Sediment constituents in the Great Astrolabe Reef lagoon (Fiji)

by C. Chevillon*, G. Yeo** & A. Di Matteo*

*Institut Français de Recherche Scientifique pour le Développement en Coopération, ORSTOM, Centre de Nouméa, B.P. A5, 98 848 Nouméa, Nouvelle-Calédonie

** The University of South Pacific, School of Pure and Applied Sciences, P.O. Box 1168, Suva, Fiji

Abstract

Sediments of the Great Astrolabe Reef lagoon were investigated using a Smith-McIntyre grab during the joint Fijian-French ASTRO cruise, in april 1994. This preliminary paper focused on carbonated biophase, wich was studied trough skeletal composition of 25 sediment samples regularly spaced in the lagoon. Counting and identification of the biogenic debris were achieved for each sample on 13 size fractions (3.98, 3, 2, 1, 0, -1, -1.32, -2, -2.32, -3, -3.32, -4 and -4.32 ϕ). The results indicates that the main constituents of the carbonated biophase of the lagoon are, in order of importance, *Halimeda* plates, foraminifers an molluscs. The lagoon as a whole, is characterized by a HALIFOR biofacies and a HaliForPel sub-facies (*Halimeda*-Foraminifers-Pelecypods). Three main types of biofacies are found : *Halimeda* biofacies (HALIMOL and HALIFOR), a foraminifer biofacies (FORAMOL) and molluscs biofacies (MOLHAL and MOLFOR). Coral reefs represent only a small part among the producers of lagoon sediments (7th rank). The excellent state of preservation of the bioclasts suggests a modern or recent sedimentation and a low impact of the hydrodynamic agents at the bottom level. The absence of lithoclasts in the sand fraction indicate a limited terrigenous influence.

1. Introduction

The sediments of the Great Astrolabe Reef in Fiji were studied during the joint Fijian-French cruise "ASTRO", conducted in April 1994 on board of ORSTOM R.V. "ALIS". The Great Astrolabe Reef and Lagoon have been the subject of a baseline study by Morrison & Naqasima (1992), but this did not include the study of the sediments.

The sedimentological description of the bottoms contributes to our basic knowledge acquisition on the environment (soft bottoms can represent up to 90 % of the lagoon area) and it is an important factor to explain the distribution of the benthic species as well as the fishes living in tropical lagoons. It allows also to consider the hydrodynamic conditions that prevail at the bottom level. Sedimentology is also a useful tool in the management of the lagoon ressources (close relationships between the nature of the sedimentary environment and some exploitable species, inventory of the areas favourable to the extraction of sand and aggregates for the building industry) and in the preservation of the environment (impact of extractions, coastal and lagoonal development for the tourist industry).

From a more fundamental point of view, the identification and the characterization of the sedimentary environments, and particularly the skeletal composition, on one hand help to understand the sediment genesis process, and on the other hand allow to quantify the respective influences of terrigenous input, reefs, and benthic communities on the development of the lagoon sediments.

The preliminary results presented below thus concern, the sedimentology and more particularly the bioclastic composition of the sediments in the Great Astrolabe Reef lagoon. The same type of sedimentological study has been conducted since 1985 in the lagoons of New Caledonia (Chevillon, *in press* (a); Clavier *et al.*, 1995) and more particularly in the northern lagoon (Chevillon, 1992, 1990; Chevillon & Clavier, 1988; Chevillon *et al.*, *in press* (a); Plunet & Truvant, 1994), in the southern lagoon (Adjas, 1988; Chevillon, 1986, 1985; Chevillon & Poumarède, *in press*; Chevillon & Richer de Forges, 1988; Debenay, 1988a, 1988b, 1988c, 1987, 1986, 1985a, 1985b, 1985c; Dugas & Debenay, 1978, 1980, 1981, 1982; Poumarède, 1994) and the eastern lagoon of the main island (Chevillon, 1989), as well as in the Ouvea (Chevillon, *in press* (b), 1996; Chevillon *et al.*, 1992) and Chesterfield atolls (Chevillon & Clavier, 1990; Chevillon *et al.*, *in press* (b); Richer de Forges *et al.*, 1988; Rico & Sonnier, 1993).
In the Great Astrolabe Reef lagoon, bio-sedimentological analysis were done along a transect of W-E close to Dravuni Island (Schneider et al., 1995).

