Proceedings of the 6th International Coral Reef Symposium, Australia, 1988, Vol. 3

SEDIMENTOLOGICAL STRUCTURE OF THE NORTHERN LAGOON OF NEW CALEDONIA

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ABSTRACT

New Caledonia's northern lagoon, situated between 19°50' and 20°10' latitude south and 163° and 164°10' longitude east, covers an area of 8 400 sq.km. As part of the sedimentological research being done on the New Caledonian lagoons, 210 samples of sediment have been taken from a sampling grid of three nautical miles. Conventional methods of sedimentology were applied (grain size determination, calculation of sedimentological indices, measurement of carbonates). The distribution of lutites, of the different types of grain size and of carbonates was marked on maps. Calculation of the indices enabled us to interpret the main trends of the sedimentary dynamics of zone. The grain sizes of the sediment tend to follow a pattern of concentric areas, with the finer particles being found towards the centre of the lagoon. This general pattern is however interrupted by the presence of passes and emerged land. The amount of carbonate contents shows that the sediment are mainly of biogenous origin. A slight terrigenous influence is however perceived in the neighbourhood of the Belep islands and near the Mainland. The figures of granulometric indices suggest the presence of slight hydrodynamic features in this lagoon. In general, the structures defined are comparable to those observed in the case of atolls.

INTRODUCTION

The northern lagoon of New Caledonia (figure 1), demarcated by Cook's reef on the East and by Français'reef on the West, is an extension, more than 140 km long, of the Mainland. Its width, about 50 km, is fairly regular, and it covers a total area of some 8,400 km² (Testau & Conand 1983). The Belep islands rise near the middle of the lagoon, while the Yandé, Paaba and Balabio islands are dotted along its southern boundary.

The isobaths of the lagoon describe a relatively simple figure. Except for the Belep islands, the bottom slopes steadily towards the North, down to a depth of 60 metres, where a great basin is separated from the continental slope by no more than a simple coral still. The inner slope of the bordering reefs is fairly steep and leads to bottoms some 30 metres deep; this is also so in the hook on the extremity of Cook's reef in the northwestern tip of the lagoon.

As part of the sedimentological research being carried out on the lagoons of New Caledonia, three cruises by R.V. VAUBAN have been conducted to study the northern lagoon. This paper describes the first results obtained from analysis of their findings. Attached is also a cartographic representation of the nature and the texture of the sediments found in this little known lagoon and a preliminary interpretation of the sedimentary structures observed there.

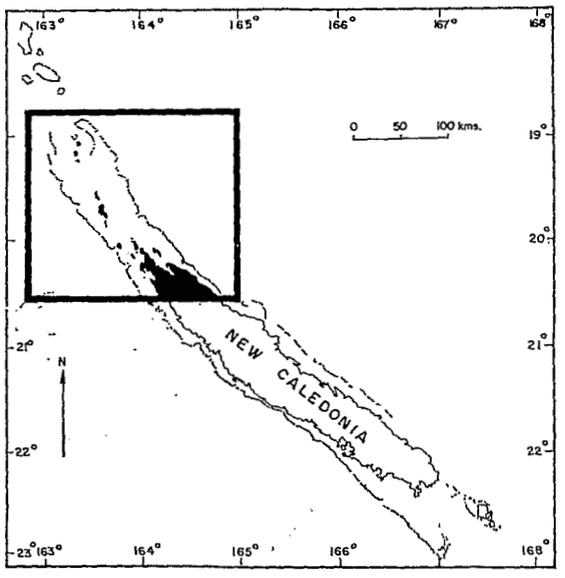

Figure 1. Localization of the northern lagoon of New Caledonia.

We shall limit ourselves to general considerations, for a detailed study of this sector will be developed at a later stage.

MATERIAL AND METHODS

Systematic sampling of the observation area was carried out. Sediment samples were taken regularly over a three-mile sampling grid. We thus obtained 210 samples in all (figure 2).

The sampling equipment used was a Neyrpic grab, this having already been used in earlier studies of sediments in New Caledonia (Debenay 1985). This small grab with its double jaws had been evolved from the Van Veen grab.

