4. SEDIMENTARY UNITS

Seismic Stratigraphy

The thickness of post-glacial deposits was determined from shallow seismic profiles, supported by vibracore data (Fig.6). The deposits are 10m thick near the coast and thin seawards. In northern Trinity Bay off the Daintree River mouth this wedge extends at least 11km offshore where it surrounds the Low Islets. The wedge narrows to the north, and is only 2-3km wide north of Cape Kimberley. Thus the major locus of modern terrigenous deposition in the region is in Trinity and Alexandra Bays.

Figure 6 also shows the location of buried channels incised into the Pleistocene surface and now overlain by post-glacial deposits. The palaeo-Daintree River trends onto the shelf from the present river mouth and there is a smaller tributary west of the Low Islets. Thalweg elevations suggest that west of Low Islets a smaller channel flowed northward, probably marking the course of the palaeo-Mossman River rather than a branch of the palaeo-Daintree. There is also a wide system of small channels emanating from the Table-Bailay drainage area.

Three seismic sequences (P,T,R) separated by two persistent reflectors (A, B) can be recognised on the 3.5kHz profiles (Fig.7). The lower reflector is very uneven, outlines channels up to 18m deep and several hundred metres across, appears as a dark, shaded zone on the profiles, and generally forms acoustic basement (Fig. 7A,B,C.). We correlate this reflector with Reflector A of Orme and others (1978) and Johnson and Searle (1984). We interpret Reflector A as the eroded Pleistocene land surface which developed during the last sea-level low. The upper reflector, B, is planar and dips gently seaward (Fig. 7B,C,D).

Seismic sequence P is acoustically opaque to the 3.5kHz system (Fig. 7A,B,C), and its upper surface is marked by Reflector A. Sequence P lies at or just below the seabed on the mid-shelf, and is also exposed in the Penguin Channel west of Snapper Island, where strong tidal currents cause scour between the mainland and the Island. In general, sequence P appears to represent the incised Pleistocene alluvium. However on line 854C D there is a prominent peak of sequence P, which lies directly off Cape Kimberley and is probably bedrock. Further work deploying a boomer seismic profiler and vibracorer is needed to confirm the nature of sequence P.

Seismic sequence T is of very irregular distribution and thickness, bounded at the base by Reflector A and at the top by Reflector B. Internal reflections vary from finely layered and laterally continuous (Fig. 7A) to irregular (Fig. 7C). These internal reflections commonly lap out beneath or are truncated by Reflector B. Sequence T tends to fill channels and depressions, and is interpreted as fluvial and estuarine sediment backfilled in landscape depressions during the post-glacial transgression.

Seismic sequence R is a laterally extensive, lenticular to wedge-shaped body, with a maximum thickness of 10m, occurring 0.5-2.0km offshore, thinning landwards, onto the mid-shelf, and also to the north (compare Figs. 7B,C,D with 7E and F). Sequence R is bounded at the base by Reflector B and at the top by the sea-bed (Fig. 7C,D,E,F). Typically the sequence comprises a shoreward part which has seaward dipping reflectors, and a seaward part which is transparent. These two parts correspond to the sublittoral sand platform, and the inner shelf mud-belt, the two major zones of modern terrigenous deposition.

Hard bottom evidenced by dark seabed reflectors in the northern seismic profiles (Fig. 7E,F) may represent remnant highs in the Pleistocene landscape (i.e. sequence P), or they may be carbonate reefs developed at slightly lower sea level, perhaps the -9m shoreline of Carter and Johnson (1986).