A more detailed sedimentological study of the Great Astrolabe Reef lagoon and a comparison with the sedimentology of New Caledonia lagoons will be

the subject of a coming publication (Chevillon & Yeo, *in prep.*).

2. Material & Methods

Twenty five samples of sediment, evenly spaced in the Great Astrolabe Reef lagoon (Fig.1 & Table 1) were collected from the R.V. "Alis", using a Smith-McIntyre grab.

Table 1: Depth (m) and position of collected samples

N°	Depth	South Latitude	East Longitude
1	31	18°43.50'	178°29.67'
2	28	18°43.49'	178°31.75'
3	22	18°44.68'	178°31.70'
4	39	18°44.57'	178°29.46'
5	17	18°45.19'	178°31.25'
6	38	18°46.11'	178°29.53'
7	43	18°46.09'	178°32.73'
8	37	18°46.97'	178°33.84'
9	35	18°46.90'	178°31.75'
10	37	18°46.99'	178°29.18'
11	39	18°48.81'	178°29.19'
12	29	18°48.80'	178°32.10'
13	34	18°48.28'	178°33.84'
14	27	18°49.48'	178°34.72'
15	29	18°49.46'	178°33.14'
16	32	18°49.48'	178°31.83'
17	34	18°49.57'	178°29.50'
18	34	18°50.77'	178°26.64'
19	31	18°50.94'	178°31.86'
20	34	18°50.71'	178°33.85'
21	30	18°52.14'	178°31.97'
22	36	18°51.64'	178°29.50'
23	31	18°48.43'	178°30.84'
24	32	18°49.83'	178°30.50'
25	31	18°42.66'	178°30.97'

In the laboratory, the samples, after homogenisation, were dried (72h à 60°C), weighed, and the mud fraction was removed by washing through a 3.98 ϕ sieve (63 µm). The remaining sediment - i.e. sand and gravel fraction (coarser than 3.98 ϕ) - was dried and weighed again, and dried-sieved using the following mesh sizes : 3.98, 3, 2, 1, 0, -1, -1.32, -2, -2.32, -3, -3.32, -4, -4.32 ϕ. We thus obtained 13 size fractions which were weighed and expressed as a percentage of the initial sample. Particle constituents were identified and counted under a binocular microscope using a Stratmann counting dish. This dish has 45 cells of 1 cm² each. For each sample and each size fraction, a cell is chosen at random and all grains within it are identified and counted; another cell is then chosen until at least 100 grains are examined (1 300 grains per sample), knowing that once a cell is started, all the grains it contains have to be examined. The results were converted into weight percentages according to the amount of the considered size fraction (Table 2), so that the total constituent percentages could be calculated (Masse, 1970).

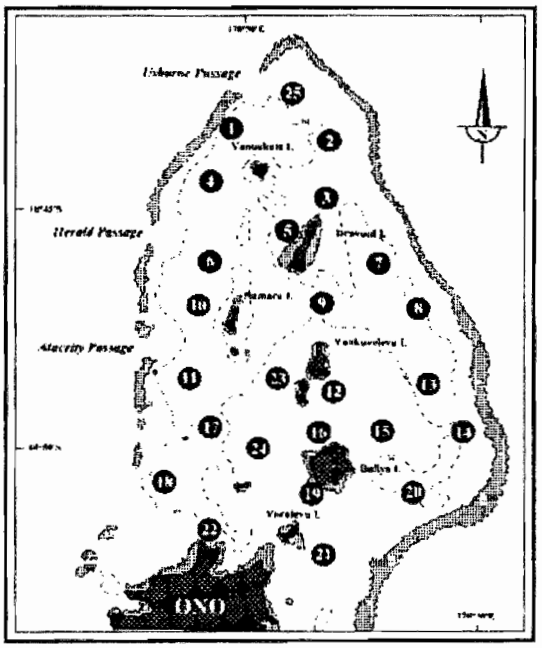

Figure 1: Locations of sampling stations

A biofacies (or facies biogen) name is then attributed to each sample according to an ordered bi-nominal or tri-nominal classification of the main constituents. For instance, if the first three bioclastic constituents are, in order of importance, molluscs, calcareous algaes and foraminifers, the biofacies name would be "MOLALGFOR". In the case of a bi-nominal classification (i.e. MOLALG), a sub-facies can be determined by involving the third constituent and the distinction between the various groups of molluscs, between the *Halimeda* plates and the red calcareous algaes within the calcareous algaes, or between the ostracodes and the other crustaceans (macroforms). For intance, the MOLALG biofacies (molluscs-calcareous algaes) could present a "GastHalFor" (Gastropods-*Halimeda*-Foraminifers) or a "PelRedFor" (Pelecypods-Red calcareous algaes-Foraminifers) sub-facies.

