Dentalium (10%), serpulids (10%), gastropods (10%) and echinoids, star fish, crab, and barnacles (10%).

105/GS/009
Description 5Y 4/2 "olive grey"
Moderately sorted sands and gravels 10%. The sand is made up of 40% carbonate and 60% quartz grains with rare lithic fragments. The carbonates are unidentified bioclastics, shell fragments and benthonic forams. The gravels made up of bivalves (90%), Dentalium (5%), serpulids (1%), and echinoids, gastropods, crustaceans, and bryozoans (4%).

105/GS/010
Description: 5Y 4/3 "olive"
Moderately sorted medium sand with gravel. The sand is 30% carbonate, 70% quartz grains, with lithic grains rare. The carbonates are composed of unidentified bioclasts and shell fragments. The gravel is composed of bivalves (95%), Dentalium (3%), and benthonic forams and gastropods (2%).

105/GS/011
Description: 5Y 4/2 "olive grey"
Poorly sorted medium to coarse sand with 10% gravel. The sand is 40% carbonate and 60% quartz. The carbonates are mainly unidentified bioclasts and benthonic forams. The gravel is made up of bivalves (90%), Dentalium (5%), serpulids (2%), benthonic forams (1%) and gastropods (2%).

105/GS/012
Description: 5Y 5/3 "olive"
Well sorted medium to coarse sand with gravel (5%). The sand is 10% carbonate and 90% quartz grains, with rare lithic grains. The carbonate include unidentified bioclasts, shell fragments and benthonic forams. The gravel is composed of many kinds of bivalves (>95%), and Dentalium, gastropods and barnacles (trace).

105/GS/013
Description: 5Y 5/2 "olive grey"
Well sorted medium sand with gravel. The sand _ 30% carbonate and 70% quartz. The carbonate is composed of unidentified bioclasts, shell fragments, benthonic forams, and spicules and spines. The gravel is made up of bivalves (90%), Dentalium (3%), benthonic forams (2%), gastropods (3%) and other fragments like corals (2%).

105/GS/014
Description: 10YR 5/6 "yellowish brown"
Medium to coarse sand with gravel. The sand is 60% carbonate and 40% quartz grains. The coarse to very coarse carbonate is more abundant than the medium grained quartz. The carbonate is made up of unidentified bioclasts, shell fragments.and benthonic forams. The gravel fraction is made up of algal-coated fragments (70%), bivalves (25%) benthonic forams, gastropods and echinoids (5%).

105/GS/015
Description: Coral fragments (pebble to cobble size) coated by coralline algae and bryozoans.

105/GS/016
Description: 2.5Y 5/2 "greyish brown"
Moderate sorted medium to coarse sand with gravel (5% -10%). The sand which comprises 40% of the sample is made up of 50% carbonate and 50% quartz grains The carbonate is made up of unidentified bioclasts, shell fragments, benthonic forams and bryozoans. The gravel is made up of shell fragments coated by coralline algae and barnacles (30%), bivalves (20%), large benthonic foram (15%), sandstone pebbles (30%), Dentalium and gastropods (5%).

105/GS/017
Description: 5Y 5/4N3 "olive"
Moderately sorted medium to coarse sand with gravel. The sand is made up of 30% carbonate, 70% quartz. The gravel is made up of sandstone aggregates (90%), bivalves, serpulids, benthonic forams and bryozoans(10%).

105/GS/018
Description: 5Y 3/2 "dark olive grey"
Poorly sorted medium to fine sands with gravel. The sand is 30% carbonate and 70% quartz grains with rare green glauconite. The carbonate is made up of unidentified bioclasts, shell fragments and benthonic forams. The gravel is composed of well rounded granules and siliciclastic fragments (85%), bivalves (10%), bryozoans and Dentalium (5%).

105/GS/019A
Description: Two pieces of bryozoan with worm tubes (1) 30mm x 40mm, (2) 10mm x 20mm.

105/GS/019B
Description: 5Y 5/3 "olive"
Coarse sand and granules, with pebbles and cobbles comprising 20% of the sediment. The sediment is made up of 80% carbonate and 20% quartz. The carbonates are composed of unidentified bioclasts, shell fragments, bivalves, bryozoan fragments, and echinoid spines. The gravel is made up of bryozoans (mesh & branching forms), 40% bivalves, and 30% echinoids, well rounded quartz, lithic fragments and gastropods (30%).

105/GS/020
Description: 5Y4/4 "olive"
Muddy fine to medium sand with gravel. The sand is 30% carbonate and 70% quartz with a few green grains. The carbonates are unidentified bioclasts, spines, and shell fragments. The gravel is lithic fragments (40%) (as in 105/GS/018), bivalves (30%) bryozoans and gastropods (30%).

105/GS/021
Description: 5Y 4/4 "olive"
Muddy fine to medium sand with gravel. The sand is 50% carbonate and 50% quartz grains including 2-3% fine sand-size green particles. The carbonates include unidentified bioclasts and shell fragments. The gravel is composed of sandstone fragments often coated by coralline algae; well-rounded lithic fragments (granule) making up 80%; bivalves up to 15% and gastropods and Dentalium comprising 5%.

105/GS/022
Description: 5Y 4/4 "olive"
Poorly sorted muddy fine to medium sand with gravel. The sand is composed of 80% carbonates and 20% quartz grains with a few green grains. The carbonates are unidentified bioclasts, shell fragments, benthonic forams (planktonic forams are rare). The gravels include sandstone fragment (40%), bivalves (50%), echinoids (5%), bryozoans, Dentalium and gastropods(5%).

105/GS/023
Description: 5Y4/4 "olive"
Muddy fine sand with gravel. The sand is composed of 40% carbonate and 60% quartz. Carbonates include unidentified bioclastics, shell fragments and benthonic forams. Gravels are made up of bivalves (80%) and sandstone rock fragments (20%).

105/GS/024A
Description: 10YR 5/3 "pale brown"
Coarse sand with pebbles, composed of 70% carbonate and 30% quartz and lithic fragments. The carbonate components are bryozoans, bivalves, benthonic forams and echinoid spines.

105/GS/024B
Description 10YR 5/4 3 "pale brown"
Coarse sand with pebbles, composed of 80% carbonate and 20% quartz. The carbonates include unidentified bioclasts, shell fragments, echinoid spines, benthonic forams and bryozoans. The gravel is made of bryozoans (50%), sandstone fragments (40%), bivalves, barnacles, solitary coral, echinoid spines and gastropods (10%)

105/GS/025
Description 5Y 5/2 "olive grey"
Muddy grey silt with very fine sand with rare gravels.Composed of 30% carbonate and 70% quartz grains. The carbonates include unidentified bioclasts, shell fragments, echinoid spines, benthonic forams, and rare planktonic forams. The gravel is mainly gastropods (60%), bivalves (30%), Dentalium and bryozoans (10%).

105/GS/026
Description: 5Y 4/4 "olive"
Muddy fine to medium sand with gravel. The sand is composed of 40% carbonate, 60% quartz grains, one pale-green lithic grain and very rare well-rounded black lithic grains. The carbonates include unidentified bioclasts, shell fragments, spines,and benthonic forams. The gravel is made up of gastropods (30%), bivalves (30%), lithic fragments (30%) and others (10%).

105/GS/027A
Description: 5Y 4/4 "olive"
Muddy silt to fine sand with gravels. The sand is composed of 70% carbonate, 30% well rounded quartz grains. The carbonate is made up of unidentified bioclasts, shell fragments and benthonic forams. The gravels include gastropods and echinoid spines.

105/GS/027B
Description: 5Y 4/3 "light olive"
Muddy silt to fine sand with biogenic granules and pebbles. The granules and pebbles make up 40%, made up almost entirely of bioclasts (bryozoans 30% , bivalves 20%, echinoid spines 10%, lithic fragments 10%, coral (octocorals and solitary) and gastropods 30%). The silt to fine sand is mainly quartz with 10% of bioclastics.

105/GS/028
Description: 5Y 4/4 "olive"
Muddy silt to fine sand with biogenic gravel. The gravel (5%) is composed mainly of granule-size lithic fragments (60%), bivalves (30%), echinoids (10%), bryozoans and gastropods. The silt to fine sand is composed mainly of quartz.

105/GS/029A
Description 10YR 5/3 "light brown"
Cobbles and pebbles, and coarse to very coarse biogenic sand. The coarse to very coarse sand is made up of 70% bioclastics and 30% quartz /feldspar. The bioclasts are mainly bivalve fragments, echinoid spines, bryozoans. Approximately 50% of the bioclastic grains are stained brown. The quartz is subrounded and moderately sorted. Coralline algae are associated with many grains.

105/GS/029B
Description: 5Y 2/6
Pebble sized coral covered with coralline algae and barnacles. Heavily bored by sponges.

105/GS/029C
Description: 10YR 5/3 "light brown"
Biogenic cobbles and coarse to very coarse sand. The cobbles make up 30% of the sample. The sand is made up of 70% bioclasts. The bio-assemblage of the pebble-size fraction is algal coated grains (30%), barnacles (20%), bivalves (20%), echinoid spines, larger forams, bryozoans and gastropod (25%)

105/GS/030
Description: 10YR 4/2 "dark greyish brown"
Fine to medium and coarse to very coarse sand; both quartzose and biogenic. The fine to medium sand (60%) is composed of 90% quartz grains, 10% shell fragments. The coarse to very coarse sands (40%) are composed of 95% bioclasts (bivalves, gastropods, bryozoans) and 5% quartz grains and lithic fragments.

105/GS/031
Description: 10YR 5/4 "yellowish brown"
Medium to fine grained sand with some coarse sand. The medium sand (95%) is composed of 95% quartz and a few lithic fragments and 5% of bioclasts. The coarse sand (5%) is made up of 90% quartz and 10% bioclasts.

105/GS/032
Description: 10YR 5/4 "yellowish brown"
Fine to medium grained quartzose sand. The fine to medium sand (99.9%) consists of well rounded quartz with rare heavy minerals. The gravel fraction (less than 1%) is made up of bivalves, gastropods and quartz.

105/GS/033
Description: 10YR 5/4 "yellowish brown"
The fine to medium sand (99.9%) consists almost entirely of quartz grains, with rare abraded fragments of bioclasts. The quartz grains are moderate to well rounded and well sorted. Approximately 20% are brown stained.

105/GS/034
Description: 5Y 4/3 "olive"
Quartzose fine sand (90%) with 10% of medium-size sand.

105/GS/035
Description: 2.5Y 5/4 "light olive brown"
Fine quartzose sand (99.9%). Nearly 95% of the quartz grains are well sorted; 5% are brown stained.

105/GS/036
Description: 2.5Y 5/4 "light olive brown"
Fine quartzose sand composed of 95% moderate to well sorted and rounded quartz grains with approximately 5% brown stained.

105/GS/037
Description: 5Y 4/4 "olive"
Fine to medium quartz sand composed of 95% quartz.

105/GS/038
Description 5Y 3/2 "dark olive grey"
Fine quartzose sand (80%) and medium sand (20%) and trace coarse and very coarse sand. Fine and medium sand is mainly quartz. The coarse to very coarse sand is 70% bioclastic. The granule fraction is 95% bivalves.

105/GS/039
Description: 5Y 4/3 "olive"
Fine quartzose sand (80%), medium sand (20%), coarse and very coarse sand (2%)

105/GS/040
Description: 2.5Y 5/4 "light olive brown"
Medium to fine sand (95%), mainly of quartz with a few percent of brown stained grains. Coarse sand (5%), mainly of bioclasts. The granule fraction (>2mm) is composed of brachiopods, bivalves (30%), barnacles (20%), and others.

105/GS/041
Description: 2.5Y 5/4 "light olive brown"
Medium to fine sand (80%) and coarse to very coarse sand (20%).The gravel is composed of 70% bivalves, 20% brachiopods and 10% larger forams.

105/GS/042
Description: 5Y 4/3 "olive"
Medium quartzose sand (95%), fine sand (5%). The medium and fine sands are mainly well rounded, well sorted quartz grains with about 20% stained brown. A few percent of coarse sand (5%) is bioclastic.

105/GS/043
Description: 5Y 4/3 "olive"
Medium to fine sand (90%), mainly of quartz grains, well sorted with 20% brown stained and a few percent black lithic fragments.The coarse fraction (10%) is mainly bioclastic.

105/GS/044
Description: 5Y 5/2 "olive grey"
70% fine to medium sand; 40% coarse sand; 10% gravel. The sediments are composed of 60% quartz and lithic fragments and 40% calcareous fragments. The fine to medium sand is composed mainly of well sorted quartz grains. The coarse sands are composed of shell fragments and well rounded lithic fragments.The >2mm fraction is composed of bivalves (65%), bryozoan (12%), carbonate-cemented rock fragments (10%).

105/GS/045
Description: 2.5Y 4/4 "olive brown"
Fine to medium sand (30%), mainly of well sorted quartz grains, 30% stained brown. Coarse sand (50%) composed of unidentified bioclasts.The gravel fraction is composed of bivalves (50%), bryozoans (25%), encrusting coralline algae (6%).

105/GS/046
Description: 5Y 4/3 "olive"
95% fine sand; 5% medium to coarse sand. The sediment is 90% quartz and 10% calcareous. The fine sand is mainly well sorted quartz with a few bioclasts.
The medium to coarse sand (5%) is mainly of bioclastic shell fragments. The gravel fraction is composed of bivalves (90%), echinoids (5%) and others (gastropods etc. - 5%).

105/GS/047
Description: 10YR 5/4 "light yellowish brown"
Medium to coarse sand with biogenic gravels.

105/GS/048A
Description: 1 specimen (living)

105/GS/048B
Description: Living coralline algae encrusting rock fragments.

105/GS/048C
Description: 10YR 5/4 "light yellowish brown" (very small sample)
Medium sand (95%: medium; 5% coarse sand) composed of 30% quartz and 70% carbonate. The medium sand is mainly bioclastics with a few quartz grains. The bioclastics are unidentified bioclasts, shell fragments, spines. The quartz grains are subangular to subrounded and clear, with a few moderately sorted, stained quartz grains. The coarse sand is mainly bioclasts.

105/GS/048D
Description: 10YR 5/3 "pale brown"
Medium to coarse sand with biogenic gravels (60% medium sand; 20% coarse sand; 20% gravel) composed of 10% quartz and 90% calcareous fragments.The medium sand is mainly bioclastics with a few quartz grains. The bioclasts are unidentified bioclasts, shell fragments, bryozoans,and others. The gravel fraction is composed of living coralline algae encrusting shells, bivalves, bryozoans and carbonate cemented rock fragments.

105/GS/049A
Description: 10YR 5/3 "pale brown"
70% medium sand; 30% coarse sand composed of 10% quartz and 90% calcareous fragments. The medium sands are mainly bioclastics with rare quartz grains. The bioclastics are unidentified bioclasts, shell fragments, bryozoans, and echinoids. The

coarse sand is almost entirely bioclastic. The >2mm fraction is composed of bivalves, bryozoans, and others.

105/GS/050
Description: 5Y 4/4 "olive"
85% fine sand (5% medium to coarse sand), composed of 60% quartz and 40% calcareous material. Fine sand is composed of quartz grains and bioclastics. The quartz is subangular to subrounded, clear and well sorted. The bioclastics are unidentified bioclasts, and shell fragments. The medium to coarse sand is entirely bioclastic. The >2mm fraction is made up of bivalves (85%), gastropods (10%), others (5%).

105/GS/051
Description: 5Y 4/4 "olive"
Gives off a hydrogen sulfide smell.
Muddy fine sand composed of 5% medium sand and 95% muddy fine sand and made up of 50% quartz and other terrigenous components and 50% carbonate fragments. The medium sand is composed of unidentified bioclasts, and shell fragments. The muddy fine sands are composed of quartz grains and bioclastics. The gravel fraction is composed of echinoids, shells, well rounded rock fragments.

105/GS/052
Description: 5Y 4/3 "olive"
Pebbly medium to coarse sand. 60% medium to coarse sand; 40% biogenic pebble - granule. Composition is 30% quartz and 70% carbonate. Medium to coarse sand (60%) composed of quartz grains and bioclastics with muddy matrix rare. Quartz is subangular to subrounded and moderately rounded and clear. Bioclasts include unidentified bioclasts, shell fragments, bryozoans, echinoids, and Dentalium. The granule to pebble (40%) fraction is composed of bryozoans (45%), bivalves (30%,) brown branching organisms (10%), well rounded rock fragments (5%) and echinoids and others (5%).

105/GS/053
Description: 5Y 4/2 "olive grey"
Muddy fine to medium sand (35% muddy matrix, 60% fine to medium sand, 5% coarse sand). In composition it is 30% quartz and 70% carbonate. The fine to medium sand (60%) is composed of 30% quartz grains and 70% bioclasts. Quartz grains are subangular and clear. The bioclasts include unidentified bioclasts, shell fragments and others. Coarse sand (5%) is composed of 100% bioclasts. The gravel fraction is composed of bivalves (80%), serpulid worm tubes (12%), bryozoans (3%), gastropods (2%), rock fragments (2%) and others (1%).

105/GS/054
Description: 5Y 5/3 "olive"
95% medium quartz sand and 5% coarse sand, composed of 70% quartz and 30% carbonate. The medium sand is mainly quartz with a few bioclasts. The quartz grains are subrounded and rounded, well sorted and clear with 5% brown stained, and also rare well rounded lithic fragments. The bioclasts include unidentified bioclasts, shell fragments, and Dentalium. The coarse sand is composed almost entirely of bioclastics, particularly shell fragments, unidentified bioclasts, and others. The gravel fraction is composed of bivalves (80%), rock fragments (15%), Dentalium (2%), bryozoans (1%) and others (2%).

105/GS/055
Description: 2.5Y 4/4 "olive brown"
Very coarse sand with biogenic pebbles (30% medium.sand, 60% very coarse sand and 10% gravel fraction), composed of 30% quartz and 70% carbonate. Medium sand is composed mainly of quartz grains with a few bioclastics. The quartz grains are

subrounded to rounded, well sorted and clear, with only 30% brown stained. The bioclasts include unidentified bioclastics, and shell fragments. Coarse to very coarse sand is composed mainly of bioclastics - unidentified bioclasts, shell fragments, bryozoans, Dentalium and echinoids. The gravel fraction is composed of bivalves (35%), bryozoans (25%,), carbonate-cemented rock fragments (15%), large forams (5%), worm tubes (2%), echinoids (1%) and others (including serpulids).

105/GS/056
Description: 5Y 4/2 "olive grey"
Muddy fine to medium sand (10% muddy matrix, 88% fine to medium sand, 2% coarse sand), composed of 40% quartz and 60% carbonate. The fine to medium sand is composed of 40% quartz and 60% bioclastics with rare (5%) black lithic fragments. The quartz grains are well rounded and clear. Bioclasts include unidentified bioclasts, and shell fragments. The coarse sand is mainly bioclastic with well rounded black lithic fragments (trace). Bioclasts include shell fragments and unidentified fragments. The gravel fraction is made up of bivalves (40%), serpulids (25%), rock fragments (15%), black grains (10%), bryozoans (5%), echinoids(1%), Dentalium (1%) and others (3%).

105/GS/057
Description: 5Y 4/2 "olive grey"
90% fine to medium sand, 10% medium to coarse sand, composed of 80% quartz and 20% carbonate. The fine to medium sand is mainly subrounded, well sorted quartz grains and rare black lithic fragments and 10-20% bioclastics, mainly of unidentified bioclasts, and shell fragments. The medium to coarse sand mainly of bioclastics, with unidentified bioclastics, shell fragments, Dentalium, and bryozoans. The gravel fraction is composed of bivalves (40%), black grains (30%), echinoids (12%), large forams (5%), serpulids (5%), rock fragment (3%), gastropods (3%) and others (2%).

105/GS/058
Description: 5Y 4/3 "olive"
Medium quartzose sand (45% medium sand, 5% coarse sand) comprised of 80% quartz and 20% carbonate. The medium sand is mainly of well rounded, well sorted quartz grains with 5-10% brown stained grains and 10% bioclasts, including unidentified shell fragments. The coarse sand is entirely bioclastic comprised of unidentified bioclasts, shell fragments and Dentalium. The gravel fraction is composed of bivalves (80%), black grains (12%), Dentalium (5%), echinoids (3%) and *Halimeda* (trace).

105/GS/059
Description: 5Y 5/2 "olive grey"
Fine to medium quartz sand (95% fine to medium sand, 5% coarse sand) composed of 85% quartz and 15% carbonate. The fine to medium sand is mainly composed of moderately sorted, subangular to subrounded, clear quartz. The coarse sand is almost entirely bioclastic, comprised of unidentified bioclasts and shell fragments. The gravel fraction is composed of bivalves (80%), large forams (10%), Dentalium (4%), echinoids (4%), and gastropods (2%).

105/GS/060
Description: Fine to medium sand (95% fine to medium sand, 5% coarse to very coarse sand) composed of 95% quartz and 5% carbonate. The fine to medium sand is mainly composed of moderately sorted, rounded quartz. The coarse sand is mainly made of shell fragments, quartz, lithic fragments, and echinoderm spines. The gravel fraction is composed of 99% bivalves and 1% crustacean fragments.

105/GS/061
Description: 10YR 6/3 "pale brown"
Gravelly very coarse sand (90% very coarse to coarse sand and 10% gravel). It is 100% carbonate. The very coarse to coarse sand is bioclastic - coralline algae, shell fragments, bryozoans, echinoid spines, and others. The gravel is composed of coralline

algae (30%), small rhodoliths (25%), rounded grains (25%), large forams (10%) echinoids (3%), gastropods (3%), living *Halimeda* and others (3%).

105/GS/064
Description: 10YR 5/6 "yellowish brown" - 10Y 7/4 "very pale brown"
95% coarse to very coarse sand, and 5% granule; composed of 90% carbonate and 10% quartz and lithic fragments. The sand is composed of benthonic forams, carbonate rock fragments, shell fragments and unidentified bioclastics. The gravel fraction is composed of carbonate rock fragments (30%), large benthonic forams (20%), bivalves (20%), gastropod (tr.), barnacles (tr.), echinoid spines (tr.), and crustaceans (tr.).

105/GS/065
Description: 10YR 5/4 "yellowish brown".
Gravelly sand made up of 90% fine-medium sand and 10% gravel, composed of 50% carbonate and 50% quartz. The fine to medium sand is well to moderately sorted and composed of benthonic forams, unidentified bioclastics, and quartz sand. The gravel is made of 30% carbonate rock fragments and 70% large benthonic forams, shells and bryozoans, and they are brown stained.

105/GS/066
Description: 5Y 5.4/2 "olive grey muddy sand"
Muddy sand with less than 5% gravel. The sand is carbonate (90%) and quartz (10%), medium to coarse grainsize and composed of benthonic foraminifera (10%), planktonic foraminifera (10%), shell fragments (30%), and pteropod spines, bryozoan fragments, unidentified grains (30%). The gravel is composed of unidentified carbonate aggregates (70%), bivalves (10%), pteropods and bryozoans (5%).

105/GS/067
Description: 5Y 4/3 "olive"
Sand with gravels less than 1%. The sands are medium to coarse grainsize, composed of carbonate (90%), and quartz (10%). Its constituents are as 105/GS/066. The gravel constituents are as 105/GS/066.

105/GS/068
Description: 5Y 5/3 "olive"
95% very fine to fine sand and 5% mud, and composed of 80% carbonate and 20% quartz. The very fine to fine sand is mainly bioclastics - shell fragments, bryozoans, pteropods, planktonic foraminifera.

105/GS/069
Description: 5Y 5/3 "olive"
Medium sand consisting of 90% medium sand and 10% coarse to very coarse sand with 20% quartz and 80% carbonate. Medium sand almost all bioclastics, 90% brown, 30% white, moderate sand. Bioclastic shell fragments, echinoid spines, bryozoans, planktonic forams - rare. Coarse to very coarse sand mainly bioclastics. The >2mm fraction is composed of rock fragments (40%), bivalves (10%), shells (30%), others (20%). Two rock specimens 5cm x 3cm x 3cm and 4cm x 2cm x 2cm, carbonate-cemented medium sandstone - very irregular shape.

105/GS/070
Description: 2.5 Y 5/2 "greyish brown"
Gravelly coarse to very coarse sand and 15% gravel, comprised of 5% quartz and 95% carbonate. The coarse to very coarse sand is made up of bioclastics with rare quartz grains. The bioclastics are shell fragments, bivalves, bryozoans, and echinoid spines. The quartz grains are medium sand size, clear and subangular to subrounded. The gravel (15%) is composed of large (pebble- to cobble-) size fragments thought to be branching coral fragments, rhodoliths and bivalves.

105/GS/071
Description: 10YR 6/4 "light yellowish brown"
Gravelly coarse to very coarse sand, composed of 80% coarse to very coarse sand and 20% gravel. It is made up of 95% carbonate and 5% quartz. The coarse to very coarse sand is composed of bioclasts, 50% brown grains and 50% white grains. The bioclastics are shell fragment, bryozoans, planktonic forams, bivalves, echinoid spines. The gravel is made up of shell fragments, bivalves, gastropods, bryozoans, and rhodoliths.

105/GS/072
Description: (same position - GS/071)
Gravel only. Platey coral fragments up to 12cmx10cmx4cm in size - abundant. They are encrusted by living coralline algae.

105/GS/073
Description: 5 Y 5/2 "olive grey"
Fine sand, quartzose, 99% fine sand, trace medium to coarse sand and made up of 90% quartz and 10% carbonate. Fine sand mainly of quartz grains, well sorted, subrounded, with rare lithic fragments. Minor amounts of calcareous material (10%): shell fragments, bryozoans. Medium to coarse sand (trace) composed of bioclastics which are mainly shell fragments with rare bryozoans.

105/GS/074
Description: 5Y 5/3 "olive"
This sample consists of 95% fine to medium sand, mainly of 90% quartz with some lithic fragments and 10% carbonate. The quartz is well sorted, subrounded to rounded, and is mainly clear (brown stained grains 25%). The bioclastics are mainly shell fragments and unidentified grains. The lithic fragments are black to dark grey siltstone. The 5% coarse sand is almost 100% bioclastics . Types include shell fragments, echinoid spines, bryozoan fragments and unidentified grains. The >2mm fraction (sieved sample) is made up of 70% bivalves, 20% foraminifera and 10% others.

105/GS/075
Description: 2.5Y 5/4 "light olive brown"
Medium to coarse sand consisting of 70% medium sand and 30% coarse sand, about 50 percent of which is carbonate. The medium sand consists of well sorted, subangular to subrounded quartz, mainly clear, but with brown stained grains. The bioclastics include shell fragments, benthonic foraminifera, echinoids spines and unidentified grains. The coarse sand fraction is almost 100% bioclastics, and includes shell fragments, bivalves, benthonic foraminifera, bryozoans, echinoids, 5% foraminifera, 2% bryozoans, 7% black grains, and 3% others.

105/GS/076
Description: 5Y 4/3 "olive"
Poorly sorted medium to very coarse sand with shelly gravels. Consists of 75% medium sand, which is composed of 40% quartz, which is moderately sorted, subangular to subrounded and clear in colour, and 60% bioclastics, which include angular, poorly sorted, shell fragments, echinoids spines, benthonic foraminifera, and unidentified grains. The 20% coarse to very coarse sand is almost 100% bioclastics, including poorly sorted, angular to sub-angular shell fragments, bivalves, gastropods, echinoids spines, bryozoans, benthonic foraminifera and unidentified grains.The 5% gravel is 30% quartzose and 70% calcareous. The >2mm fraction includes 69% bivalves, 8% black foraminifera (*Marginopora*), 8% other foraminifera, 5% gastropods, 5% bryozoans, 3% cemented sediments, and 2% others.

105/GS/077
Description: 10YR 6/4 "light yellowish brown"
70% medium to 30% coarse to very coarse sand consisting of 95% carbonate and 5% quartzose grains. The medium sand is almost all bioclastics with small amounts of quartz grains. The coarse to very coarse sand is also almost 100% bioclasts, which include poorly sorted, angular to subrounded shell fragments, benthonic foraminifera, bivalves, gastropods, echinoid spines, bryozoans, Dentalium and unidentified grains. The >2mm (sieved) fraction includes 35% algal coated grains, 35% bivalves, 20% foraminifera, 3% bryozoans, 3% gastropods, 2% cemented rock fragments, 2% others.

105/GS/078
Description: 10YR 7/4 "very pale brown"
This sample is 80% medium and 20% coarse to very coarse sand, and is nearly 100% carbonate, with a trace of quartz. The medium sand is bioclastic, moderately sorted, and subangular to rounded in shape. The sand fraction consists of shell fragments, benthonic foraminifera, echinoid spines and unidentified grains. The >2mm (seived) fraction includes 38% algal coated grains, 22% bivalves, 15% foraminifera, 8% *Halimeda*, 7% bryozoans, 6% gastropods, 2% echinoids, and 2% others.

105/GS/079
Description: 10YR 7/4 "very pale brown"
50% medium to 45% coarse to very coarse sand and 5% gravel. This sample is 100% carbonate. All fractions are 100% bioclastic, moderately sorted, subrounded, and include shell fragments, benthonic foraminifera and unidentified grains. The >2mm (seived) fraction consists of 73% algal coated grains, 12% foraminifera, 8% bivalves, 2% echinoids, 2% bryozoans, 1% *Halimeda*, and 2% others.

105/GS/080
Description: 2.5Y 5/4 "light olive brown"
60% fine to medium sand and 40% coarse to very coarse sand. The sample consists of 90% carbonate and 10% quartz. The fine to medium sand is bioclastic, with some quartz, and is poorly sorted, partly muddy and angular to subrounded. The bioclasts include shell fragments, echinoids spines, benthonic foraminifera, and unidentified grains. The coarse to very coarse sand is also almost 100% bioclastic, poorly sorted, angular to rounded, with some of the grains stained brown. Included in this fraction are shell fragments, echinoids spines, benthonic foraminifera, and brown stained unidentified grains are common (reworked carbonates?). The >2mm (sieved) fraction includes 89% algal coated grains, 8% bivalves, and others 3%.

105/GS/081
Description: 2.5Y 5/4 "light olive brown"
Consists of 95% fine to medium sand and 5% coarse sand. The sample is 90% carbonate and 10% quartz. The fine to medium sand is 90% bioclastics and 10% quartz with the bioclastics being moderate to well sorted and angular to rounded in shape. Some grains are stained brown. This fraction includes shell fragments, planktonic foraminifera, benthonic foraminifera and unidentified grains. The coarse sand fraction is 100% bioclastics and is poorly sorted and angular. The bioclasts include shell fragments, echinoids, benthonic foraminifera and unidentified grains. The >2mm (sieved) fraction includes 64% algal encrusted grains (relict?), 26% bivalves, and 10% others.

105/GS/082
Description: 5Y 6/4 "pale olive"
Muddy sample consisting of 95% very fine to fine sand to 5% mud, and is 80% carbonate to 20% quartz. The very fine to fine sand fraction contains 90% bioclastics and 10% quartz. The bioclastics are moderate to well sorted, and angular to rounded in shape. Some of the grains are stained brown. Included are shell fragments, planktonic

foraminifera, benthonic foraminifera and unidentified grains. The coarse sand is poorly sorted and angular. The bioclasts include shell fragments, echinoids, benthonic foraminifera, and unidentified grains. The >2mm (sieved) fraction includes 64% algal encrusted grains (relict?), 26% bivalves, and 10% others.

105/GS/083
Description: 2.5Y 6/2 "light brownish grey"
90% fine to medium sand and 10% coarse to very coarse sand, all 100% carbonate. The fine to medium bioclastic sand is well sorted and subangular to well rounded. Included in this fraction are abundant planktonic foraminifera, benthonic foraminifera, pteropod fragments, shell fragments, and unidentified grains. The coarse to very coarse sand is also 100% bioclastic, and is poorly sorted and angular to well-rounded in shape. Included in this fraction are shell fragments, benthonic foraminifera, pteropod fragments, planktonic foraminifera, echinoids and unidentified grains. The >2mm (seived) fraction includes 60% relict carbonate grains, 20% pteropods, 10% bivalves, and others 10%.

105/GS/084
Description: 2.5Y 4/4 "olive brown"
90% fine to medium sand and 10% coarse to very coarse sand, with the sample consisting of 90% carbonate and 10% quartz. The fine to medium sand fraction is moderately sorted and angular to sub rounded. It includes shell fragments, benthonic foraminifera, pteropod fragments, planktonic foraminifera and unidentified grains. The quartz is moderately sorted, subangular to subrounded and clear. The coarse to very coarse sand is 100% bioclastics and is poorly sorted, angular to rounded with some brown stained relict carbonate grains (common) . Included in this fraction are shell fragments, benthonic foraminifera, echinoids, and unidentified grains. The >2mm (seived) fraction includes 35% relict carbonate grains, 30% platey relict grains (*Halimeda*), 25% bivalves, 3% echinoids, 2% foraminifers, and 5% others.

105/GS/085
Description: 5Y 5/2 "olive grey"
70% fine to medium sand, 25% coarse to very coarse sand and 5% gravel (granule size). Sample consists of 90% carbonate and 10% quartz. The fine to medium sand fraction is angular to subrounded in shape, and the bioclastics include shell fragments, benthonic foraminifera, planktonic foraminifera, and unidentified grains. The quartz is subangular to subrounded and is clear. The coarse to very coarse sand fraction is almost 100% bioclastics, with poorly sorted grains, which are angular to subrounded in shape. The bioclasts include shell fragments, benthonic foraminifera, echinoids, relict carbonate grains, and unidentified grains. The >2mm (seived) fraction includes, limestone fragments, rhodolith pebbles, coral fragments, molluscan shells, echinoids, and benthonic foraminifera. The rhodoliths are abundant, 10mm to 25mm in size; most are rounded, and some are encrusted by red living coralline algae.

105/GS/086
Description: 10YR 7/4 "very pale brown"
Sample consists of a gravelly medium to very coarse sand with rhodoliths. 75% medium sand, 20% coarse to very coarse sand and 5% gravel. The sample is 100% carbonate. The medium sand is moderately sorted and angular to subrounded in shape. The bioclasts include shell fragments, benthonic foraminifera, and unidentified grains. The coarse to very coarse sand fraction is poorly sorted, with angular to rounded grains, and includes shell fragments, benthonic foraminifera, echinoids, and rounded brown stained carbonate grains and unidentified grains. The >2mm (seived) fraction includes rhodoliths, large benthonic foraminifera, molluscan shells, and limestone granules. The rhodoliths are encrusted by living coralline algae; they are 10-30mm in diameter.

105/GS/087
Description: 7.5YR 6/6 "reddish yellow"
Sample consists of a medium to very coarse, poorly sorted sand, with less than 5% gravel. The sand fraction is almost 100% carbonate, with a trace of quartz in the very fine sand fraction, and it consists of limestone fragments, shell fragments, benthonic foraminifera, echinoid spines, and other unidentified bioclasts. The gravel fraction includes, limestone fragments, shells and shell fragments, benthonic foraminifera, and rare rhodoliths (1cm diam.).

105/GS/088
Description: 10YR 6/4 "light yellowish brown" to 10YR 5/6 "yellowish brown"
The sample consists of a medium to coarse moderately sorted sand and some (<1%) gravel. The sand fraction consists of 90% quartz and 10% carbonate, including benthonic foraminifera, shell fragments, and other unidentified bioclastics. The gravel fraction consists of molluscan shells, other shell fragments, foraminifera, and brachiopods.

105/GS/089
Description: 20% sand and 80% gravel. The sand fraction is poorly sorted, medium grained with 70% quartz, and 30% coarse to very coarse carbonates. The gravel includes cobble- to pebble-size rhodoliths, and limestone or sandstone cobbles. The carbonate sands include, shell fragments, benthonic foraminifera, bryozoans, echinoids, and other unidentified bioclasts. The >2mm (seived) fraction includes pebble size rhodoliths, limestone fragments, molluscan shells, benthonic foraminifera, bryozoans, echinoids, and other unidentified bioclasts.

105/GS/089 - 04
Description: This sample consists of gravel-size sandstone fragments, encrusted by living coralline algae, bryozoans and serpulids, together with granule- to pebble-size. sediments.

105/GS/089 - 05
Description: Cobble-size sandy limestone, with grainstone to packstone matrix. Fine to very coarse in texture, with 30% quartz grains. Sample includes benthonic foraminifera, shell fragments, unidentified bioclastics and isopachous cement.

105/GS/089 - 08
Description: barnacles on cobbles.

105/GS/090
Description: 5Y 6/4 "pale olive"
The sample consists of 15% mud, 65% fine sand, and 20% medium sand. It is 80% carbonate and 20% quartz. The mud fraction is pale olive to olive yellow in colour, and is calcareous mud. The fine sand fraction is 70% bioclastics, 30% quartz, and is poorly sorted, and includes planktonic foraminifera, shell fragments, unidentified grains, and others. The quartz is subangular to subrounded, clear in colour, and moderately sorted. The medium sand fraction is almost 100% bioclastics of angular to rounded shape, and includes shell fragments, benthonic foraminifera, planktonic foraminifera (some brown stained) and unidentified grains. The >2mm (seived) fraction consists of 76% cemented relict grains (granule-size), 15% bivalves, 3% gastropods, 1% Dentalium, and 3% others.

105/GS/090 - 1
Description: A very irregular shaped carbonate cemented sandstone approximately 7cm x 5cm x 3cm in size.

105/GS/091
Description: 2.5Y 5/4 "light olive brown"
Gravelly fine to very coarse sand, consisting of 20% fine sand, 60% coarse to very coarse sand and 20% gravel. The sample is 90% carbonate, and 10% quartz. The fine sand fraction is 50% bioclastic and 50% quartz, which is poorly sorted, and partly muddy. The bioclasts are angular to subrounded, and include planktonic foraminifera, shell fragments, unidentified grains, and others. The quartz is subangular to subrounded in shape and clear in colour. The coarse to very coarse sand is almost 100% bioclastics, which consist of angular to rounded, poorly sorted, 40% grains are brown stained, and include carbonate grains, shell fragments, benthonic foraminifera, echinoids and others. The >2mm (seived) fraction consists of 49% elongated coralline encrusted coral branches, 30% rhodoliths, 7% delicate branching corals, 5% bryozoans, 4% bivalves, and 5% others, which include echinoids, solitary corals, and forams. The 10-20mm size rhodoliths have abundant living encrustation around their cortices, and branching coral? fragments are also encrusted with living red algae. A few branches are 20-50mm long.

105/GS/092
Description: 10YR 7/6 "yellow"
The sample consists of 50% gravel to very coarse sand and 50% medium to coarse sand. The sample is almost 100% carbonate, with a trace of quartz. The gravel consists of 5% pebble-size rhodoliths and 95% granule-size bioclastic material. The >2mm (seived) fraction includes rhodoliths, benthonic foraminifera, bryozoans, echinoids, and *Halimeda*. The sand fraction consists of rounded to subrounded, poorly sorted bioclasts and limestone fragments.

105/GS/092 - 2
Description: The sample is a limestone cobble, 14cm x 12cm x 7cm in size, that is coated by coralline algae. The rock is a boundstone consisting of coral and coralline algae and it is extensively bored, with some borings partly filled by material of wackestone to packstone texture.

105/GS/093
Description: 10YR 6/4 "light yellowish brown"
Sample consists of gravelly sand (10% gravel and 90% sand) with almost 100% carbonate (quartz less than a few percent.). The sand fraction consists of medium sand with coarse to very coarse sand grains of unidentified bioclasts and benthonic foraminifera. The >2mm (seived) fraction includes lithic pebbles/granules, which are in some cases coated by red coralline algae, molluscan shells, barnacles and benthonic foraminifera.

105/GS/096
Description: 2.5Y 5/2 "greyish brown"
The sample consists of 5% gravel with 90% sand and is 90% quartz and 10% carbonate. The sand fraction is fine-grained and well sorted. Carbonate is moderately sorted, and includes benthonic foraminifera, shell fragments, bryozoans, planktonic foraminifera, and unidentified bioclasts. The >2mm (seived) fraction consists of pebble- to cobble-size dark grey calcareous sandstone fragments, molluscan shells and platey and branching hermatypic corals; plus barnacle fragments, echinoid spines, benthonic foraminifera, and carbonaceous material.

105/GS/097
Description: 5Y 5/2 "olive grey"
Muddy fine to very coarse sand, with 10% mud, 60% fine sand, 30% coarse to very coarse sand. The sample is 70% carbonate and 30% quartz. The mud fraction is a pale olive to light olive grey calcareous mud. The fine sand fraction consists of 50% bioclastics, 50% quartz, and is poorly sorted, with bioclasts of angular to rounded

dimensions, that include shell fragments, benthonic foraminifera, planktonic foraminifera, pteropod fragments, and unidentified grains. The quartz is subangular to subrounded and clear. The coarse to very coarse sand fraction is almost 100% carbonate. The bioclasts are angular to rounded grains with 20% of them being brown stained. The bioclasts include shell fragments, brown stained carbonate grains, benthonic foraminifera, echinoids and unidentified grains. The >2mm (seived) fraction includes 37% rhodoliths, 18% relict grains (granule size), 16% delicate branching coral, 12% *Halimeda*, 6% bivalves, 3% gastropods, 3% echinoids, 3% foraminifera, and 2% others.

105/GS/098
Description: %Y 5/2 "olive grey"
Muddy fine sand, 20% mud and 80% fine sand. The sample is 70% carbonate and 30% quartz. The mud is light olive grey to pale olive calcareous mud. The fine sand fraction includes 70% bioclastics, 30% quartz and is moderately sorted. The bioclasts are angular to rounded in shape and include planktonic foraminifera, shell fragments, benthonic foraminifera, pteropod fragments, and unidentified grains. The quartz is subangular to subrounded, clear, with black lithic fragments (5%). The >2mm (seived) fraction includes 40% pteropods, 25% echinoids, 18% bivalves, 6% spicules (origin unknown), 3% foraminifera, and others 4%.