After homogenization, a sample of about 200 gr of sediment was taken for grain size determination and put to dry at 50° C for 72 hours, the samples were then weighed for the first time, and afterwards the sandy fraction was separated from the fine fraction by manual wet sifting, using a 63 µm sieve. Once the fine fraction had been completely eliminated, the remaining portion was again dried and then weighed; the percentage of mud was assessed from the difference in weight. The sandy fraction was then passed through a sieve-shaker with mesh sizes : 20, 2.5, 1, 0.5, and 0.063 mm. Each time the remainder was weighed, then its weighted percentage was calculated (Buchanan 1984). The carbonate content in the sediment was obtained from the fine fraction, using a calcimetre (Bonneau & Souchier 1979). The mode of each grain size distribution was determined and after semiloga-

rithmic cumulative curves had been constructed, the following sedimentological indices were calculated : average size, sorting index, kurtosis, skewness (Folk & Ward 1957).

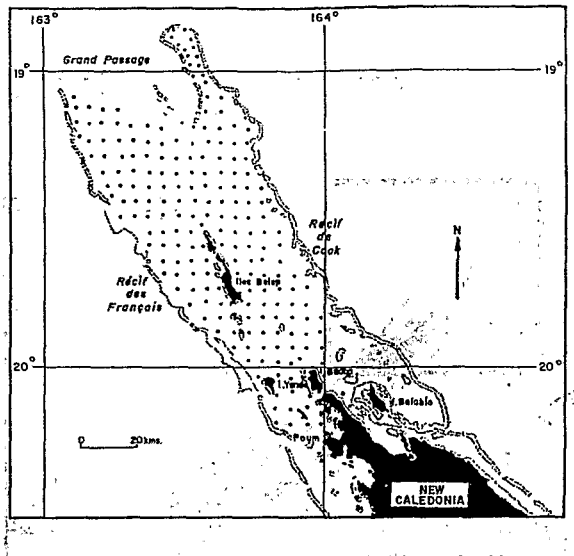

Figure 2. Location of sampling stations in the northern lagoon of New Caledonia.

RESULTS

Mud distribution

The distribution of muds in the northern lagoon is shown in figure 3.

Generally speaking, the mud percentages occur in concentric areas, the highest percentage being found towards the middle of the lagoon. This general tendency does not persist around the Belep isands, where the silting gradient is interrupted. An increase in the percentage of fine particles is observed also towards the extreme north of the Mainland.

Grain size facies

The map of grain size facies (figure 4) was drawn up from the proportions of the different size classes found in each sediment sample. The percentage of the fine fraction appears very clearly in this diagram in respect of the areas where this class is dominant (>25 %).

In the rest of the lagoon the grain size facies are evidence of the effect of the passes. These are indicated by the consistent presence of sand and gravel facies associated with a ring of larger sand grains. In the northeastern tip one finds fine and larger sands alternating; this reflects the numerous openings in the barrier reef.

Distribution of carbonates

The map of carbonates (figure 5) shows a very distinct predominance of sediments of biogenous origin : most samples reveal a carbonate content greater than 85 %. This observation, deduced from the fine fraction, is corroborated by the absence of non carbonated material in the other grain size classes. It will be noted however that there are some zones where a lowercarbonate content (70 to 85 %) suggests terrigenous influences. This is particularly clear near the Mainland and to leeward of the Belep islands.

Sedimentological indices

By using sedimentological indices it is possible to obtain a detailed analysis of the sedimentary types. Thus in areas where there is a high proportion of fine particles, characteristic of the middle part of the lagoon, the average size ranges between 0.25 and 0.063 mm with a mode less than 0.063 mm. Drawing nearer to the reef, these figures increase steadily until they reach 0.5 to 1 mm for the average size, while the mode varies according to the sample between 0.25 and 1 mm.

Around the passes and in the north eastern tip, the average size of sediments and the mode are greater than 2.5 mm.

The majority of samples taken from the northern lagoon shows a figure for sorting between 1 and 2 Ø. Higher figures (2 to 4 Ø) are found around the passes and in the neighbourhood of the northern part of the Mainland, while the lowest figures correspond to the areas with the highest quantity of mud (0.5 to 1 Ø).

Kurtosis figures for the whole lagoon range between 0.5 and 1.5 Ø; the extreme categories are thus not represented. Similarly, the skewness figures are all lower than 0.3 Ø.

DISCUSSION

If the characteristics of the sediment and the isobath graph are studied together it will be seen that depth is not an essential factor in sediment distribution. This lack of relationship is notable in respect of muds, the highest percentages of which are observed on bottoms 30 to 60 m deep in the middle of the lagoon, and also on bottoms less than 20 m deep around the coastal bays of the Mainland. It appears more likely that the distribution observed is linked to hydrodynamic features.