Table 2: Skeletal composition calculation processes

Size fractions		Skeletal constituents A, B, C...	
N°	weighed %	numerical %	weighed %
1	P_1	$A_1, B_1, C_1..$	$P_1A_1, P_1B_1, P_1C_1..$
2	P_2	$A_2, B_2, C_2..$	$P_2A_2, P_2B_2, P_2C_2..$
:	:	:	:
13	P_{13}	$A_{13}, B_{13}, C_{13}...$	$P_{13}A_{13}, P_{13}B_{13}, P_{13}C_{13}..$
		Total :	**A% , B%, C% (Σ = 100%)**

3. Results

3.1 Overall skeletal composition

The main producers of sediment in the Great Astrolabe Reef lagoon are, in order of importance, *Halimeda* (*Halimeda* plates can represent up to 86 % of the sediment constituents), foraminifers and molluscs (pelecypods and gastropods essentially and in equal proportion) (Fig. 2). Other groups of organisms take part, in a more limited way, in the production of the lagoon sediment : crustaceans (macroform), madreporians (coral), calcareous tubes (vermetid molluscs or serpulid worm tubes), echinoderms, bryozoans, scaphopods molluscs, sponges (spicules), alcyonarians (spicules), ostracods and red calcareous algaes (Table 3). In addition there are a certain number of reduced debris (identified or non-identified grey grains), natural agregates and undetermined fragments (generally small grains - <0,5 mm - altered by abrasion, microperforation or diagenesis).

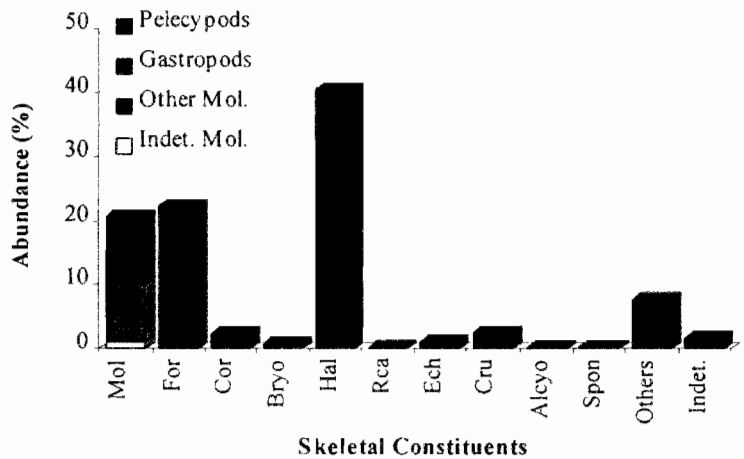

Figure 2 : Mean skeletal composition (n=25) of the sediments of the Great Astrolabe Reef lagoon (Mol : Molluscs, Other Mol. : Scaphopods and Pteropods, Indet. : indeterminates, For : Foraminifers, Cor : Corals, Bryo : Bryozoans, Hal : Halimeda plates, Rca : Red Calcareous Algaes, Ech : Echinoderms, Crus : Crustaceans, Alcyo : Alcyonarian spicules, Spon : Sponge spicules, Others : serpulid worm tubes, altered grains, grain aggregates, lithoclasts)

The small amount of undetermined fragments (an average of 1.65 %) reveals that the bioclasts are in an excellent state of preservation. It may be concluded on one hand that the production of sediments is modern or recent (no relict biophase) and on the other hand, that the hydrodynamic on the bottom is light (no abrasion, little transfer).

Finally, it should be underlined that the absence of lithoclasts (mineral elements of terrestrial origin) indicates a very low terrigenous influence in the sand fraction. The presence of high islands in the lagoon, suggests that terrigenous input exist, but that their influence may be probably detected only on the fine fraction of the sediments (< 63 µm).