105/GS/099
Description: 5Y 5/3 "olive"
Fine to medium sand consisting of 70% fine sand and 30% medium to coarse sand. The sample is 50% carbonate and 40% quartz. The fine sand fraction is 60% quartz, and 40% bioclastics, partly muddy. The quartz is subangular to subrounded, clear, with a few brown stained grains (10%). The bioclasts are angular to rounded and poorly sorted, and include benthonic foraminifera, planktonic foraminifera, shell fragments, pteropod fragments and unidentified grains. The medium to coarse sand is almost 100% bioclastics, consisting of angular to rounded and poorly sorted grains, and includes shell fragments, benthonic foraminifera, echinoids, bryozoans, pteropods fragments, and unidentified grains. The >2mm (seived) fraction includes 27% relict grains (cemented granule-size fragments), 26% pteropods, 18% bivalves, 10% echinoids, 7% gastropods, and others 12%.

105/GS/100
Description: 5Y 5/2 to 5/3 "olive grey to olive"
Fine to coarse sand consisting of 70% fine sand and 30% medium to coarse sand. The sample is 65% quartz and 35% carbonate. The fine sand fraction consists of 90% quartz and 10% bioclastics, and the quartz is subangular to rounded, clear, and well sorted, with a few black lithic fragments (5%). The bioclasts are subangular to rounded, well to moderately sorted and include shell fragments, benthonic foraminifera, planktonic foraminifera (trace) and unidentified grains. The medium to coarse sand fraction is almost 100% bioclastics, being angular to rounded and poorly sorted, and most of the grains are brown stained. They include rounded brown stained carbonate grains, benthonic foraminifera, shell fragments, and unidentified grains. The >2mm (seived) fraction includes 35% relict *Halimeda* plates, 30% foraminifera, 15% bivalves, 8% rock fragments, 4% echinoids, 3% gastropods, and 5% others.

105/GS/101
Description: 2.5 Y 6/2 "light brownish grey"
Sample consists of fine to very coarse sand, with dark red rhodoliths, 10-20mm in diameter and coated by living coralline algae, being common to abundant. The sample is made up of 40% fine to medium sand, 50% coarse to very coarse sand and 10% gravel, with 95% carbonate and 5% quartz. The fine to medium sand fraction is 90% bioclastics and 10% quartz. The bioclasts are subangular to rounded and moderately sorted, and include, shell fragments, benthonic foraminifera, planktonic foraminifera (trace), and unidentified grains. The coarse to very coarse sand fraction is almost 100%

carbonate, and is angular to rounded and poorly sorted. 60% of the grains are brown stained and include rounded (relict?) brown stained carbonate grains, shell fragments, benthonic foraminifera, echinoids and unidentified grains. The >2mm fraction includes 80% rhodoliths and algal coated grains, 10% foraminifera, 6% echinoids, and 4% of others.

105/GS/102
Description: 7.5Y 6/4 "light brown"
Gravel and medium to very coarse sand consisting of 65% medium sand, 30% coarse to very coarse sand and 5% gravel. The sample is 60% carbonate and 40% quartz. The medium sand fraction is 60% quartz and 40% bioclastics and is poorly sorted. The quartz is subangular to rounded and is clear, with minor amounts (5-10%) of brown-stained grains. The bioclasts are subangular to rounded; some of of the grains are brown stained. Bioclasts include shell fragments, benthonic foraminifera, echinoids, and unidentified grains, The coarse to very coarse sand fraction is almost 100% carbonate, and is angular to rounded and poorly sorted; 70% of the grains are brown stained. Included are rounded (relict?) brown stained carbonate grains, shell fragments, benthonic foraminifera, echinoids, gastropods, and unidentified grains.
The >2mm (sieved) fraction consists of 39% algal coated grains (including rhodoliths) 25% bivalves, 15% *Halimeda*, 12% foraminifera, 2% echinoids, 1% bryozoans, and 6% others.

105/GS/103
Description: 2.5Y 5/2 "greyish brown"
Sample is a medium quartzose sand and consists of 97% quartz and 3% carbonate. The medium sand fraction is almost pure quartz, with lithic grains (1-2%) and rare bioclastic grains (3%). The quartz is clear, with a few brown stained grains (5-10%). Lithics are black to dark grey, subangular to rounded siltstone. The rare bioclasts include benthonic foraminifera, shell fragments, echinoid spines, and unidentified grains. The >2mm (seived) fraction consists of 36% bivalves, 23% gastropods, 20% foraminifera, 12% shell "hash" granules, and 9% others.

105/PD/002
Description: Platey corals (living and dead) coated by coralline algae, together with soft algae, brittle starfish, sponges, bryozoans, barnacles, *Halimeda*, molluscs, rhodoliths, and bioclastic coarse to very coarse sands.

105/PD/002-1
Description: Green soft algae trapping sediments on the surface, *Halimeda* made of 1 - 2 cm plates, not so hard as small Halimeda (low calcification), other soft green seaweed.

105/PD/002-2
Description: Red soft seaweed; sponge attachment. Bryozoans coating the soft algae result in hollow bryozoan tubes in the sediment.

105/PD/002-4
Description: Brittle starfish

105/PD/002-5
Description: Living platey coral on dead platey coral (coral - algae - bryozoan). 20-30% of bottom surface of the dead coral is covered by encrusting bryozoans.

105/PD/002-15
Description: Sieved sample: Pebbles of rounded and bored carbonates, white coloured algal coated pebbles, coralline algae with living red colour, coralline algal coated pebbles. Abraded molluscan shells, hermatypic coral fragments, large

foraminifera, echinoid spines, branching articulated coralline algae coated by bryozoans, *Halimeda* plates (rare), branching bryozoans (rare).

105/PD/003
Description: 20cm size sea urchin (echinoid). Bryozoans and sponges coat the spine of living echinoid.

105/PD/003-12
Description: Sieved gravel fraction. Red coloured living coralline algal coated pebbles, red coloured living branching articulated coralline algae, white coloured carbonate pebbles, white coloured branching articulated corallines. *Halimeda* plates, larger forams, molluscan shells, bryozoans, echinoids, hermatypic coral fragment.

105/DR/001
Description: 10YR 7/4 "very pale brown"
The sample is composed of 90% coarse to very coarse sand and 10% gravel made up of 90% carbonate and 10% lithic fragments. The coarse to very coarse sand is almost all bioclastic made up of fragments of bivalves, bryozoans, echinoid spines, benthonic forams, and others. The gravel is made up of rhodoliths (60%) coralline algal fragments (30%) large forams (5%,) and rock fragments (3%).

105/DR/002
Description: Coral boulders, many almost coated entirely by coralline algae. Rhodolith limestone composed of living rhodoliths and very coarse bioclastic grains.

105/DR/002-1
Description: 10YR 7/8 - 2.5Y 7/8 "yellow"
46cmx43cmx16cm rhodolith limestone. Rhodoliths are 1-4 cm diam., surfaces are smooth or knobby in many cases; matrix is medium to very coarse granule and well lithified/cemented packstone - grainstone, rhodolith limestone, mudstone (one side) and floatstone /packstone (the other side). Rock surface is coated by mudstone, worm tubes, oysters, bryozoans and encrusting forams on one side while the other side is coralline algal coated.

105/DR/002-2
Description: 18cmx17cmx25cm. Rhodolith rudstone with worm borings. The rhodoliths are 2-3cm in diameter, concentric structure, the surfaces of which are bored; in some cases there is no matrix between the rhodoliths. The matrix is a medium to very coarse granule, well lithified packstone.

105/DR/002-3
Description: Coral-algal boundstone 20cmx25cmx13cm. Outer part of the rock sample is bored by sponges.

105/DR/002-41
Description: Taken in pipe dredge.

105/DR/003
Description:
1. 5Y 6/2 "light olive grey"
95% mud with 5% very fine sand. The mud is homogeneous, with black particles. The fine sand is comprised of shell fragments.
2. 2.5Y 6/2 "light brownish grey"
Muddy very fine sand (80% very fine sand, 20% mud) is composed of shell fragments, bryozoans and calcareous spicules.
Sieved sample - pteropods 40%, Dentalium (6%), rock fragments. (10%), bivalves (5%), crinoids (3%), gastropods (3%), spines (2%), echinoids (2%), corals (1%), and others 8%.

Two rock samples:
(1) 10YR 5/3 "pale brown"
coarse to very coarse grainstone with gravel (5cmx10cmx2cm). Grains are mainly bioclastics with brown lithic fragments, plus brown, well sorted, subangular-subrounded shell fragments, echinoid spine.
(2) 10YR 2/2 "very dark brown"
siltstone (15cmx7cmx7cm) - very hard, old.

105/DR/004 - LOST

105/DR/005
Description: Limestone boulders - abundant. Shale fragment - 1 specimen. Sandy mud also recovered. Two rock types observed:
Type A: porous large rhodolith-foram packstone/grainstone
Type B: tight fossiliferous wackestone.
Sandy mud 5Y 6/3 "pale olive". 70% mud, monotonous, with rare black particles. 30% very fine to fine sand, consisting of planktonic foraminifera, pteropods spines, shell fragments, bryozoans , *Ostrea* (?). The gravel is composed of bryozoans, pteropods and mollusc shells.

105/DR/005-1
Description: 2.5Y 8/4 "pale yellow" - 2.5 Y 8/0 "white"; type A
Porous rhodolith-large foram packstone/grainstone. The rhodoliths are 2-4cm diam. Large forams are common, with some up to 20mm in length and 1mm thick; one foram is 5mm thick. The matrix is composed of fine to medium sand size bioclastics.

105/DR/005-2
Description: 2.5 Y 8/4 "pale yellow" - 5 Y 8/2 "white"; type A
Rhodoliths up to 3.5cm diam. Large forams (*Lepidocyclina*) up to 1cm long are common. The largest is about 4cm long.

105/DR/005-3
Description: 10 YR 5/4 "yellowish brown"; type B
Floatstone with wackestone/mudstone matrix, 38cmx19cmx13 cm. Gravel is composed of mollusc shells, coral (solitary), or bryozoans. The sand fraction is composed of forams. The surface is covered by an Mn crust.

105/DR/005-4
Description: 10 YR 8/2 "white"; type A, but tight
2cmx8cmx3.5cm rhodolith-large foram floatstone with packstone matrix. Surface is bored by sponges(?).

105/DR/005-6
Description: 2.5 Y 7/6 "yellow" - 10 YR 7/1 "white"; type A
8cmx8cmx3cm large foraminifera-rhodolith floatstone with grainstone to packstone matrix. The gravel-size fraction is composed of forams (*Lepidocyclina* ,1cm long) and rhodoliths (2.5cm diam.). The sand is coarse to very coarse and composed largely of benthonic forams. Other unidentified grains.

105/DR/006
Description: Four limestone blocks.

105/DR/006-1
Description: 2.5 Y 8/4 "pale yellow"
20cmx17cmx11cm packstone/wackestone, composed mainly of medium sand-size benthonic and planktonic forams. Other components include echinoids, unidentified grains, bryozoans, pebble-size bivalve shells (recrystallised), gastropods, brachiopods, and pteropods. Vugs are filled by modern muddy sediment. No intergranular cement is apparent. Intergranular spaces are filled by consolidated lime mud.

105/DR/006-2
Description: 10 YR 7/2 - 3 "light grey - very pale brown"
Packstone, medium to very coarse sand size, composed of benthonic forams, planktonic forams and bryozoans. The gravel is composed of pebble-size bryozoans. Vugs as large as 1cm occur, presumably borings, while intergranular spaces are filled by lime mud.

105/DR/006-3
Description: 10 YR 8/3 "very pale brown"
11cmx11cmx8cm packstone/grainstone. Medium sand-size benthonic and planktonic forams, bryozoans, mollusc shells, solitary corals and echinoids. Larger forams appear to be *Lepidocyclina*. The grainstone is very friable. The planktonic forams should be sufficiently abundant for age determination. Sparry cement is identified filling intergranular pores.

105/DR/006-4
Description: 2.5 Y 7/6 "yellow" with surface of 10 YR 4/4 "dark yellowish brown"
20cmx17cmx11cm packstone/grainstone. Medium sand size benthonic and planktonic forams, bryozoans, molluscan shells and echinoids. Grainstone is very friable.

105/DR/007
Description: Coral boulders - some coated by living coral. Limestone boulders. Large crinoids (?), and some living rhodoliths, 1-5cm in diam.

105/DR/007-1
Description: Rhodolith rudstone - 21cmx12cmx10cm. Rhodoliths are 5-30mm diam., with a maximum of 8cm; they tend to be oval in shape and have well developed concentric structure. The rhodoliths show grain to grain contact. The matrix is composed of coarse to very coarse bioclastics forming a grainstone/packstone. Many of the platey corals present appear to be *Montipora* sp.; *Goniopora* spp. are also present.

105/DR/007-2
Description: Porous and bored algal wackestone/mudstone. The algal layer is thick - 25mm. The mudstone matrix is composed of silt- to very fine sand-size particles with some some bivalves and gastropods.

105/DR/007-3
Description: Algal wackestone to mudstone. Rhodolith: 0 1.5cm, irregular shape, solitary coral? Some algal layers. Worm tube 8mm. Large foram - 15mm. Matrix is silt to very fine size bioclasts.

105/DR/007-4
Description: Platey coral boulder with worm tubes, and living surface. Worm tube borings are common.

105/DR/007-5
Description: Crinoids (?). Branch is about 10mm in diameter, 23cm high, and surface is red in colour, maybe coated by living coralline algae. Coral limestone with black thick (5mm) manganese (?) coating.

105/DR/008
Description: Coral boulders - many coralgal limestone, living *Halimeda* - light green leaf - 1cmx1cm to 2cmx3cm; about 1.5mm thick.

105/DR/008-3
Description: 10cmx12cmx5cm, coral-algal boundstone, with encrusting coralline algae; shell fragment on one section. Surface is coated by living red coralline algae.

105/DR/008-4
Description: Coral-algal limestone; fossiliferous wackestone with many vugs. Fossils: shell fragment, gastropods, and others.

105/DR/009-1
Description: 5Y 6/1 "light grey to grey"
Muddy sand to sandy mud. Sand grains consist of mainly of bioclasts which are made up of shell fragments, Dentalium fragments, pteropod spicules, bryozoans, gastropods and bivalves. The mud fraction consists of lime mud.

105/DR/009-2
Description: Sieved sample (>2mm)
Branching bryozoans (20%), bivalves (20%,) manganese coated limestone gravel (5%), sponges (5%), gastropods (5%), echinoids (10%), coral (octocoral, stony coral) (10%), pteropods (10%), solitary corals (5%) and benthonic foraminifera (trace).

105/DR/009-3
Description: 5Y 2/2 "black" (Manganese) - 5Y 3/2 "dark reddish brown"
Wackestone with Miliolidae, Bryozoa, and unidentified grains. Difficult to describe, very dense, hard.

105/DR/009-4
Description: 3cmx3cmx1.5cm, coral fragment with grainstone.

105/DR/009-5
Description: 4cmx3cmx1cm, packstone with unidentifiable grains.

105/DR/009-6
Description: Rock fragment with coral.

105/DR/009-8
Description: 5cmx5cmx2cm, as DR/009-3.

105/DR/009-9
Description: 3cmx4cmx1.5cm, bryozoans with very coarse packstone.

105/DR/009-10
Description: 3.5cmx4cmx1.5cm, manganese coated breccia.

105/DR/009-11
Description: 5Y 8/2 "white"
2cmx1cmx1cm aggregate of planktonic and benthonic forams.

105/DR/010-1
Description: 10Y 8/2
35cmx20cmx10cm fossiliferous grainstone to packstone with coralline algae; dense, hard, well consolidated, well cemented, and partly not cemented. Fossil component 1-4mm, well sorted, with coralline algae, shell fragments, gastropods, and others.

105/DR/010-2
Description: 10YR 7/4 "very pale brown"
12cmx23cmx14cm rhodolith-large foram packstone/wackestone, partly grainstone; Dense, hard, well consolidated, and well cemented. Rhodoliths are 5-30mm diam., with concentric texture well developed. Large foraminifera are approximately 5-10mm in length, mostly *Lepidocyclina* and *Operculina* (?). Other fossils are bivalve fragments. Matrix is a lime mudstone.

105/DR/010-3
Description: 14cmx10cmx3cm. Algal grainstone/packstone. Sieved sample consists of coral (?) 55%, rock fragments 30%, bivalves 6%, solitary coral 3%, pteropods 3%, others 3%.

105/DR/010-5
Description: 7.5YR 4/4
3cmx2cmx2cm brown mudstone with unknown tightly packed and hard microfossils.

105/DR/010-6
Description: 14cmx8cmx5cm manganese encrusted rock fragments of coarse to very coarse grainsize. Grains consist of calcareous material including shell fragments, spicules, bryozoans, and others. The matrix is a black manganese material, with the inner part a dark red 2.5YR 3/6.

105/DR/011
Description: Limestone boulders, coated by encrusting coralline algae on one side, suggesting a rocky sea bottom. The other side is sparsely coated by bryozoans and worm tubes. Many of the boulders are rhodolith limestones, with the rhodoliths being some 2-7cm diam., and some having corals as nuclei. The fine granule to very coarse sand is almost 100% carbonate, consisting of the skeletons of benthonic foraminifera, bryozoans, echinoids, soft coral spicules, and gastropods. Many of the grains are not identifiable. Living species, on the surface of the boulders, include gorgonians, starfish and sponges. The seived samples include 60% limestone pebbles and granules (20% algal coated rhodoliths, 40% limestone gravels), 10% branching bryozoans , 10% pelecypods, 5% gastropods, plus trace amounts of the remains of echinoids, crustaceans, solitary coral, and barnacles.

105/DR/011-5
Description: 10YR 5/6 "yellowish brown"
Algal coated boundstone consisting of encrusting coralline algae binding calcareous sediments. Matrix consists of very fine to fine sand size calcareous material with a few shell fragments.

105/DR/011-6
Description: 70cmx40cmx12cm rhodolith rudstone (not cut). Aggregates of rhodoliths, from 1-6cm in diameter, with fragments of bivalves, bryozoans, worm tubes, barnacles, and coralline algae incorporated One side is coated by living red coralline algae. The matrix is a friable very coarse granule-sized grainstone. The grain component consists of bivalves, echinoid.spicules, bryozoans and others.

105/DR/011-7
Description: 10YR 6/4 "light yellowish brown"
35cmx25cmx10cm rhodolith rudstone/floatstone. One side is coated by living red coralline algae. The rhodoliths are 7-40mm in diameter, and consist of coral and shell fragments as nuclei. The outer concentric layer is from 3 to 5mm thick. The other grain components of the rock consist of bivalve fragments. The matrix consists of a friable coarse to very coarse grainstone.

105/DR/011-8
Description: 10YR 5/6 "yellowish brown"
25cmx23cmx13cm coral floatstone, consisting of a large *Goniopora* sp (?), approx. 20cmx12cmx12cm in size, with numerous sponge and bivalve borings. Matrix consists of a dense, fossiliferous packstone/wackestone.

105/DR/011-9
Description: 2.5Y 7/6 "yellow"
20cmx20cmx15cm vuggy algal boundstone with dense wackestone matrix. A large shell fragment (about 3cm in diameter) is bonded to the rock by coralline algae.

105/DR/011-11
Description: 10YR 6/4 to 6/6 "light yellowish brown to brownish yellow"
Rhodolith floatstone, consisting of rhodoliths of approximately 5 to 25mm in diameter, with a concentric layer of coralline algae and a core of shell fragments and echinoids. Other grains include bivalves, echinoids, bryozoans, sponges, worm tubes, solitary coral and others. Matrix varies from a coarse to very coarse grainstone to a tight fine to medium packstone/wackestone. The grainstone part is porous and friable, and makes up the majority of the matrix.

105/DR/012
Description: 5Y 4/2 "olive grey" (sand sample only)
Consists of fine to medium sand as follows: 80% fine to medium sand, 15% coarse to very coarse sand, and 5% gravel (60% carbonate and 40% quartz). The fine to medium sand consists mainly of bioclastics with a small amount of quartz, and lithic fragments. Bioclastics include, shell fragments, bryozoans, pteropod spicules, echinoid spines and planktonic forams. The quartz grains are well sorted, subangular to subrounded and are clear. Lithic fragments are dark grey to black grains, composed of of two types: (i) well rounded black shale or slate, and (ii) sub angular to angular grains with an irregular shape and rough surface. The coarse to very coarse sand is almost 100% bioclastics which includes bivalves, gastropods, bryozoans, worm tubes, and others.The 5% gravel fraction consists of 70% bivalves, 20% lithic fragments, 5% gastropods, 3% serpulids, and 2% others, including bryozoans, echinoids, Dentalium etc .

105/DR/013
Description: Sandy limestone and carbonate cemented calcareous sandstone boulders are common. Oyster shell fragments common, and a few bivalve shells.

105/DR/013-1
Description: 10YR 7/4 "very pale brown"
20cmx10cmx5cm medium-coarse grainstone/packstone to medium-coarse carbonate cemented calcareous sandstone with some parallel lamination. The grains are composed of 60% bioclastics and 40% quartz ; well sorted, and partly cemented. The bioclastics include shell fragments, echinoids spines and unidentified grains. The quartz appears subrounded, clear, and well sorted. The matrix, where it exists, consists of a white lime mud. Some white laminations, <1mm to 2mm thick are traceable components. A lot of barnacles are present on the surface of the sample.

105/DR/013-2
Description: 10YR 6/6 - 6/3 "brownish yellow to pale brown"
20cmx18cmx6cm medium sandy packstone/grainstone to medium carbonate cemented calcareous sandstone, with grains composed of 60% bioclastics and 40% quartz. The bioclastics consist of shell fragments, benthonic forams, and other unidentified grains. The quartz grains are subangular to subrounded and clear. There is a trace of black lithic fragments. The rare matrix consists of white lime mud. The rock is fairly well cemented, mainly by calcite in the form of dense fringing cements and equant spar fills. The rock is vuggy, in that there are horizontally disposed vugs about 5-12 mm high and several centimetres wide, which appear to have been formed as a result of washout of uncemented sediment.

105/DR/013-3
Description: 10YR 6/3 "pale brown"
20cmx18cmx12cm fine to medium carbonate cemented calcareous sandstone with some large shell and lithic fragments. The sandstone consists of 60% quartz and 40% bioclastics. The composition of the bioclastics and the type of quartz are similar to the previous sample. There are several large shell fragments, about 10mm in length and 1mm thick. Three lithic, grey to dark grey rock fragments were observed. These 1 to 4mm sized grains appear to be predominantly quartzose.

105/DR/013-4
Description: 2.5Y 8/2 "white"
28cmx15cmx6cm fragment of a platey coral with encrusting coralline algae and barnacles encrusting the upper surface, whereas the lower surface is stained brown. The coral has been bored by worms and bivalves, the latter excavating cavities of the order of 2.5x1.5cm.

105/DR/013-5
Description: 4cm long by 2.5cm high, branching bryozoan with dark red (7.5R 3/8) encrusting forams about 1 to 3mm high present on the surface.

105/DR/013-6
Description: Oyster shell fragments around 5-10cm, max. 15cm.

105/DR/013-7
Description: Carbonate cemented calcareous sandstone fragments.

105/DR/013-8
Description: Bivalve and echinoid fragments.

105/DR/013 - Sand fraction from pipe dredge
Description: 5Y 5/3 "olive"
Coarse to very coarse sand with bioclastic gravel. 80% coarse sand, 15% very coarse sand and 5% gravel. 80% carbonate, 20% quartz. The coarse sand fraction consists of about 30% quartz that is well sorted and subangular to subrounded. 80% of the quartz is clear, the rest is brown stained. The remaining bioclastics (70%) consist of shell fragments, echinoid spines, benthonic forams and others. The very coarse sand fraction consists almost exclusively of bioclastics, mainly shell fragments, echinoids, bryozoans and barnacles. The gravel fraction contains 50% bryozoans, 30% bivalves, 12% rock fragments, 3% forams, 3% gastropods, 2% others.

105/DR/014
Description: Abundant carbonate-cemented calcareous sandstone boulders, many of which are platey, as if they were thinly cemented layers. A quantity of unconsolidated sediment was sieved.

105/DR/014-1
Description: 5Y 6/3 "pale olive" to 10YR 6/2 "light brownish grey"
11cmx10cmx3cm fine to medium, carbonate-cemented calcareous sandstone with black stained surface. The sandstone is 30% carbonate and 70% quartz. The quartz is well sorted, subrounded to rounded and clear. Some black lithic particles are present in the non-carbonate fraction. The bioclasts consist of abraded shell fragments and other unidentifiable grains. The sparse matrix appears to be lime mud. The rock is friably cemented.

105/DR/014-2
Description: 10YR 6/6 "brownish yellow"
28cmx28cmx10cm dense, hard calcareous sandstone with some borings by bivalves and sponges. The sandstone is 40% carbonate and 60% quartz, with the more dominant quartz grains being well sorted, subangular to subrounded, and mainly clear, but with some iron oxide coated grains. Bioclasts consist of abraded shell fragments and other unidentifiable grains. There is virtually no matrix, but the rock is well cemented by what appear to be isopachous fringes of sparry calcite cement around and connecting grains, sometimes forming meniscus cement, whereas some intergranular pores are filled with coarse sparry calcite cement.

105/DR/014-3
Description: 5Y 5/4 "olive" to 7.5YR 5/6 "strong brown"
One side of this 20cmx20cmx0.8cm platey calcareous sandstone is partly stained black, whereas the other side is brown and oxidised. The sandstone is 30% carbonate and 70% quartz, the latter consisting of subangular to subrounded, well sorted grains with some grey lithic fragments. The bioclasts are unidentifiable in hand specimen. The rock is well cemented with isopachous fringing and coarse sparry calcite cements.

105/DR/014-4 to -8
Description: Platey carbonate-cemented calcareous sandstones with some boring and encrustation.

105/DR/014 - Sand fraction from pipe dredge
Description: 5Y 5/2 "olive grey"
Medium to coarse carbonate sand with 60% medium sand and 40% coarse to very coarse sand. The sample is 70% carbonate and 30% quartz and lithic fragments. The medium sand fraction is composed of 50% bioclastics and 50% quartz. The bioclasts include shell fragments, echinoid spines, benthonic foraminifera and unidentified grains. The quartz is subangular to subrounded, well sorted and clear. The coarse to very coarse sand is mainly bioclastics, but with some lithic fragments. The bioclasts include bivalves, gastropods, echinoids, benthonic foraminifera and bryozoans. Some grains are black in colour. The lithic fragments appear to be grey, rounded siltstone.

105/DR/015
Description: Large shell fragments with a few encrusting coralline algae, and limestone boulders with a few encrusting coralline algae. A sand fraction was sieved.

105/DR/015-1
Description: 5Y 8/1 "white" and 7.5R 2/4 "very dusty red"
Sample size approximately 18cmx11cmx5cm. Coral fragment with barnacles, coated by red living coralline algae, with some boring.

105/DR/015-2
Description: 5Y 7/3 "pale yellow" to 5Y 6/3 "pale olive"
Sample consists of rhodoliths with coral fragments with encrusting coralline algae. The vuggy coral fragments are bored by bivalves. Most of the outer part consists of a thin layer of coralline algae 0.5mm thick, while the surface is coated by living red coralline algae, with barnacles and worm tubes.

105/DR/015-3
Description: 5Y 8/1 "white" to 5Y 6/1 "light grey"
Sample size is approximately 8cmx6cmx2cm, and is a rhodolith, The sample is layered, thick on one side 15mm with the surface coated by encrusting coralline algae, barnacles, and worm tubes.

105/DR/015-4
Description: This sample consists of a shell fragment, and is approximately 10cmx8cmx4cm in size, with encrusting coralline algae. It is violet in colour with most of the outer part showing a thin layer of encrusting coralline algae 1-3mm in thickness. Fine to medium bioclastic packstone to wackestone, with the surface coated by living coralline algae with barnacles and worm tubes.

105/DR/015-5
Description: Large shell fragments, and aggregates. Three large shells recognised, each about 10cm in diameter.

105/DR/015-6
Description: 5Y 5/3 "olive"
Large shell fragments, each approximately 5cm to 10cm in diameter, and most of them coated by living coralline algae. This sample includes sand fraction consisting of medium 60% with bioclastics including shell fragments, bryozoans and unidentified grains. The quartz is moderately sorted, sub rounded to rounded grains with a few (10%) brown stained grains. The 40% very coarse sand fraction (plus >2mm sieved fraction) consists mainly of bioclastics, including shell fragments, bivalves, bryozoans, echinoids, coralline algal fragments.

105/DR/016
Description: 5Y 5/3 "olive"
Sandy sample consisting of 5% coarse to very coarse sand which is almost 100% bioclastic including shell fragments in abundance, pteropod fragments are common, rare bryozoan and echinoids spines, and trace planktonic forams. The >2mm fraction consists of the following: 18% echinoid plates, 15% gastropods, 15% bivalves, 15% rock fragments (rounded), 10% pteropods, 8% forams, 15% algal encrusted pebbles and 4% others. The 80% fine sand fraction is composed mainly of bioclastics, with a small amount of quartz (well sorted, subangular and clear in colour), and includes the following: planktonic forams, shell fragments, rare echinoid spines, pteropod fragments and unidentified grains. The 15% mud fraction is a uniform, calcareous material with trace black particles. The sand fraction consists of 90% carbonate and 10% quartz.

105/DR/017
Description: 10YR 6/4 "light yellowish brown"
This sample is 80% carbonate and 20% quartz and it includes algal encrusted coral and sandstone boulders and living coral, together with algal encrusted shell fragments and algal encrusted pebble- to cobble- size material. The coarse sand consists mainly of bioclastics with a few quartz grains; the bioclastics include shell fragments, echinoids, bryozoans, and others. The quartz is well sorted and subrounded to rounded and is clear in colour. The very coarse sand is almost 100% bioclastics, including shell fragments, bivalves, gastropods, echinoids, bryozoans, and others. The 5% gravel fraction (>2mm) consists of the following: algal encrusted grains 35%, bivalves 30%,

sandstone fragments 15%, forams 10%, corals 10%, bryozoans 3%, gastropods 3%, others 4%.

105/DR/017-1
Description: 10YR 6/4 "light yellowish brown"
Sandstone boulder with white encrusting algae and white platey coral. The algal encrusted and carbonate cemented sandstone is hard and well consolidated, and relatively clean. The sand is composed of 80% quartz and 20% bioclastics, and is subangular to subrounded. The grains are clear, with large black lithic fragments (5%) and also unidentified bioclasts. The matrix consists of a porous, but well cemented lime mudstone, with most grains in contact with each other.

105/DR/017-2
Description: 10YR 5/6 "yellowish brown"
Algal and barnacle encrusted fine to medium carbonate cemented sandstone. The sandstone is composed of 80% quartz and 20% bioclastics, with a trace of lithic fragments The grains are well sorted, subangular to subrounded and clear. The bioclastics include subrounded and well sorted unidentified grains. The lithic fragments include black, angular to subangular siltstone.

105/DR/017-3
Description: 10YR 6/4 "light yellowish brown"
A conglomerate of fine to medium carbonate cemented sandstone pebbles, coated by white encrusting algae less than 1mm thick. The sample is hard, well consolidated, with the grains being 85 to 90% quartz, and 10% to 20% bioclastics. The quartz is subangular to subrounded, clear and moderately well sorted. The bioclasts are mainly unidentified grains. The matrix is a white, well cemented lime mudstone, with isopachous fringing cements.

105/DR/017-4
Description: Medium-grained carbonate cemented sandstone, 30cmx15cmx8cm in size, encrusted by both thin layers of living and dead coralline algae. The sandstone is hard and well consolidated, with hint of bedding. The grains consist of 80% quartz and 20% bioclastics ,with trace lithic fragments. The quartz is subangular to subrounded and moderately well sorted and clear. The bioclasts include mainly unidentified grains, which are moderately sorted and subrounded. The lithic fragments are black dark, and angular to subangular. Isopachous fringing cements form bridges at grain contacts, but some intergranular pores remain cement free.

105/DR/018
Description: 10Y 7/4 "very pale brown"
This dredge recovered 40% algal limestone boulders, some of which are encrusted by red living coralline algae; 40% coral boulders, which are in some cases encrusted by red living coralline algae; and 20% rhodoliths, which are red in colour. The sand fraction consists of 80% coarse sand and 20% very coarse sand. The sample is 100% carbonate. The coarse sand fraction is poorly sorted, angular to subrounded in shape, and the bioclasts include shell fragments, benthonic foraminifera, and unidentified grains. The very coarse sand is poorly sorted, angular to rounded in shape, and includes bivalves, gastropods, benthonic foraminifera, rounded brown carbonate fragments, echinoids and unidentified grains. The >2mm (seived) fraction includes limestone granules, rhodoliths, coral fragments, molluscan shells, echinoids and benthonic foraminifera.

105/DR/018-1
Description: Approximately 25 specimens of rhodoliths, approximately 30-70mm in diameter. Most of them are encrusted by red (5R 3/6 "dark red") living coralline algae. The surface is relatively smooth and concentric layering can be observed in section.

105/DR/018-2
Description: 2.5Y 8/2 "white"
Rhodolith rudstone sample, approximately 18cmx18cmx9cm in size. This sample is covered by a 10-25mm white, concentric layering. The matrix is a fine to medium packstone to wackestone.

105/DR/018-3
Description: 2.5Y 8/4 "pale yellow" to 2.5Y 7/2 "light grey"
Coral-algal boundstone approximately 33cmx22cmx9cm, very hard, dense with some boring. Platey corals, 3-10mm thick, form alternative layers, intercalated with the encrusting coralline algae.

105/DR/019
Description: 10Y 7/3 "very pale brown"
30% medium sand, 65% coarse to very coarse sand, 5% gravel. The sample is 100% carbonate. The medium sand fraction is moderately sorted and subangular to rounded in shape. The bioclastics include shell fragments and unidentified grains. The coarse to very coarse sand consists of poorly sorted, angular to rounded grains, and includes shell fragments, benthonic foraminifera, echinoids, rounded carbonate grains and unidentified grains. The >2mm (seived) fraction includes rhodoliths (some with small pinnacles on their surface), limestone granules, benthonic forams, and a trace bryozoans and echinoids.

105/DR/019-1
Description: Rhodolith limestone boulder of approximate 30cmx18cmx10cm dimension. Part of the limestone is grainstone to packstone in texture. The rhodoliths are 1-2cm diam., show concentric structure in section, and their surfaces are bored and sometimes encrusted by bryozoans. One sample has an echinoid nucleus. The grainstone/packstones matrix consists of medium sand to granule bioclastic grains, which are very poorly sorted. The bioclasts include algal fragments, benthonic foraminifera, shell fragments, echinoids, coral fragments and bryozoans.

105/DR/019-2
Description: Rhodolith, approximately 9cmx8cmx5cm in dimension. Dense outermost coating is bored and filled with internal material. The rhodolith has a 5cmx1.5cm coral as a nucleus.

105/DR/019-4
Description: 10Y 5/6 "yellowish brown"
Sample is a limestone boulder, which is coated by non-living coralline algae, approximately 23cmx13cmx7cm in size, and is highly bored . The matrix consists of a packstone of very fine- to medium-sand size bioclastic grains.

105/DR/019-5
Description: A cobble boundstone sample with worm tubes, which is coated by coralline algae. The sample is approximately 11cmx10cmx6cm in dimension. Some part of the cobble surface is coated by coralline algae. The rhodolith and limestone granules are trapped, and other parts are entirely filled by purple coloured soft material.

105/DR/019-20
Description: Grainstone with submarine cementation as observed by thin section.

105/DR/020
Description: 10YR 7/4 "very pale brown"
This sample consists of 10% limestone, 25% coral cobble/boulder with 60% rhodoliths, pebble to cobble in size, and 5% of molluscan shells, barnacles, and *Halimeda*. The sand fraction is almost 100% carbonate with trace quartz grains. It is

medium to very coarse, poorly sorted sand, with arenaceous foraminifera, shell fragments, echinoid spines, coral fragments, soft coral spines, and bryozoans. The >2mm (seived) fraction includes rhodoliths, rounded limestone fragments, large benthonic forams and echinoids.

105/DR/020-5
Description: 10YR 6/6 brownish yellow" to 10YR 5/6 "yellowish brown"
A limestone fragment with a surface coated by almost dead coralline algae, and orange coloured bryozoans.

105/DR/020-10
Description: 8cmx8cmx7cm rhodolith. It appears that this particular example has grown to a size where only its upper surface is now being encrusted (in other words it has become immobile). This is apparent from outer layers only growing on one side and soft algae and barnacles being attached to the same side, but not the other.

105/DR/021
Description: The sample is made up of boulder, cobble, and sand fractions and one side of each gravel fragment is covered by red algae. The boulders are coral blocks, algal encrusted limestone, *Millepora* and encrusting algae. The cobbles are algal crust limestone, corals, rhodoliths. The sand fraction consists of 50% quartz and 50% carbonates, and is a moderately sorted medium sand. The carbonates are planktonic foraminifera, benthonic foraminifera, molluscan shell fragments, bryozoans, echinoids, pteropod fragments, and other unidentified bioclastics. The >2mm(seived) fraction includes limestone fragments, molluscan shells, benthonic foraminifera, bryozoans, echinoid, pteropod, solitary coral, rare rhodoliths and *Halimeda.*

105/DR/023
Description: Sample consists of algal limestone boulders, and cobbles, sand fraction and seived >2mm sample. Most of the boulders and cobbles are encrusted by red living coralline algae.

105/DR/023-1
Description: 10YR 6/8 "brownish yellow" 10YR 5/6 "yellowish brown" and 2.5Y 8/2 "white"
16cmx12cmx5cm algal boundstone. Two generations of algal growth are observed. The boundary between the two generations is very sharp. The surface of the sample is partly coated by red living algae.

105/DR/023-2
Description: 10YR 8/3 to 7/6 "very pale brown to yellow"
30cmx25cmx20cm algal boundstone (algal stromatolite). Coated by red living coralline algae, white encrusting algal layering approximately 10mm thick, diagenetic alteration grey and dense. Algal layering with interlayered porosity abundant. Each layer less than 1mm thick. Two algal growing generations are observed. The algal layering of the older generation is very pale brown to yellow. It is partly effected by diagenetic alteration. This part is grey, dense and very hard. The algal layering of newer generations are white and 10mm thick. The surface is encrusted by red living coralline algae.

105/DR/023-3
Description: An algal boundstone (algal stromatolite) of 35cmx20cmx12cm dimension. The grey part is dense, hard and algal layering is faint. The pale yellow to grey part has obvious algal layering which is less than 1mm to 2mm thick with porosity between the layers. The yellowish brown part is tight and composed of internal sediment. The white part seems more fresh than other parts, and has obvious algal layering.

105/DR/023-4
Description: 10YR 5/6 "yellowish brown"
The sample is 10cmx7cmx6cm in dimension and consists of coarse, porous, consolidated, but friable, bioclastic grainstone with some shell fragments. The grains are poorly sorted, angular to subrounded, and most grains are brown stained. It includes shell fragments, benthonic foraminifera, planktonic foraminifera, echinoids, rounded carbonate grains, and unidentified grains. It has no matrix, and little cement, only at grain contacts. Porosity is both intergranular and intragranular. The texture is grain supported, and clean. The sand fraction (2.5Y 5/4 "light olive brown") is coarse to very coarse, with 20% medium sand, 80% coarse to very coarse sand, and it is 90% carbonate. The medium sand is 85% bioclastics and 15% quartz, which is poorly sorted. The bioclasts are angular to subrounded, with brown stained grains, and include shell fragments, benthonic foraminifera, planktonic foraminifera and unidentified grains. The quartz is subangular to subrounded, and clear in colour. The coarse to very coarse sand is almost 100% bioclastics and is poorly sorted, angular to rounded, and 40% brown stained carbonate grains, as well as shell fragments, benthonic foraminifera, echinoids, coralline algae, and unidentified grains. The >2mm fraction consists of 28% branching coral , 20% bivalves, 12% bryozoans, 12% gastropods, 8% echinoids, 8% rhodoliths, 5% *Halimeda*, 3% rock fragments, 2% foraminifera and 2% others.

105/VC/003
Description: 10YR 4/3 "dark brown)"; little recovery except for 3cc of sediment at core bottom.
Gravelly sand (sand 70% - gravel 30%) (carbonate 35% - quartz 65%) The sand is well sorted medium sand composed of subrounded quartz (90%) and carbonate (5%), composed of benthonic forams, unknown, lithics (tr) and black grains.
The gravel fraction is composed of abraded carbonate grains, including benthonic forams, algal fragments and unidentified fragments.

105/VC/016
Description: 5Y 5/2 "olive grey"
This sample was dredged by the vibrocorer frame, and consists of 5% gravel and 95% sand. The sand fraction includes 30% quartz, 20% lithics and glauconite and 50% carbonate. The gravel fraction includes 80% sandstone pebbles, 15% molluscan shells and trace amounts of Dentalium, bryozoans and solitary corals.

105/GC/015
Description: 5Y 6/4 "pale olive" to 10YR 5/4 "light yellowish mottled brown"
This sample was collected from the outer side of the core bomb and represents the surface of the sea floor. The sample consists of a clayey mud; 95% mud, 5% of a very fine bioclastic sand, composed of shell fragments, benthonic forams, spines, planktonic forams (8-10%) with black particles 5%.

105/GC/018
Description: 7.5YR 5/4 "brown" to 10YR 5/4 "yellowish brown"
Consists of limestone fragments from the base of the core (core catcher sample). This locality might have the same sea bottom condition as 105/DR/011. Some parts of the limestone are coated by red coralline algae and worm tubes. The limestone is a packstone, consisting of benthonic forams, mollusc shells and coralline algae. The attached sediment consists of bryozoans, fragments of solitary coral and mollusc shells.