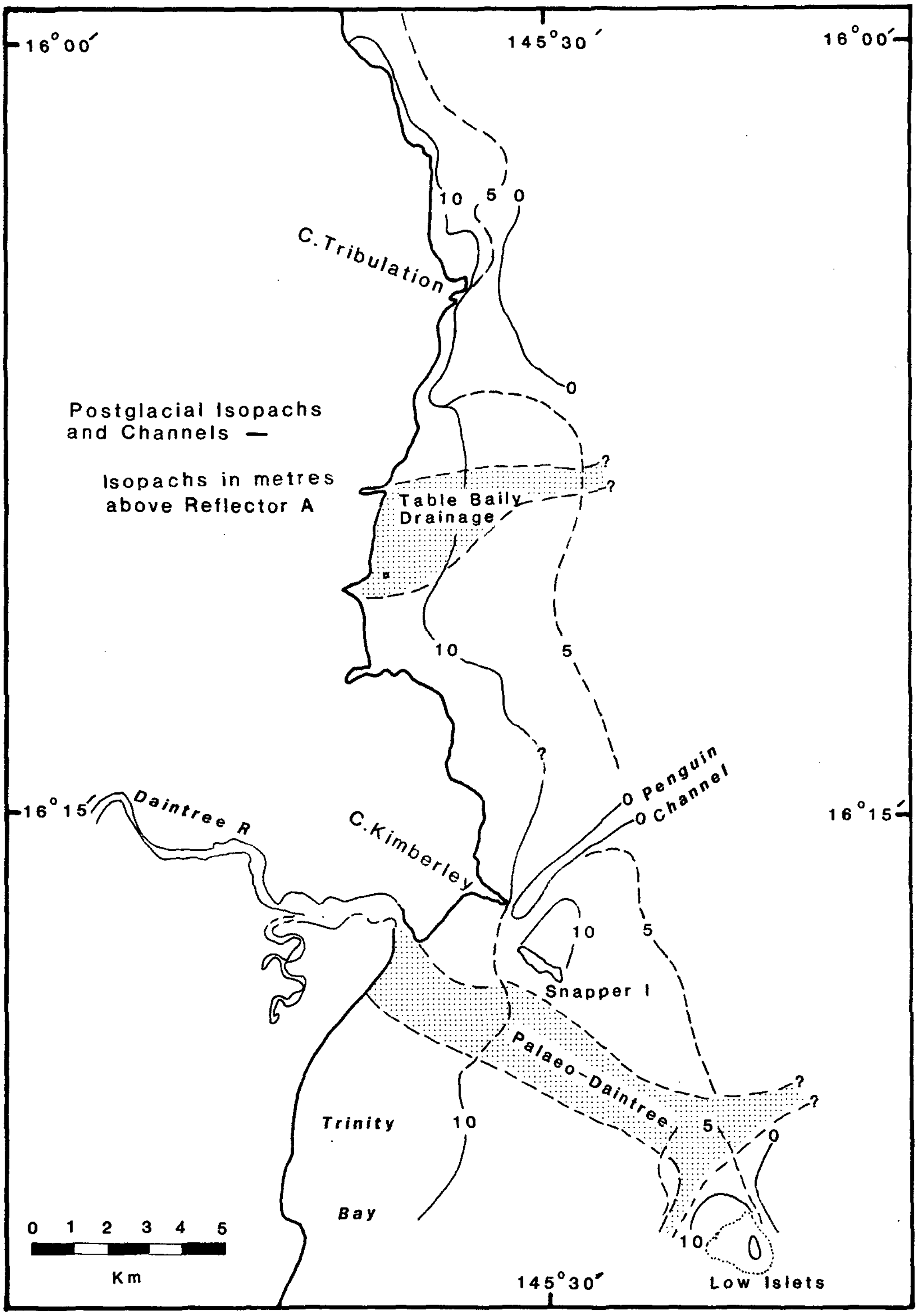

Figure 6. *Isopach map of post-glacial sediment overlying Reflector A, and location of buried palaeo-channels.*