3.2 Biogenous facies

The quantitative ordered classification of the biophase main constituents, reveal an important variability of the sediment composition since, not less than 5 biofacies and 10 sub-facies have been counted (i.e. nearly one sub-facies every 2 samples) (Fig. 3 & Table 4). Every sub-facies involves the three main constituents (*Halimeda*, foraminifers and molluscs) and shows hereby, the obvious supremacy of these three groups in the constitution of the sediment biophase. Still, two exceptions stand out : the GasHalCor sub-facies (Gastropod-*Halimeda*-Corals, station 5) and the ForPelCru (Foraminifers-Pelecypods-Crustaceans, station 22).

Table 3: Skeletal composition of samples (%)

	Station																								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**Lagoon**
Pelecypods	9.1	16.3	8.9	13.0	13.2	7.9	28.6	22.4	6.7	6.6	7.6	2.9	6.1	13.6	4.4	10.0	8.6	10.5	10.1	9.1	3.8	18.0	2.9	2.9	23.0	**10.6**
Gastropods	9.6	11.2	8.9	7.8	13.6	10.8	8.9	15.6	5.6	15.9	12.3	2.4	4.7	11.7	6.4	5.3	6.6	16.7	5.6	7.5	4.2	7.5	2.7	2.7	16.2	**8.8**
Scaphopods	1.7	0.9				0.3	0.7			0.6				0.6								1.3		0.0	0.8	**0.3**
Pteropods																				0.1						**0.004**
Indet. Molluscs		0.7	3.5	0.7	2.2	3.4		1.1	0.7	0.5	0.3	0.1	1.4	0.5	1.7	0.7	0.3	0.3	1.0	1.4	0.1			0.2	0.6	**0.9**
Foraminfers	64.2	56.0	8.9	9.5	10.7	9.0	42.3	28.3	23.0	36.2	20.9	9.8	11.0	6.5	16.8	23.3	7.4	17.6	62.6	26.1	3.7	41.1	7.0	4.1	13.1	**22.4**
Corals	0.4	0.8	5.4	4.7	20.5	6.4			0.9	0.5	3.0	0.6	0.3	1.4	0.1		4.4	3.6	0.1	1.7	1.5		0.1	1.3	1.2	**2.4**
Bryozoans	0.6	1.0	0.1	2.1		1.5					0.4	2.1	0.2	0.9	1.0	1.0	1.1	2.5	0.2	0.9	0.7	0.2		1.4	1.2	**0.8**
Red Calcareous Algae			0.2											0.7				0.1		0.7	0.1			0.1	2.1	**0.16**
Halimeda	3.1	5.3	24.2	48.1	26.5	40.1	4.2	10.1	58.0	17.5	25.2	78.8	74.4	57.0	57.7	49.0	58.1	36.6	11.3	41.2	83.3	1.2	86.6	82.3	35.5	**40.6**
Echinoderms	1.3	0.4	0.6	2.0	0.8	5.1	1.1	1.9	0.1	3.1	3.6	0.5	0.3	1.5	0.5		1.3	1.2	0.5	0.8				0.2	0.3	**1.1**
Ostracods																					0.3			0.2		**0.02**
Crustaceans	1.2	3.8	2.0	3.5	1.3	1.6	3.4	5.2	0.7	1.5	3.2	1.8	0.3	2.9	3.2	3.4	2.4	4.2	2.4	4.4	1.6	4.2	0.4	1.2	1.3	**2.4**
Alcyonarians	1.1			0.3				0.6									1.7									**0.1**
Sponges		0.9		0.3								0.3			0.2				0.5					0.2	1.6	**0.2**
Serpulid worm tubes			0.4	1.9	1.3	0.9	0.7		0.3	0.1		0.6	1.0	1.2		2.0	0.5	0.5	1.5	0.8	0.8	25.6	0.4		1.4	**1.7**
Reduced grains	5.2	1.5		3.6	4.9	8.4	3.3	9.5	0.2	8.1	15.5				6.8	0.7	4.4	0.9	2.3	1.8		0.4		2.8		**3.2**
Oxidized grains				0.4																						**0.01**
Aggregates	2.6	1.5	1.1	1.9	3.3	3.5	6.9	5.4	2.6	9.2	8.1		0.3	1.5	1.4	4.8	3.2	5.4	1.6	3.5				0.4	1.6	**2.8**
Lithoclasts																										-
Indeterminate			35.8		1.8	1.2			1.0	0.2									0.2	0.4		0.6				**1.6**