Table 1. Seismic way points in Area 1 on the continental margin to the east of Noosa Heads

1	26°20.0'S	153°08.5'E	Complete turn
2	26°20.0'S	153°09.5'E	Start line 105/1 (090°)
3	26°20.0'S	153°57.5'E	Start turn
4	26°21.0'S	153°57.1'E	Complete turn
5	26°20.0'S	153°56.5'E	Start line 105/2 (±331°)
6	26°14.0'S	153°52.9'E	Start turn
7	26°15.0'S	153°54.5'E	Complete turn
8	26°15.0'S	153°53.5'E	Start line 105/3 (270°)
9	26°15.0'S	153°23.0'E	Start turn
10	26°14.0'S	153°24.0'E	Complete turn
11	26°15.0'S	153°24.0'E	Start line 105/4 (180°)
12	26°26.0'S	153°24.0'E	Start turn
13	26°25.0'S	153°23.0'E	Complete turn
14	26°25.0'S	153°24.0'E	Start line 105/5 (090°)
15	26°25.0'S	153°54.5'E	Start turn
16	26°24.0'S	153°53.9'E	Complete turn
17	26°25.0'S	153°53.5'E	Start tie line (±200°)
18	26°31.0'S	153°51.1'E	Start turn
19	26°30.0'S	153°52.5'E	Complete turn
20	26°30.0'S	153°51.5'E	Start line 105/6 (270°)
21	26°30.0'S	153°21.0'E	Start turn
22	26°29.0'S	153°21.8'E	Complete turn
23	26°30.0'S	153°22.0'E	Start line 105/7 (±171°)
24	26°36.0'S	153°23.2'E	Start turn
25	26°35.0'S	153°22.0'E	Complete turn
26	26°35.0'S	153°23.0'E	Start line 105/8 (090°)
27	26°35.0'S	153°46.5'E	Start turn
28	26°37.0'S	153°46.5'E	Complete turn
29	26°37.0'S	153°45.5'E	Start line 105/9 (270°)

Table 2. Correlation of seismic sequences off Noosa Heads

SECTION 105/01	SECTION 105/05	SECTION 105/06	SECTION 105/08	SECTION 105/09	SECTION 105/10
Sequence 1 parallel onlapping reflectors	Sequence 1 parallel reflectors, prograding & onlapping	Sequence 1 alternating seaward prograding & onlapping	Sequence 1 parallel onlapping reflectors	Sequence 1 parallel reflectors, probably composite prograding & onlapping	Sequence 1 parallel reflectors, blanketing sequence
Sequence 2 onlapping, downlapping & prograding reflectors	Sequence 2 onlapping reflectors	Sequence 2 onlapping reflectors	Sequence 2 parallel onlapping reflectors		Sequence 2 parallel onlapping reflectors
Sequence 3 onlapping reflectors	Sequence 3 prograding reflectors		Sequence 3 parallel onlapping reflectors	Sequence 2 parallel reflectors	Sequence 3 parallel reflectors
	Sequence 4 prograding reflectors		Sequence 4 parallel prograding reflectors	Sequence 3 prograding reflectors	Sequence 4 parallel prograding reflectors
	Sequence 5 prograding reflectors				
Sequence 4 onlapping, downlapping & parallel reflectors	Sequence 6 prograding banks	Sequence 3 mounded, parallel, onlapping, & some prograding reflectors	Sequence 5 prograding, downlapping, & onlapping reflectors	Sequence 4 downlapping & prograding reflectors	Sequence 5 parallel reflectors in north, prograding reflectors in south
	Sequence 7 onlapping & prograding reflectors				
Sequence 5 downlapping & onlapping reflectors	Sequence 8 prograding banks				
Sequence 6 onlapping reflectors	Sequence 9 parallel prograding reflectors		Sequence 6 parallel, onlapping, downlapping, & mounded reflectors		Sequence 6 prograding reflectors in south
	Sequence 10 parallel prograding reflectors	Sequence 4 parallel onlapping reflectors	Sequence 7 onlapping reflectors		Sequence 7 prograding reflectors in south
	Sequence 11 parallel prograding reflectors				
		Sequence 5 cyclical onlapping & prograding reflectors	Sequence 8 onlapping, parallel, prograding, & mounded reflectors	Sequence 5 prograding reflectors	Sequence 8 prograding from south
			Sequence 9 onlapping & parallel reflectors	Sequence 6 parallel reflectors	Sequence 9 parallel reflectors
			Sequence 10 onlapping, parallel, prograding, & mounded reflectors	Sequence 7 onlapping parallel reflectors	Sequence 10 parallel reflectors, perhaps mounding?
		Sequence 6 prograding reflectors, thinning west	Sequence 11 prograding, downlapping, & onlapping, reflectors		Sequence 11 prograding from south
		Sequence 7 prograding & onlapping reflectors	Sequence 12 prograding reflectors	Sequence 8 prograding reflectors	Sequence 12 partly prograding, partly infilling basement relief

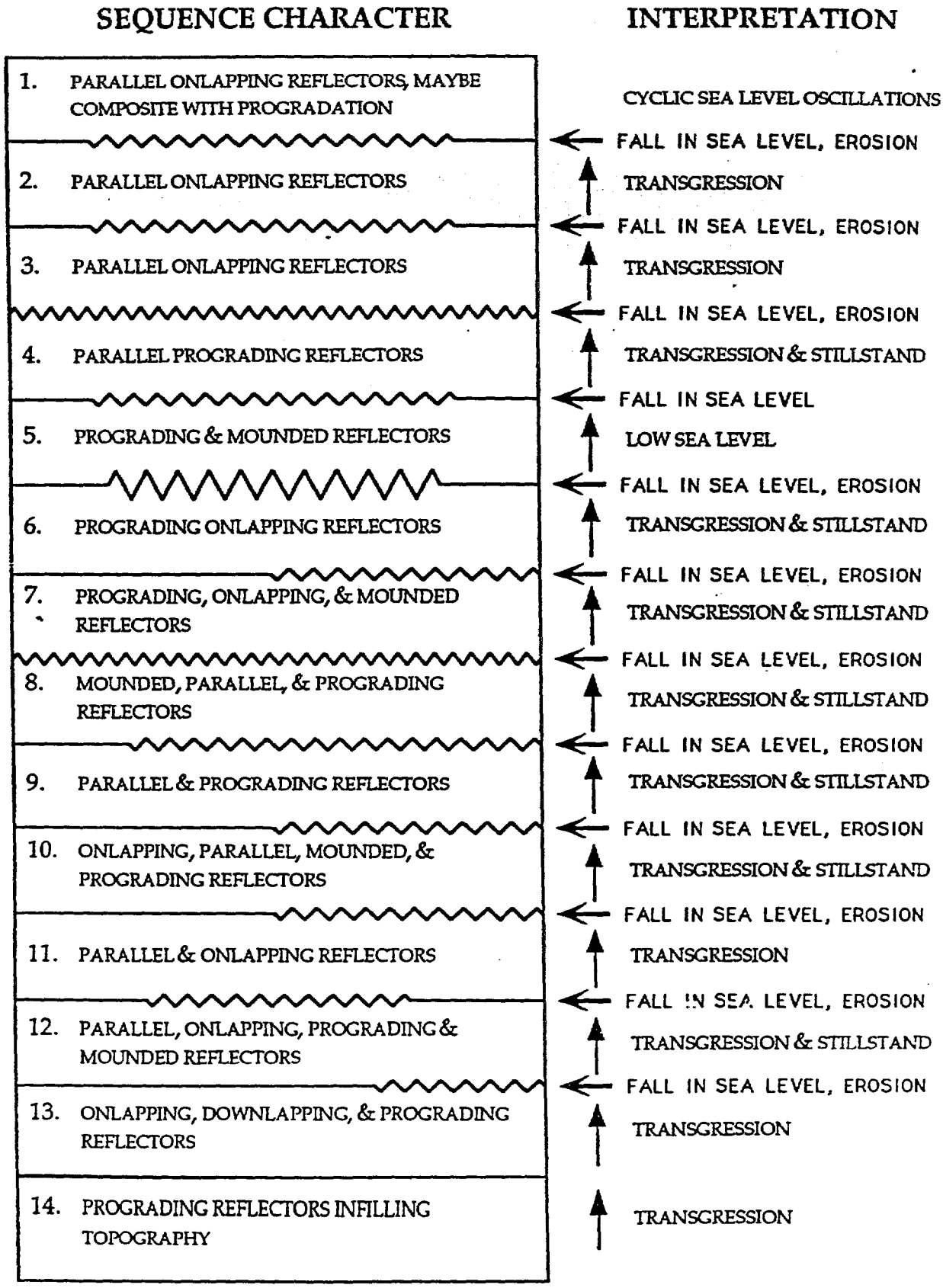


Table 3. Area 1 composite sequence stratigraphy and interpretation.
NOTE (i) Most sequence boundaries are somewhat conformable and somewhat erosional.
(ii) Only one sequence boundary is totally conformable in all sections, although a number may be conformable in one section.

Table 4. Age picks of samples from Area 1 off Noosa Heads

Sample No.	Age(10x3yrs) s.s.	Age(10x3yrs) s.l.	Core Length(cm)	Lithology	Water Depth(m)
Core Samples				dk olv clay w/bit vf sand	
GC014cc	390-240	390-0	620	dk olv clay	1475
GC015cc	around 3560	older than 3560	108	dk olv clay	1623
GC015top	3560-2750	3560-2750	108	dk olv clay	1623
GC017cc	240-0	240-0	127	vdk gy clay w/f. s.	252
GC017top	240-0	240-0	127	vdk gy clay only sl sandy	252
GC019cc	60-0	240-0	358	dk olv sl. sandy Md	347
GC019top	60-0	240-0	358	olv sl. sandy Md	347
GC020cc	60-0	240-0	386	vdk olv f. sandy Md.	355
GC021cc	60-0	240-0	344	dk gy only sl. sandy Md.	413
GC022cc	60-0	240-0	330	dk olv Md. w/vf. s.	621
GC023cc	60-0	240-0	338	dl olv clay w/only sl. vf. s.	842
GC024cc	60-0	240-0	285		1080
GC025cc	60-0	240-0	402	dk olv clay w/bit f. s.	1022
GC026cc	60-0	240-0	310	vdk olv clay w/bit vf. s.	719
GC027cc	60-0	240-0	296	vdk olv clay w/bit vf. s.	496
GC029cc	60-0	240-0	306	vdk olv clay w/bit f. s.	1020
GC030cc	60-0	240-0	525	olv clay w/sl f. s.	361
GC031cc	60-0	240-0	524	olv clay	311
GC032cc	60-0	240-0	517	olv clay w/only bit f. s.	356
VC006cc	240-0	240-0	267	olv muddy f. s.	222
VC006 60cm a/b	60-0	240-0	267	olv muddy f. s.	222
VC007cc	60-0	240-0	340	dk olv f. s.	205
VC010cc	390-0	390-0	56	olv m. s.	62
VC011cc	390-0	390-0	76	brn calc m. s.	52
VC012cc	60-0	240-0	132	muddy, dk olv f-m. s.	42
VC013cc	60-0	240-0	62	dk olv muddy vf-f. s.	54
VC014cc	240-60?	240-0	145	dk olv f-m. s.	185
VC015cc	240-60?	240-0	156	dk olv f-m. s., muddy	180
VC016cc	60-0	240-0	83	olv f-m. s.	136
VC017cc	60-0	240-0	72	dk olv c. s.	136
VC018cc	60-0	240-0	92	calc. grnl	118
VC019cc	60-0	240-0	59	olv m. s.	53
VC023cc	60-0	240-0	56	vdk gy c-vc. s.	99
VC024cc	240-60?	240-0	44	olv vc. c. w/ ab shell frag muddy	130
VC025cc	60-0	240-0	183	olv vf. s. sl muddy	127
Surface Samples					
DR012	60-0	240-0		olv m. s.	70
DR013	60-0	240-0		lt brn c. s.	60
DR014	60-0	240-0		gy vc. s.	66
DR015	60-0	240-0		brn shelly vc. s.	48
DR016	60-0	240-0		brn-lt olv f. s. w/ m-c. s. shell frag.	298
Rock Samples					
DR011-01	Barren	Barren		Mtx of Lst Pbl	
DR011-02	1660-0	1660-0		Mtx of Rh Lst Bld	
DR014-01	1660-0	Latest Pliocene-0		calc. Sst Cbl	66
DR014-02	No D. S.	No D. S.		a/a	66
DR014-05	No D. S.	No D. S.		a/a	66
DR014-06	390-0(390-240?)	1660-0		a/a	66
DR014-07	Barren	Barren		a/a	66

Table 5. Calcareous nannofossil assemblages and their relative abundance from core samples - Area 1

	Overall Abundance	Preservation	*Braarudosphaera bigelowii*	*Calcidiscus leptoporus*	*C. macintyrei*	*Ceratolithus cristatus*	*Coccolithus pelagicus*	*Crenalithus doronicoides*	*C. productus*	*Discoaster asymmetricus*	*D. brouweri*	*D. pentaradiatus*	*D. tamalis*	*D. tribrachiatus*	*Discolithina japonica*	*D. multipora*	*Emiliania huxleyi*	*Gephyrocapsa caribbeanica*	*G. oceanica*	*G. parallela*	G. spp. (small forms)	*Helicosphaera carteri*	*Pseudoemiliania lacunosa*	*Reticulofenestra pseudoumbilica*	*Rhabdosphaera clavigera*	*Scapholithus fossilis*	*Sphenolithus abies*	*S. moriformis*	*Umbilicosphaera* spp.
GC-014	C	G		VR				F										C	C	R	A	R			F				
GC-015-CC	C	GM	VR	R	R		VR	A		R	R				VR							R	R		R		VR		
GC-015-TOP	C	M		R	R		R	A	F		R	VR	VR	VR		R						R	R		R	VR			
GC-017-CC	F	MP		R				A									F	C	F	R	A	R			R				
GC-017-TOP	F	M		R				A	R								F	F	F	R	C								
GC-019-CC	C	G		R		VR		F							VR		A	F	R		F	VR				R			
GC-019-TOP	C	GM		F				C							VR		A	F	F		F				VR	VR			
GC-020	C	GM		F				F									A	F	F		C	F			R				
GC-021	C	GM		R				F							VR		A	F	F		F	R				R			
GC-022	C	GM		F				F								VR	A	R	R		F	R			VR	VR	vr		
GC-023	C	M		VR		VR		C								R	A	F	F		C	R			R	VR			
GC-024	C	G		F				C									A	F	F		F				F	VR			
GC-025	C	G		R				F									A	R	R		F	R			R	VR			
GC-026	C	G		R		VR		F							VR		A	R	R		F	R			VR	VR			
GC-027	C	G		R				F									A	F	F		F	R			VR	R			
GC-029	C	G		R			VR	C							VR		A	R	R		F	VR			VR	R			
GC-030	A	GM		F				C								VR	A	F	F		C	R			R	R			
GC-031	C	GM		F				C									A	F	R		F	VR			R	VR			
GC-032	C	GM		F				C							VR		A	F	R		F	VR			VR	R			
VC-006-CC	C	GM		R				A									C	F	F	R	C	R							
VC-006-60cm	C	G		R				C	R								A	R	F		F	VR			VR				
VC-007	F	M		R				C									A	F	R	R	F	VR			R				
VC-010	VR	MG		R			VR	A	VR								C	F	R		C	R		vr	VR	VR			VR
VC-011	VR	MP		R				A	R								C	R	R		F								VR
VC-012-CC	R	G		R				C									A	F	F	VR	C	R				VR			
VC-012-10cm	R	GM		VR		VR		C							VR		A	F	F	VR	C	R							
VC-012-58cm	VR	M		R				C	R								A	F	F		C	VR							
VC-012-TOP	VR	MG		VR				C							VR		A	F	F		C				VR				
VC-013	C	M		VR				C									A	F	F		C	R				VR			
VC-014-CC	R	M	VR	R				A									C	F	F		C	VR				R		vr	
VC-014-40cm	R	MG						C									A	F	C		F								
VC-014-80cm	R	G		R				C								VR	A	R	F		F	VR			VR	VR			
VC-014-TOP	R	G		F				C									A	F	F		F	R			VR	R			
VC-015-CC	R	M	VR	R				C	VR						VR		C	R	F		C	VR			R	R			VR
VC-015-25cm	R	M		F				C	R								A	R	F		F				VR	R			VR
VC-016	R	GM		VR				C									A	F	F		F	VR			VR	VR			
VC-017	R	M	VR	R				C									A	R	F		R	VR							
VC-018	R	G	VR	R				C									A	R	F		F	VR				R			
VC-019	R	MG		R				C									A	F	F	VR	F	VR				VR		vr	
VC-023	VR	G		R				F									A	R	F		F	R			VR	VR	vr		
VC-024	VR	MG		VR		VR		A									C	F	F		F	VR			VR	VR	vr		
VC-025	VR	M		R				C									A	F	F	VR	F	R			VR	R			

Table 6. Calcareous nannofossil assemblages and their relative abundance from rock samples - Area 1

	Overall Abundance	Preservation	*Braarudosphaera bigelowii*	*Calcidiscus leptoporus*	*C. macintyrei*	*Ceratolithus cristatus*	*Crenalithus doronicoides*	*C. productus*	*Discolithina japonica*	*D. multipora*	*Emiliania huxleyi*	*Gephyrocapsa caribbeanica*	*G. oceanica*	*G.* spp. (small forms)
DR-11-01	B													
DR-11-02	R	VP		x		x	x					x		x
DR-14-01	R	VP					x	x	cf	x		x		x
DR-14-02	R	VP		x	cf		x							
DR-14-05	R	VP		x			x	x			x			
DR-14-06	F	P					x					x	x	x
DR-14-07	B													

Table 7. Calcareous nannofossil assemblages and their relative abundance from dredge samples - Area 1

	Overall Abundance	Preservation	*Braarudosphaera bigelowii*	*Calcidiscus leptoporus*	*Ceratolithus cristatus*	*Crenalithus doronicoides*	*C. productus*	*Discolithina japonica*	*D. multipora*	*Emiliania huxleyi*	*Gephyrocapsa caribbeanica*	*G. oceanica*	*G.* spp. (small forms)	*Helicosphaera carteri*	*Rhabdosphaera clavigera*	*Scapholithus fossilis*
DR-012	VR	G		R		C				A	C	F	F	R		
DR-013	VR	M			cf	C			R	A	F	R	C	R		
DR-014	VR	M		R		C		R		A	F	R	F	R		
DR-015	VR	MG		VR		C	VR			A	F	F	F	VR	R	
DR-016	VR	M		R		C		VR		A	F	F	C	R	VR	VR

Table 8. Seismic way points in Area 2 on the continental margin to the east of Fraser Island.

Tie Lines

T1	26°37.0'S	153°39.0'E	Start line 105/10
T2	26°30.0'S	153°48.8'E	Start line 105/11
T3	26°20.0'S	153°50.5'E	Start line 105/12
T4	26°10.0'S	153°51.0'E	Start line 105/13
T5	25°20.0'S	153°44.0'E	Start line 105/14
T6	25°04.5'S	153°39.7'E	Start line 105/15
T7	24°48.0'S	153°31.5'E	Start line 105/16
T8	24°48.0'S	153°29.1'E	Start turn

Main lines

1	24°49.0'S	153°20.0'E	Complete turn
2	24°49.0'S	153°21.0'E	Start line 105/17 (090°)
3	24°49.0'S	153°41.0'E	Start turn
4	24°48.0'S	153°39.4'E	Complete turn
5	24°49.0'S	153°40.0'E	Start line 105/18 (±154°)
6	24°55.5'S	153°43.5'E	Start turn
7	24°54.5'S	153°44.0'E	Complete turn
8	24°54.5'S	153°43.0'E	Start line 105/19 (270°)
9	24°54.5'S	153°22.0'E	Start turn
10	24°53.5'S	153°22.7'E	Complete turn
11	24°54.5'S	153°23.0'E	Start line 105/20 (±169°)
12	25°00.5'S	153°24.3'E	Start turn
13	24°59.5'S	153°23.0'E	Complete turn
14	24°59.5'S	153°24.0'E	Start line 105/21 (090°)
15	24°59.5'S	153°46.0'E	Start turn
16	24°58.5'S	153°44.7'E	Complete turn
17	24°59.5'S	153°45.0'E	Start line 105/22 (±169°)
18	25°05.5'S	153°46.3'E	Start turn
19	25°04.5'S	153°47.0'E	Complete turn
20	25°04.5'S	153°46.0'E	Start line 105/23 (270°)
21	25°04.5'S	153°24.0'E	Start turn

22	25°03.5'S	153°24.7'E	Complete turn
23	25°04.5'S	153°25.0'E	Start line 105/24 (±169°)
24	25°10.5'S	153°26.3'E	Start turn
25	25°09.5'S	153°25.0'E	Complete turn
26	25°09.5'S	153°26.0'E	Start line 105/25 (090°)
27	25°09.5'S	153°47.0'E	Start turn
28	25°08.5'S	153°45.5'E	Complete turn
29	25°09.5'S	153°46.0'E	Start line 105/26 (±156°)
30	25°15.5'S	153°49.0'E	Start turn
31	25°14.5'S	153°49.5'E	Complete turn
32	25°14.5'S	153°48.5'E	Start line 105/27 (270°)
33	25°14.5'S	153°24.0'E	Start turn
34	25°13.5'S	153°24.7'E	Complete turn
35	25°14.5'S	153°25.0'E	Start line 105/28 (±169°)
36	25°21.0'S	153°26.3'E	Start turn
37	25°20.0'S	153°25.0'E	Complete turn
38	25°20.0'S	153°26.0'E	Start line 105/29 (090°)
39	25°20.0'S	153°51.0'E	End line 105/29

Table 9. Age picks of samples from Area 2 off Fraser Island

Sample No.	Age(10x3yrs) s.s.	Age(10x3yrs) s.l.	Core Length(cm)	Lithology	Water Depth(m)
Core Samples					
GC001	60-0	240-0	40	grnsh gry foram sandy clay w/s.	546
GC002-01	60-0	240-0	3	dk brn, muddy consolid c. s.	810
GC002-02	60-0	240-0	3	lt olv nanno ooze	810
GC003	830-390	1190-390	350	foram-nanno ooze grnsh gy	542
GC004	390-240	390-0	18	cemented lt brn m. s.	264
GC008bottom	older-3560	older-3560	35	wht grn gy, sandy mud	600
GC008-00	mixed flora	older-3560, 240-0	35	sandy mud	600
GC008-01	mixed flora	older-3560, 240-0	35	a/a	600
GC008-02	mixed flora	older-3560, 240-0	35	a/a	600
GC009cc	390-240	390-60	378	lt olv nanno ooze	818
GC010cc	ca4000-3560	older-3560	430	wht olv nanno ooze	1171
GC011cc	60-0	240-0	not core	brn gy f. s. poor mud	209
GC013cc	390-240	390-60	406	wht gy nanno ooze	1200
Surface Samples					
VC003	240-0	240-0		c sand	44
DR001	60-0	240-0		brn vc. s. w/shell frag.	80-100
DR005-10C5	240-0	240-0		mud filling cavity	400-100
DR009-00	60-0	240-0		olv mud sl sandy	271
DR010bulk	60-0	240-0		c sand	438
DR021-09B	60-0	240-0		mud in cavity of lst	ca 100
GS068	60-0	240-0		brn, f-m. s. sl muddy	215
GS069	60-0	240-0		ylw brn, muddy, c. s.	149
Rock Samples					
DR002-CN1	Barren			matrix of rhodolith lst	94
DR002-CN2	Barren			a/a	94
DR002-CN3	Barren			a/a	94
DR002-CN4	Barren			a/a	94
DR003	Barren			matrix of lst	300-800
DR005	Barren			matrix of lst	400-1000
DR005-CN1	Barren			a/a	400-1000
DR005-CN2	Barren			a/a	400-1000
DR005-CN3	Barren			a/a	400-1000
DR005-CN5	Barren			a/a	400-1000
DR006-01	Barren			matrix of lst	420
DR006-02	Barren			a/a	420
DR006-03	1660-0	16607-0		a/a	420
DR006-04	Barren			a/a	420
DR006-05	Barren			a/a	420
DR006-06	Barren			a/a	420
DR009-01	Barren			small lst pebble	271
DR010-01	Barren			rhodolith lst boulder	438
DR010-02	Barren			a/a	438
DR010-03	Barren			a/a	438
DR010-04	Barren			a/a	438
DR010-05	Barren			a/a	438
DR010-06	Barren			coralline algal lst boulder	438
DR010-07	Barren			a/a	438
DR010-08	Barren			a/a	438
DR010-09	Barren			a/a	438
DR010-10	Barren			a/a	438
DR010-11	Barren			a/a	438
DR010-12	Barren			a/a	438
DR010-13	Barren			a/a	438
DR021-11A-01	1660-0	1660-0		pst/wst mtrx of coral/algal lst	ca 100
DR021-11A-02	Barren			a/a	ca 100
DR021-11A-03	1660-0	1660-0		pst/wst mtrx of coral algal lst	ca 100
DR021-11B	Barren			a/a	ca 100
DR021-11C	Barren			a/a	ca 100
DR021-11D	Barren			a/a	ca 100
DR021-08	Barren			a/a	ca 100
DR021-09A	Barren			a/a	ca 100
DR021-10-01	Barren			a/a	ca 100
DR021-10-02	Barren			a/a	ca 100
DR021-10-03	Barren			a/a	ca 100
DR021-10-04	Barren			a/a	ca 100
DR021-22	Barren			a/a	ca 100
DR021-23	Barren			a/a	ca 100
DR023-02	Barren			mtx of algal Lst	ca 80
DR023-05	Barren			a/a	ca 80
GS071-01	Barren			gst part of lst	28
GS071-02	240-0	240-0		a/a	28

Table 10. Calcareous nannofossil assemblages and their relative abundance from gravity cores - Area 2

	Overall Abundance	Preservation	*Braarudosphaera bigelowii*	*Calcidiscus leptoporus*	*C. macintyrei*	*Ceratolithus cristatus*	*Coccolithus pelagicus*	*Crenalithus doronicoides*	*C. productus*	*Discoaster asymmetricus*	*D. brouweri*	*D. pentaradiatus*	*D. variabilis*	spp. *pp.*	*Discolithina japonica*	*D. multipora*	*Emiliania huxleyi*	*Gephyrocapsa caribbeanica*	*G. oceanica*	*G. parallela*	spp. (small forms)	*Helicosphaera carteri*	*Pseudoemiliania lacunosa*	*Reticulofenestra pseudoumbilica*	*Rhabdosphaera clavigera*	*Scapholithus fossilis*	*Sphenolithus abies*	*S. moriformis*	*Umbilicosphae* spp. *p.*
GC-001	A	G		F		VR		A							R		A	F	F		C	R			F	F		vr	
GC-002-01	F	MG		C				C	F								A	F	R	R	F				F	F			
GC-002-02	A	G	VR	R				C							VR		A	F	F	R	R	R			F	F			
GC-003	A	M		F				A							R			F	R	R	C	R	F						
GC-004	C	MP		F				A	F									C	VR		C	VR			F				
GC-008-BTM	C	MP		VR	VR		F		R					R	R							VR		R	R		A	C	VR
GC-008-00	F	M		R			R							VR		R		VR	R		R						C	R	
GC-008-01	C	GM		F		VR	R	F										F			A	R	R		R			F	
GC-008-02	C	M			R		F								R			F			C				R		A	F	
GC-009	A	G		VR				A							VR			F	R		A	VR			R				
GC-010	A	MG		R	R		R			R	R	VR	VR	C		R							R	A	R		A		
GC-013	A	G		R			VR	C							VR	VR		F	R	VR	A	R			R	R			

Table 11. Calcareous nannofossil assemblages and their relative abundance from dredge and grab samples - Area 2

	Overall Abundance	Preservation	*Braarudosphaera bigelowii*	*Calcidiscus leptoporus*	*Crenalithus doronicoides*	*Emiliania huxleyi*	*Gephyrocapsa caribbeanica*	*G. oceanica*	*G. parallela*	*G.* spp. (small forms)	*Helicosphaera carteri*	*Rhabdosphaera clavigera*	*Scapholithus fossilis*
GC-011	C	G		F	C	A		R	R	F			
VC-003	R	M		x	x	x		x		x			
GS-068	R	G		F	C	A	F	F		C	F	VR	
GS-069	R	G			C	A	R	F		F	R	R	
DR-001	VR	G	R	R	F	A	F	R		C			
DR-005-10C5	F	P		x		x	x			x			
DR-009-00	C	G			C	A	F	F	R	C		F	
DR-010-BULK	R	G			C	A	F	F	R	C		F	R
DR-021-09B	C	G		R	C	A	F	F		C	F	R	

Table 12. Calcareous nannofossil assemblages and their relative abundance from the rock matrix of dredge and grab samples - Area 2

	Overall Abundance	Preservation	*Braarudosphaera bigelowii*	*Calcidiscus leptoporus*	*Crenalithus doronicoides*	*C. productus*	*Emiliania huxleyi*	*Gephyrocapsa caribbeanica*	*G. oceanica*	*G.* spp. (small forms)
DR-002-CN1	B									
DR-002-CN2	B									
DR-002-CN3	B									
DR-002-CN4	B									
DR-003	B									
DR-005	B									
DR-005-CN1	B									
DR-005-CN2	B									
DR-005-CN3	B									
DR-005-CN5	B									
DR-006-01	B									
DR-006-02	B									
DR-006-03	VR	P			x	x		cf		x
DR-006-04	B									
DR-006-05	B									
DR-006-06	B									
DR-009-01	B									
DR-010-01	B									
DR-010-02	B									
DR-010-03	B									
DR-010-04	B									
DR-010-05	B									
DR-010-06	B									
DR-010-07	B									
DR-010-08	B									
DR-010-09	B									
DR-010-10	B									
DR-010-11	B									
DR-010-12	B									
DR-010-13	B									
DR-021-08	B									
DR-021-09A	B									
DR-021-10-01	B									
DR-021-10-02	B									
DR-021-10-03	B									
DR-021-10-04	B									
DR-021-11A-1	R	P		x	x	x		x		x
DR-021-11A-2	B									
DR-021-11A-3	VR	P			x	x		x		x
DR-021-11B	B									
DR-021-11C	B									
DR-021-11D	B									
DR-021-22	B									
DR-021-23	B									
DR-023-02	B									
DR-023-05	B									
GS-071-01	B									
GS-071-02	R	PM		R	C		A	F	R	F

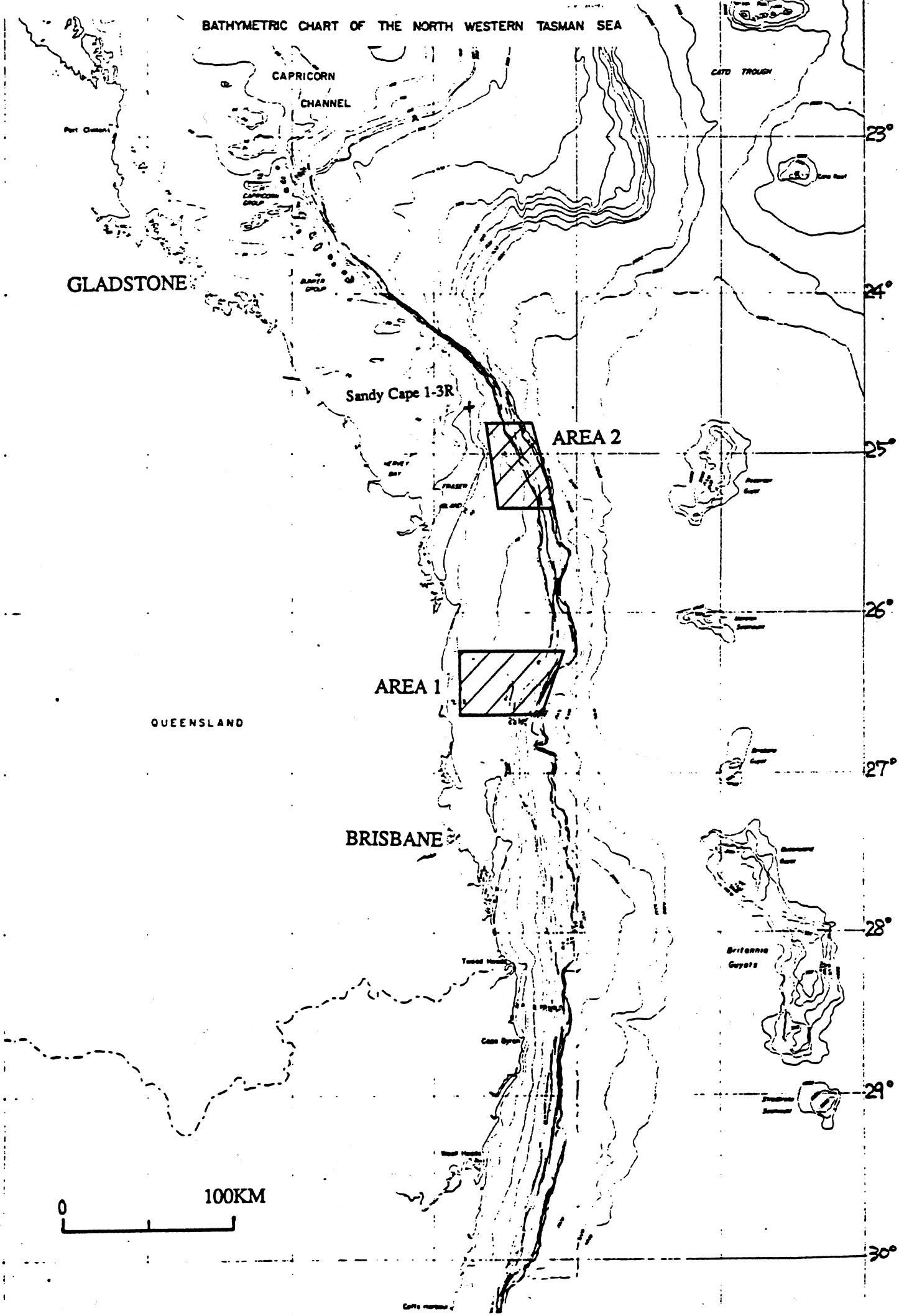


Figure 1. Bathymetry and position of the proposed study areas in southern Queensland.

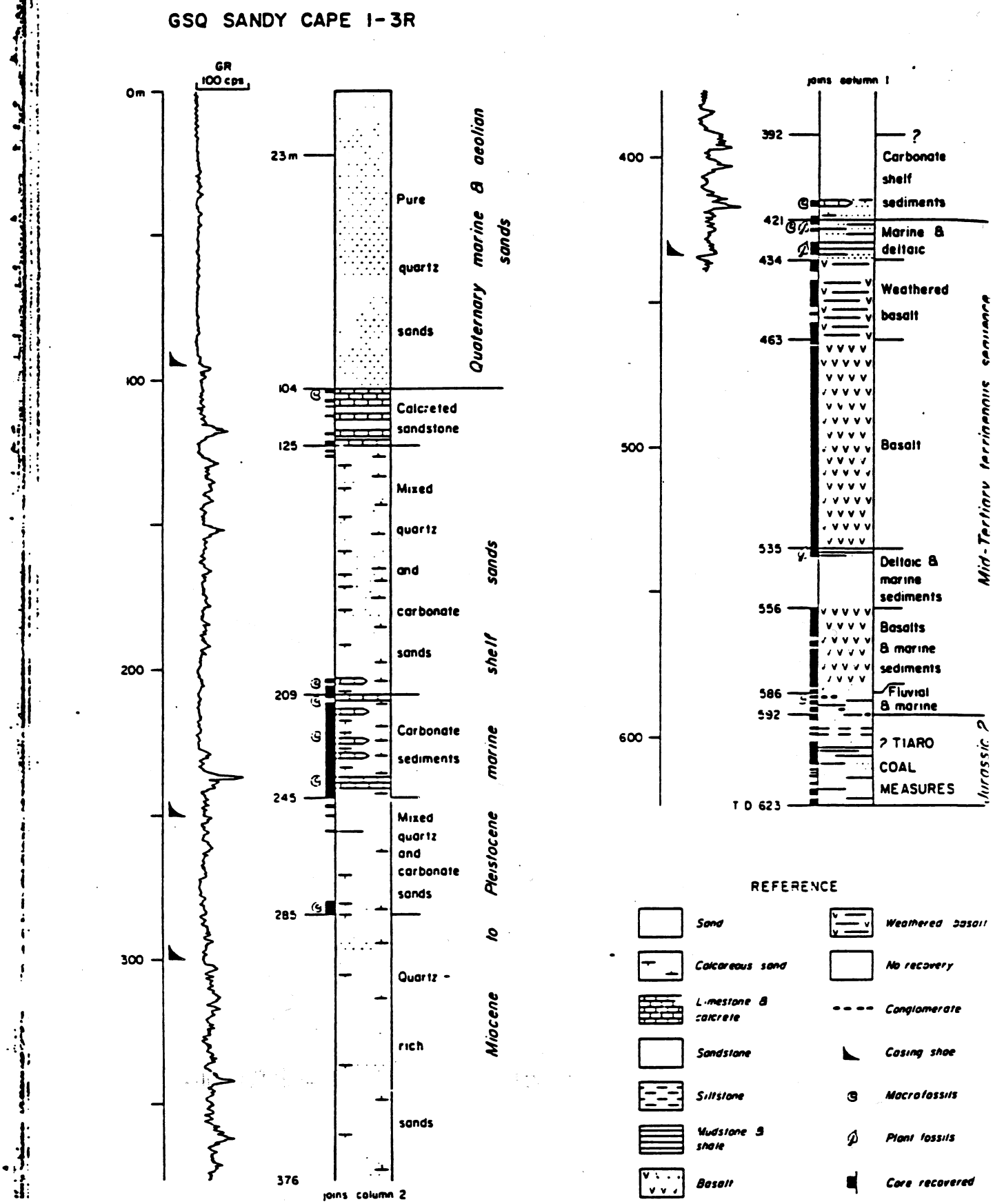


Figure 2. Survey drilling log for Sandy Cape 1-3R.