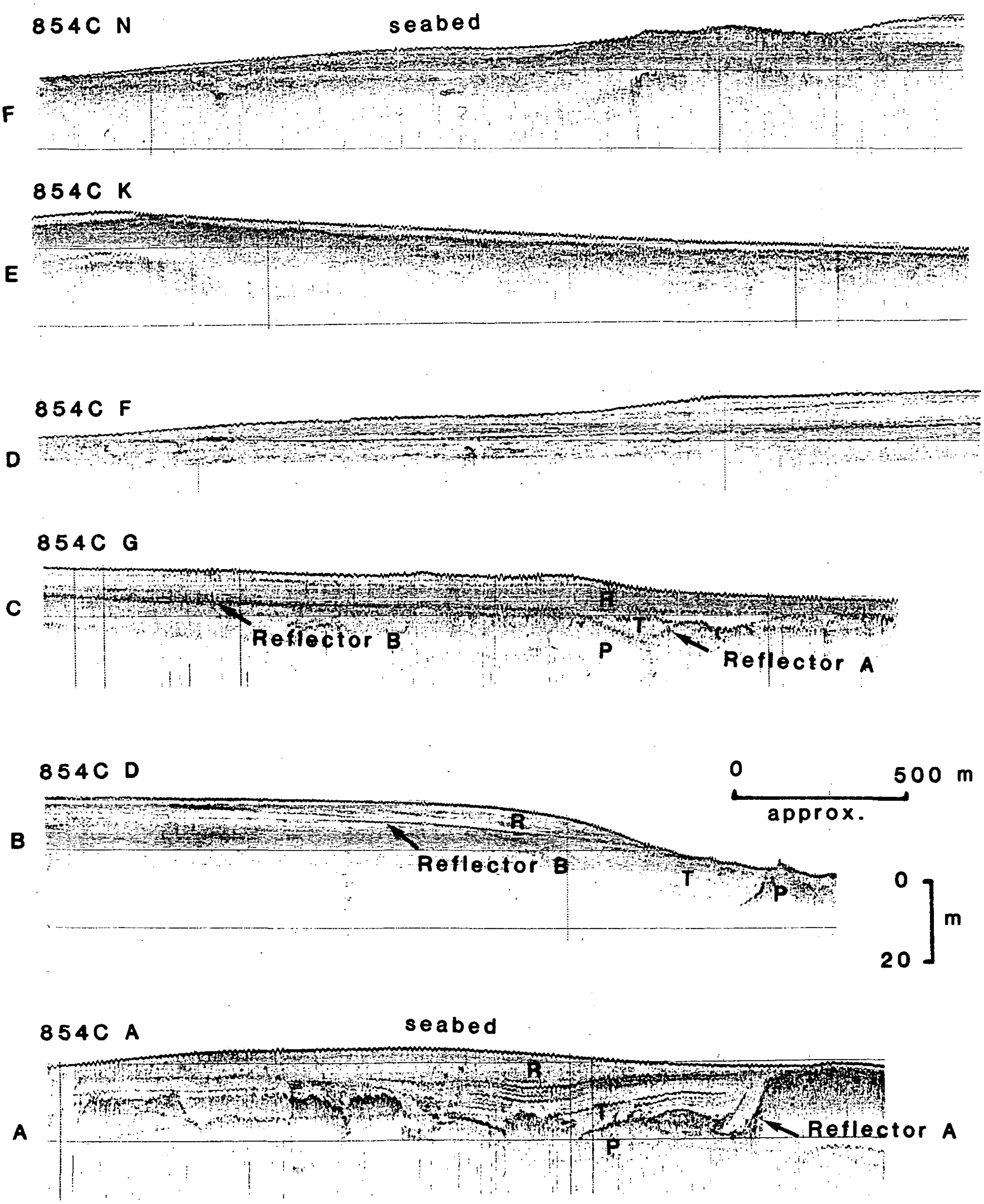

Figure 7. *Representative shallow seismic profiles, positioned from south to north. Profile A crosses the channel of the palaeo-Daintree River.*

All profiles stopped just seaward of the shallow water fringing reefs which would constitute a cap on sequence R. Thus sequence R is interpreted as deposition, at essentially stable sea level, of both terrigenous influx and subsidiary carbonates derived from the fringing reefs.