On the whole, the sedimentological indices that have been calculated are fairly typical of a low-energy environment (no extreme values for kurtosis and skewness, mediocre sorting index), except around the passes and near the reef. However, smaller average size and improved sorting towards the middle of the lagoon indicate that there is transport of fine particles towards this area. This general pattern is comparable to structures observed on atolls (Maxwell et al. 1964, Guilcher et al. 1969) and is very different from those of the Australian Great Barrier Reef (Maxwell 1968, Flood & Scoffin, 1978, Flood et al., 1978, Flood & Orme, 1988) and of the southwestern lagoon of New Caledonia (Debenay 1985, Chevillon & Richer de Forges 1988). These fine particles are almost exclusively formed of carbonates, which is evidence of their organic source.

Definite knowledge of the part played by the reef in their origin will be obtained from a study of the bioclastic composition of the lagoon's sediments.

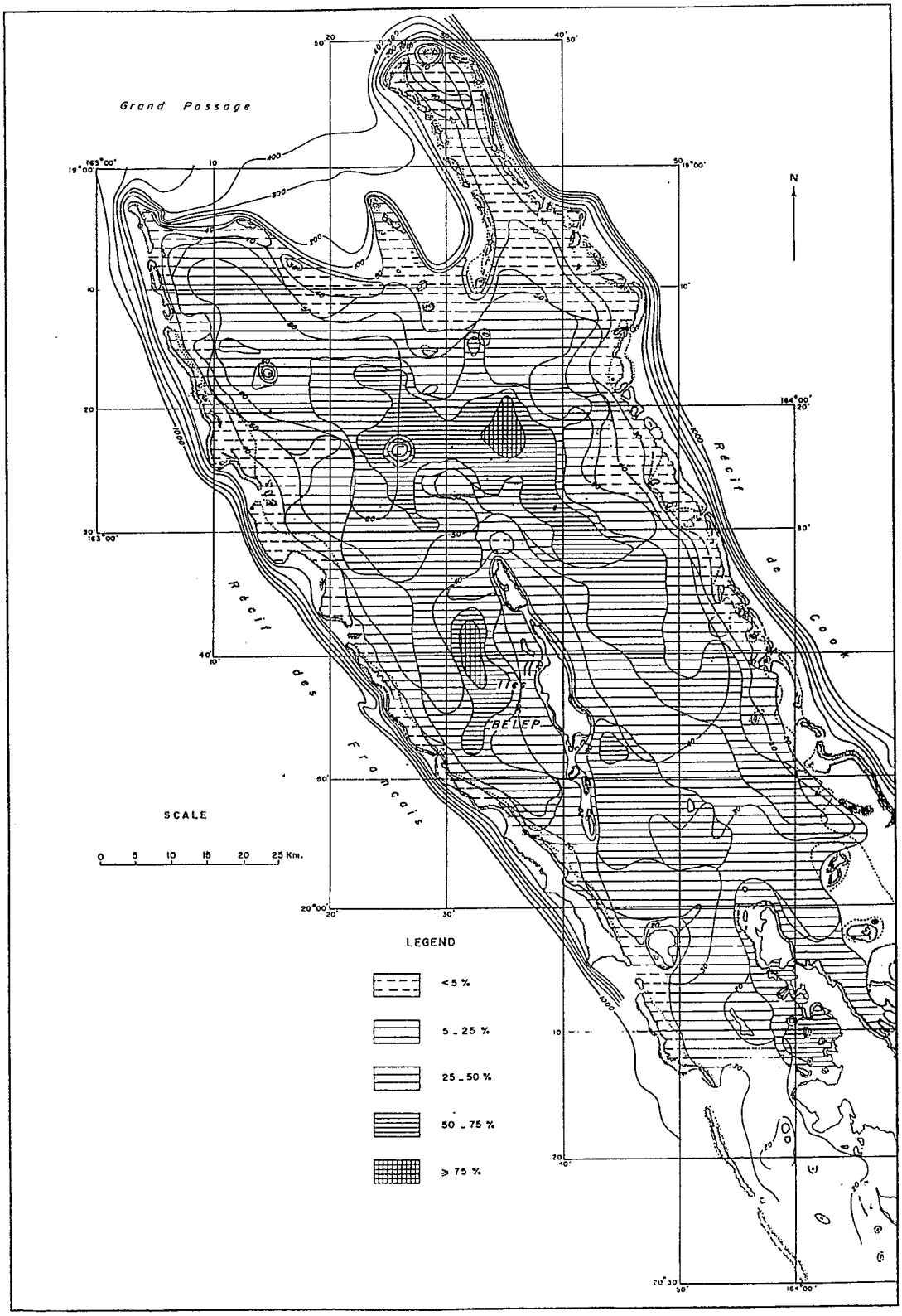

Figure 3. Mud distribution in the northern lagoon of New Caledonia.