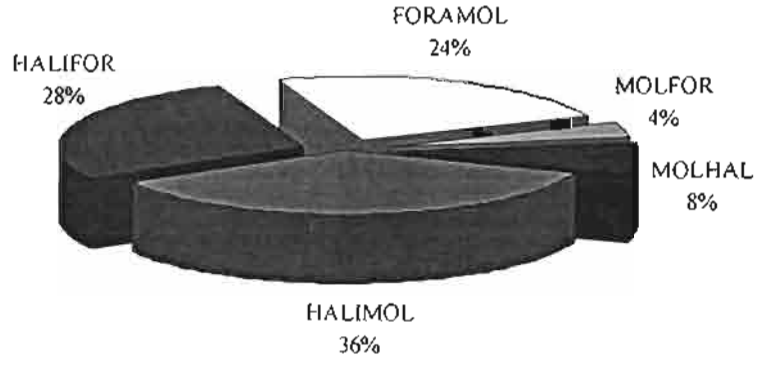

Figure 3: Pie chart showing the proportions of main biofacies

Three types of main biofacies stand out : the *Halimeda* biofacies, which represents 64 % of the samples (HALIMOL : 36 % and HALIFOR : 28%), one foraminifer biofacies (FORAMOL : 24%) and the mollusc biofacies (12% of the samples among which : MOLHAL = 8% and MOLFOR = 4%).

Table 4: Composition and abundance of the sub-facies

SUB-FACIES	Abundance	Stations
HalPelFor	24%	3, 4, 13, 14, 17, 24
HalGasFor	12%	6, 18, 21
HalForPel	20%	9, 12, 16, 20, 23
HalForGas	8%	11, 15
ForGasHal	8%	1, 10
ForPelHal	12%	2, 7, 19
ForPelCru	4%	22
PelForHal	4%	8
GasHalCor	4%	5
PelHalFor	4%	25

From the average composition of the biophase, the lagoon is globally characterized by the main HALIFOR biofacies and the association of *Halimeda*-Foraminifers-Pelecypods (HalForPel sub-facies)

4. Conclusion

In the Great Astrolabe Reef lagoon, *Halimeda*, foraminifers, and gastropod and pelecypod molluscs are ranked first among the producers of the sedimentary biophase. Corals, which bioclasts are specific of reef and lagoon environments, represent only a small part of the sediment composition (7th rank of the constituents). Coral reefs contribution to the lagoon sedimentation is consequently, extemely weak. Recent sedimentation and weak hydrodynamic conditions at the bottom level are strongly suggested by the small proportion of indetermined debris and by the excellent state of preservation of the bioclasts observed from the binocular microscope examination. The absence of lithoclasts (mineral elements of terrestrial origins) reveals, despite the presence of high islands in the lagoon, a weak terrigenous influence. Even though the Great Astrolabe Reef lagoon can be characterized by three types of main biofacies - the *Halimeda* facies (HALIMOL and HALIFOR), the foraminifers facies (FORAMOL) and the molluscs facies (MOLHAL and MOLFOR) - not less than 10 sub-facies have been identified (i.e. nearly one sub-facies every 2 samples), proving hereby, an important variability in the bioclastic composition of the samples. At a more general level, the biophase average composition allows a description of the Great Astrolabe Reef lagoon by the HALIFOR main biofacies and the *Halimeda*-Foraminifers-Pelecypods sub-facies.

5. References

Adjas A, 1988. Sédimentologie comparée de quelques modèles lagonaires actuels des milieux récifaux coralliens du Pacifique (Nouvelle-Calédonie, Polynésie). Thèse Doct., Univ. Provence, 340 p.