Sedimentary Units and Age Structure

Five stratigraphic units were intersected by the drilling (Figs.8,9) :

- Modern alluvium
- Beach-beach ridge sand
- Reef top unit
- Inner shelf unit
- Pleistocene unit

Textural data for the sediments are shown in Figure 10. Apart from the alluvial units, the major units are lithologically distinct. Both modern and Pleistocene alluvium samples are designated by the same symbol and show a wide range of compositions.

The **modern alluvium** is poorly-sorted, red-brown, commonly mottled, muddy sand with up to 50% gravel. The gravel fraction is granule to pebble sized lithoclasts of schist or Fe-oxide cemented fine sediment, probably reworked laterite. The sand fraction is consistently fine to medium sand-size, mainly clear/grey angular quartz, with minor Fe oxide cemented grains. Felspars are rare.

The **beach-beach ridge** sands are grey, well sorted, fine to medium, quartzose (80%) sand. Skeletal carbonate composes 5-15% of the samples and is mainly comminuted bivalve and coral debris. Gravel and mud fractions total less than 25% of the sample. Mica forms up to 5% of the sample in some layers, especially towards the base of the unit. An organic rich soil layer up to 0.5m thick with common pumice clasts is generally developed landward of high tide levels.

The **reef top unit** contains massive head corals and columns, surrounded by poorly sorted matrix. Drillhole 4 penetrated a Porites column 5m thick, and similar columns were encountered in other drilling in nearby reefs (B. Partain, *pers. comm.*). The matrix is composed of poorly sorted gravelly sands and sandy gravels, generally with less than 15% mud (one sample has 40% mud). The gravel fraction is composed of abraded coral fragments up to 50mm in size, with finer bivalve, gastropod, bryozoan and coral debris. Rare lithoclasts and plant material also occur. The sand fraction contains 50-90%, poorly sorted, angular, grey, very fine to coarse grained quartz. The skeletal carbonate comprises broken, but commonly fresh grains of foraminifera, bivalves, gastropods and echinoid spines.

The **inner shelf unit** is composed of muddy sand and sandy mud with less than 8% gravel. Two units are recognised in the cores, an upper unit (A), and a lower unit (B). Unit A contains 25-71% mud, and generally forms the seabed. The gravel is skeletal debris, mainly fresh bivalve, echinoid and crustacean material with minor plant detritus. The sand fraction is dominantly (85- 95%) clear, angular, fine quartz with minor micromolluscs, benthic foraminifera, echinoid fragments. Unit B contains 52-87% mud. The gravel is a variable mixture of skeletal debris (molluscs, echinoids, corals, bryozoans) and yellow quartz grains. The sand fraction contains 50-95% clear, angular quartz, with minor mica and plant detritus. The skeletal grains are foraminifera, echinoids and bryozoans. Towards the base, unit B has medium to coarse quartz and Fe-oxide cemented grains, which have been reworked from the underlying Pleistocene alluvium.

The **Pleistocene alluvium** is composed of gravelly and sandy mud with 85% mud. The sediment is generally mottled red brown/ochre/grey with gravel sized discoloured quartz clasts and Fe-oxide cemented fine sediments (?laterite). Poorly sorted, very fine to coarse quartz grains, Fe-oxide grains and minor mica are present, but no skeletal carbonate.

