

## 5 CARBONATE SEDIMENTS

### 5.1 Definitions

Coral sand is the most sought-after carbonate sediment for the marine aquarium trade in north Queensland. It is derived from the break-down of the skeletons of hard corals and other calcareous skeletons, and as such is a marine product. There are several carbonate sediment marine products described in section 6 of the Queensland Fisheries Act 1976-1989 as follows:

'coral' means coelenterate animals of the class Anthozoa: the term includes the uncompacted skeletons of those animals;

'coral limestone' means a calcareous deposit derived from coral or other marine product but does not include shell-grit or star sand;

'shell-grit' means the broken remnants of sea-shells;

'star sand' means a form of sand composed of the calcareous skeletons of the unicellular animals known as foraminifera.

Collection of these marine products from Queensland waters is licensed under the terms of section 35 of the Act by the Division of Fisheries and Wetlands Management of the Department of Primary Industries (DPI).

### 5.2 Use of carbonate sediment in marine aquariums

Spotte (1973, 1979) describes the uses of, and requirements for, carbonate sediment in marine aquariums. The sediment is used as a substrate layer about 8 cm thick, and it functions as a buffer to maintain both seawater alkalinity and a pH of about 8.3. The buffering properties of the sediment decline over time, and replacement is necessary within about 2 years.

The characteristics of suitable carbonate sediments listed by Spotte (1973) are:

- i) calcium carbonate ( $\text{CaCO}_3$ ) and magnesium carbonate ( $\text{MgCO}_3$ ) content,
- ii) grains 2-5 mm in diameter,
- iii) uniform sized grains (graded, or well sorted) and
- iv) grains of a rough and angular shape.

Crushed coral is particularly good but crushed shell and dolomite rock are also suitable. Limestone rock contains little  $\text{MgCO}_3$ , and is less desirable. This report considers potential sources of biogenic carbonate sediment, namely coral and shell materials.

### 5.3 Demand for carbonate sediments

Discussions with aquarium trade retailers indicate that there is a steady demand for carbonate sediment in north Queensland, although this appears to be mostly in the Townsville area. Retailers between Cairns and Mackay stock coral sand, but further south they deal mainly with shell-grit obtained from Hervey Bay. Costs of obtaining the material are high, and at \$0.70/kg coral sand is considerably more expensive than the \$0.20/kg charged for shell-grit by retailers in southern Queensland.

Demand for coral sand comes mainly from hobby aquarists. The total amount of sand required by these hobbyists is not known, but the needs of a typical individual aquarist can be assessed. Assuming two large display tanks (2 m x 1 m basal area) with 10 cm of coral sand the total volume of sediment required amounts to  $2 \times 1 \times 0.1 \times 2 = 0.4 \text{ m}^3$ . Allowing for renewal every two years this amounts to an annual requirement of  $0.2 \text{ m}^3$ . Assuming a coral sand density of 1.5, this represents an initial requirement of 600 kg and a further 300 kg of sediment per year.

There have been occasional demands for large volumes of coral sand by commercial aquarium operators. For example, the Great Barrier Reef Aquarium used 300 tonnes of coral sand to cover its  $600 \text{ m}^2$  to a depth of 0.4 m. Used in these large aquaria the coral sand does not need regular replacement.

Large volumes of coral sands have also been sought by tourist resort operators who wish to create or renourish resort beaches.

Some data is available on the amounts of carbonate sediments taken in Queensland waters. These come from the DPI, and are based on returns furnished by the licensed operators. Average yearly totals for 1985-1989 have been:

|              |               |
|--------------|---------------|
| Coral sand   | 6,510 kg/yr   |
| Coral rubble | 940 kg/yr     |
| Shell-grit   | 117,240 kg/yr |
| Star sand    | 860 kg/yr     |
| Living coral | 16,100 kg/yr  |

### 5.4 Carbonate sediment deposits

#### 5.4.1 Introduction

There are numerous environments where suitable biogenic carbonate sediments may occur. These include:

- 1 reef flat sediment accumulations
- 2 beaches and spits associated with fringing reefs
- 3 shell beaches, chenier ridges, and shell banks
- 4 fossil reefs
- 5 coral cays and associated beaches
- 6 sub-tidal leeward detrital reef slopes
- 7 *Halimeda* banks.

Most of these environments are restricted to areas within the GBRMP and thus are not available as potential sediment sources. This section discusses only those environments that occur in the primary target areas outside the GBRMP but within the GBR Region. These are the reef flat sediment accumulations, beaches and spits associated with fringing reefs, and shell

beaches, chenier ridges and shell banks. Information on the other environments (4-7 above) is presented in Appendix 1.

#### 5.4.2 The coral reef sediment system

As can be seen, most of the environments where suitable biogenic carbonate sediments occur are found in association with coral reefs. The production, transport and accumulation of reef sediments can be viewed as a simple system (Figure 1).