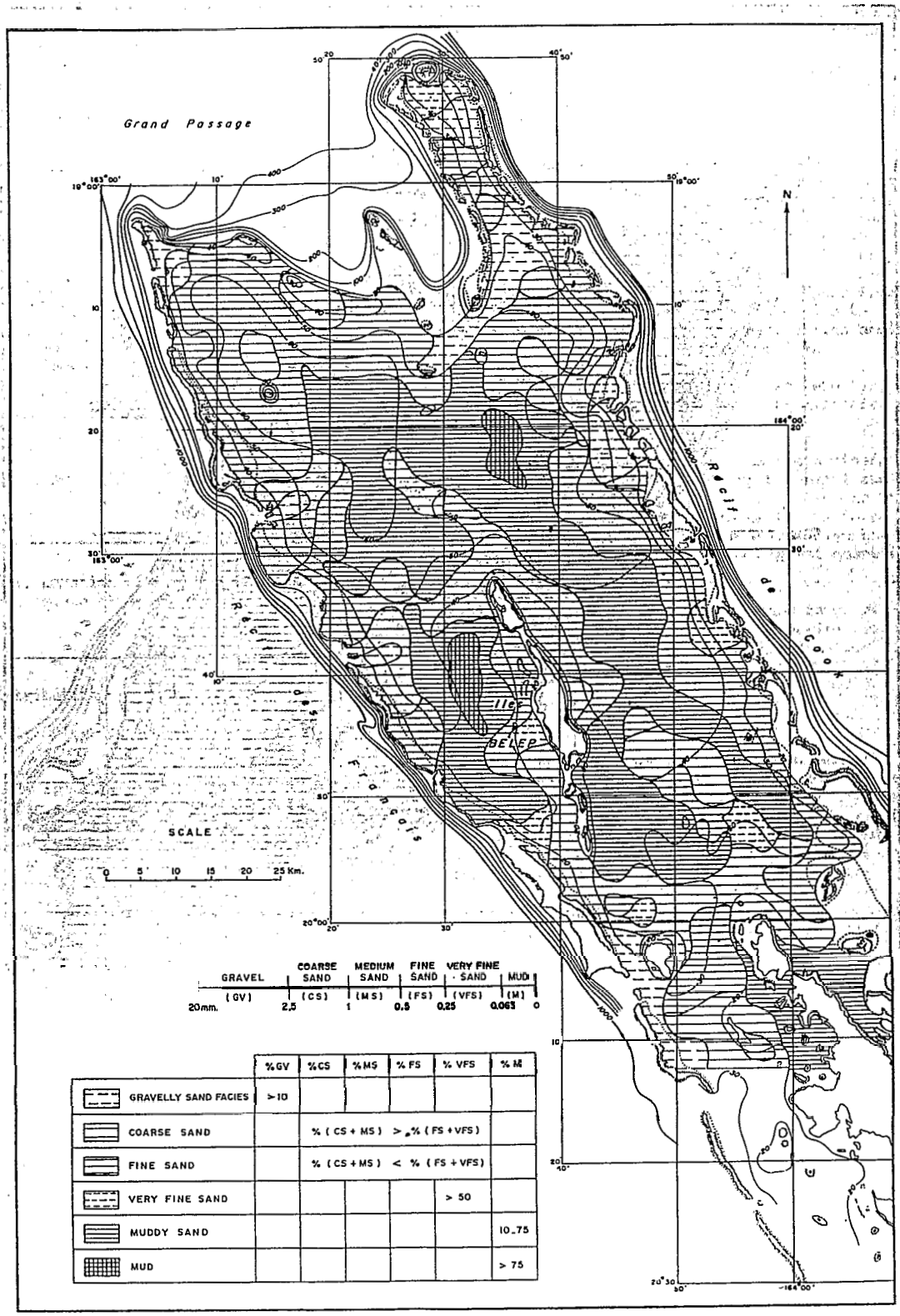

Figure 4. Distribution pattern of grain size facies in the northern lagoon of New Caledonia. Scale grade and class terms agree with the classification of Weydert (1971).