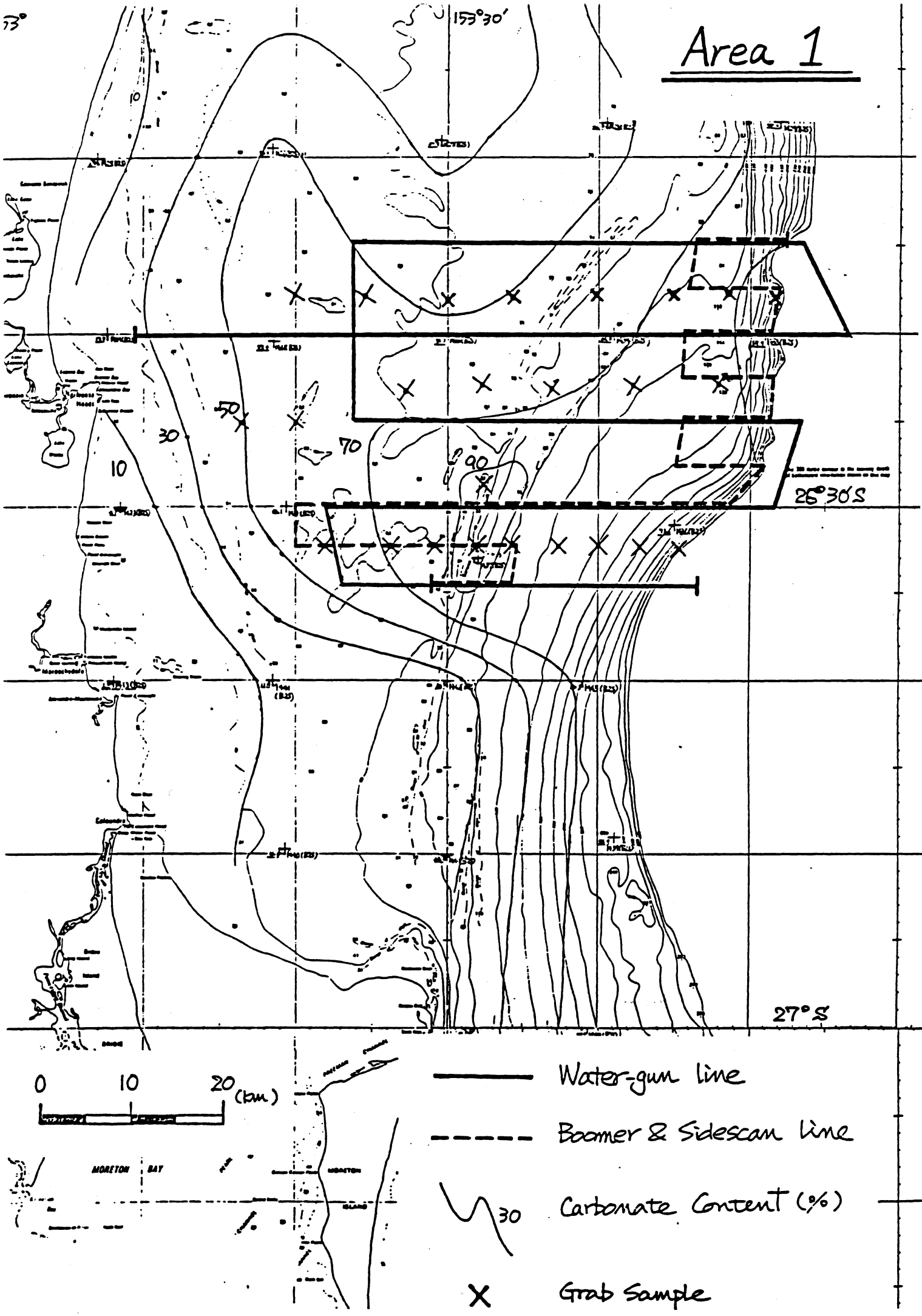


Figure 3. The position of study are No 1, and the proposed distribution of seismic

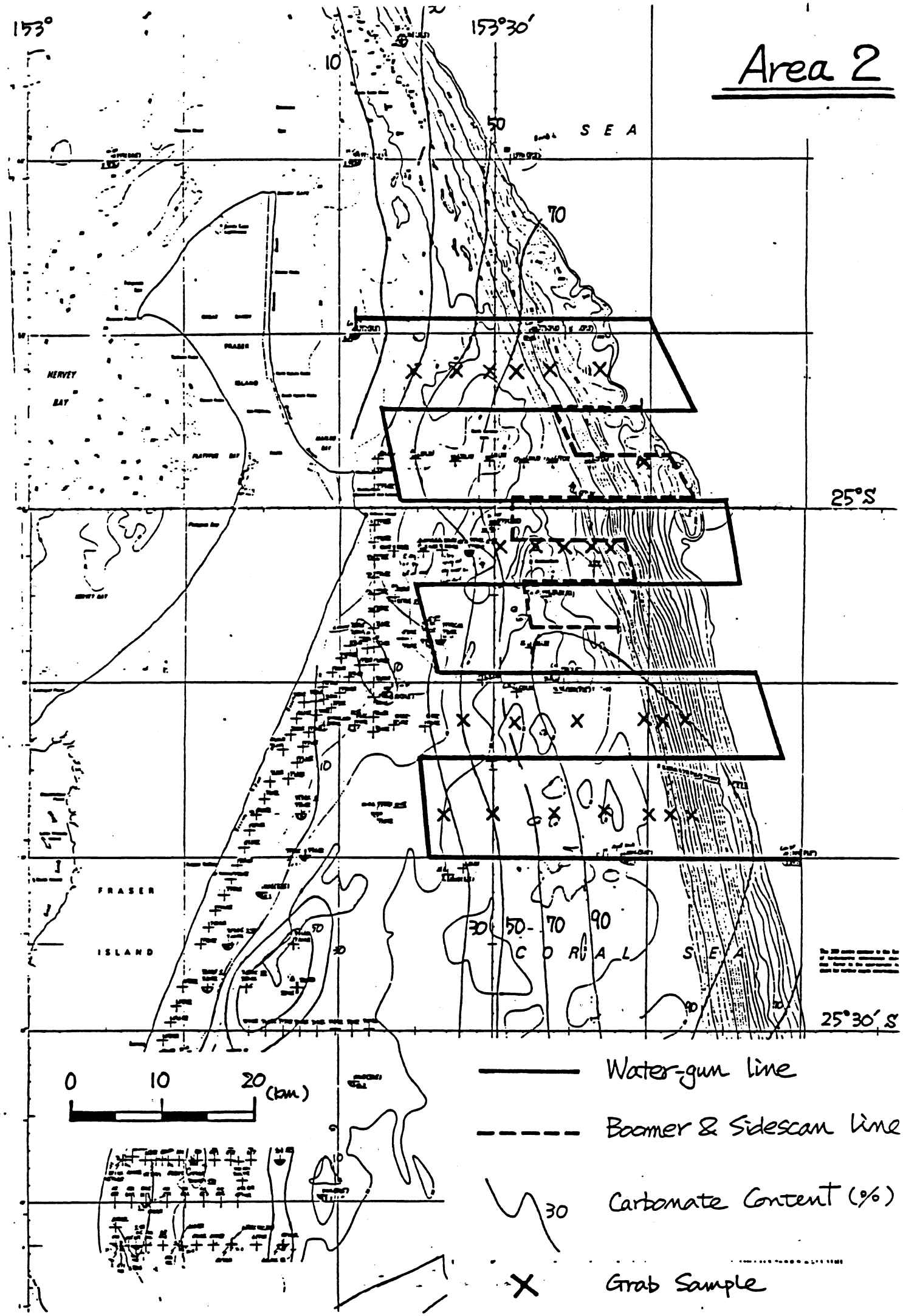
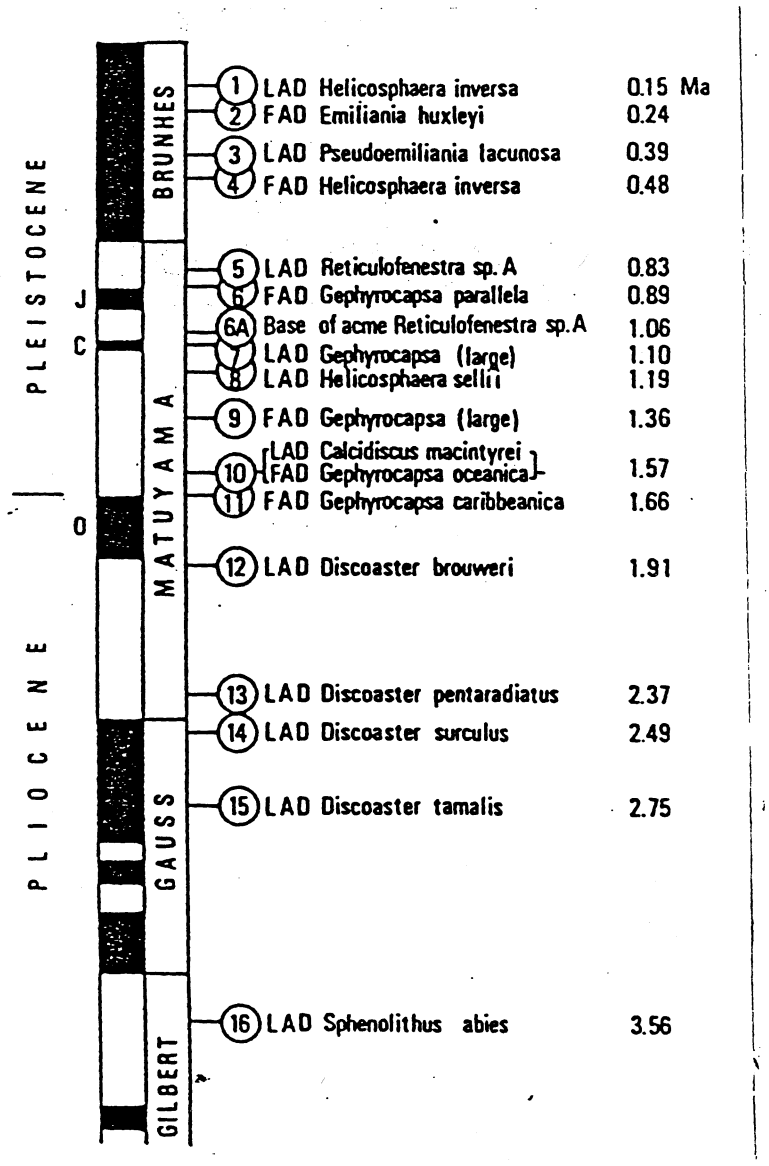


Figure 4. The position of study area No 2, and the proposed distribution of seismic



Age	Zone		Subzone	
Quaternary	CN15	Emiliania huxleyi		
	CN14	Gephyrocapsa oceanica	CN14b	Ceratolithus cristatus
			CN14a	Emiliania ovata
	CN13	Crenalithus doronicoides	CN13b	Gephyrocapsa caribbeanica
			CN13a	Emiliania annula
Pliocene	CN12	Discoaster brouweri	CN12d	Calcidiscus macintyrei
			CN12c	Discoaster pentaradiatus
			CN12b	Discoaster sulculus
			CN12a	Discoaster tamalis
	CN11	Reticulofenestra pseudoumbilica	CN11b	Discoaster asymmetricus
			CN11a	Sphenolithus neoabies
	CN10	Amaurolithus tricorniculatus	CN10c	Ceratolithus rugosus
			CN10b	Ceratolithus acutus
			CN10a	Triquetrorhabdulus rugosus

Figure 18. Correlation of nannofossil zones with the palaeomagnetic time scale (after Sato and Takayama, 1990) and nannofossil zonation of the Pliocene and Quaternary (after Okada and Bukry, 1980).

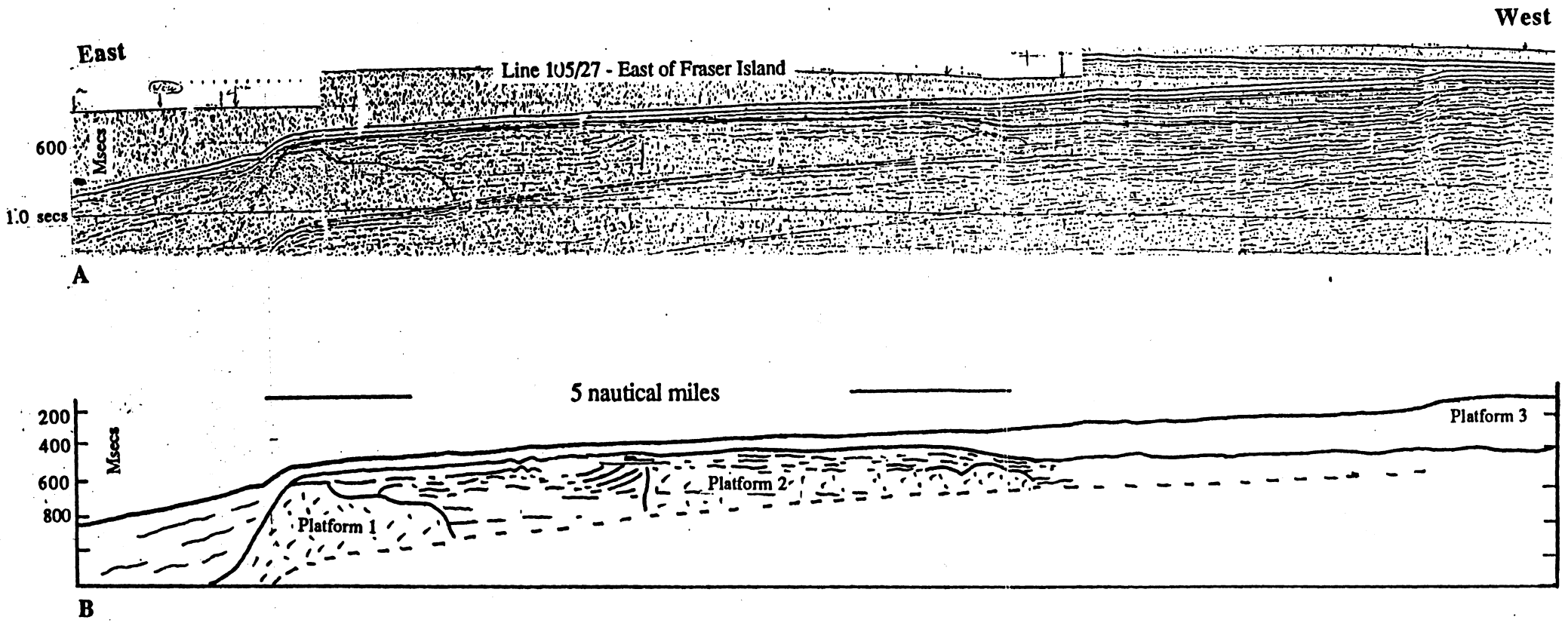
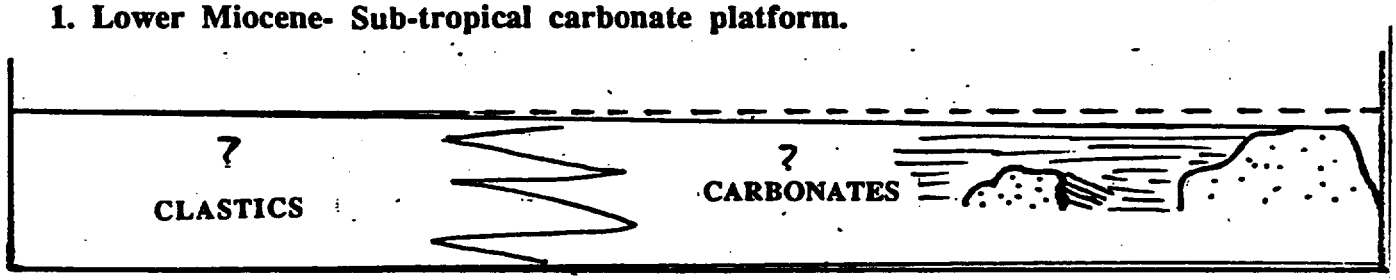


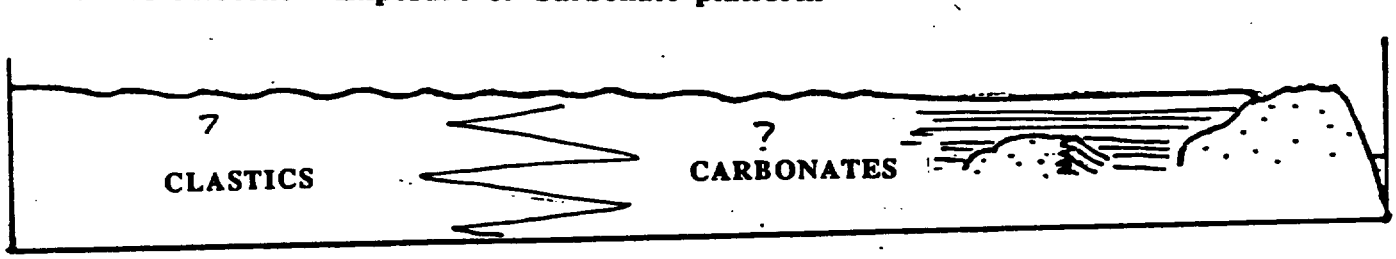
Figure 26 Seismic line 105/27 to the east of Fraser Island in southern Queensland and B. Line drawing of the same line showing the distribution of the major facies and particularly the three platforms.

Figure 27 Schematic development of the Fraser Island margin

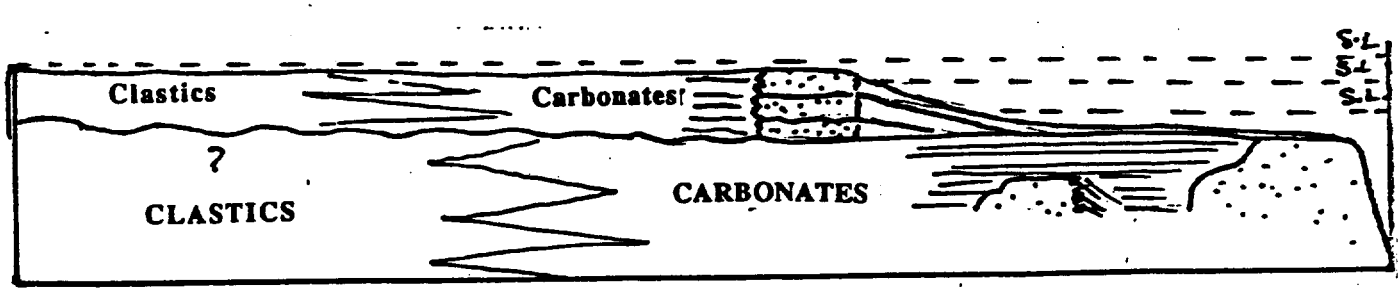
1. Lower Miocene- Sub-tropical carbonate platform.



2. Mid Miocene - Exposure of Carbonate platform



3. Development through a succession of sea level oscillations



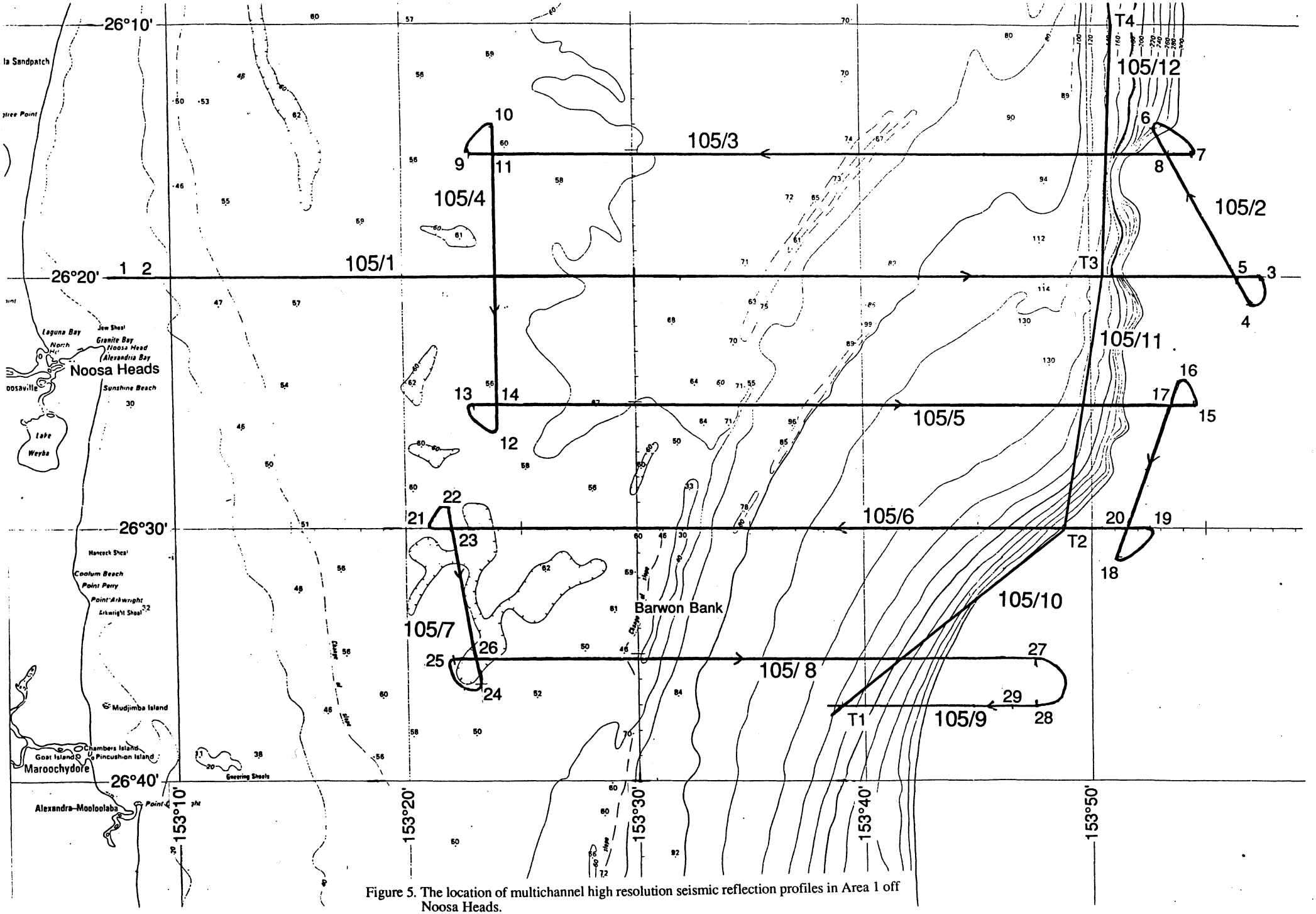


Figure 5. The location of multichannel high resolution seismic reflection profiles in Area 1 off Noosa Heads.

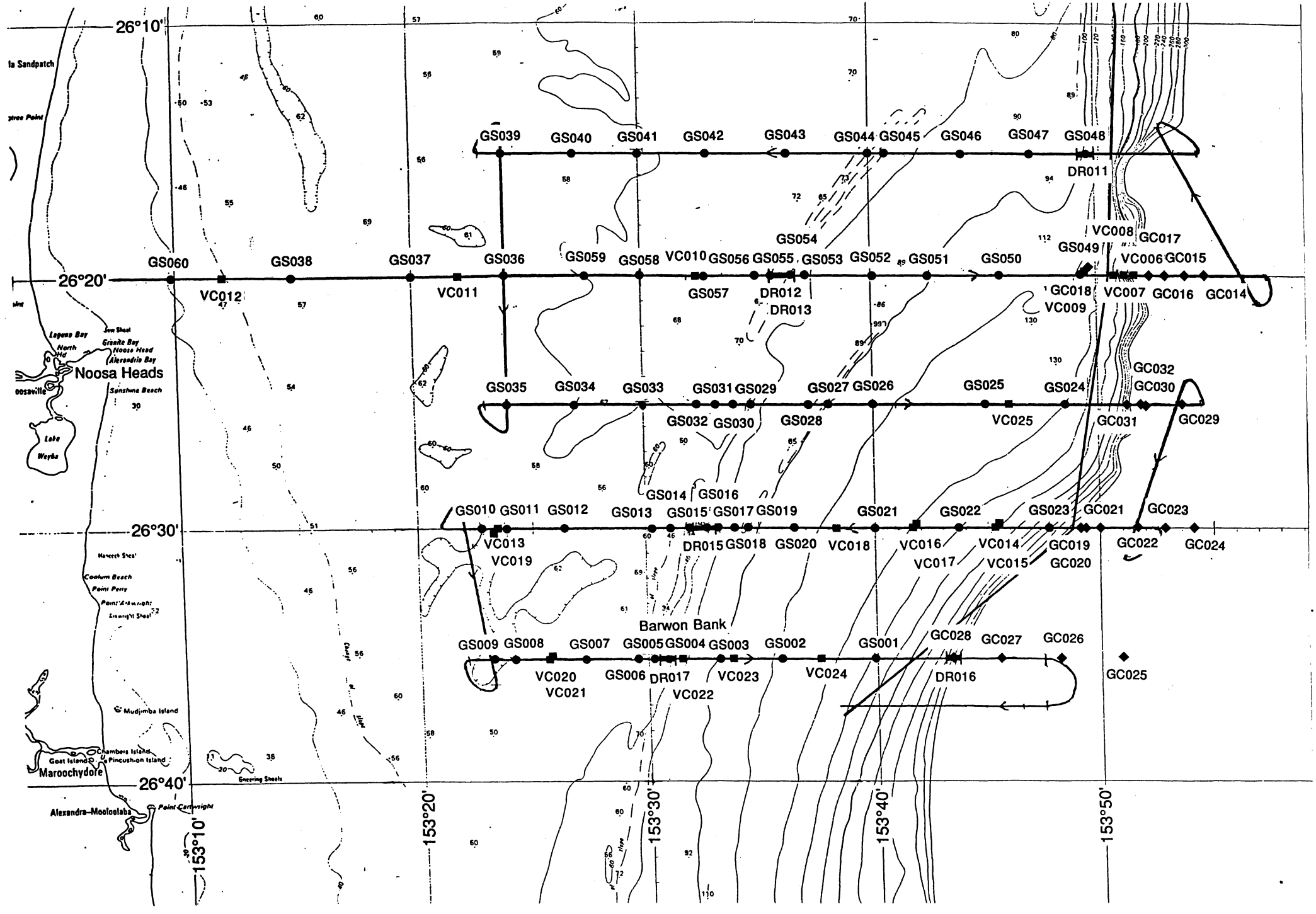


Figure 12. Location of sampling stations - Area 1

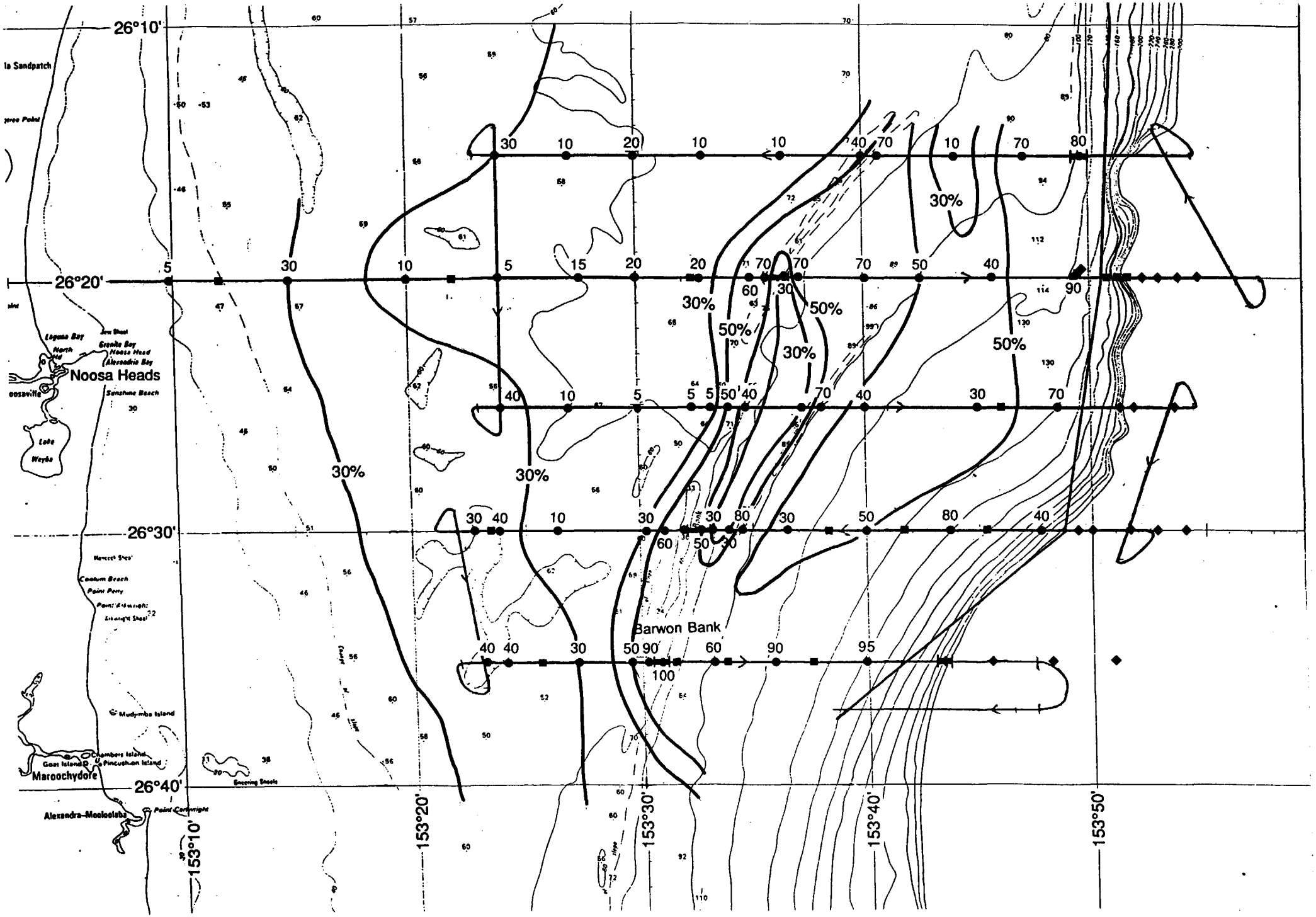


Figure 13. Estimated carbonate content of grab samples - Area 1

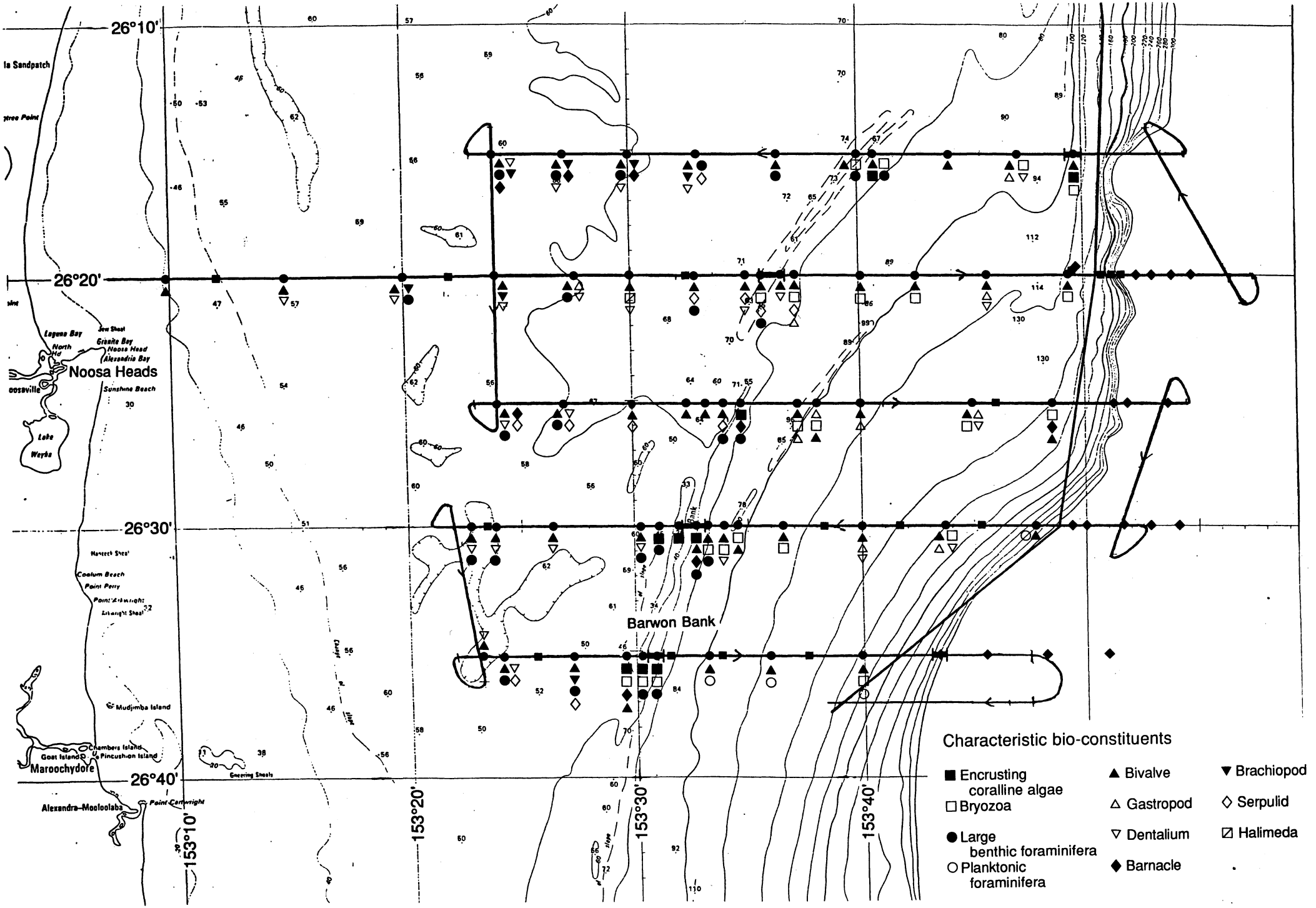


Figure 14. Characteristic bioconstituents of grab samples - Area 1

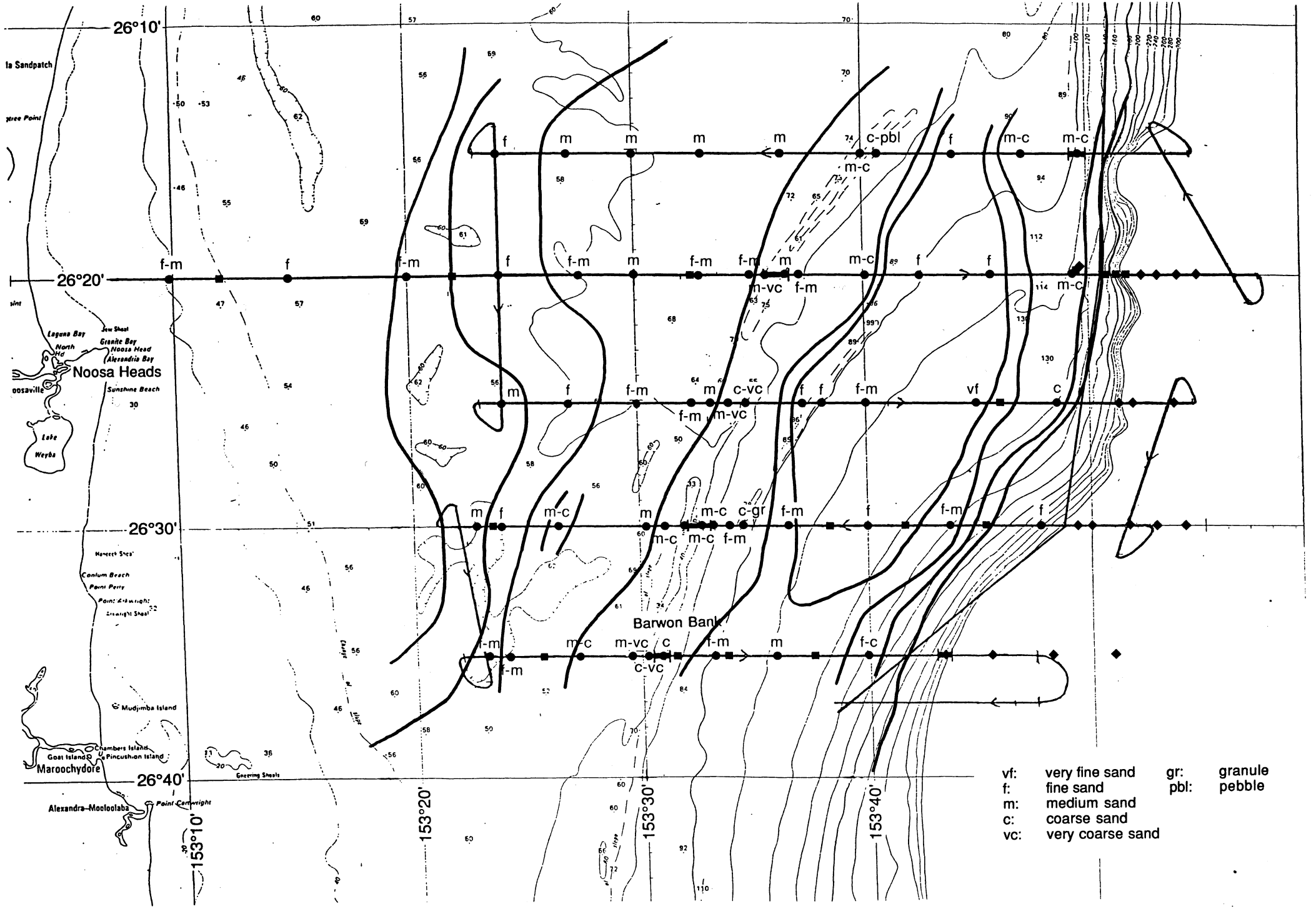


Figure 15. Grainsize distribution - Area 1

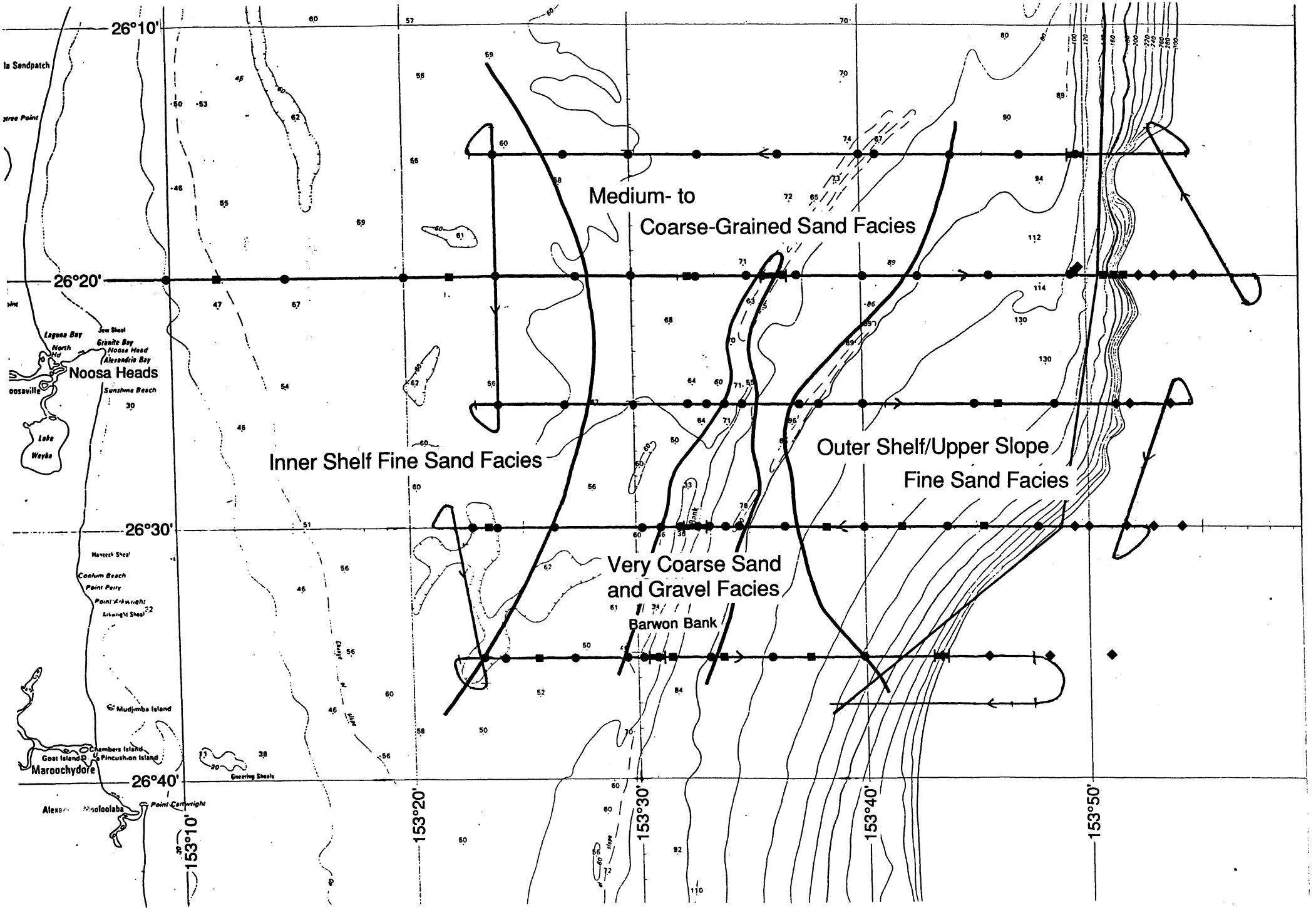


Figure 16. Facies distribution - Area 1

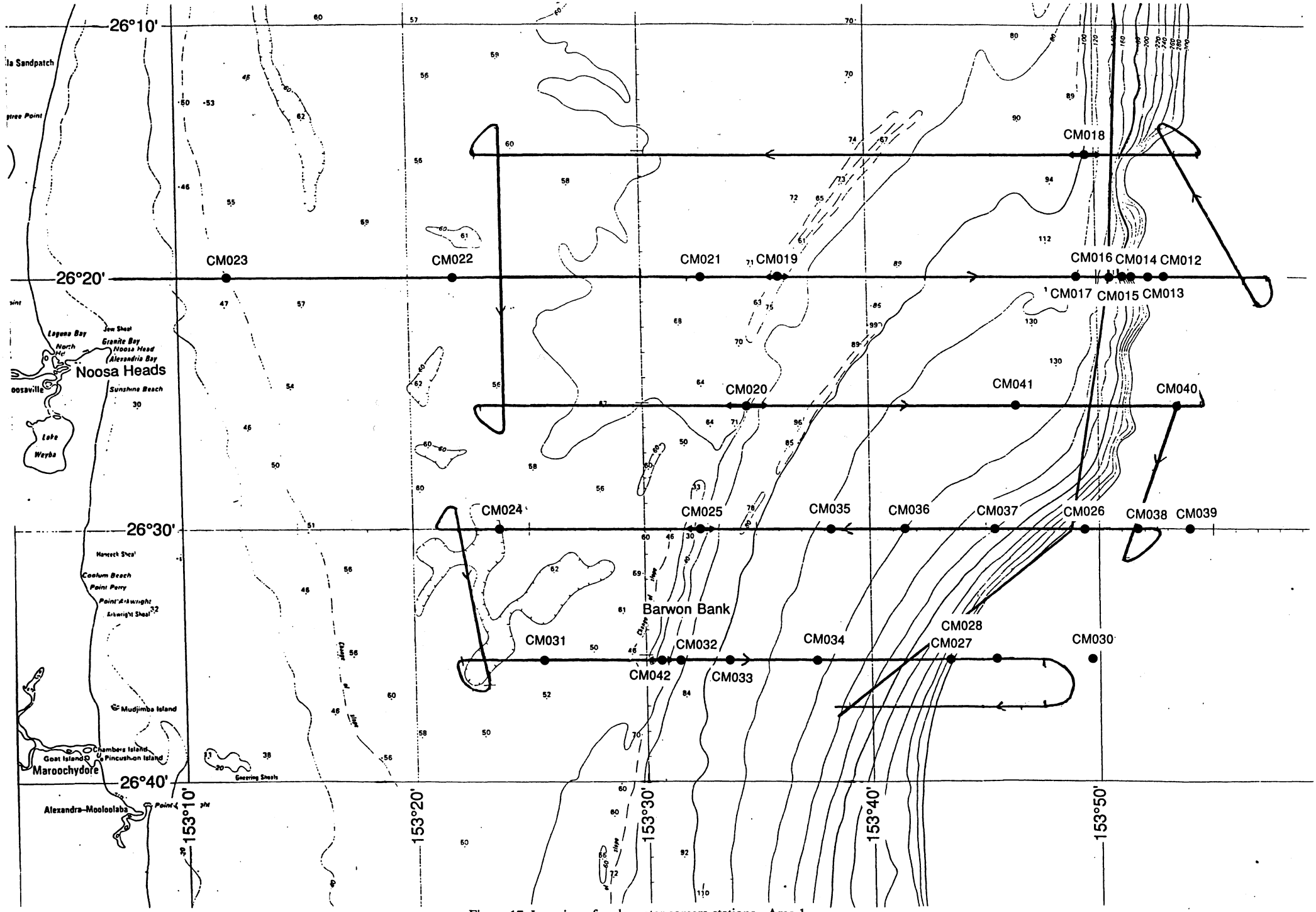


Figure 17. Location of underwater camera stations - Area 1

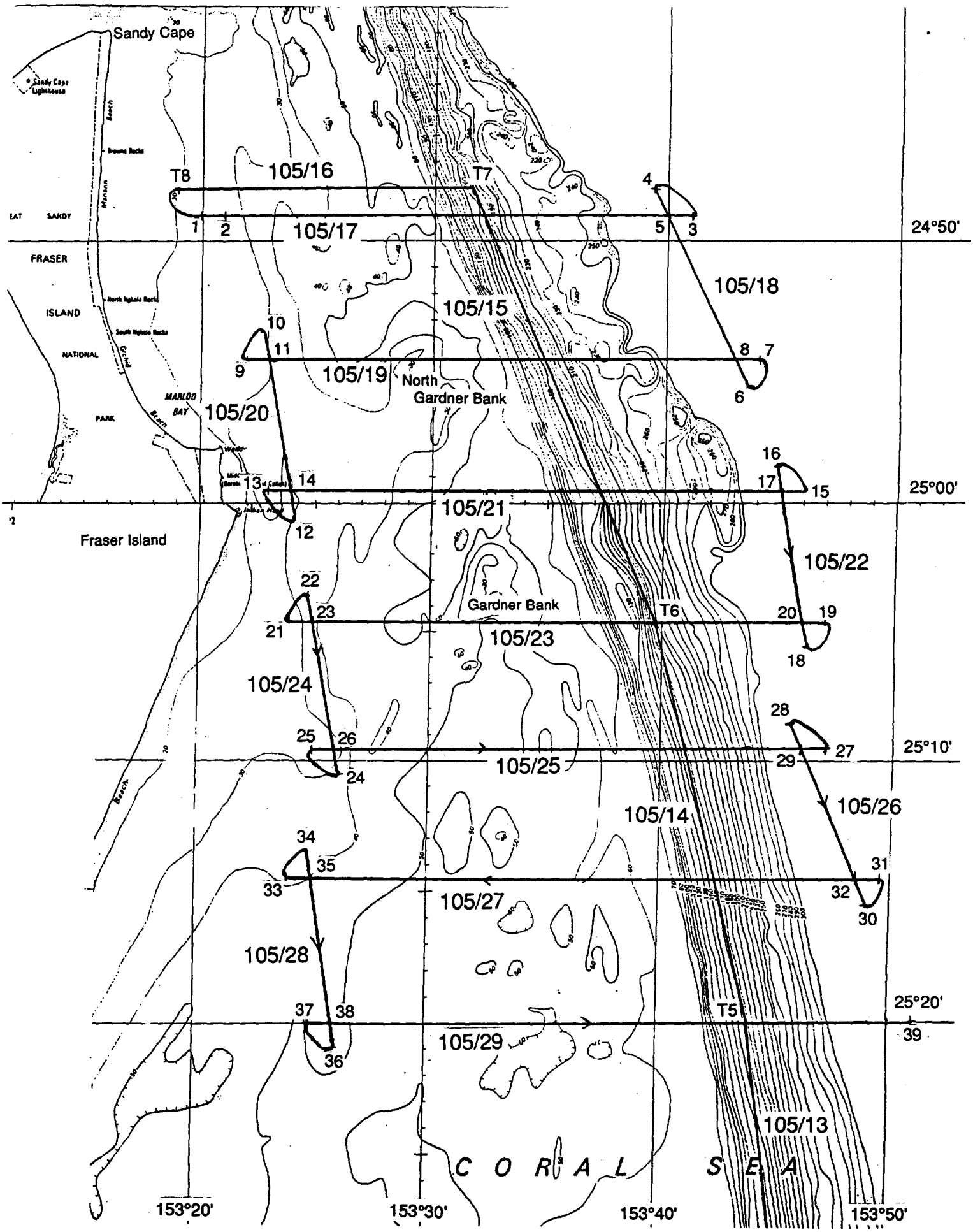


Figure 19. The location of multichannel high resolution seismic reflection profiles in Area 2 off Fraser Island