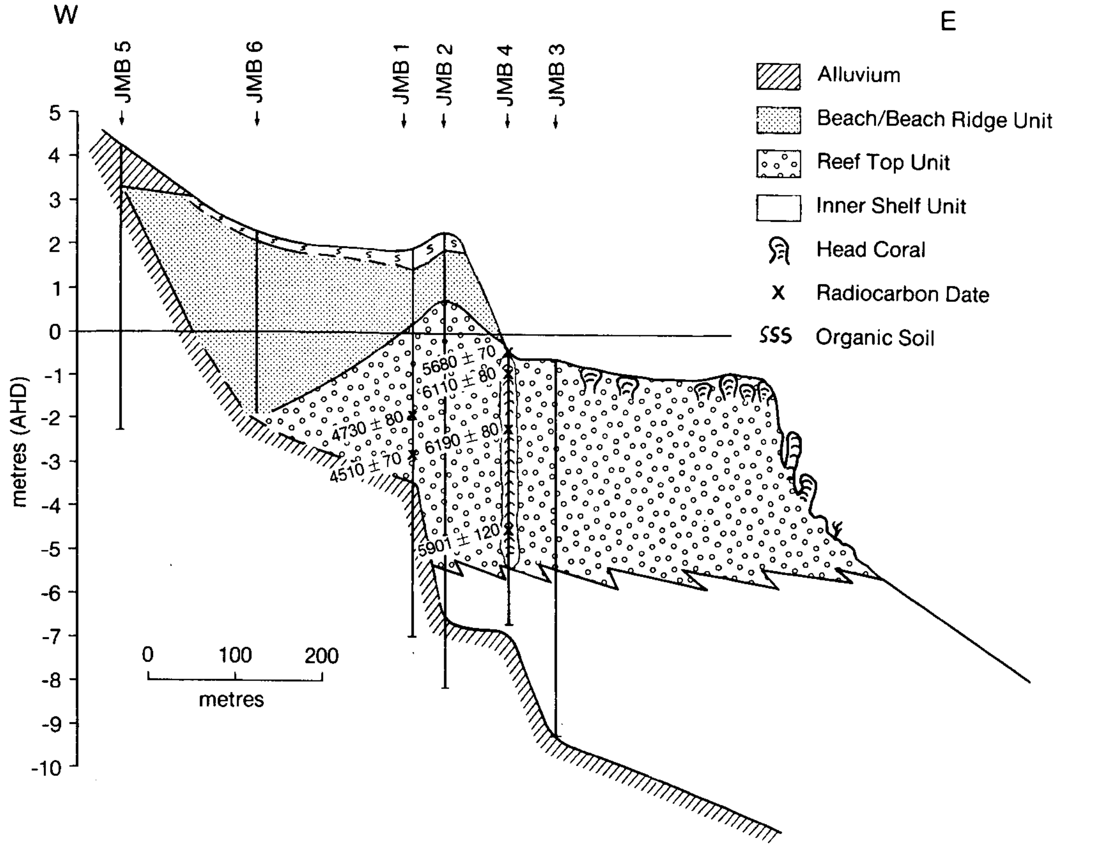

Figure 8. *Stratigraphy of coastal fringe as determined by augur drilling. Drillhole locations are shown in Figure 3.*