Chevillon C, in press (a) Skeletal composition of lagoonal modern sediments in New Caledonia . Coral, a minor constituent. Coral Reefs (1995)

Chevillon C, in press (b) Sedimentological map of the lagoon of the Ouvea atoll (Loyalty Islands, New Caledonia). 1/75 000, ORSTOM, Noumea (French-English & colours)

Chevillon C, 1996 Texture, granulométrie et composition bioclastique des sédiments actuels de l'atoll d'Ouvéa (Iles Loyauté, Nouvelle-Calédonie) In : B. Richer de Forges (Ed.), Les fonds meubles des lagons de Nouvelle-Calédonie (Sédimentologie, Benthos) Etudes & Thèses, Vol 2, ORSTOM, Paris : 7-43

Chevillon C, 1992 Biosédimentologie du Grand Lagon Nord de la Nouvelle-Calédonie. Etudes & Thèses, ORSTOM (Ed.), Paris, 224 p.

Chevillon C, 1990 Biosédimentologie du Grand Lagon Nord de la Nouvelle-Calédonie . caractérisation des faciès

sédimentaires par l'Analyse en Composantes Principales. Proc. 8th Int. Soc. for Reef Studies Congress (ISRS), Noumea (New Caledonia), pp. 165-172

Chevillon C, 1989. Sédimentologie descriptive et cartographie des fonds meubles du lagon de la côte est de Nouvelle-Calédonie. 3 feuilles : (1) Carte de répartition des Types Granulométriques, (2) Carte de répartition des Lutites, (3) Carte de répartition des Carbonates. 1/200 000, ORSTOM, Nouméa (couleurs)

Chevillon C, 1986. Les sédiments de la corne sud-est du lagon néo-calédonien : missions de janvier à mai 1986, recueil des données. Rapp. Sci. & Techn., ORSTOM, Nouméa, **40** : 1-13

Chevillon C, 1985. Contribution à l'étude sédimentaire des dépôts du lagon sud-ouest de Nouvelle-Calédonie. La plaine lagonaire. D.E.A. Univ. Aix-Marseille II, 30 p.

Chevillon C & Clavier J, 1990. Résultats préliminaires sur la sédimentologie du lagon des îles Chesterfield (Nouvelle-Calédonie). Proc. 8th Int. Soc. for Reef Studies Congress (ISRS), Noumea (New Caledonia), pp. 173-178

Chevillon C & Clavier J, 1988. Sedimentological structure of the northern lagoon of New Caledonia. Proc. 6th Int. Coral Reef Symp., Townsville, Vol. **3**, pp. 425-430

Chevillon C & Yeo G, in prep. Recent sediments of the Dravuni lagoon (Great Astrolabe Reef, Fiji) : skeletal composition and comparison with lagoons of New Caledonia

Chevillon C, Clavier J & Garrigue C, 1992. Preliminary data on the sediments of the Uvea lagoon (New Caledonia). Proc. 7th. Int. Coral Reef Symp., Guam (Mariana Islands, USA), pp. 1127-1132

Chevillon C, Plunet S & Truvant C, in press (a). Sedimentological map of the Great Northern Lagoon of New Caledonia. 1/300 000, ORSTOM, Noumea (French-English & colours)

Chevillon C & Poumarède N, in press. Sedimentological map of the southern lagoon of New Caledonia (from Mont Dore to Ile des Pins). 1/150 000, ORSTOM, Nouméa (French-English & colours)

Chevillon C & Richer de Forges B, 1988. Sediments and bionomic mapping on soft bottoms in the south-western lagoon of New Caledonia. Proc. 6th Int. Coral Reef Symp., Townsville, Vol. **2**, pp. 589-594

Chevillon C, Rico E & Sonnier A, in press (b). Sedimentological map of the Chesterfield islands lagoon (New Caledonia). 1/250 000, ORSTOM, Nouméa (French-English & colours)

Clavier J, Bour W, Chevillon C, Douillet P, Garrigue C, Kulbicki M & Richer de Forges B, 1995. Programme LAGON "Connaissance et mise en valeur du lagon de Nouvelle-Calédonie" : le bilan. ORSTOM, 70 p.