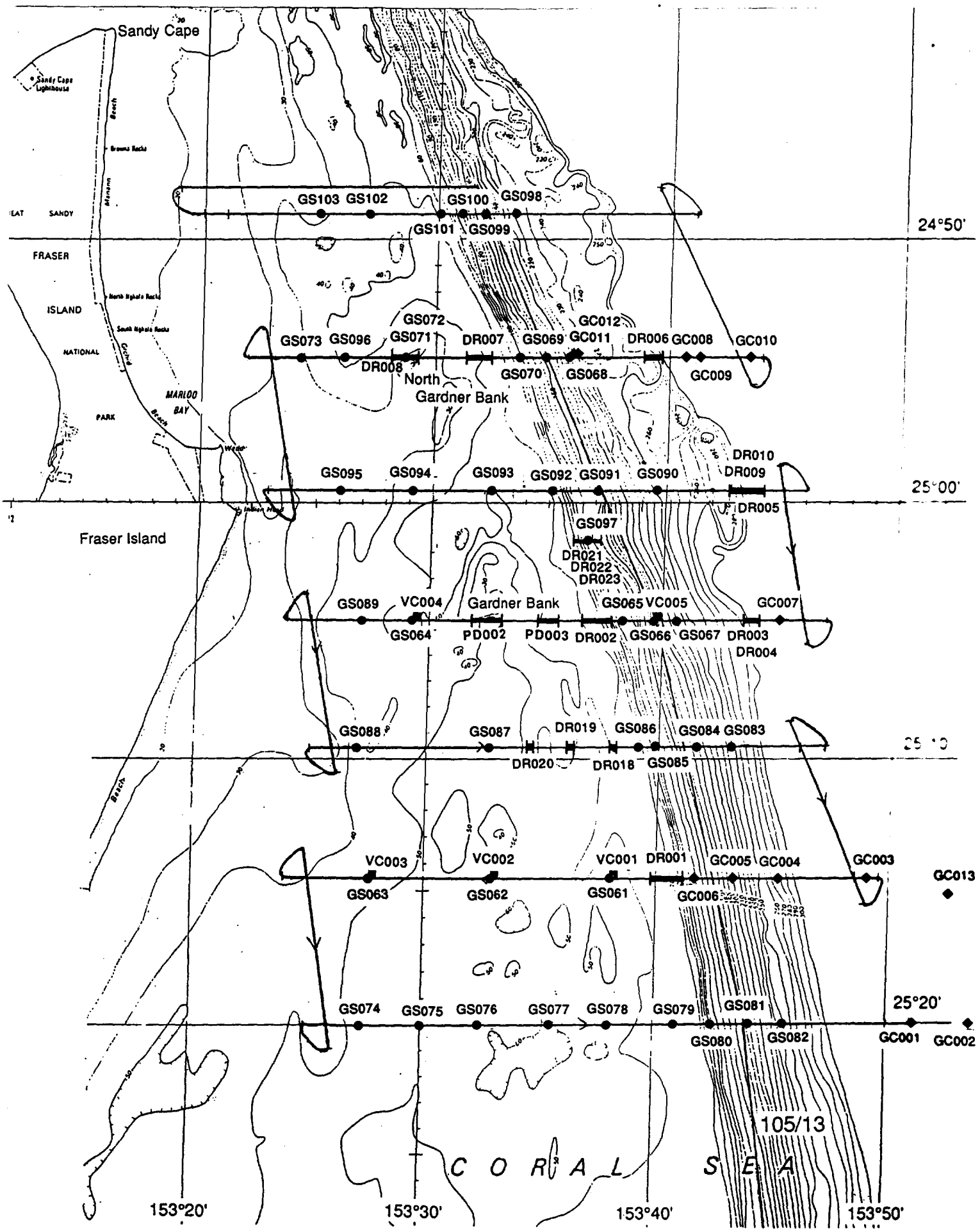


Figure 28. Location of sampling stations - Area 2

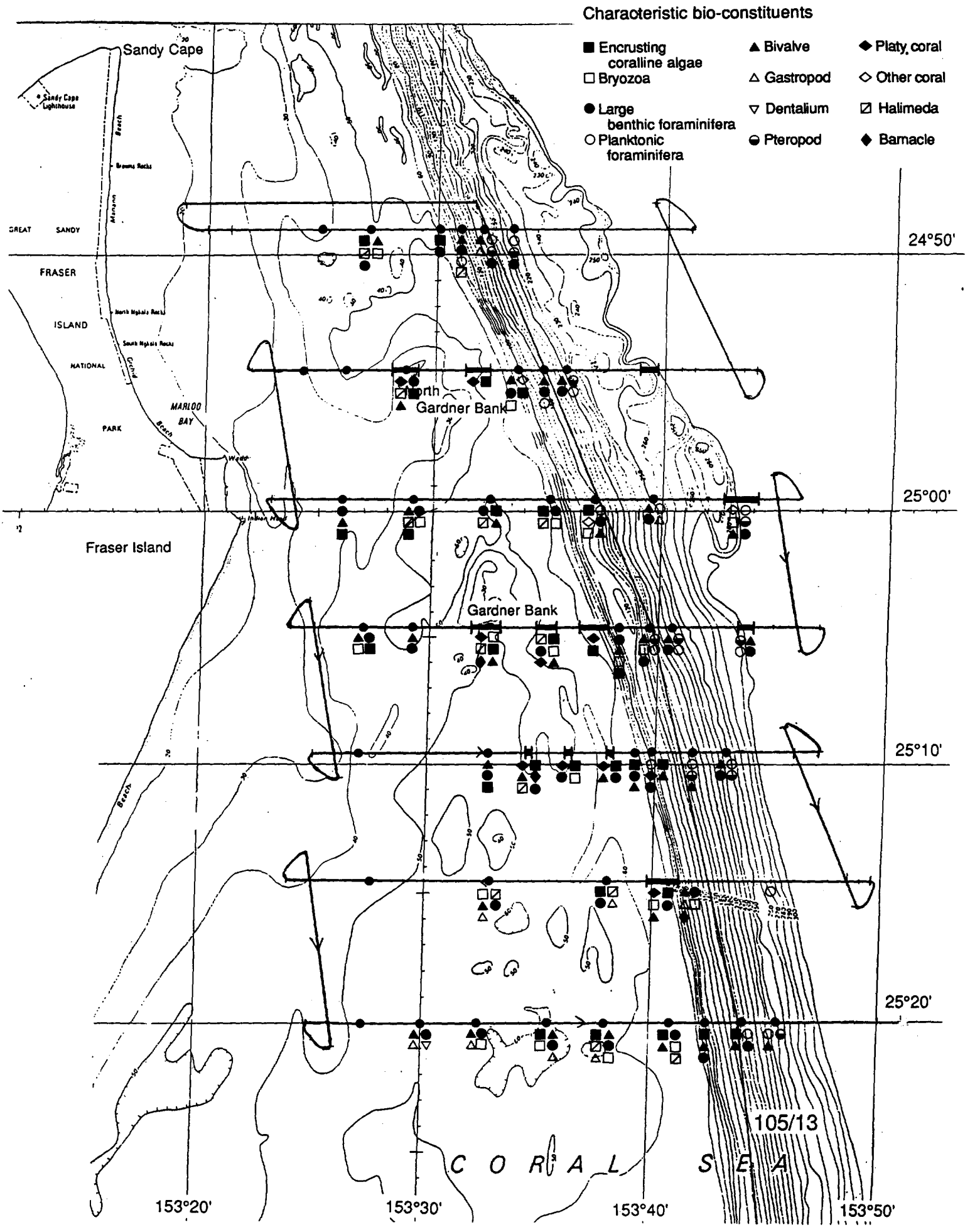


Figure 29. Characteristic bioconstituents of grab samples - Area 2

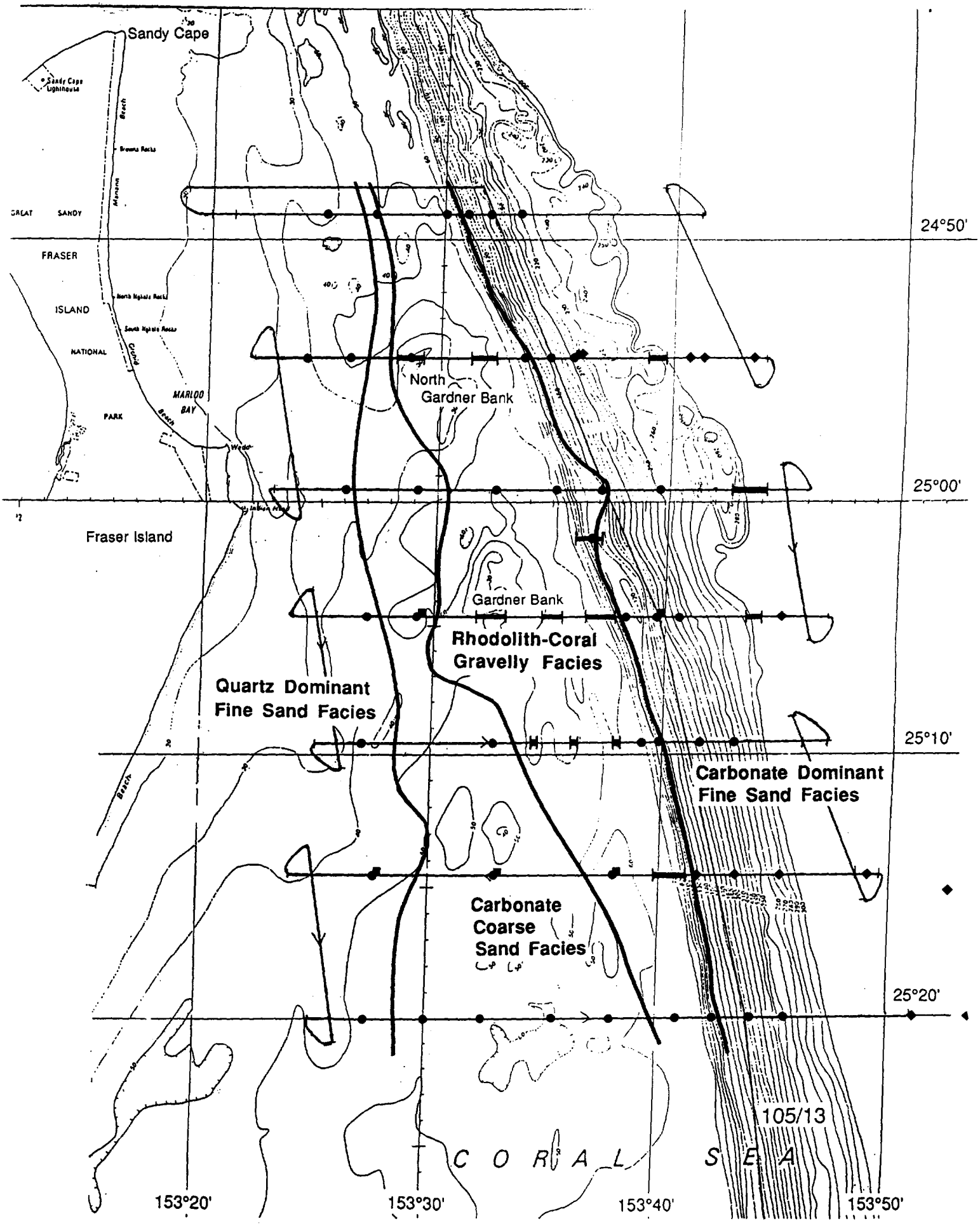


Figure 30. Facies distribution - Area 2

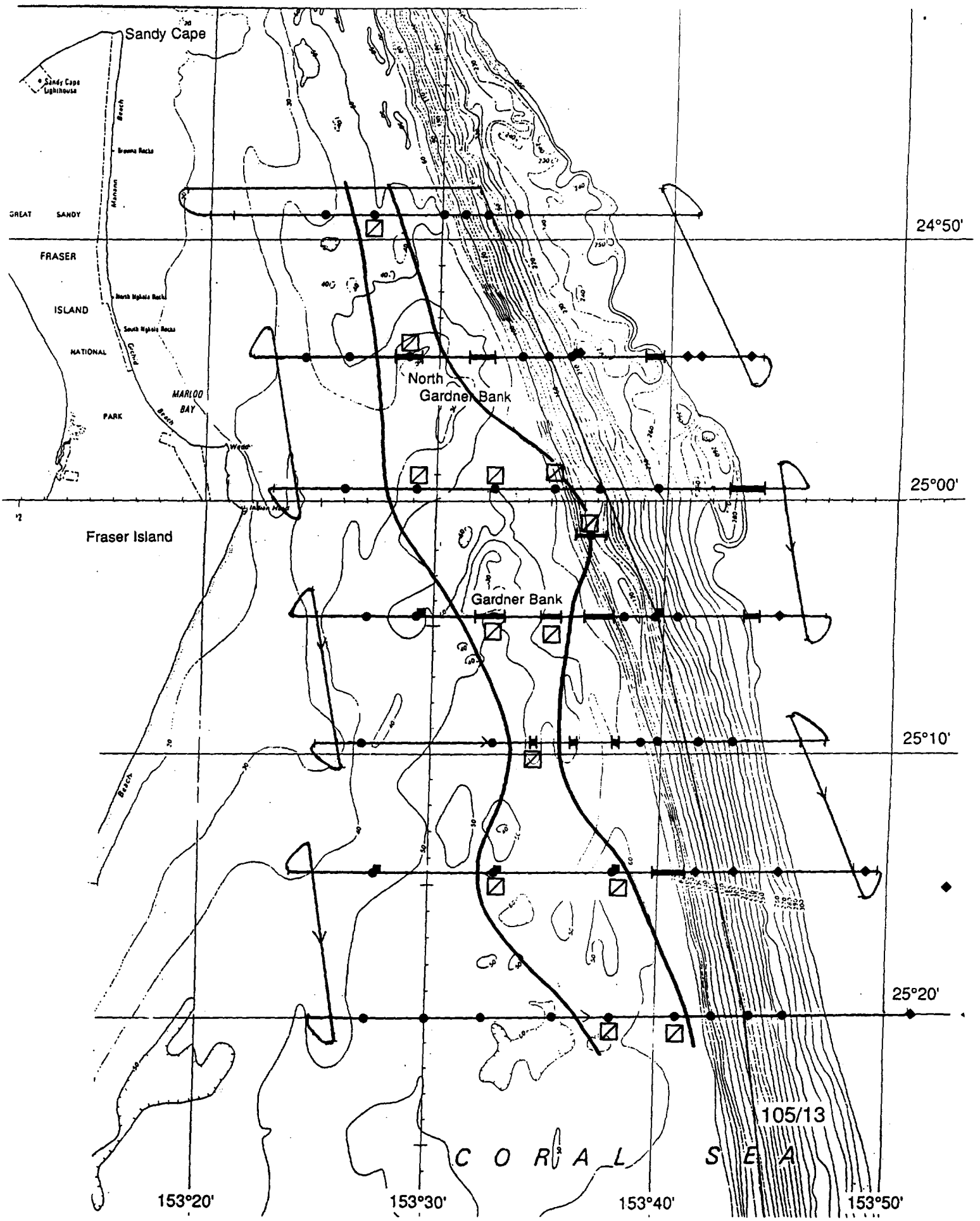


Figure 31. Distribution of *Halimeda* - Area 2

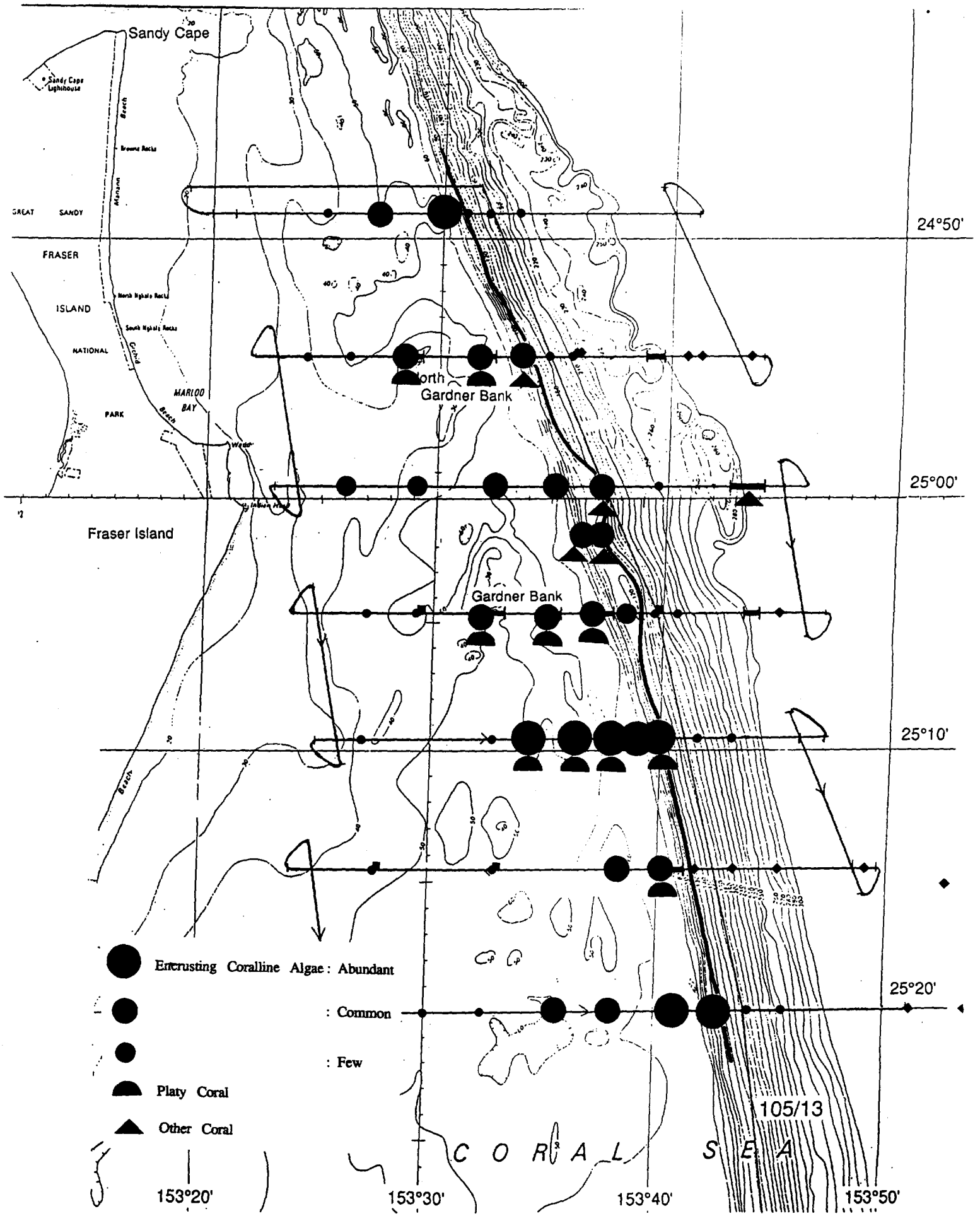


Figure 32. Distribution of corals and coralline algae - Area 2

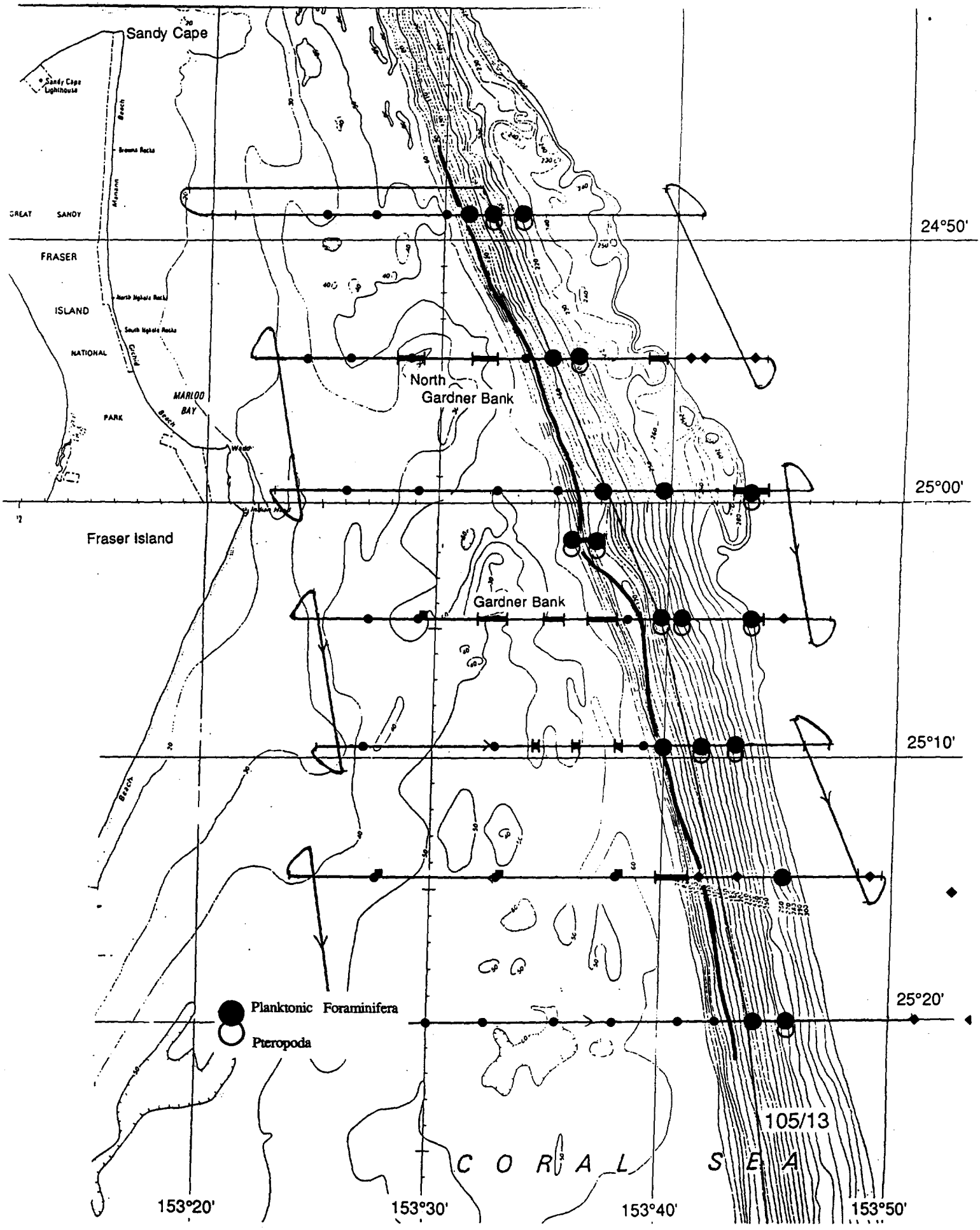


Figure 33. Distribution of planktonic foraminifera and pteropods - Area 2

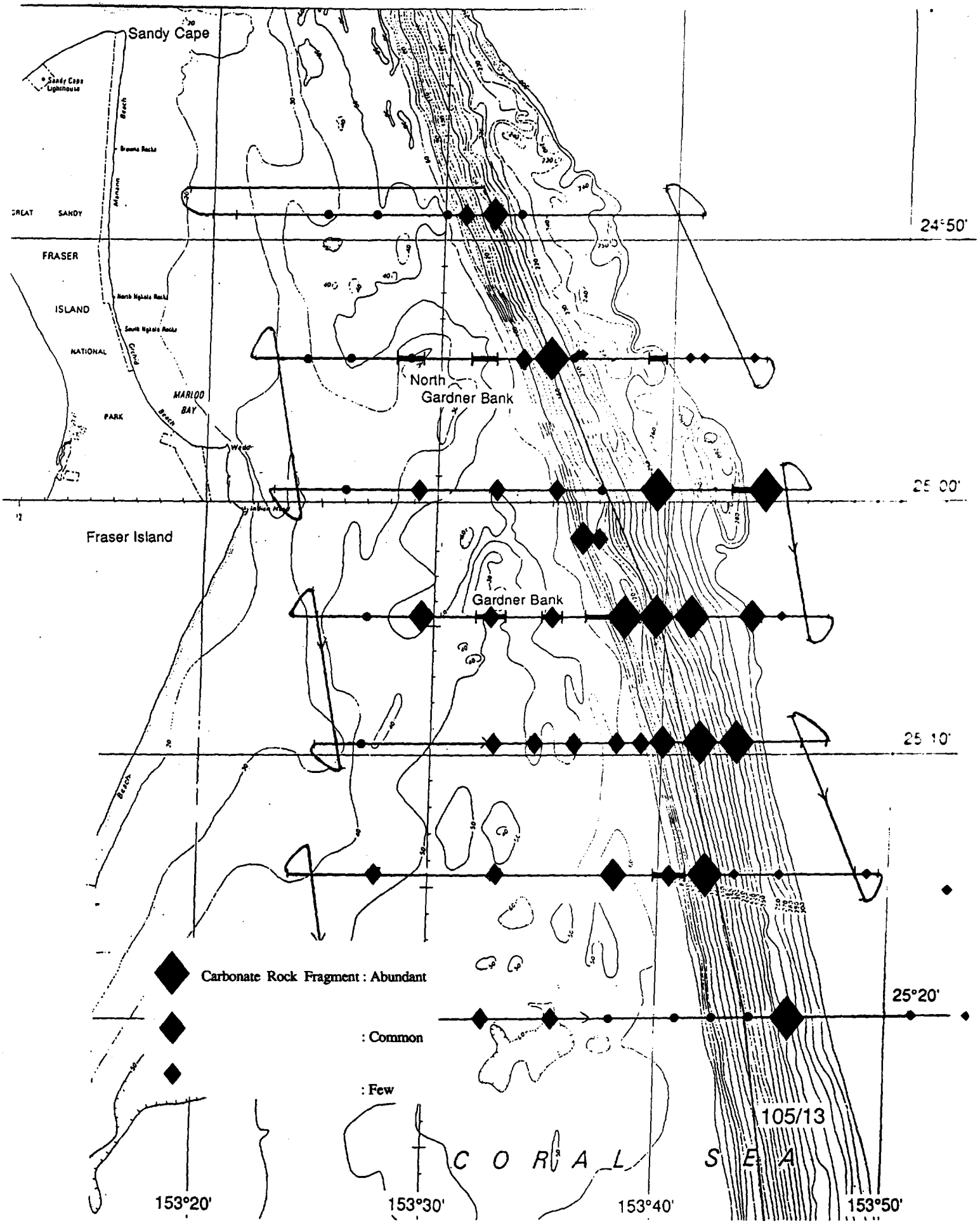


Figure 34. Distribution of carbonate rock fragments - Area 2

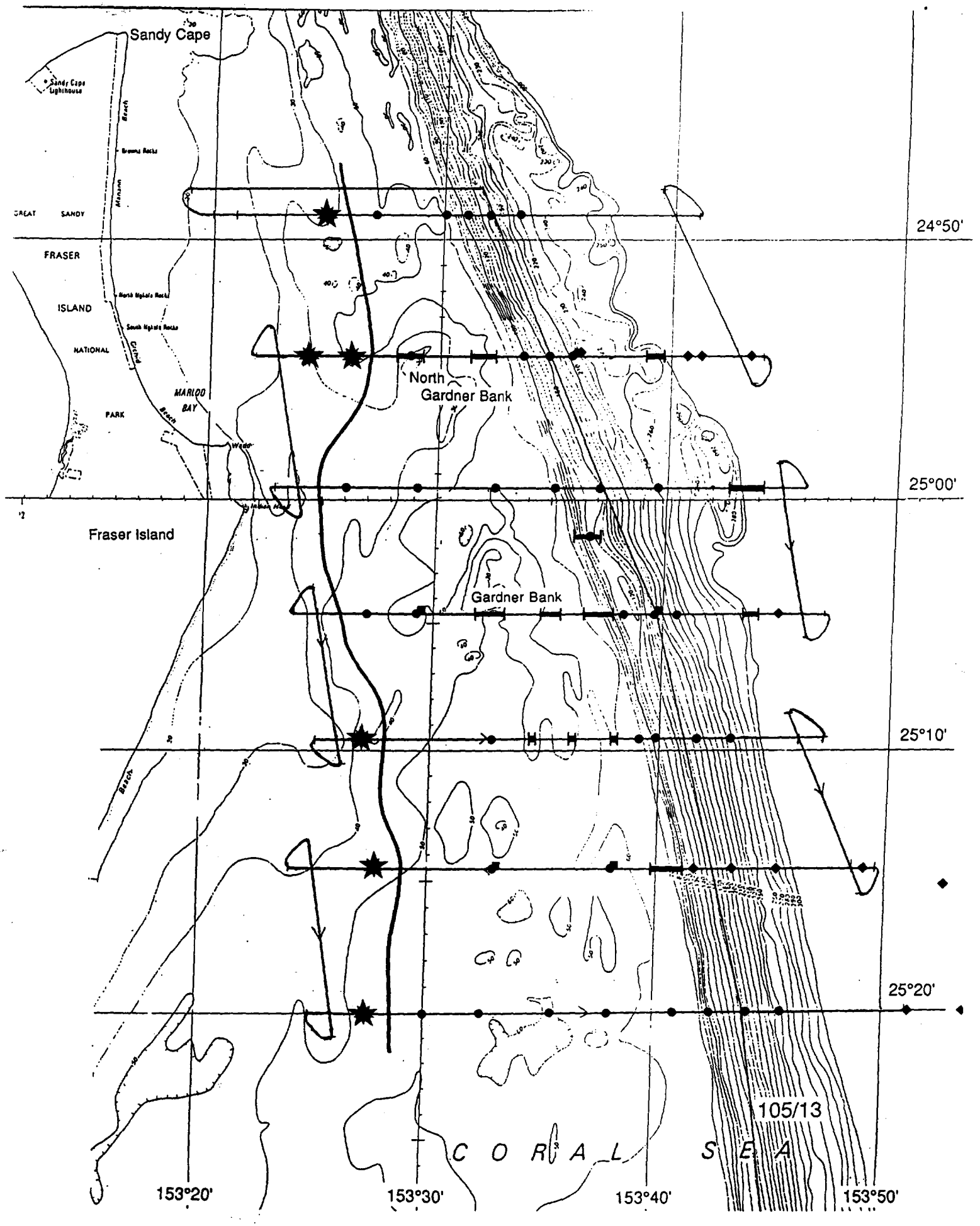


Figure 35. Distribution of quarts - Area 2

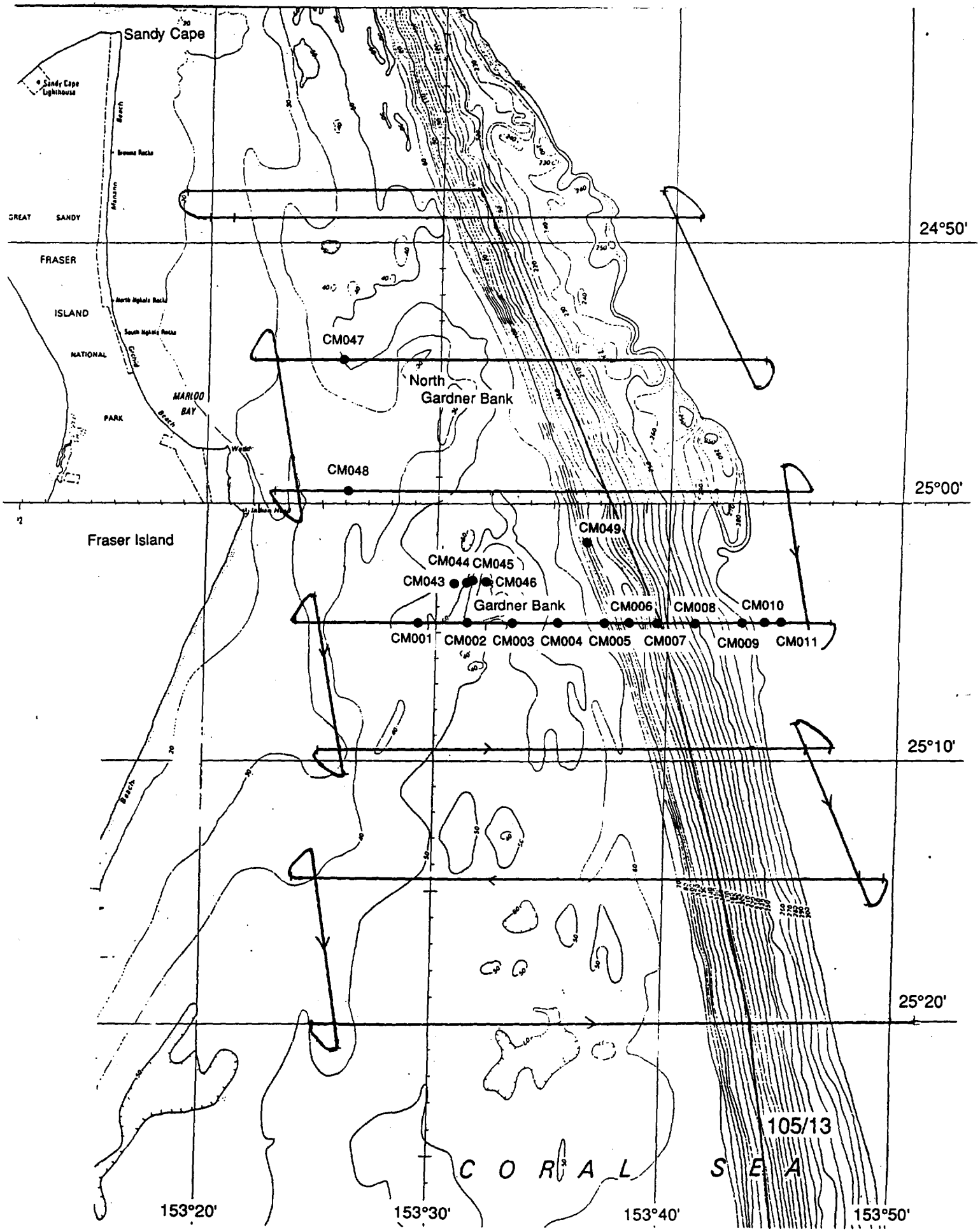


Figure 36. Location of underwater camera stations - Area 2

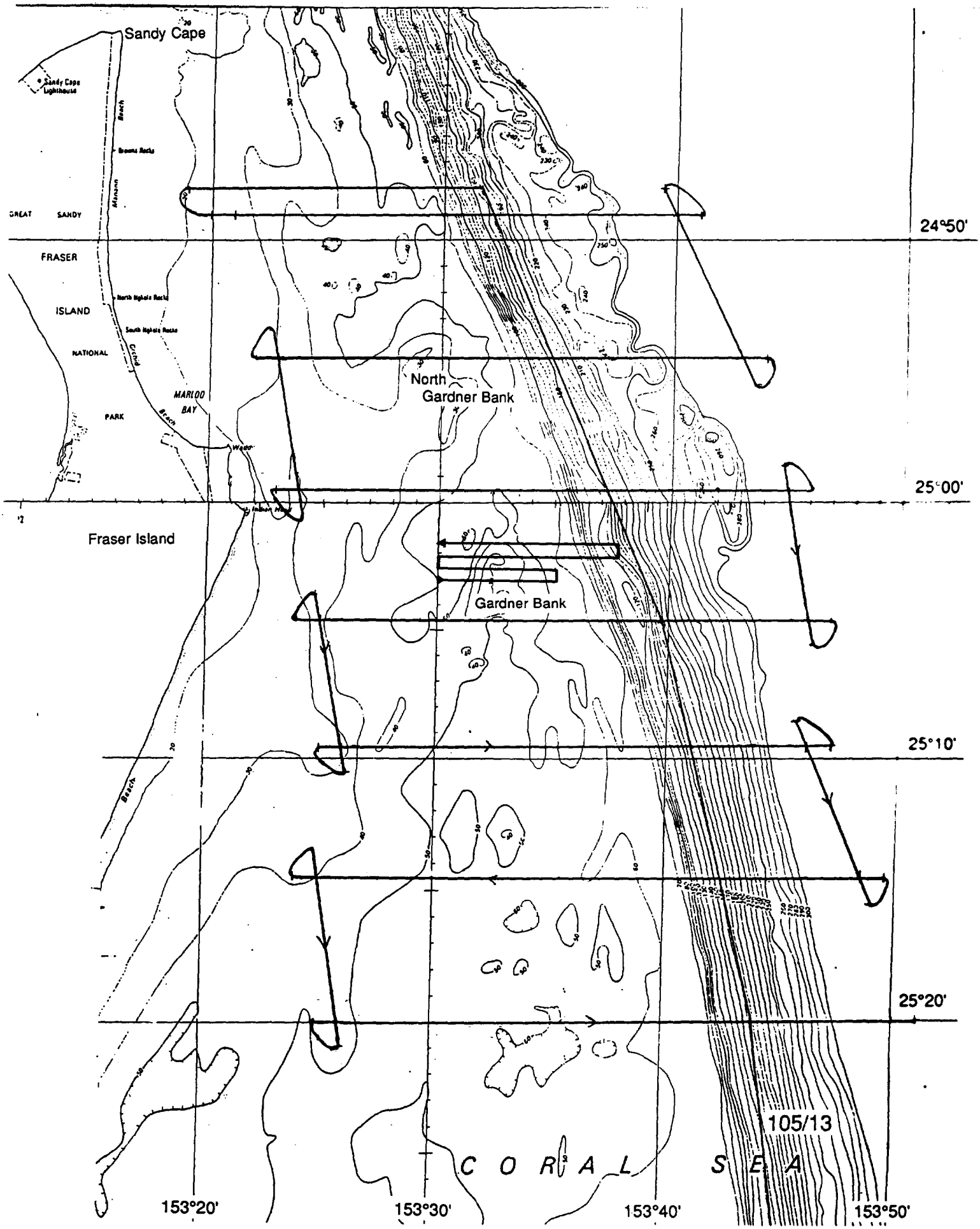
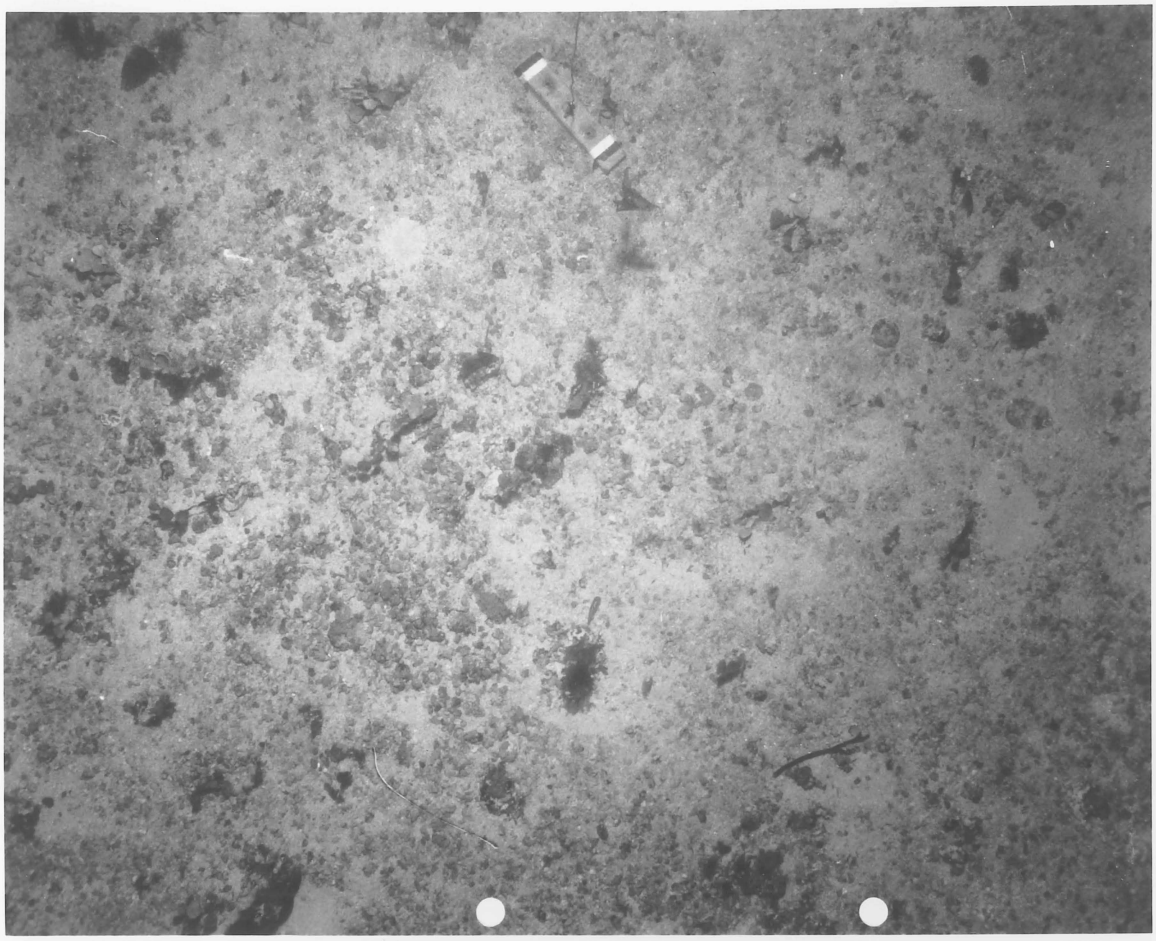