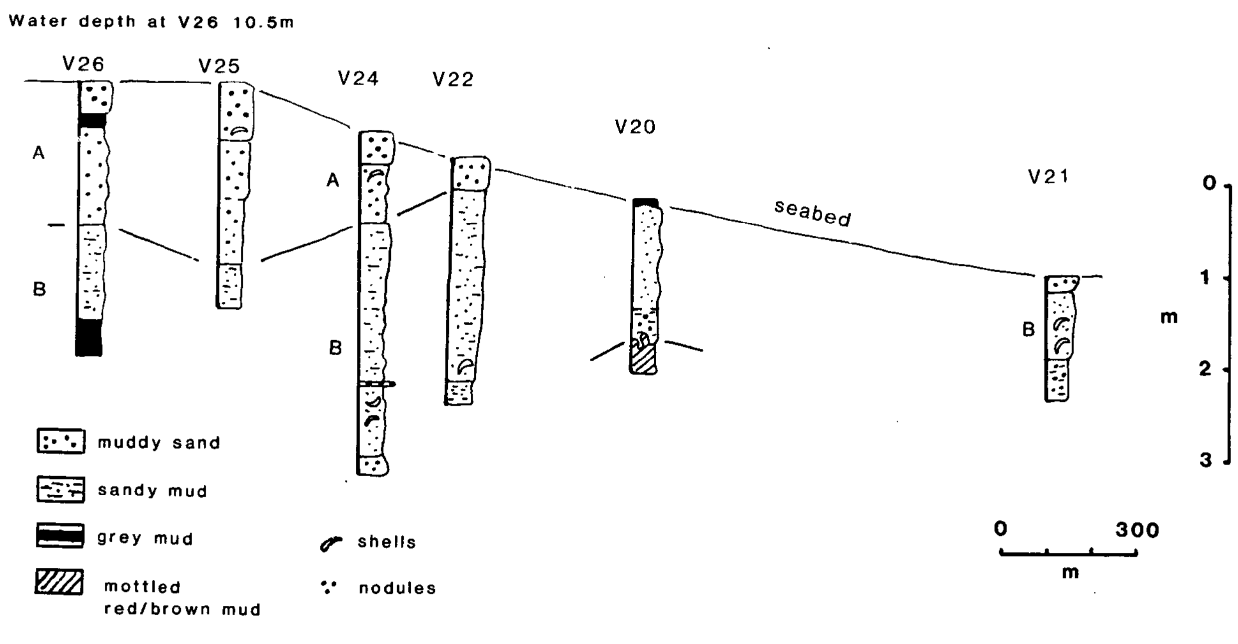

Figure 9. *Inner shelf stratigraphy determined from vibracores. Core locations are shown in Figure 2.*

The onshore drilling shows the reef top unit is overlain to landward by the beach-beach ridge sands, which are in turn overlain by a wedge of modern alluvium (Fig.8). This sequence unconformably overlies Pleistocene alluvium. Unfortunately the layers immediately overlying the unconformity were sandy and water-saturated, and could not be recovered, so the nature of this stratigraphic level is not known as well onshore as it is offshore.

The offshore vibracores show that the inner shelf unit thins seawards, and that it consists of unit A developed mainly nearshore, and unit B developed further seaward. Unit B is generally muddier, as would be expected of the more seaward deposit, but it also contains sandy sediment admixed from a basal transgressive sand sheet, itself derived from reworking of Pleistocene alluvium.

Radiocarbon dating of samples from the inner part of the fringing reef section (Fig.8, **Appendix III**) shows the reef top unit commenced accumulating at least 6000 yr BP, and that the coral column in drillhole 4 grew upward and was later encased in the matrix sediment. The top of the column and several surrounding microatolls at the same level on the sandflat have planar tops at -0.6m (AHD). This level is approximately 0.8m higher than modern coral growth, and coincides with data of Chappell and others (1983) from further south in the central Great Barrier Reef which showed a late post-glacial sea-level high of +1m around 6000 yr BP. The raised, dead coral platform at the outer margin of the fringing reef is also higher than modern coral growth, indicating growth at a slightly higher sea-level.

Nature of the Clay Fraction

The high terrigenous content of all the sedimentary units indicates that the Cape Tribulation fringing reefs have developed in an environment of consistent terrigenous influx. Fine to medium quartz sand constitutes 50% of the sand fraction in all units.

The mud is also dominantly non-carbonate (Fig.10, **Appendix IV**). Most samples contain % acid-soluble material, and those with 20-50% come from the reef top unit and the beach-beach ridge sand. X-ray diffraction analyses show the clay-size carbonate is a mixture of calcite, magnesian calcite and probably aragonite. The calcite may be derived from bioerosion of oysters, reworking of soil carbonate from Pleistocene alluvium, or contemporary input.

The mineralogy of the terrigenous clays was investigated by X-Ray diffraction to test whether such a technique could be used to trace modern inputs (**Appendix V**). The terrigenous clays are a mixed assemblage.