Debenay JP, 1988a. Recent foraminifera tracers of oceanic water movements in the southwestern lagoon of New Caledonia. Palaeogeogr., Palaeoclimatol., Palaeoecol., **65** : 59-72

Debenay JP, 1988b. Dynamique sédimentaire au débouché de la baie du Prony (Nouvelle-Calédonie) : dispersion des lutites et des tests d'un foraminifère : Operculina bartschi (Cushman). Rev. Paléobiol., Vol. Spéc. **2** : 765-770

Debenay JP, 1988c. Foraminifera larger than 0.5 mm in the southwestern lagoon of New Caledonia : distribution related to abiotic properties. Journ. Foraminifer. Res., **18** (2) : 158-175

Debenay JP, 1987. Répartition des sédiments carbonatés et relation avec l'hydrodynamisme dans un environnement récifal complexe : le lagon sud-ouest de Nouvelle-Calédonie. Bull. Soc. géol. France, **4** : 769-776

Debenay JP, 1986. Un modèle de lagon actuel transposable à des paléoenvironnements récifaux : le lagon sud-ouest de Nouvelle Calédonie. C. R. Acad. Sci., Paris, tome 303, **II** (1) : 63-66

Debenay JP, 1985a. Recherches sur la sédimentation actuelle et les thanatocoénoses des Foraminifères de grande taille dans le lagon sud-ouest et sur la marge insulaire sud de Nouvelle-Calédonie. Thèse Doct., Univ. Aix-Marseille II, 200 p + annexes

Debenay JP, 1985b. Le lagon sud-ouest et la marge insulaire sud de Nouvelle-Calédonie : importance et répartition des foraminifères de grande taille. Océanogr. trop., **20** (2) : 171-192

Debenay JP, 1985c. Le genre Amphistegina dans le lagon de Nouvelle-Calédonie. Rev. Micropal., **28** (3) : 167-180

Dugas F & Debenay JP, 1978. Carte sédimentologique et carte annexe du lagon de Nouvelle-Calédonie au 1/50000e, feuille "Mont Dore". Notice explicative n°76, ORSTOM, Paris, 20 p.

Dugas F & Debenay JP, 1980. Carte sédimentologique et carte annexe du lagon de Nouvelle-Calédonie au 1/50000e, feuille "Tontouta". Notice explicative n°86, ORSTOM, Paris, 44 p.

Dugas F & Debenay JP, 1981. Carte sédimentologique et carte annexe du lagon de Nouvelle-Calédonie au 1/50000e, feuille "Prony". Notice explicative n°91, ORSTOM, Paris, 35 p.

Dugas F & Debenay JP, 1982. Carte sédimentologique et carte annexe du lagon de Nouvelle-Calédonie au 1/50000e, feuille "Nouméa". Notice explicative n°95, ORSTOM, Paris, 45 p.

Masse JP, 1970. Contribution à l'étude des sédiments bioclastiques actuels du complexe recifal de l'île de Nossi-Bé (Madagascar). Recueil des Travaux de la Station Marine d'Endoume, Marseille (France), **10** : 229-251

Morrison RJ & Naqasima MR (Eds), 1992. Fiji's Great Astrolabe Reef and lagoon : a baseline study. Environmental Studies Reports, Institute of Natural Ressources, The University of the South Pacific, 150 p.

Plunet S & Truvant C, 1994. Réalisation de la carte sédimentologique du Grand Lagon Nord de la Nouvelle-Calédonie. Chevillon C. (Ed.), Mem. Stages, Sci. Mer, Biol. Mar., ORSTOM, Nouméa, 13 p. + annexes

Poumarède N, 1994. Réalisation de la carte sédimentologique du lagon sud de Nouvelle-Calédonie (du Mont Dore à l'Ile des Pins). Chevillon C. (Ed.), Mem. stages, Sci. Mer, Biol. Mar., ORSTOM, Nouméa, 20 p.

Richer de Forges B, Chevillon C, Laboute P, Bargibant G, Menou JL & Tirard P, 1988. La campagne CORAIL 2 sur le plateau des îles Chestrefield (N.O. "Coriolis" et N.O. "Alis", 18 juillet - 6 août 1988). Rapp. Sci. Techn., Sci. Mer, Biol. Mar., ORSTOM, Nouméa, **50** : 1-68

Rico E & Sonnier A, 1993. Réalisation de la carte sédimentologique du lagon des îles Chesterfield (Nouvelle-Calédonie). Mem. Stages, Sci. Mer, Biol. Mar., ORSTOM, Nouméa, 15 p. + annexes

Schneider W., Schnmelzer I. & Wuertz J., 1995. Bio-sedimentological studies across the Great Astrolabe Reef and lagoon, Dravuni, Fiji. The University of the South Pacific, Marine Studies, Technical Report n° 95/3, 15 p. + Appendix (A-D)