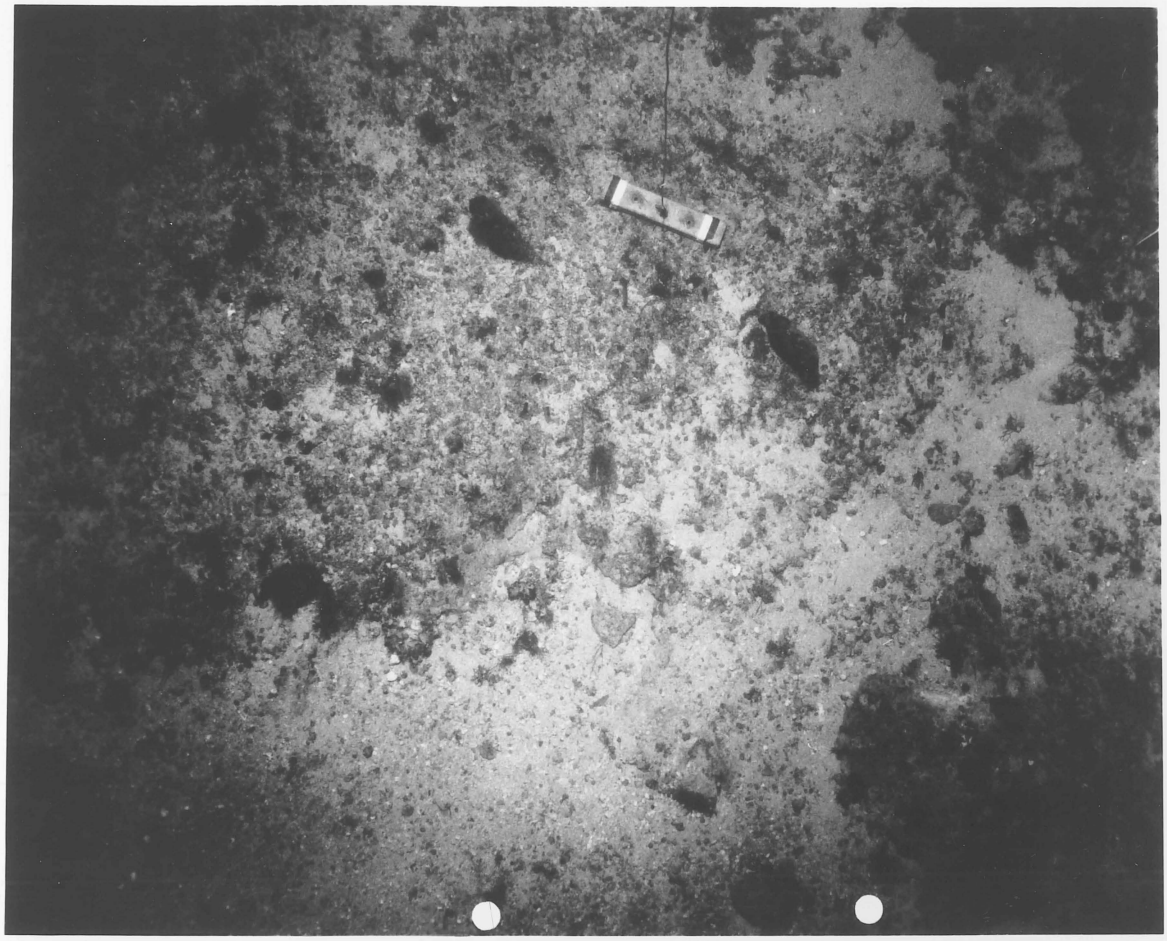
Figure 37. Location of sidescan sonar tracks - Area 2

105/CM/001

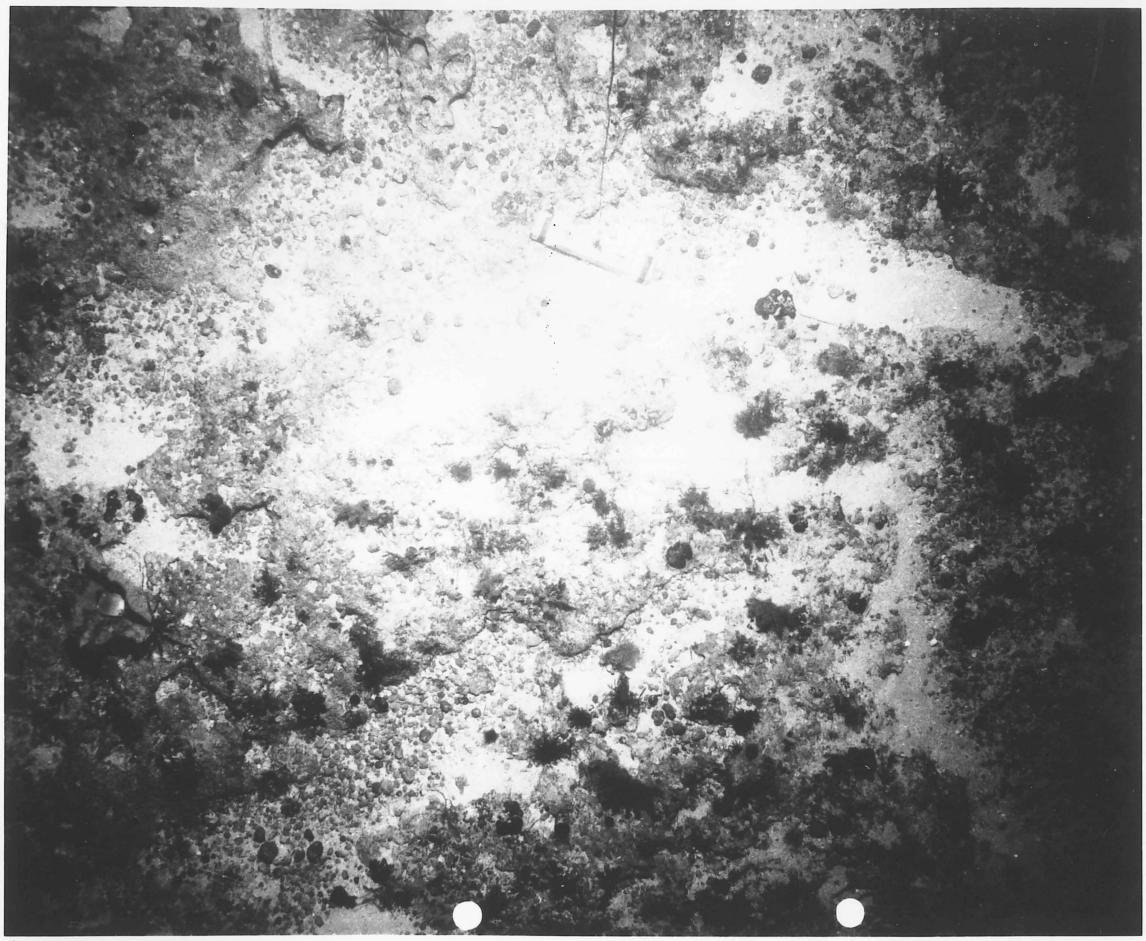


105/CM/002

105/CM/003



105/CM/004



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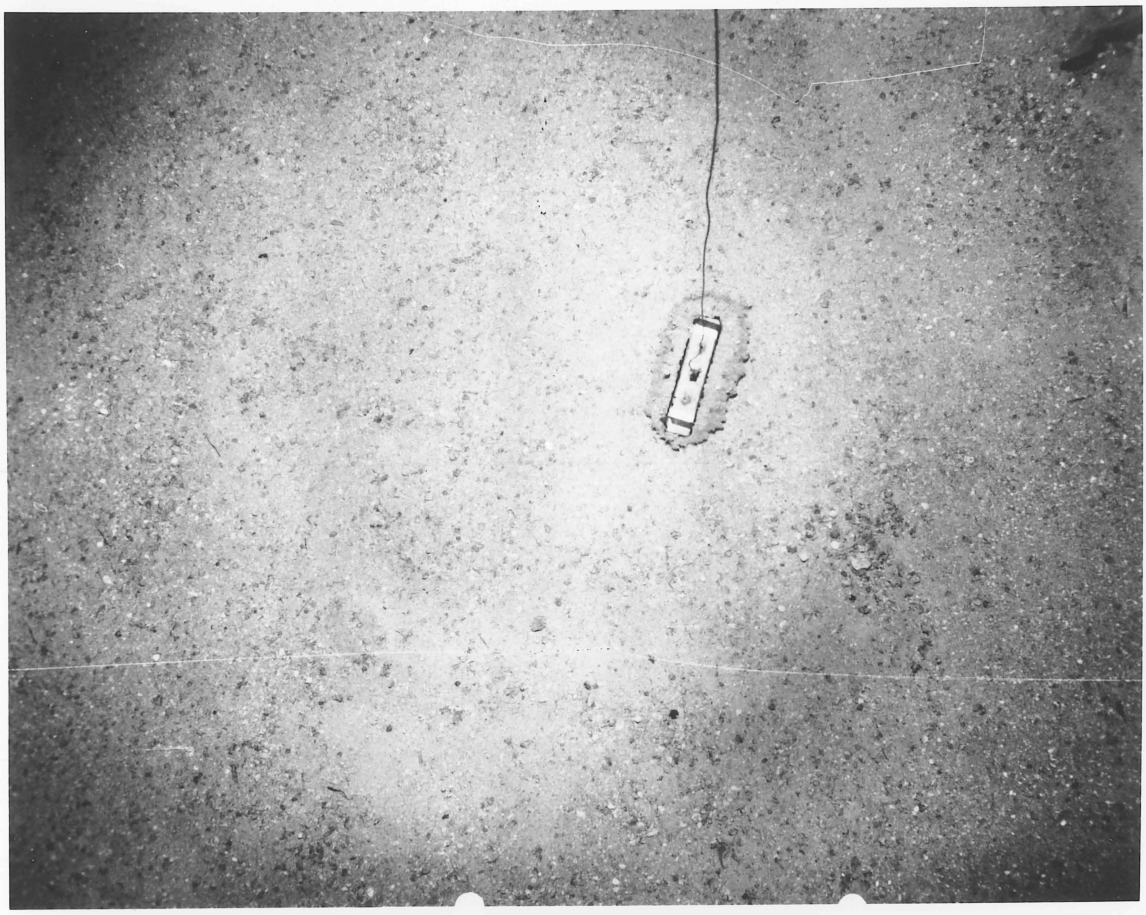
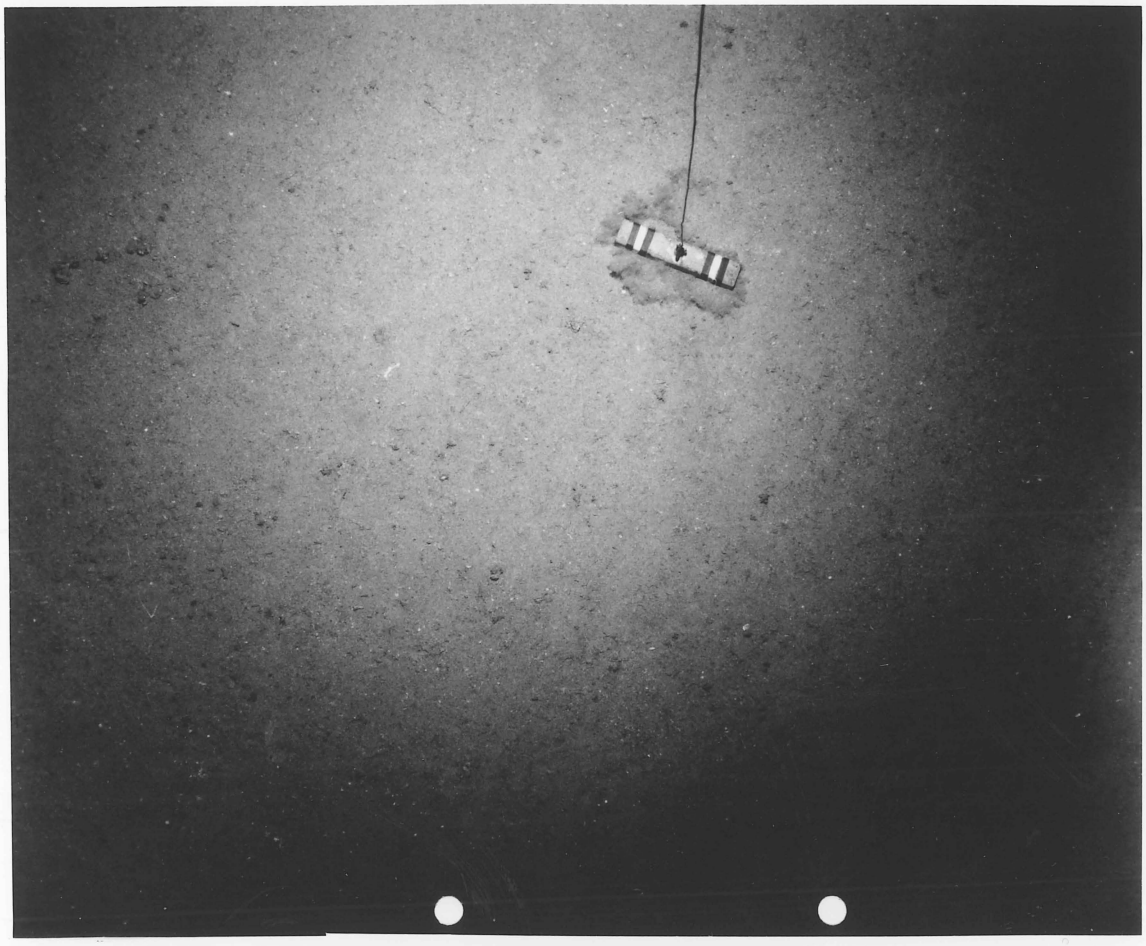


105/CM/006

105/CM/011



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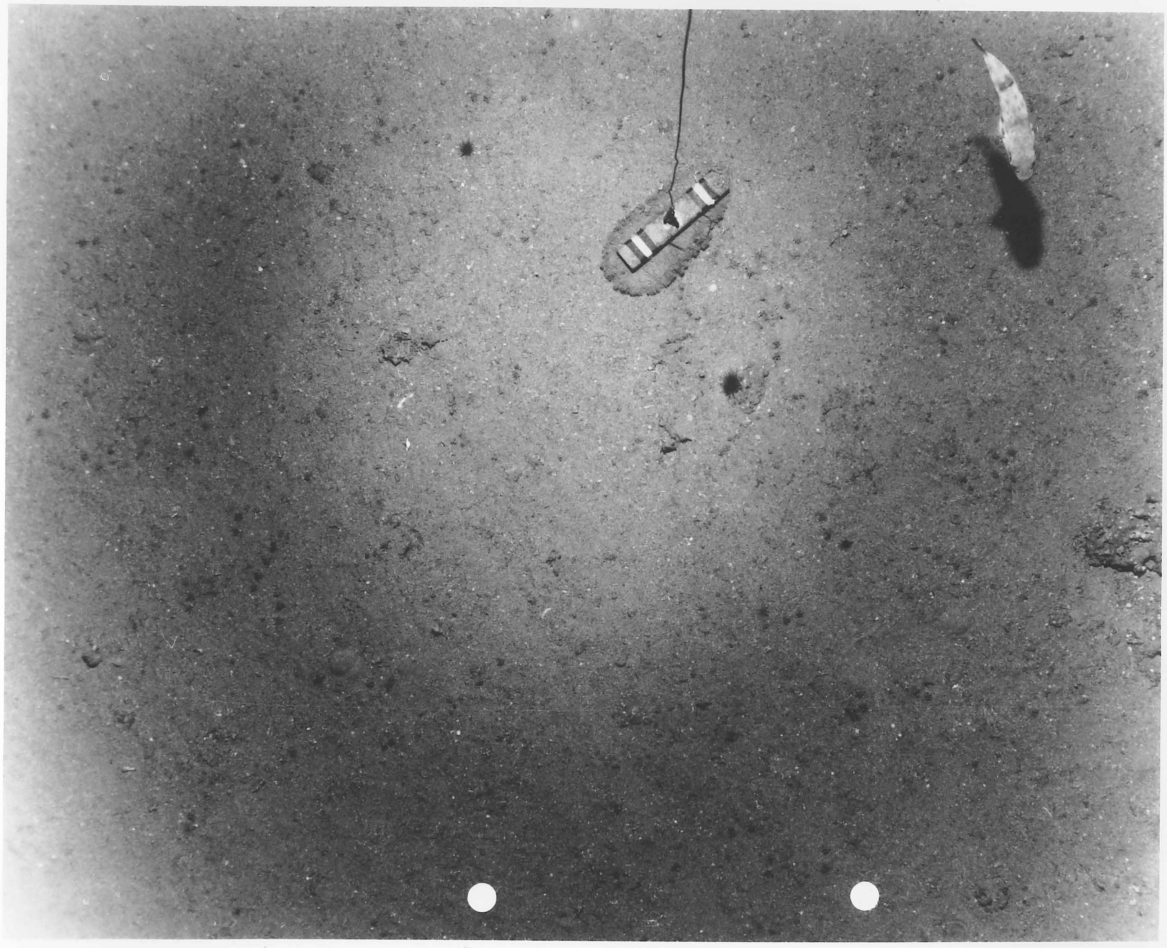

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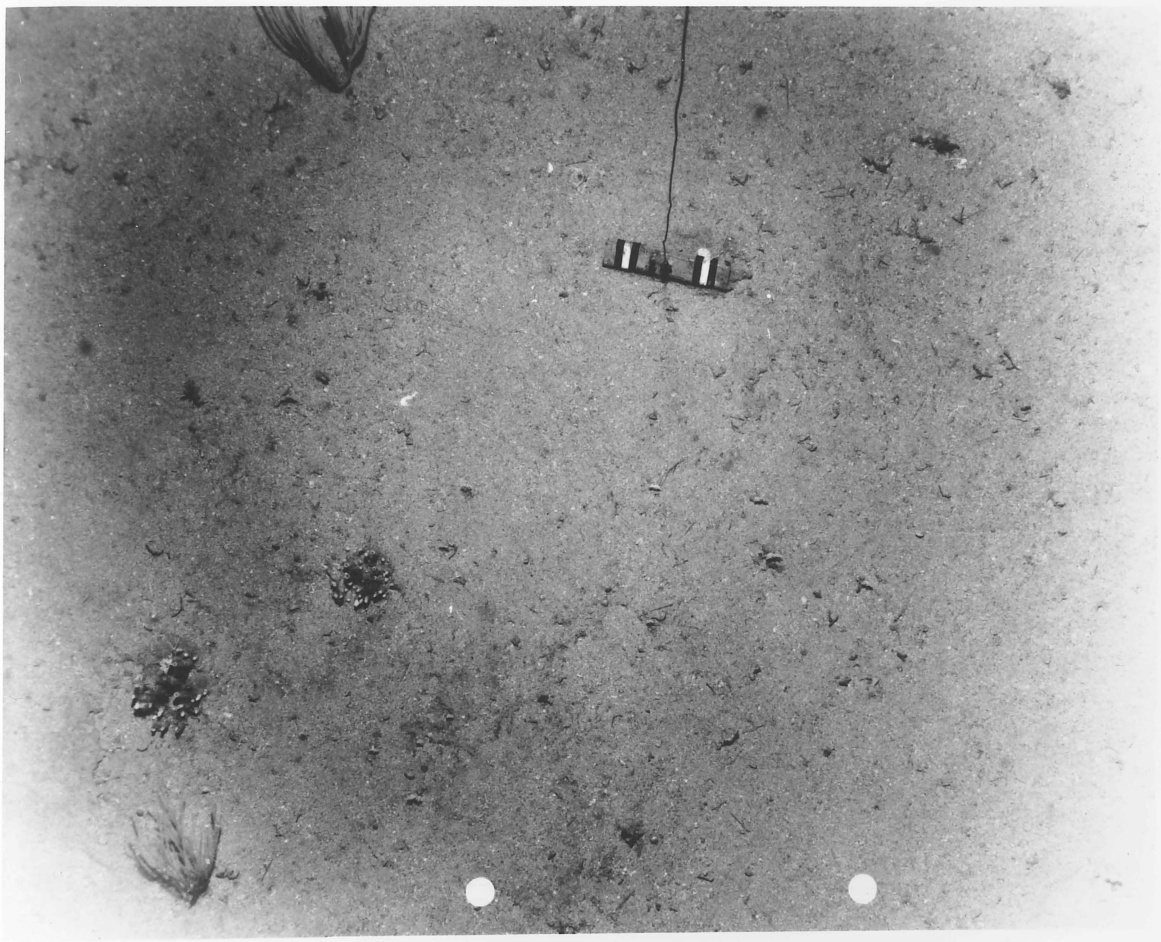

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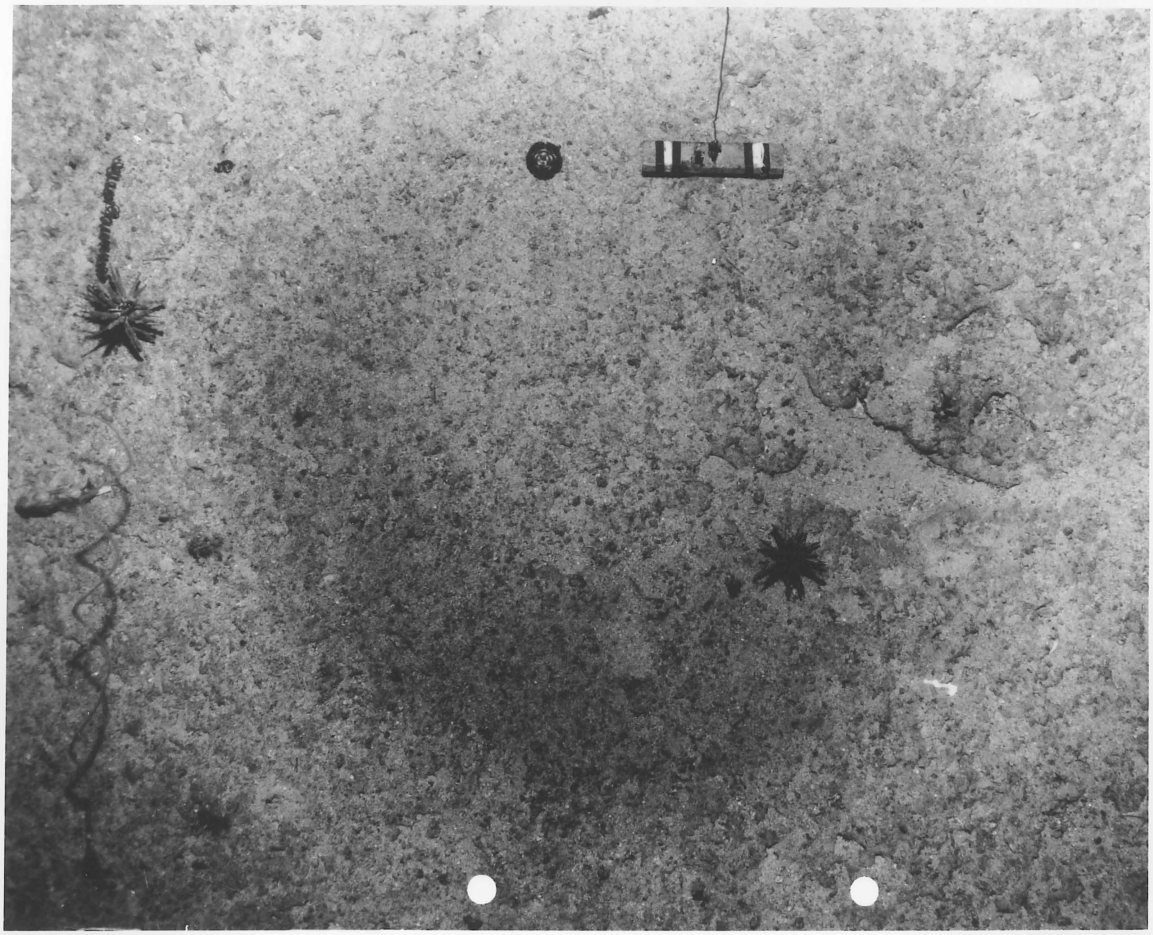

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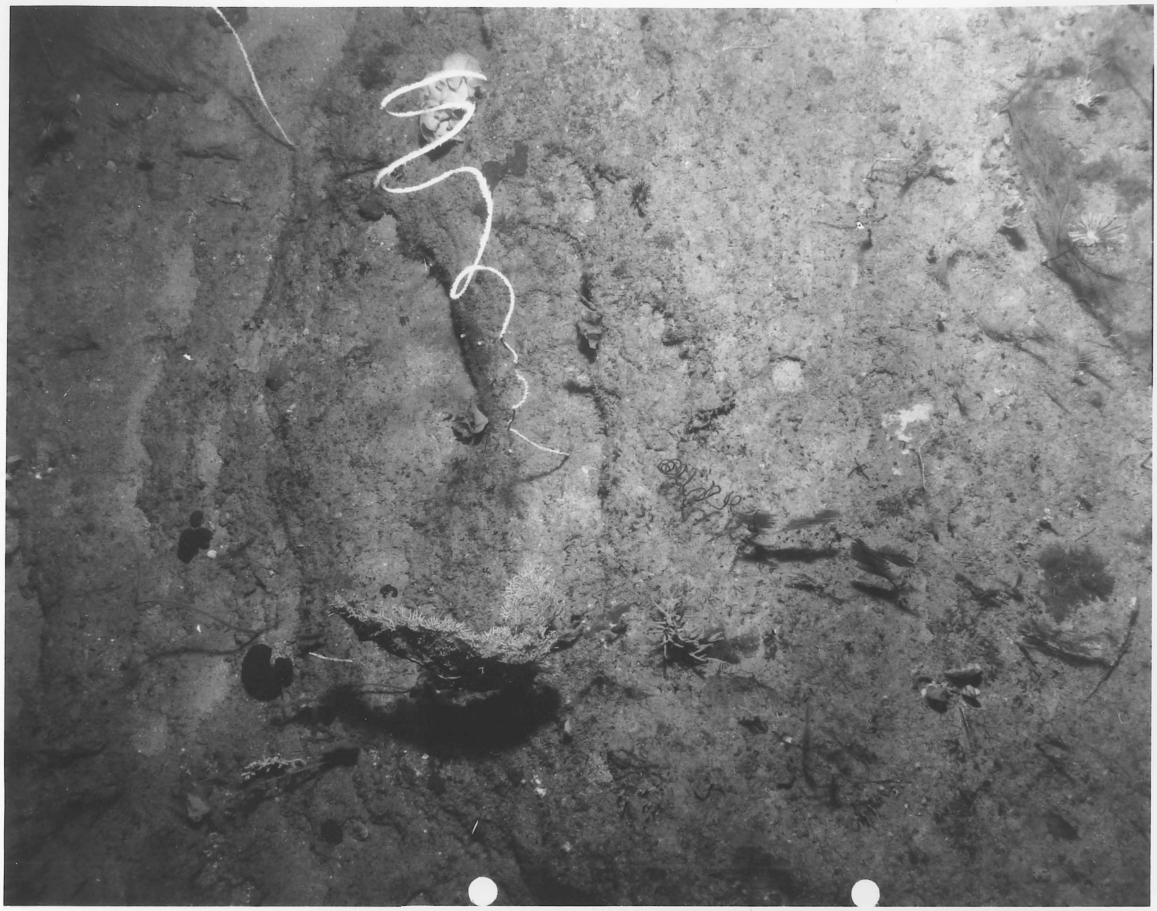

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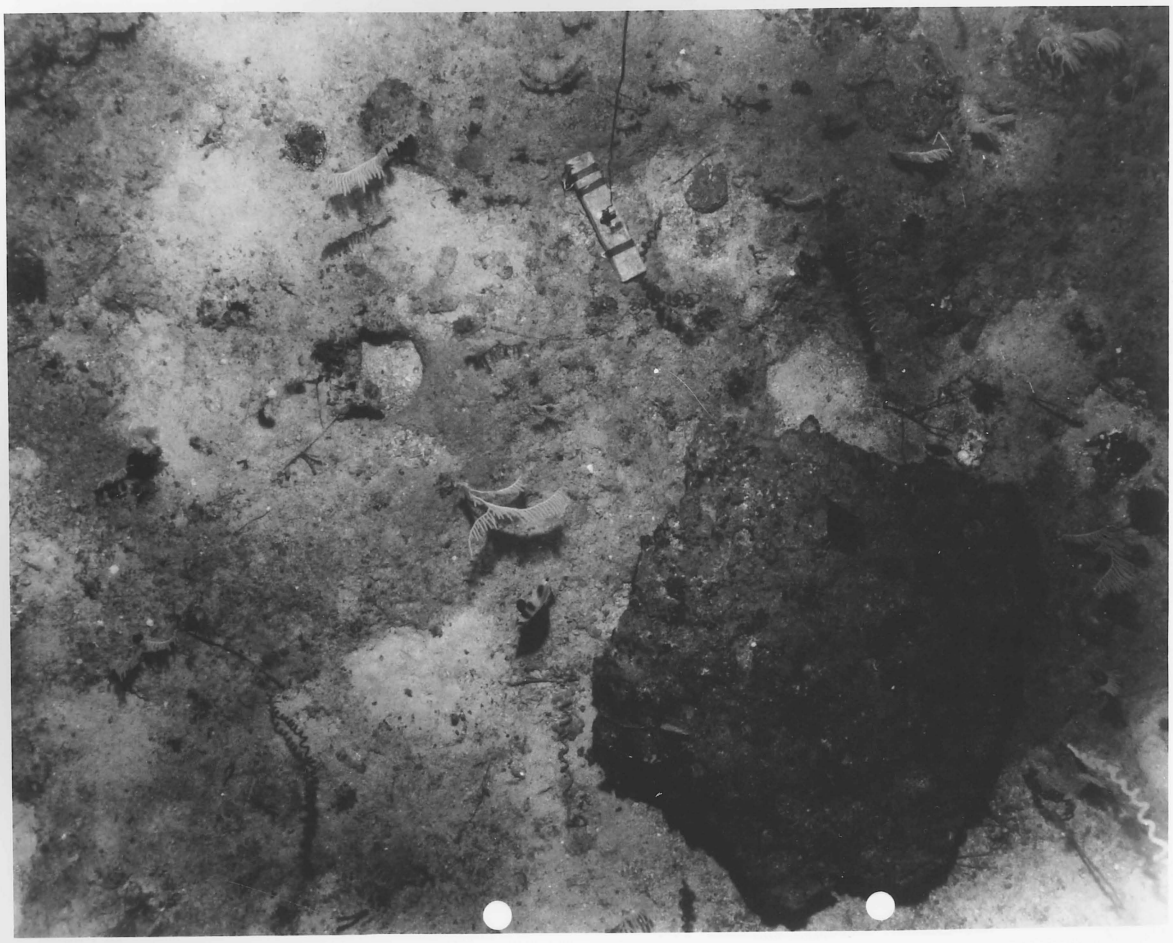

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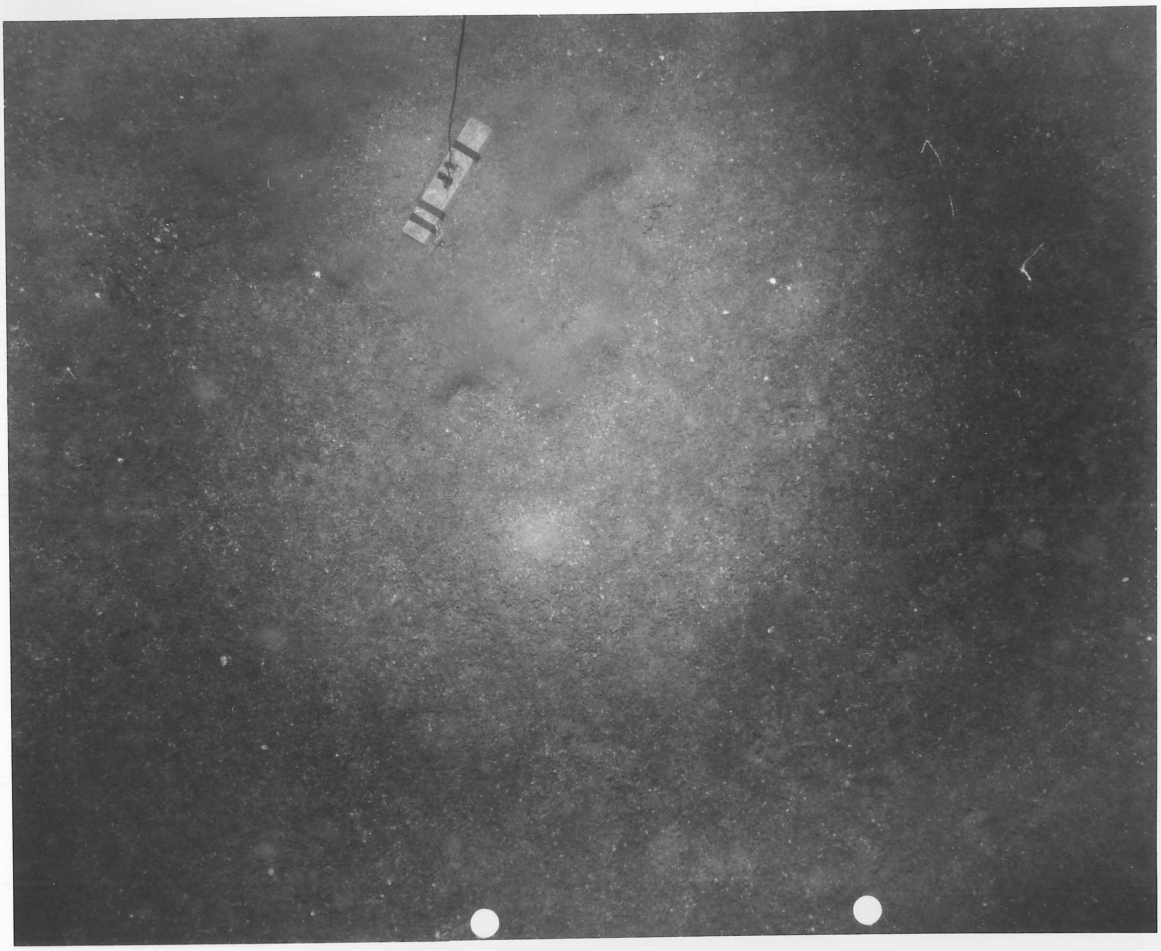

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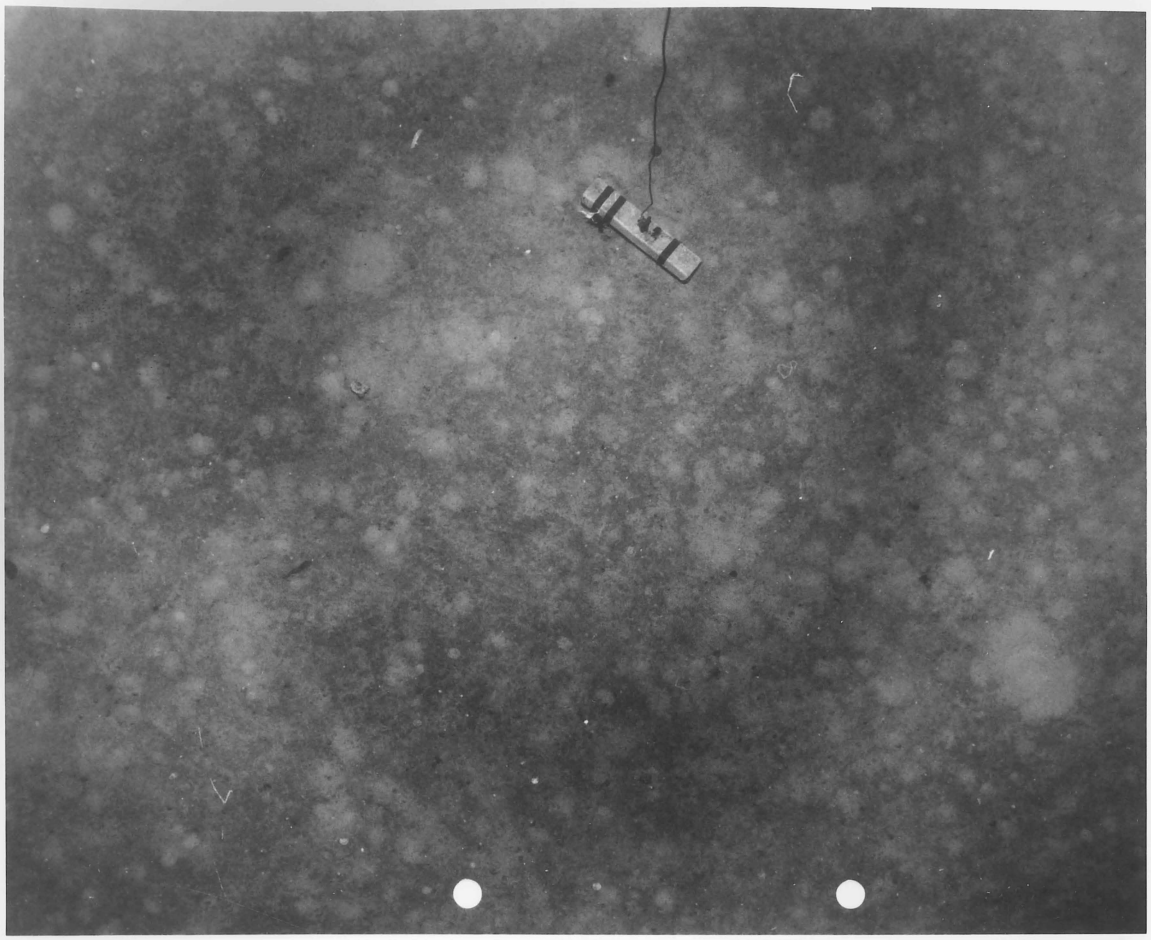