Preliminary sampling of the contemporary input indicates two assemblages. The first is composed of abundant kaolinite and illite/illite-smectite mixed layer clays, and rare smectite. The second is characterized by abundant hydromica/vermiculite and vermiculite-mixed layer clays, with common kaolinite and illite, and lacking smectite. In summary, contemporary input appears to be dominated by kaolinite, hydromica/vermiculite, subsidiary mixed layer I-S clays, and only rare smectite.

Modern marine beach/beach-ridge, nearshore and inner shelf clays are characterized by common to abundant smectite, smectite/illite mixed layer clays and large d-spacing material. Kaolinite is common to abundant and illite common. This marine clay mineral assemblage contains minimal amounts of smectite, and is distinctly different to that being discharged to the sea by coastal creeks in the area, and by the Daintree River. However, in the beach/beach-ridge sediments onshore there is also a mixed-layer smectite/vermiculite, from which develops a discrete vermiculite phase down the hole.

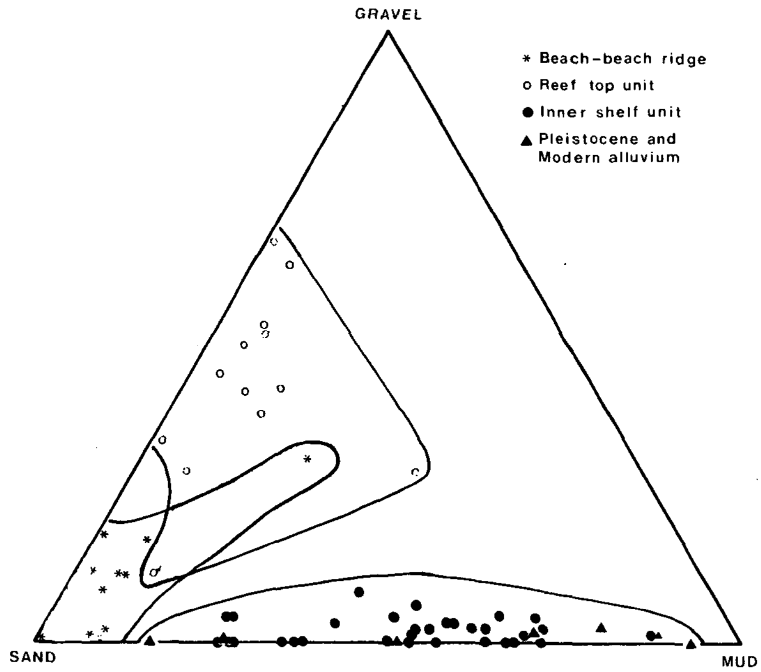

Figure 10. *Ternary diagram showing gravel, sand and mud contents of sediments from auger and vibracore samples. Shading delimits samples from the same environments.*