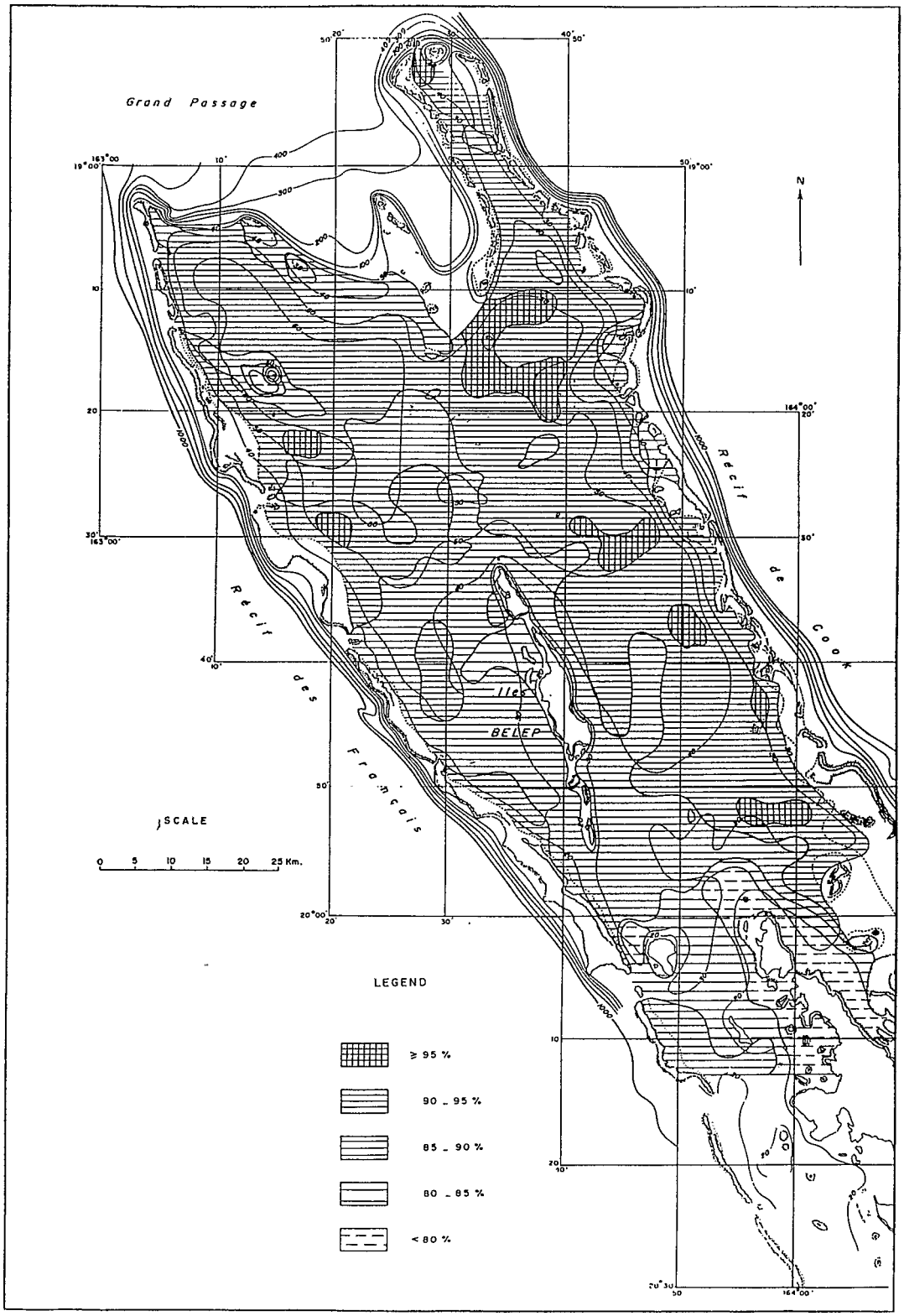

Figure 5. Carbonate percentage distribution in the sediments of the northern lagoon of New Caledonia.

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