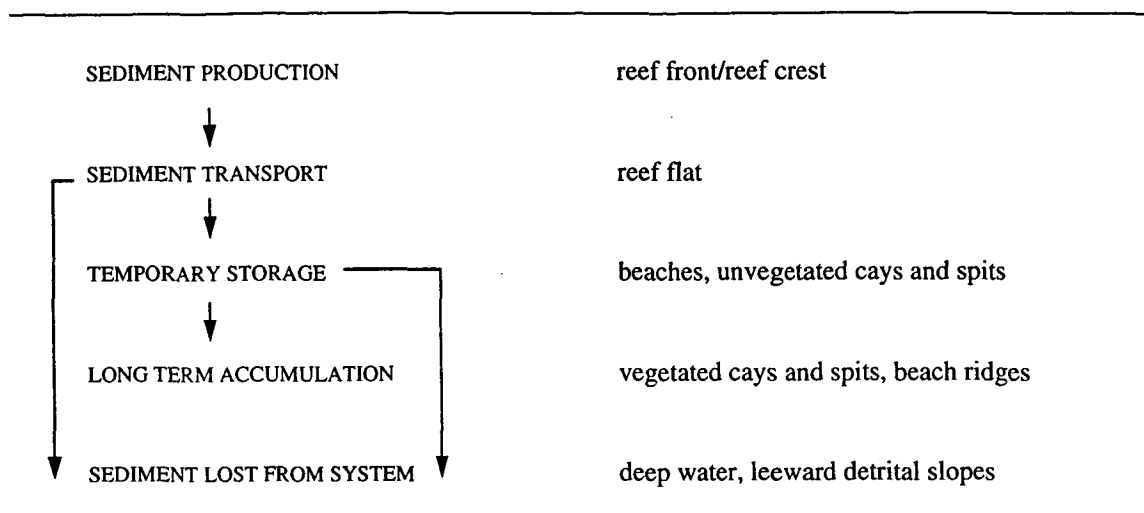


Figure 1. Coral reef sediment system

The action of high energy waves on the windward reef front and reef crest produces coral debris which is transported by waves and currents across the reef flat. Temporary storage of sediment may occur on the reef flat or in a beach, and long term accumulation occurs in coral cays, spits, and beach ridges. Sediment swept off the reef flat into deeper water (>10 m) is lost from the system.

In this way a sediment budget can be envisaged in which over the long term, the amount of sediment produced is balanced by the amount stored and lost from the system. Little is known of the rate of production or volume of material involved in coral reef sediment budgets. Clearly, removal of sediment from any part of such a system needs to be carefully considered so as to minimise possible effects in the system as a whole. This applies particularly to sediments in the transport and temporary storage elements of the system.

Production of sediment is very episodic, and probably only occurs when reefs are influenced by storm waves generated by tropical cyclones. Sediment transport is also infrequent, although probably occurs under a wider range of wave conditions.

When initially produced coral debris is coarse, comprising fragments 1-10 cm across known as coral shingle. As this material is transported it breaks down rapidly to fine sand (0.25 mm). Clearly, natural processes do not produce large volumes of the coral sediment sizes (2-5 mm) required by the marine aquaria trade.

### 5.4.3 Fringing Reefs

Fringing reefs are the only reef type occurring in the primary study areas along the mainland coastline of the GBR Region. These include reefs attached to the mainland and offshore islands. Thirty-nine fully developed fringing reefs covering a total area of nearly 51 km<sup>2</sup> occur, and these are summarised in Table 3.

| Section          | Fringing Reefs | Number outside GBRMP | Total area covered (km <sup>2</sup> ) | Average size (km <sup>2</sup> ) | Number larger than 0.5 (km <sup>2</sup> ) |
|------------------|----------------|----------------------|---------------------------------------|---------------------------------|---|
| Cairns           |                | 23                   | 40.05                                 | 1.74                            | 15  |
| Central          |                | 4                    | 6.60                                  | 1.65                            | 2   |
| Mackay/Capricorn |                | 12                   | 4.13                                  | 0.34                            | 2   |
| TOTAL            |                | 39                   | 50.78                                 | 1.30                            | 19  |

Table 3. Fringing reefs in coastal areas excluded from GBRMP

It was considered likely that only the larger of these reefs, greater than 0.5 km<sup>2</sup>, would produce suitable quantities of carbonate sediment. These areas (see below, Section 6.1) were targeted for field assessment.

### 5.4.4 Shell beaches, chenier ridges and shell banks

As noted above, shell-grit is a possible cheap alternative to coral sand suitable for use in marine aquaria, and widely used in southern Queensland. Further descriptions of these environments are given in Appendix 1. Two such sites are discussed below as potential secondary sources of carbonate sands (Section 6.6.2, 6.6.3).

### 5.4.5 Summary

Although a variety of environments where high carbonate sediments may occur are found in the GBR Region, most occur only within the GBRMP and are thus not available as potential sources.

The size, shape and sorting characteristics of the carbonate sediments that are available outside the GBRMP are generally not suitable for marine aquaria. In particular, the 2 mm - 5 mm size range required is quite rare in natural sediments, and most material would need crushing and grading for it to fit this criterion.

Most of the potential sources are associated with coral reef sediment systems. No reef sediment budgets have yet been established, and thus it is not possible to accurately determine levels of sustainable carbonate sediment yield from these systems.

Collectors of coral sand for the marine aquaria trade have in recent years operated mainly on reef flats. These sediments are the source materials that make up nearby beaches, cays and some spits. Collection of these sediments will have an effect on the sediment budgets of any associated beaches and should therefore be carefully monitored.