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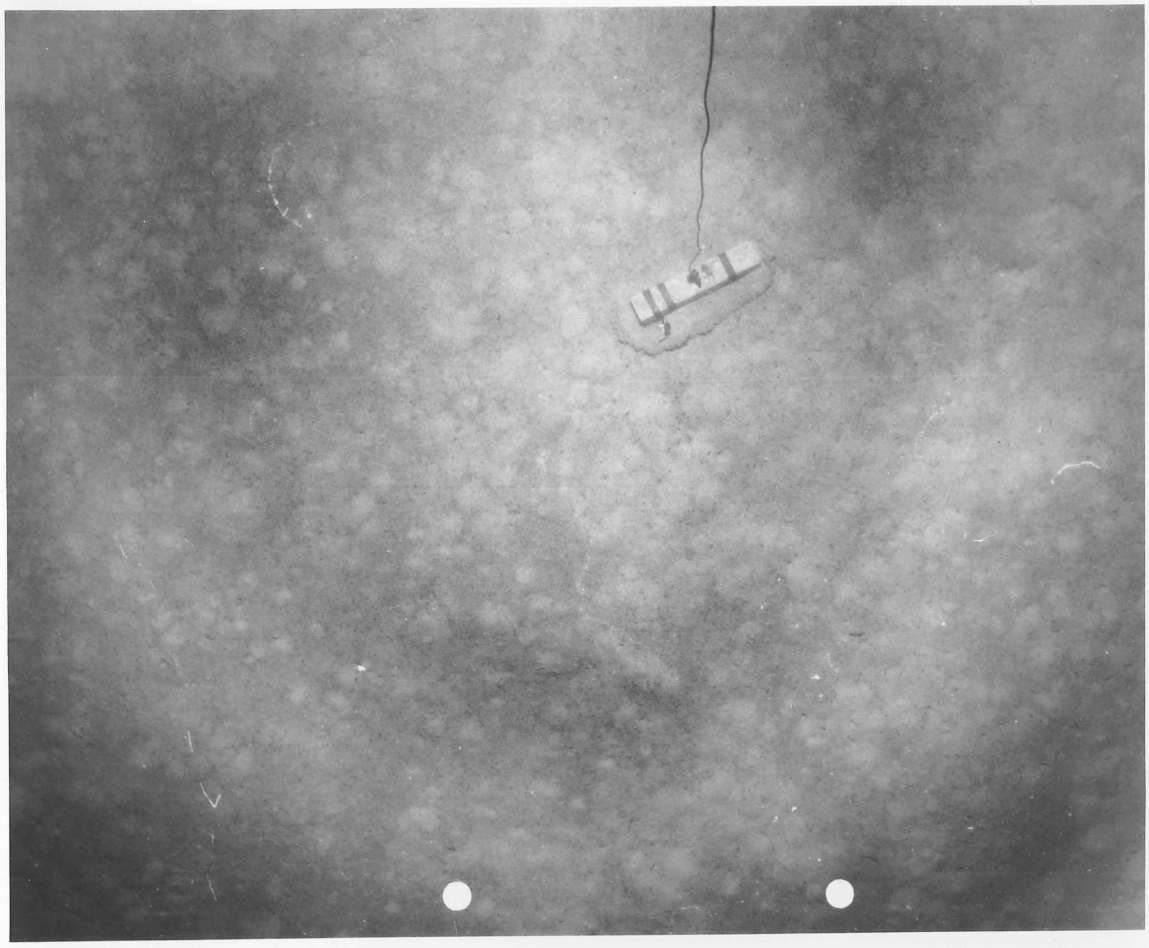

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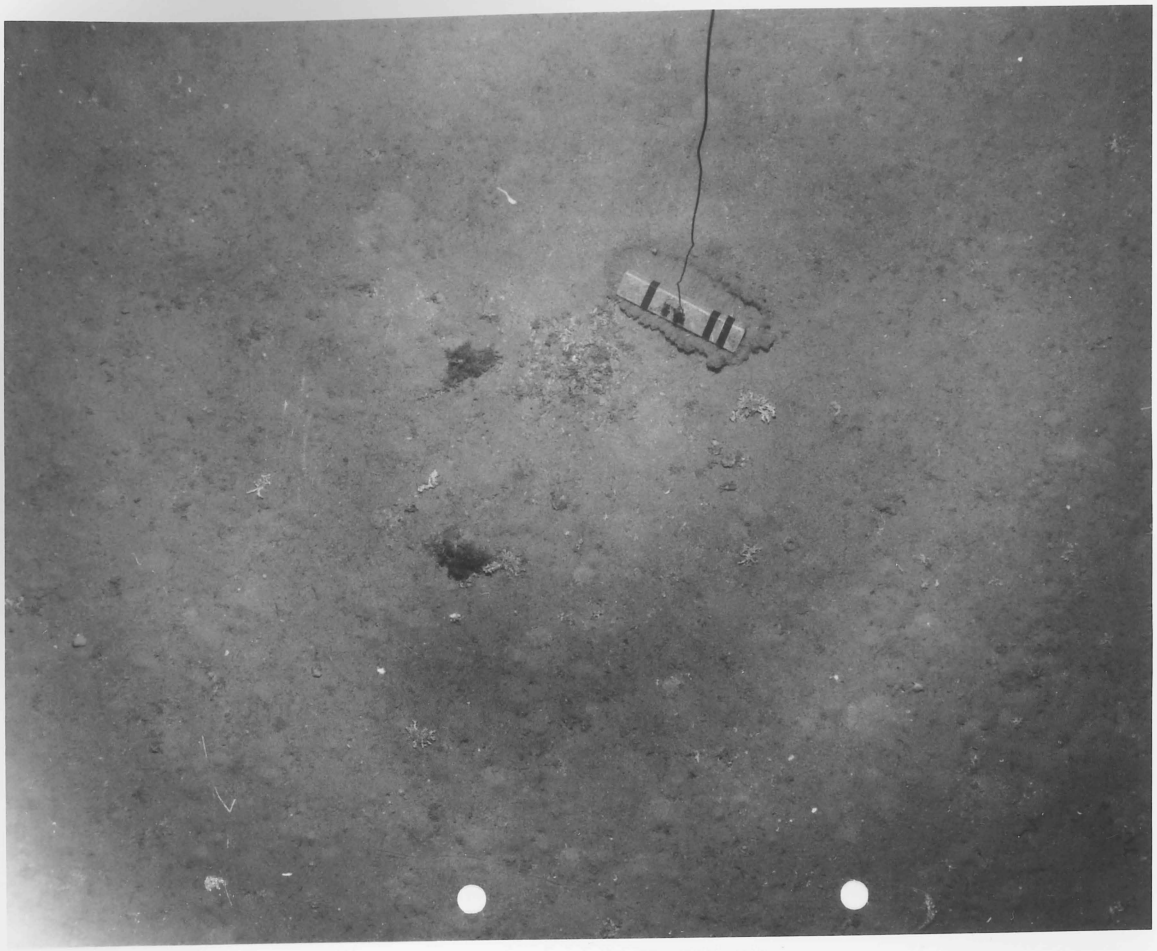

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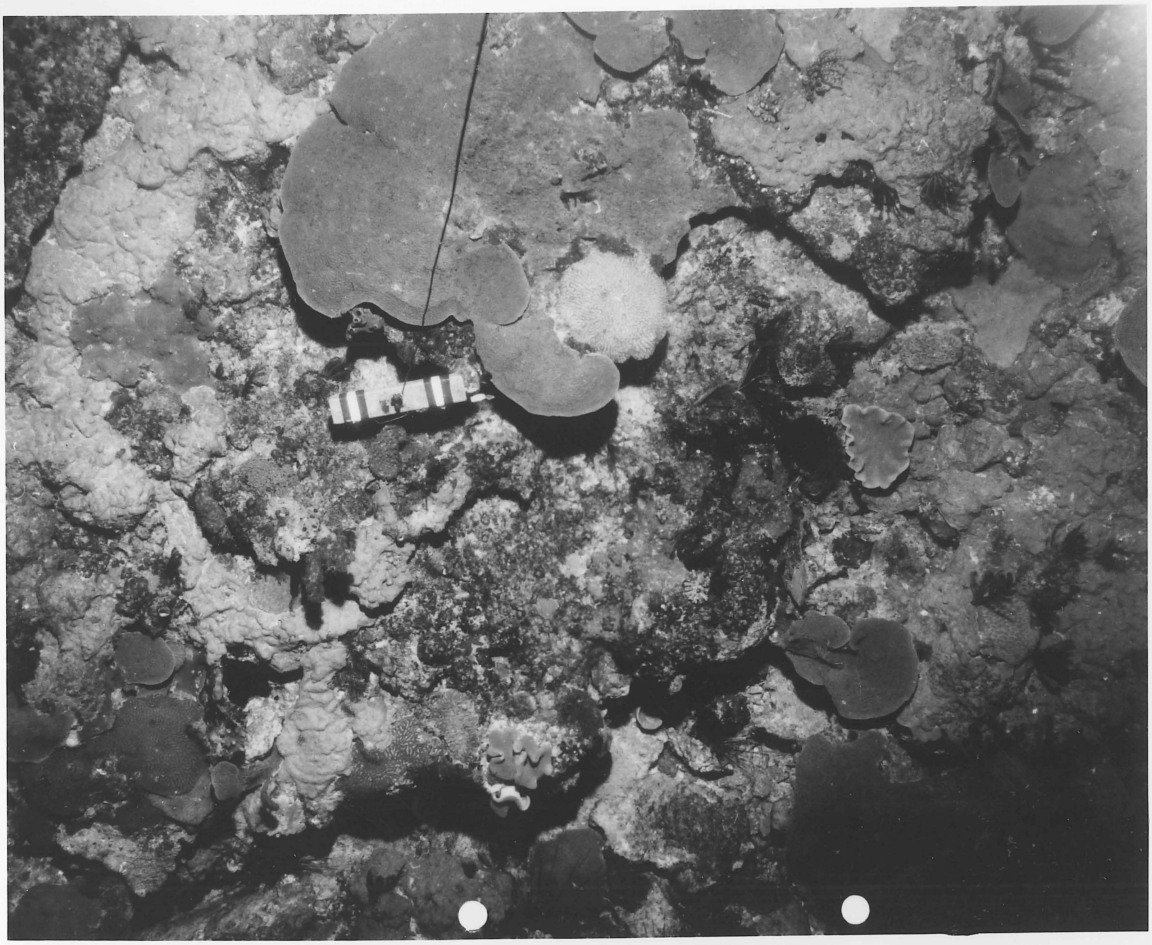

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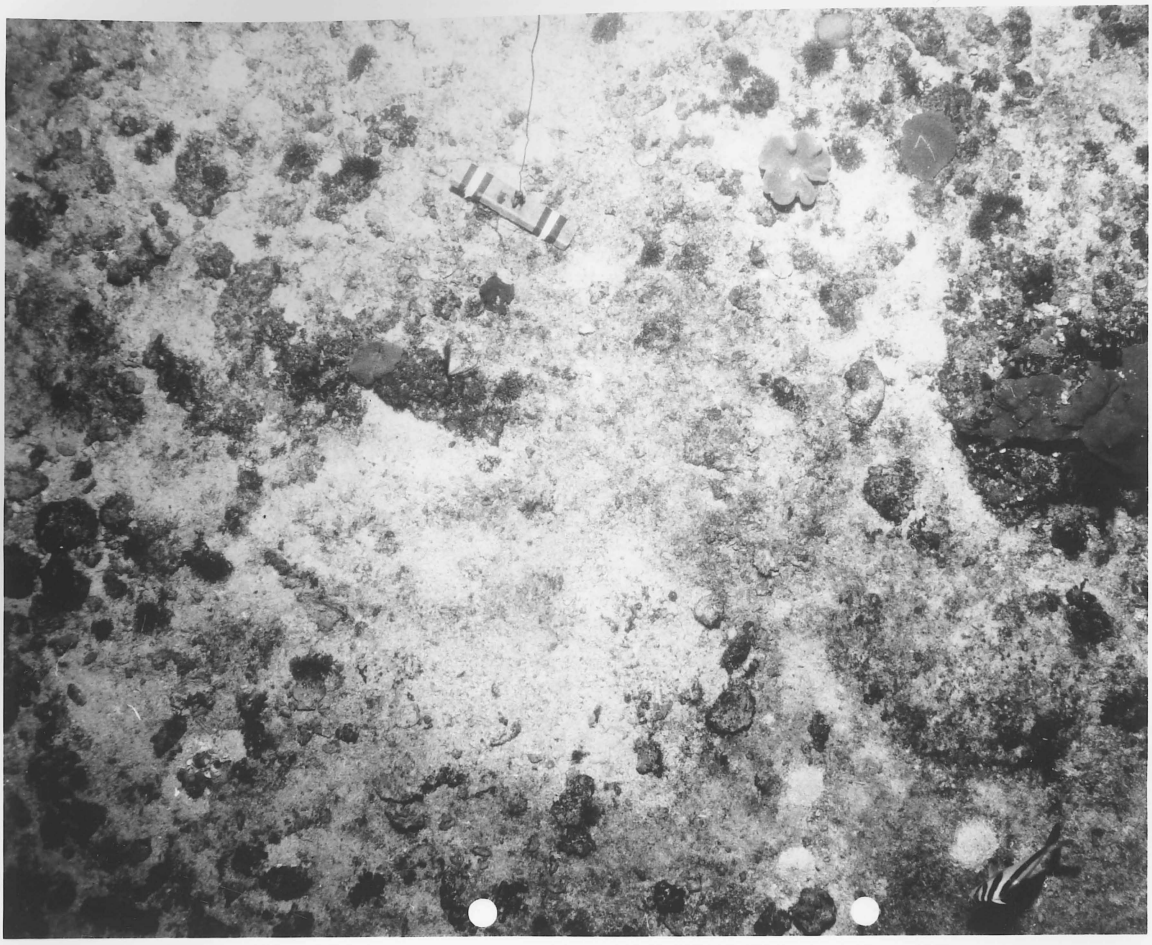

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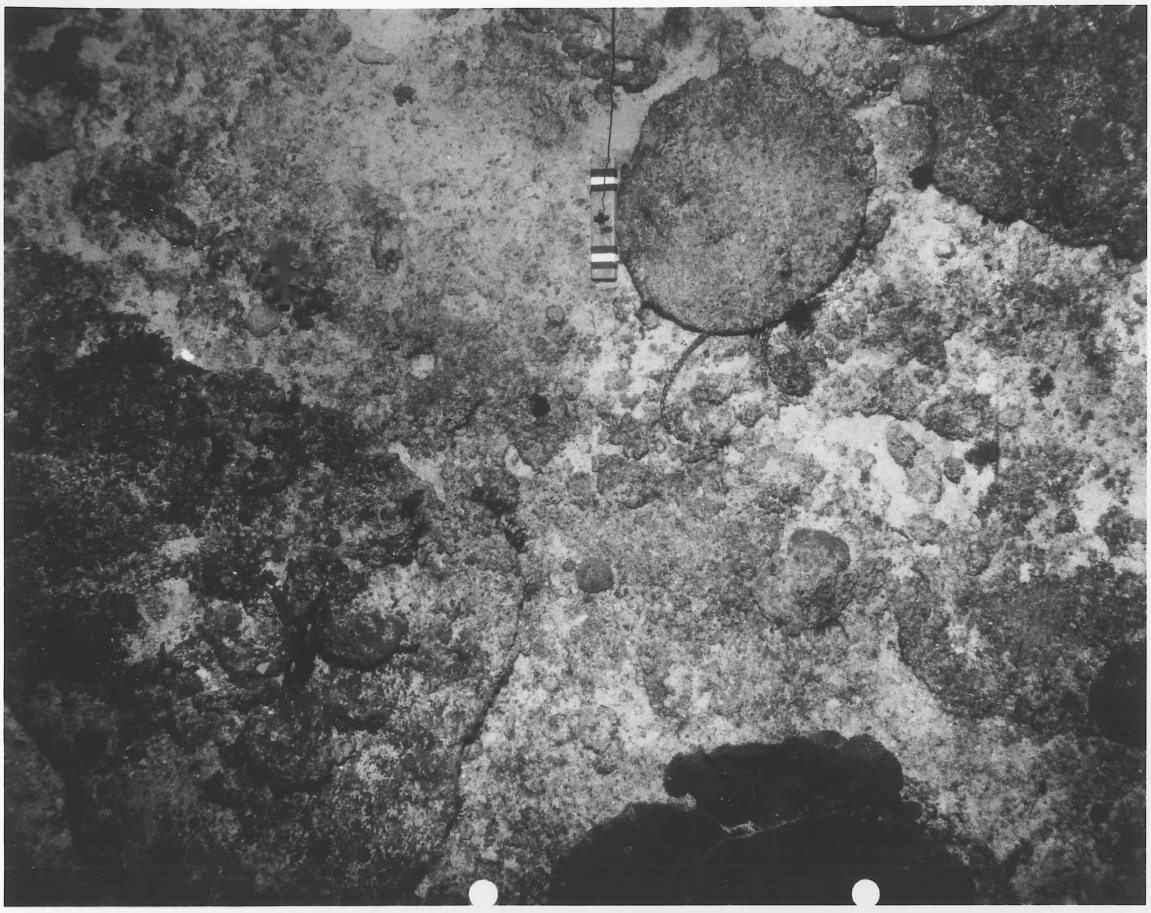

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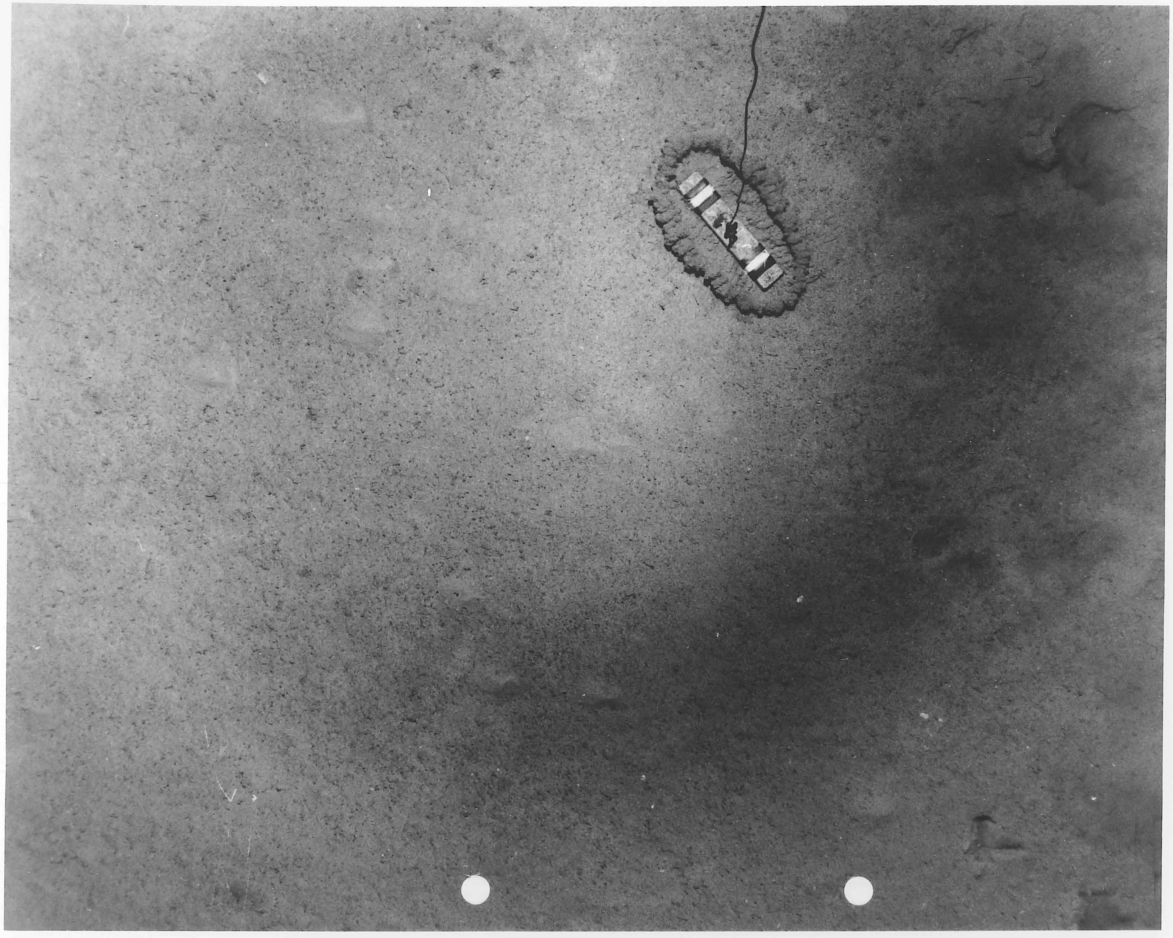

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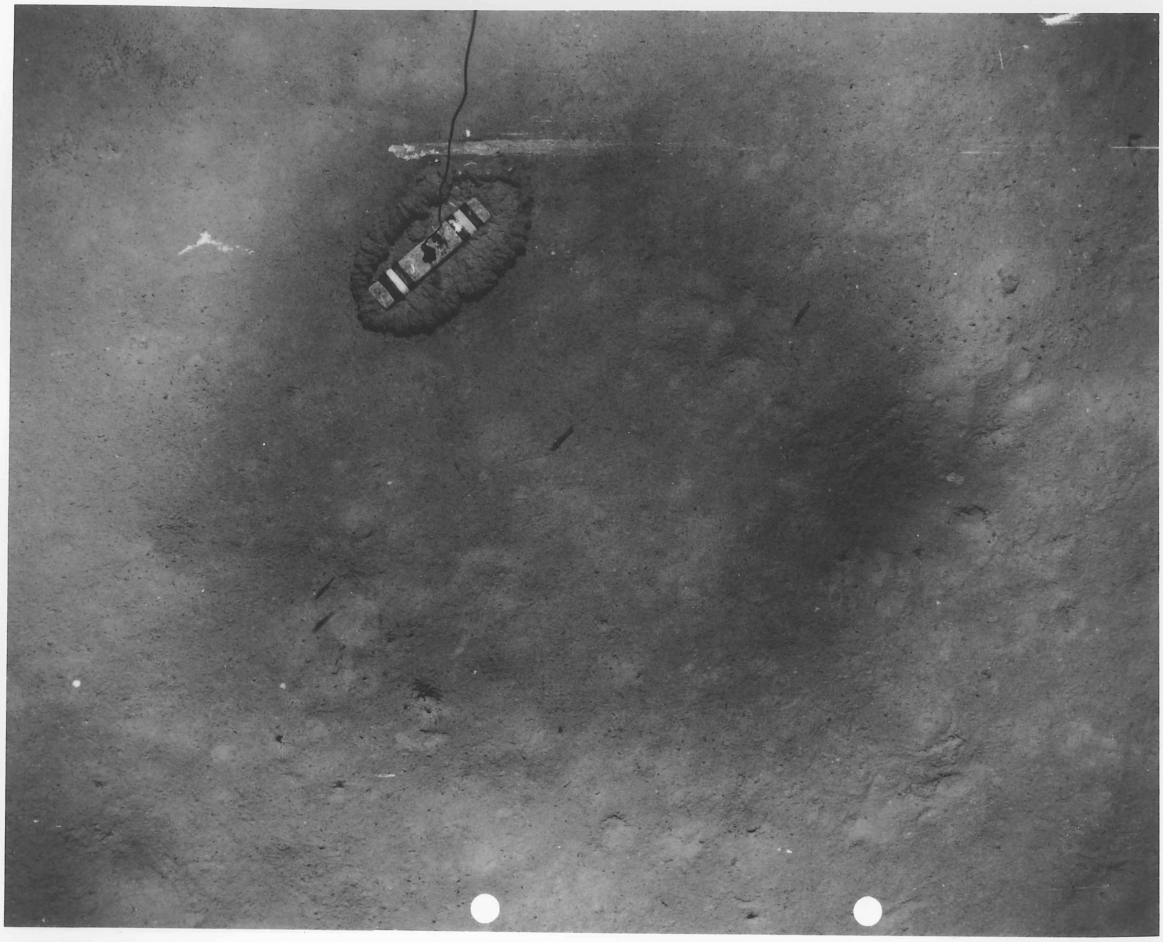

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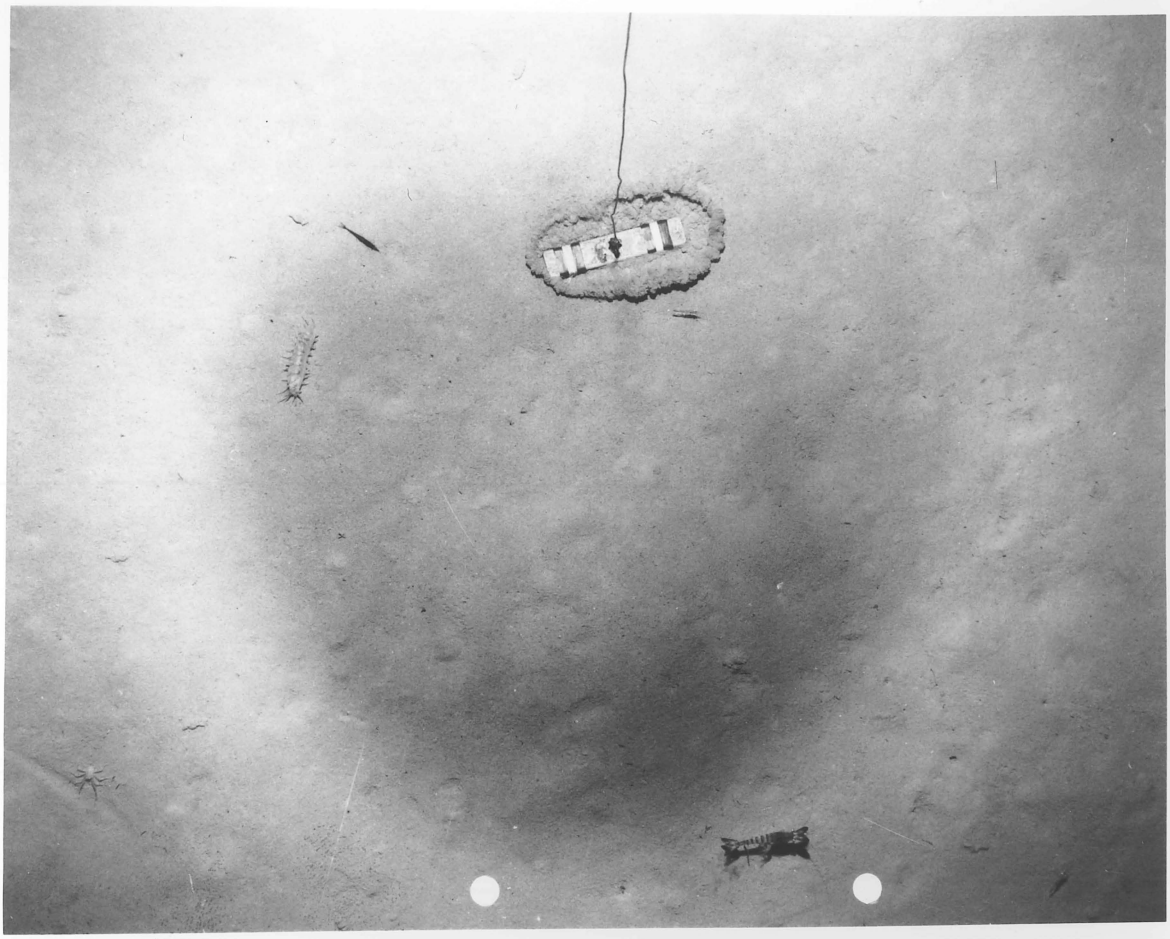

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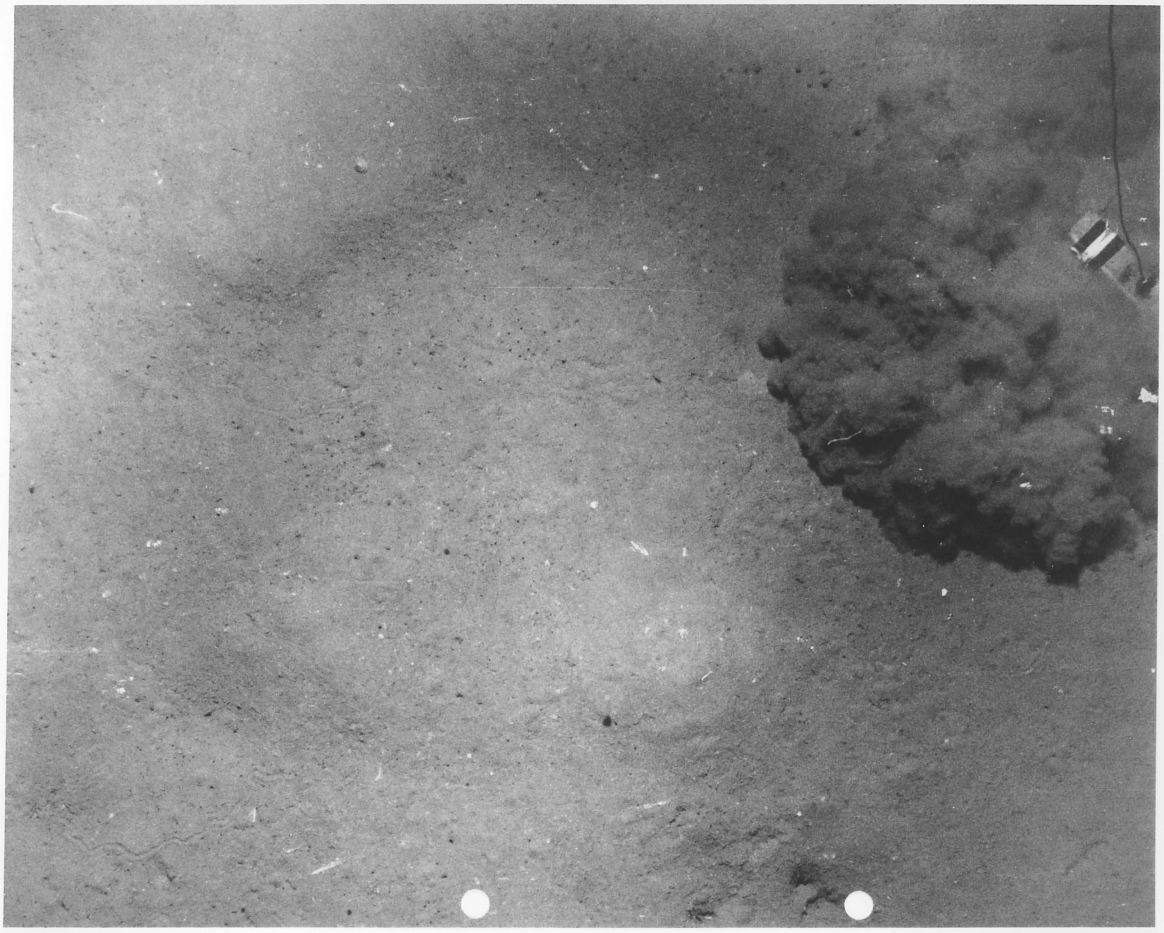
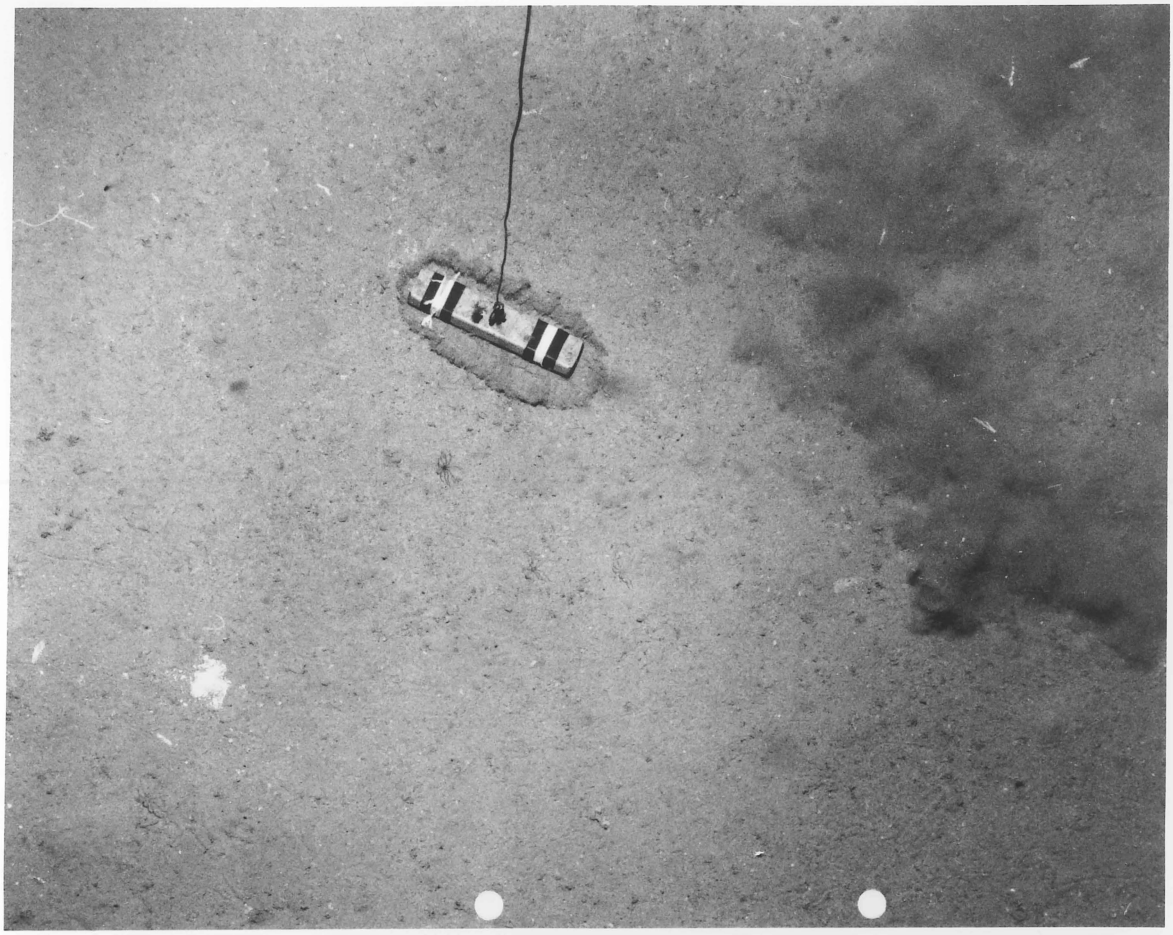


105/CM/033



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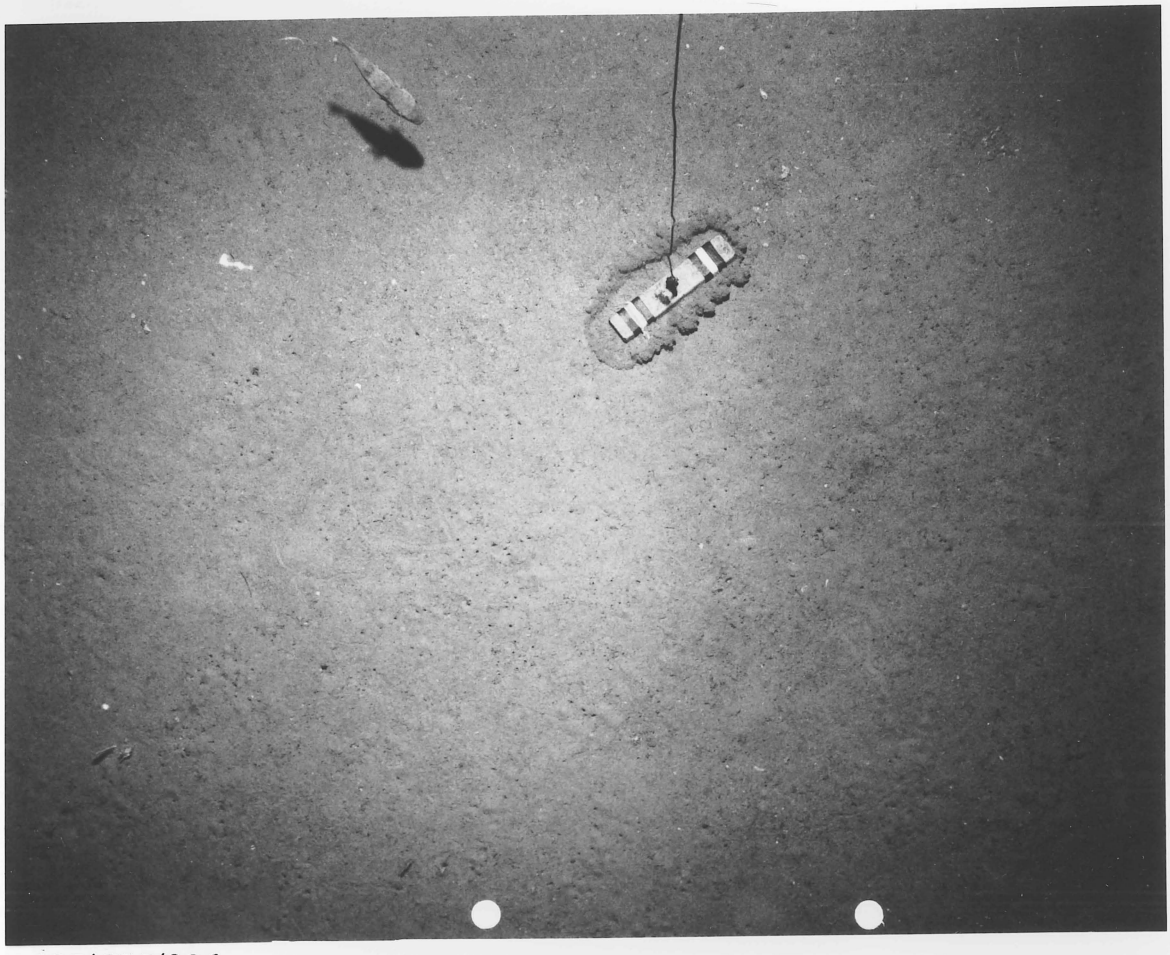
105/CM/035



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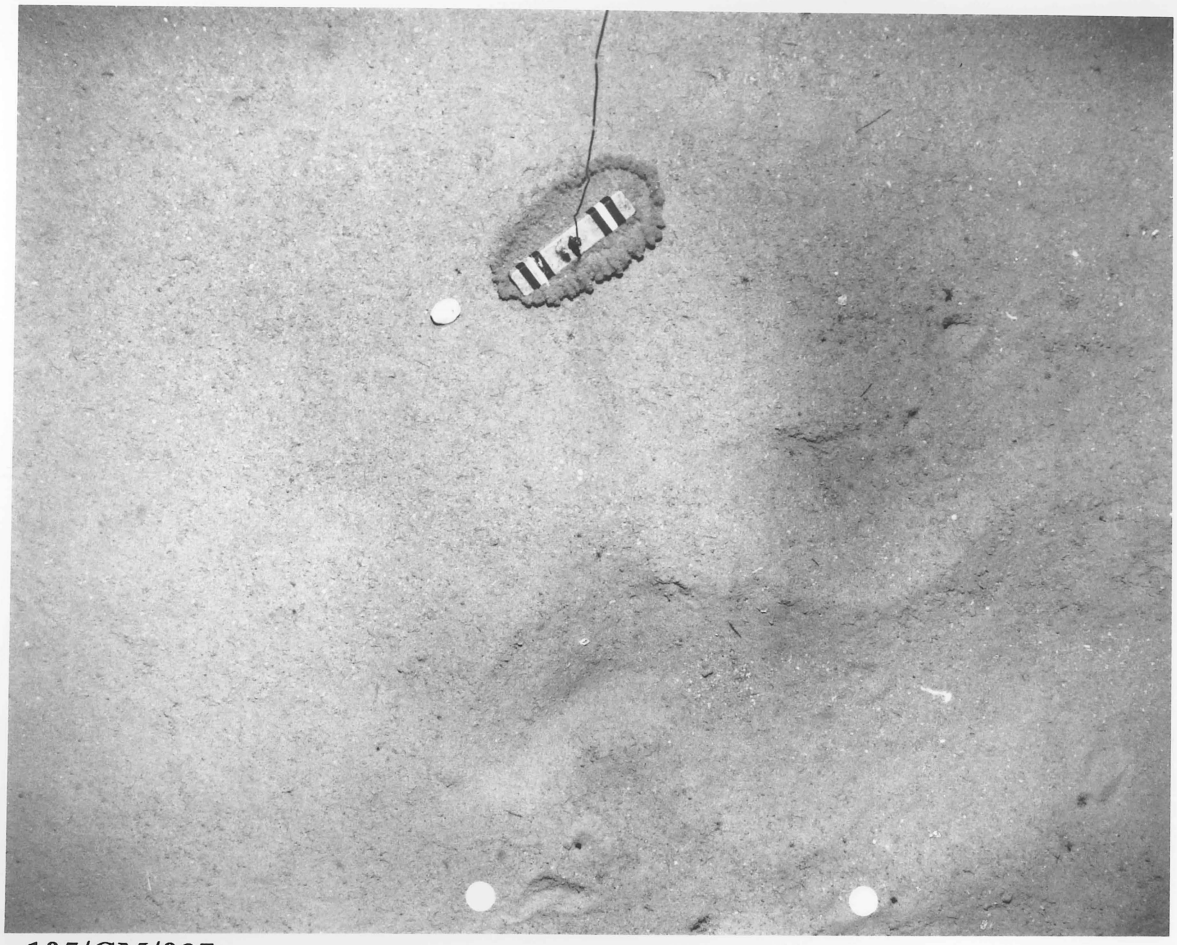
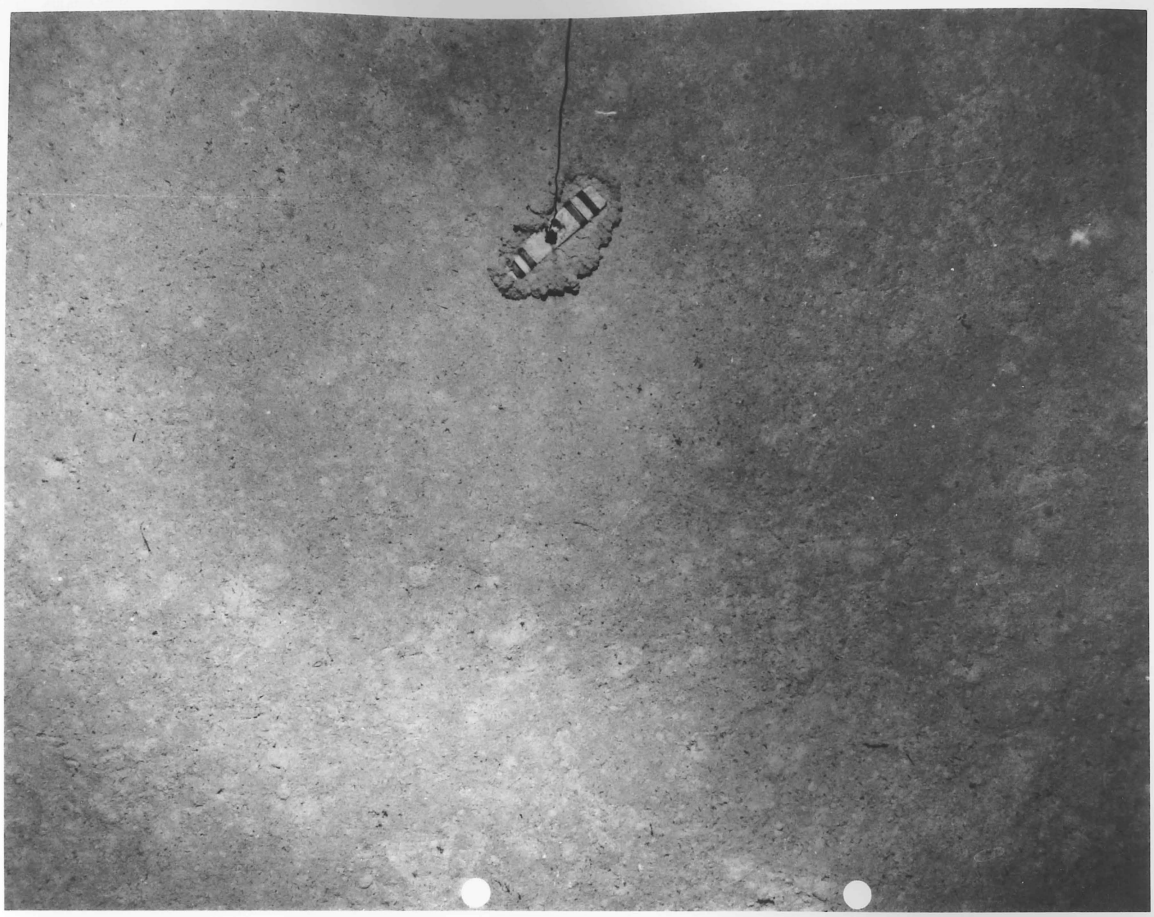