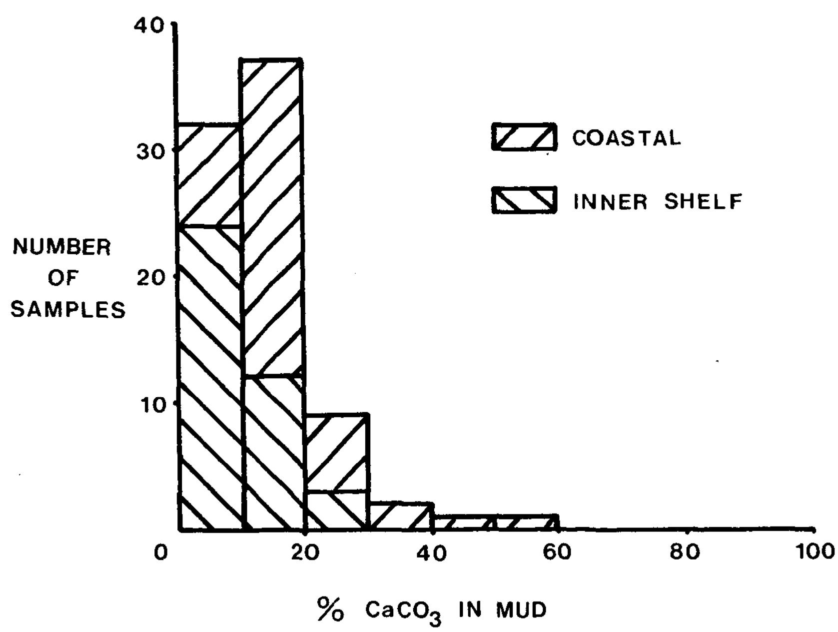

Figure 11. *Acid soluble (calcium carbonate) percentages of muds.*

The mottled muddy sediment underlying the inner shelf unit is dominated by kaolinite and illite, with hydromica and beidellite-kaolinite mixed layer clays. Smectite and smectite- mixed layer clays are rare. This assemblage is also typical of the Pleistocene unit recovered by auger drilling under the shoreward edge of the present coastal plain. However, onshore, kaolinite is even more dominant over illite. This clay mineral assemblage is more like the contemporary input and its composition suggests formation in a weathered kaolinite-rich soil horizon. Thus it seems clay minerals cannot be used to trace the discharge of individual drainage systems in this area.

In summary both the modern terrigenous inputs and the mottled muds are dominated by kaolinite/illite assemblages, while the modern marine sediments are dominated by smectite and illite- smectite mixed layer clays. It is unlikely the modern clays are being selectively transported away from the immediate offshore area. The different assemblages are probably due to rapid diagenesis of the clays when they are immersed in the marine environment.

5. DEVELOPMENT OF THE CAPE TRIBULATION AREA FRINGING REEFS

The Cape Tribulation area fringing reefs are developed mainly on coastal sediment bodies. The reef appears to grow as an irregular, indented wall which builds seawards, and is later encased in detrital material. The present reef margin has a deeply-incised spur and groove morphology with isolated coral colonies growing seaward of the reef edge. The drillhole data show the subfossil reef-flat also contains coral columns surrounded by detrital sediment, supporting this interpretation. Modern coral growth is generally in water depths shallower than ca 6m below AHD. Such a limited depth range of coral growth is consistent with other data from the literature amd with the turbid waters commonly observed during fieldwork. Thus the reef-top unit has a potential thickness of ca 7m and is prograding seawards over muddy deposits of the inner shelf unit.

Reef accumulation is very similar to other fringing reefs from the Great Barrier Reef region described previously by Hopley and others (1983) and Johnson and Risk (1986). Carbonate-rich reefal deposits are prograding seawards over finer grained, terrigenous sediments which are accumulating on the inner shelf seaward of the fringing reef. Sandy beach and beach ridge sediments are being deposited to landward by shoreward transport of skeletal carbonate across the reef flat, and by longshore transport of terrigenous sediment from river and creek mouths.

The reefs have grown throughout their history in an environment of heavy terrigenous influx. Sediments of all units have terrigenous contents greater than 50%, and in many cases greater than 80%. Data from continuous cores through the inner shelf unit show the carbonate content of the mud is highest (17- 26%) in the surficial sediments at the deeper water edge of the inner shelf unit. The carbonate content of the mud is generally constant, in the range 1-11% throughout most of the unit, indicating there has been little change in terrigenous influx during accumulation.

We interpret the dead columns and microatolls on the reef-flat, and the dead raised reef-margin, as representing corals stranded by the mid- Holocene fall in sea-level. Similar emergent, subfossil reefs also occur further south (Chappell and others,1983; Johnson and Risk,1986). The Cape Tribulation "fringing reefs" in fact lack live coral on the reef-flat and crest, and contemporary coral growth is restricted to the fore-reef slope.