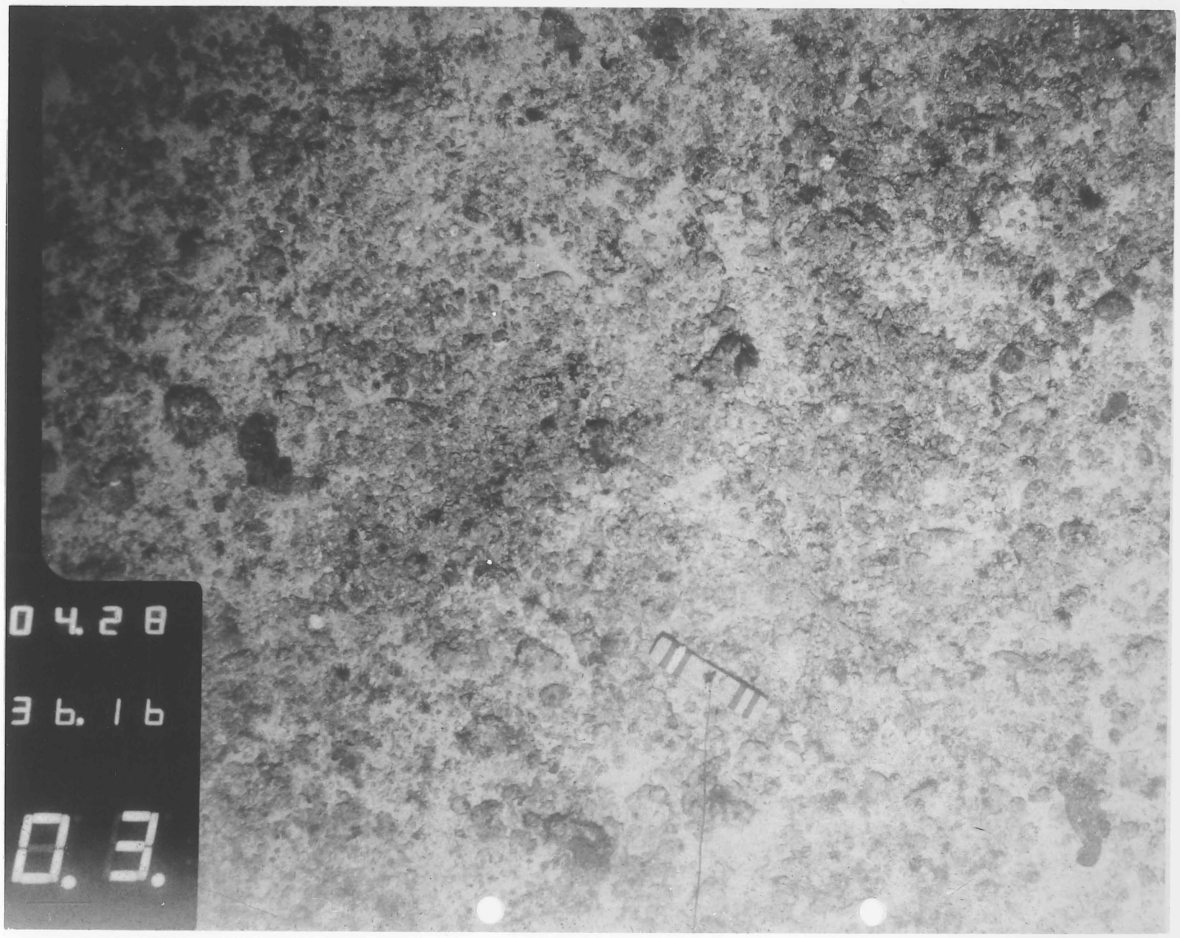
105/CM/037

105/CM/038



105/CM/039

105/CM/040



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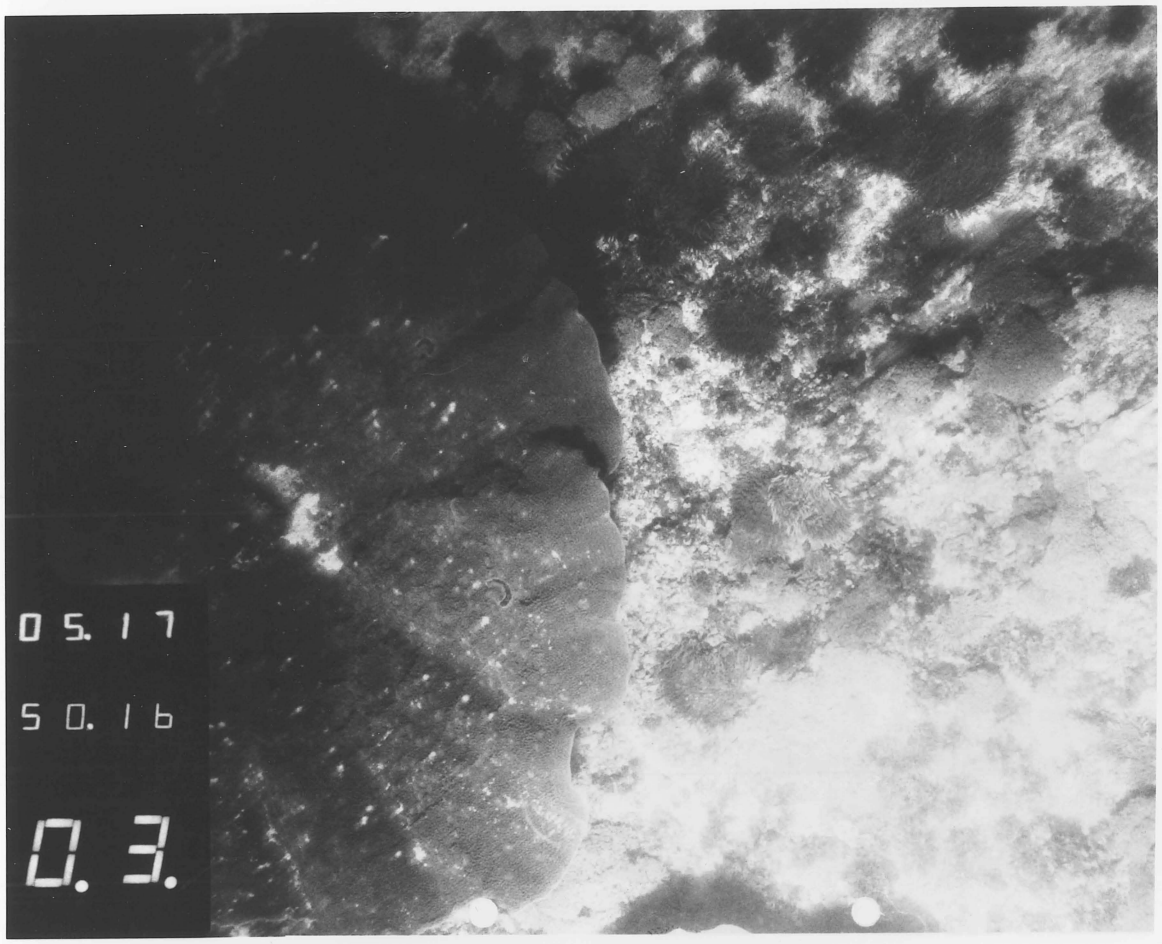
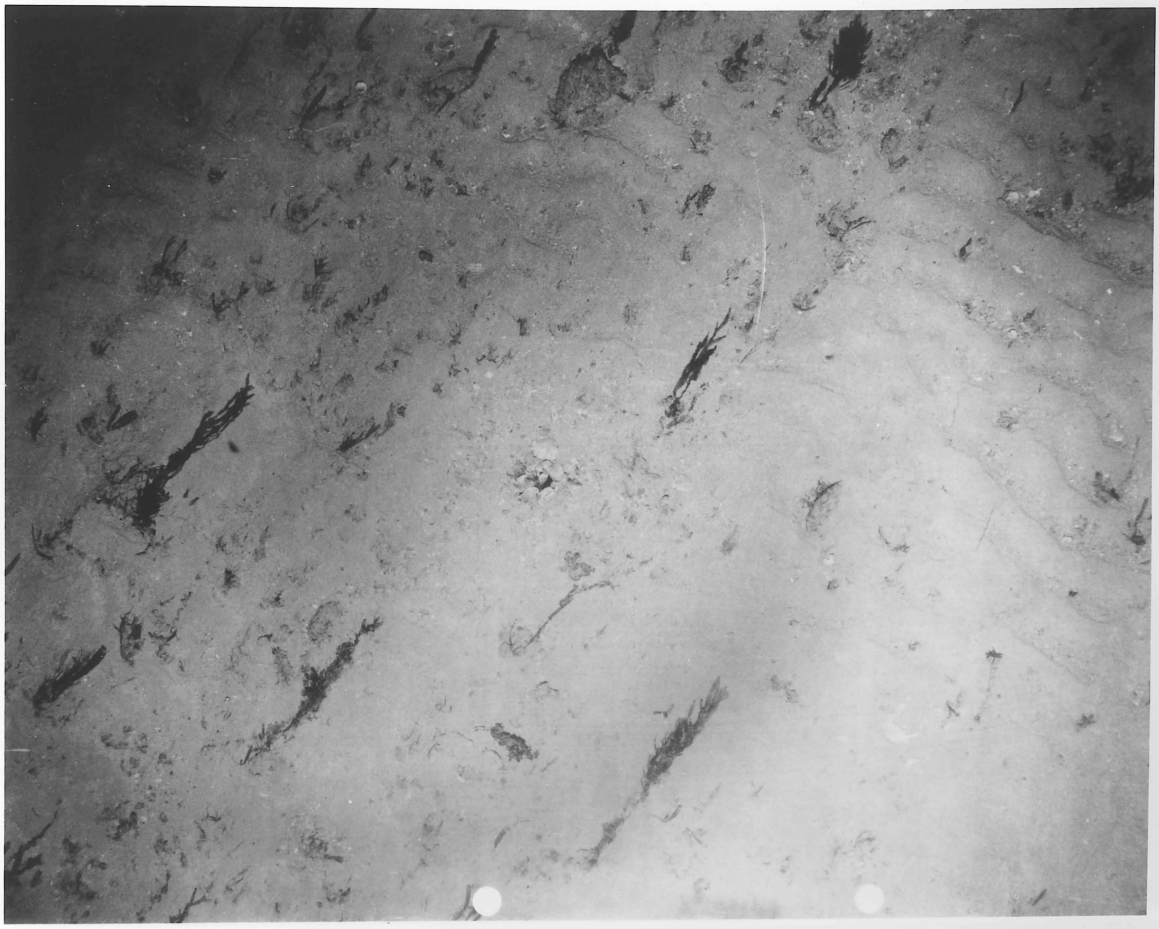
105/CM/043

105/CM/043



105/CM/043

105/CM/047



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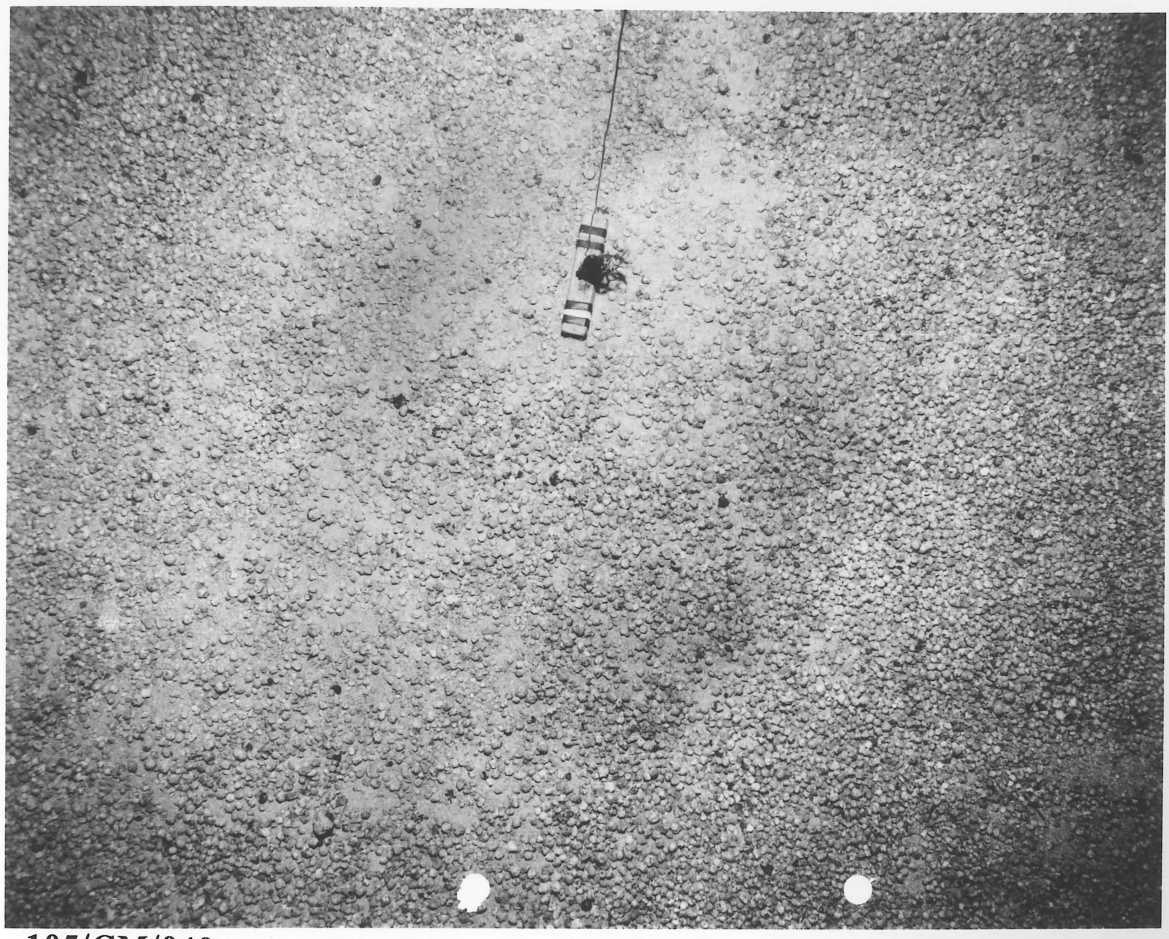

105/CM/049

Line 105/01 - East of Noosa Heads

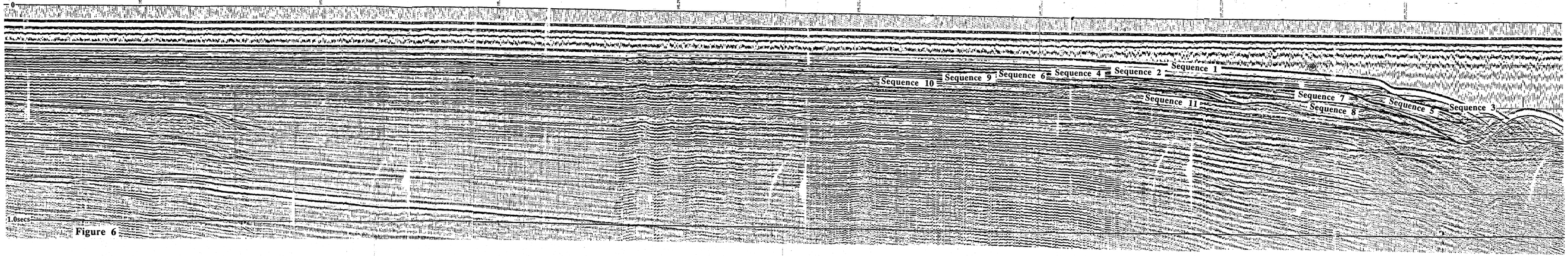

Figure 6

Line 105/05 - East of Noosa Heads

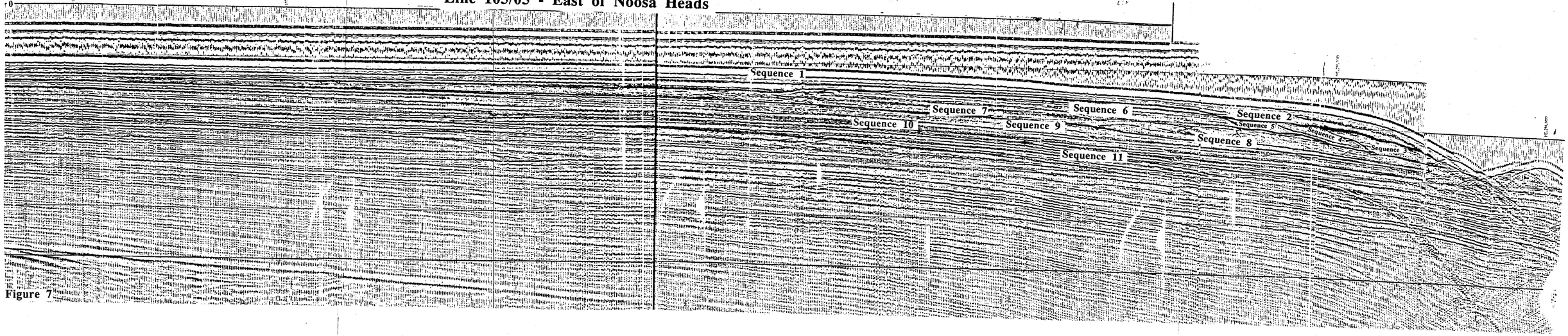

Figure 7

Line 105/06 - East of Noosa Heads

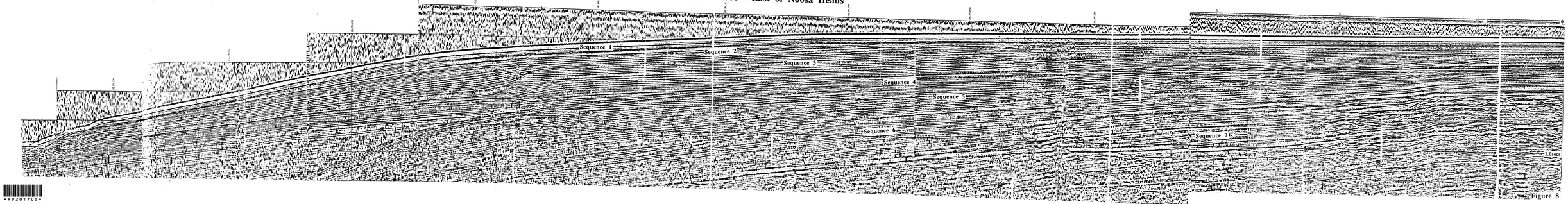

Figure 8

Line 105/08 - East of Noosa Heads

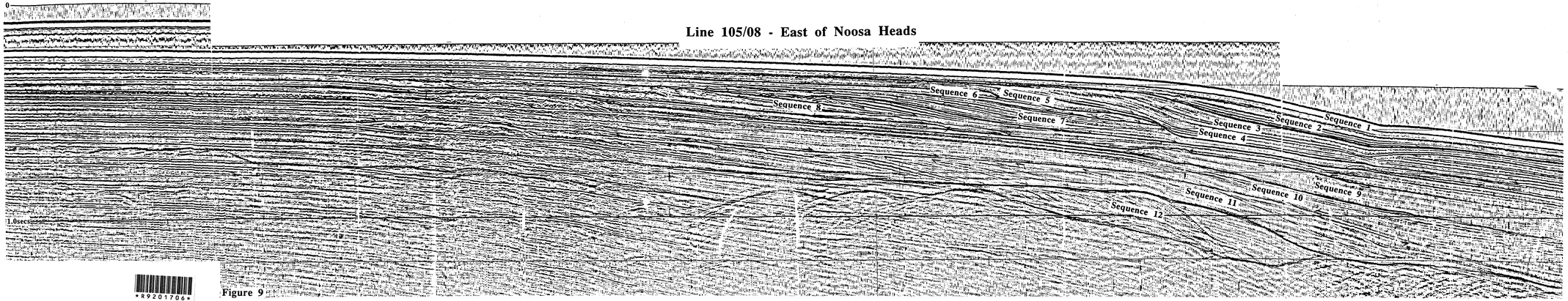

Figure 9

Line 105/09 - East of Noosa Heads

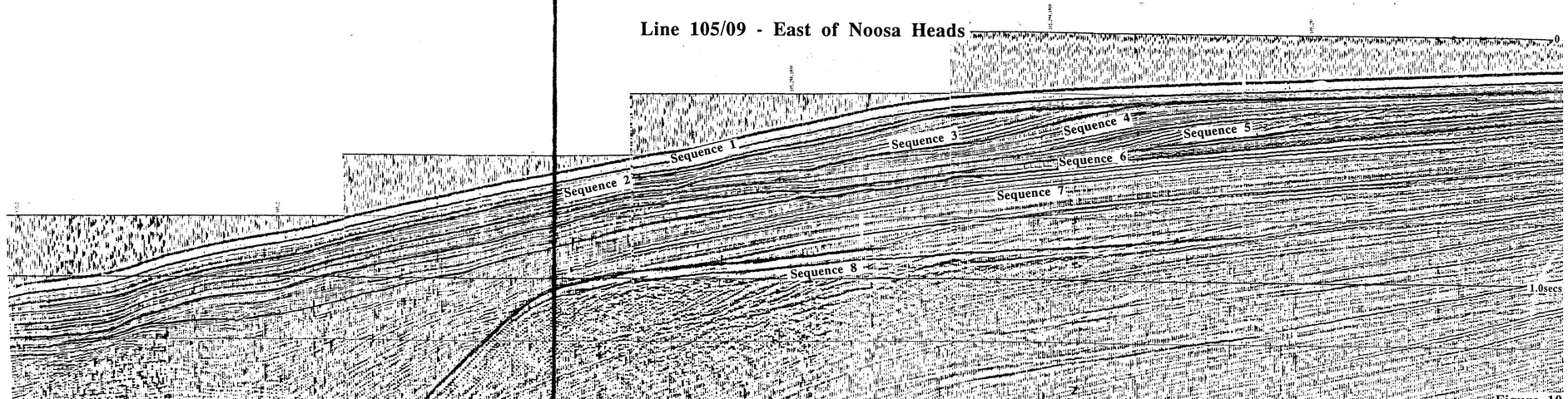

Figure 10

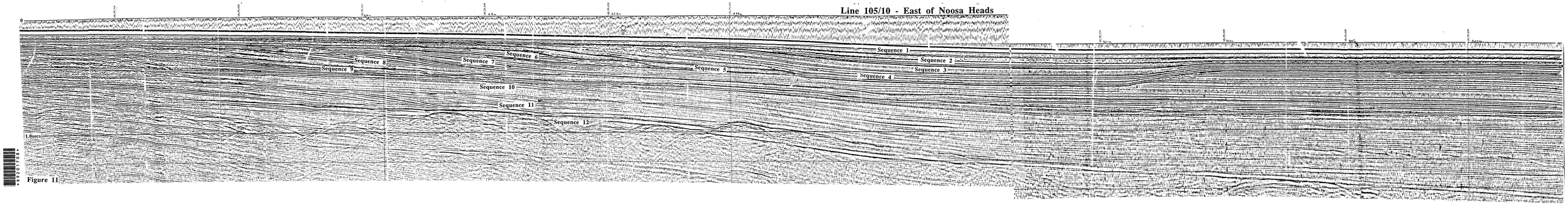
Line 105/10 - East of Noosa Heads
0
1.0secs
Sequence 1
Sequence 2
Sequence 3
Sequence 4
Sequence 5
Sequence 6
Sequence 7
Sequence 8
Sequence 9
Sequence 10
Sequence 11
Sequence 12

Figure 11

Line 105/17 - East of Fraser Island

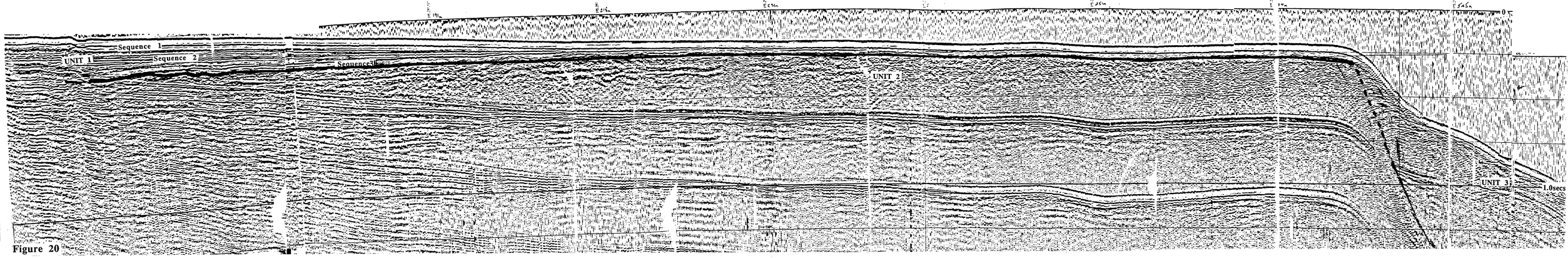

Figure 20

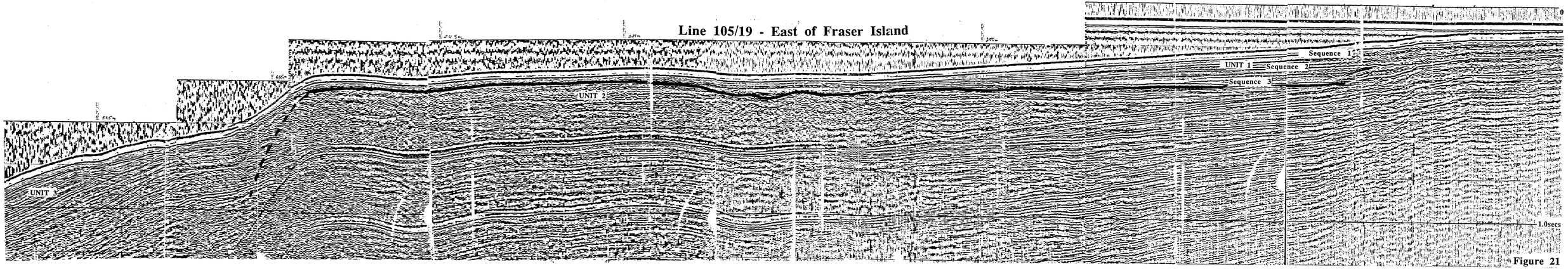

Figure 21

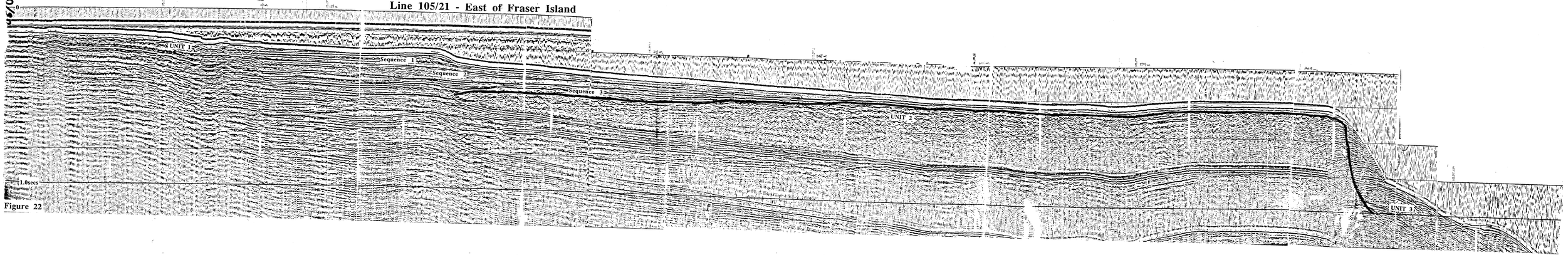

Figure 22

Line 105/23 - East of Fraser Island

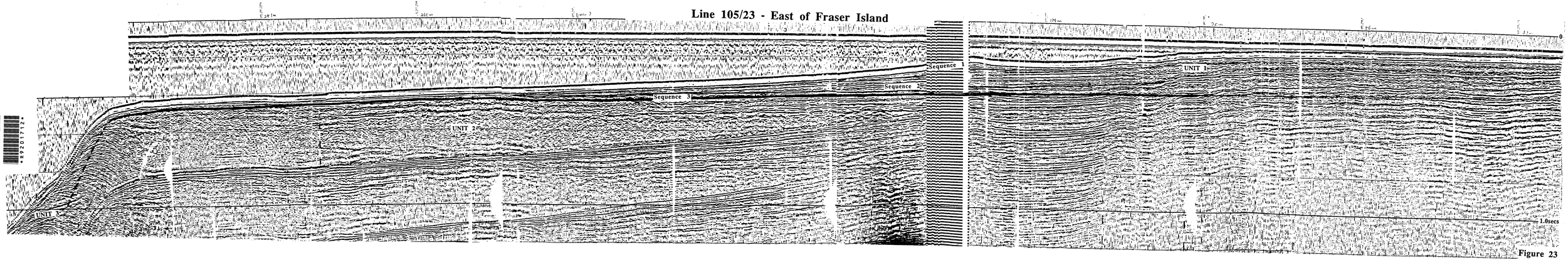

Figure 23

Line 105/25 - East of Fraser Island

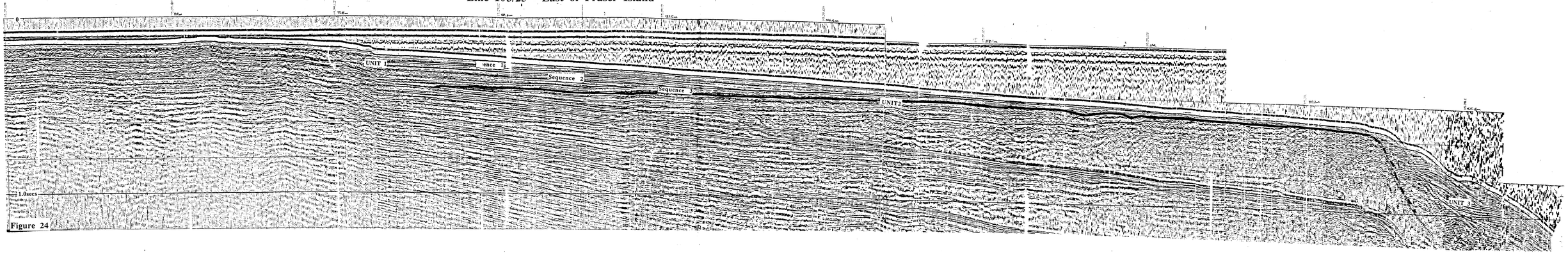

Figure 24

Line 105/27 - East of Fraser Island

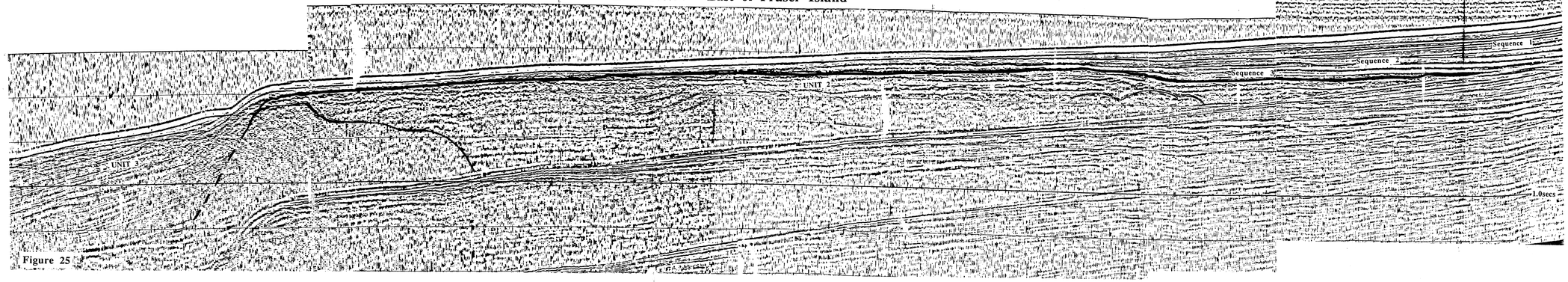

Figure 25

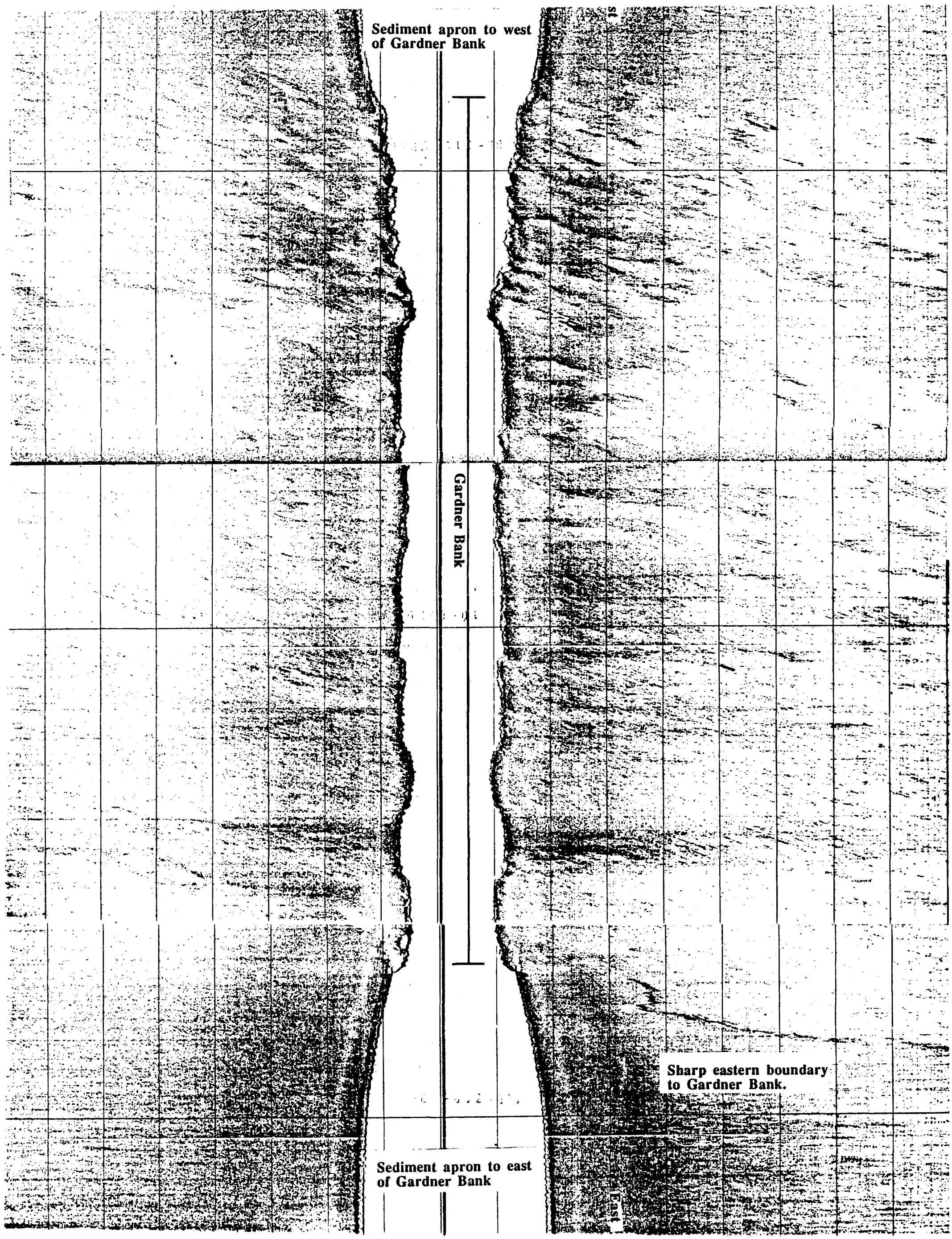

Figure 38 . Sidescan line 1 run from west to east across the top of the Gardner Bank. The scale from west to east is about two miles.

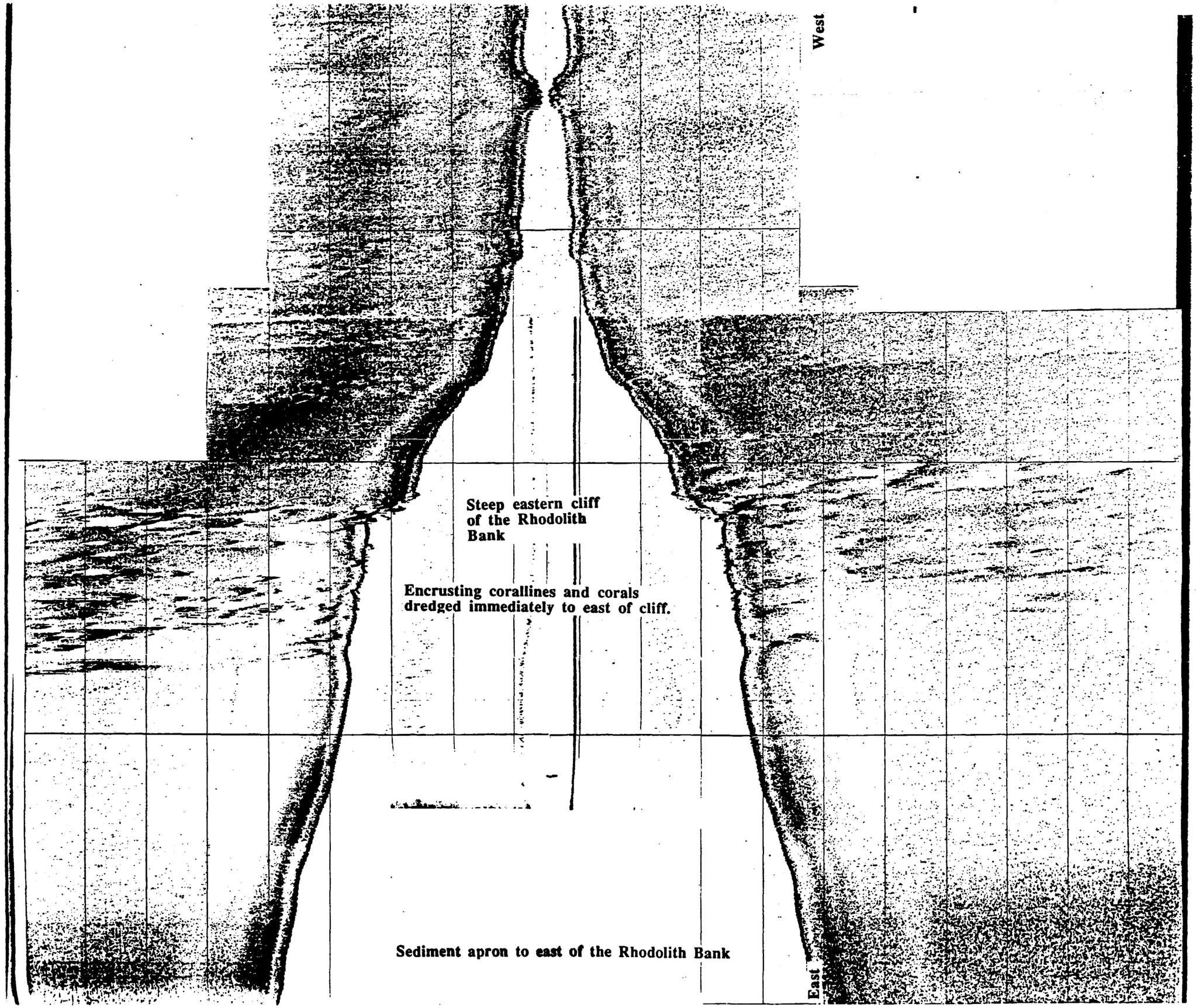

Figure 39. Part of sidescan Line 7 crossing the eastern edge of the Rhodolith Bank and its boundary with the deep shelf terrace. The scale from west to east is about one mile.