

Organic carbon, nitrogen and phosphorus in the Great Astrolabe Reef lagoon sediments. Preliminary results.

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Abstract

Carbon, Nitrogen and phosphorus were studied in the Great Astrolabe Reef sediment. Organic carbon, nitrogen and phosphorus percentages were respectively, in average for the whole lagoon top layer sediment, 0.19, 0.024 and 0.006. Organic carbon was lower than this measured in the French Polynesian atolls, organic phosphorus was higher.

1. Introduction

Measurements of organic material content of sediments are very important. Indeed, nutrient requirements for lagoonal production may be met through recycling of autochthonous material in the sediments. One of the principal factors which governs rates of nutrient regeneration from sediments was the amount of organic matter incorporated into those sediments from the water above. In this paper, we present results of carbon and phosphorus content in the sediments located at the sea-water interface (SWI) of the GAR lagoon.

2. Material and methods

Eleven stations (Figure 1) were investigated in the GAR lagoon for sediment C and N analysis. These stations were the same as for the microphytobenthic primary production study. Their depth and their visual characteristics appear in Table 1.

All stations were prospected by scuba diving. Sampling was done with hand corer 2.7 cm inner diameter, from which 0.5 cm-thick (for the first) and 1 cm thick (for the following ones) slices were removed immediately on board. (following the method described by Charpy-Roubaud (1987). The P analysis were made in Papeete (French Polynesia) ORSTOM Center and the C analysis in Perpignan's University (France).

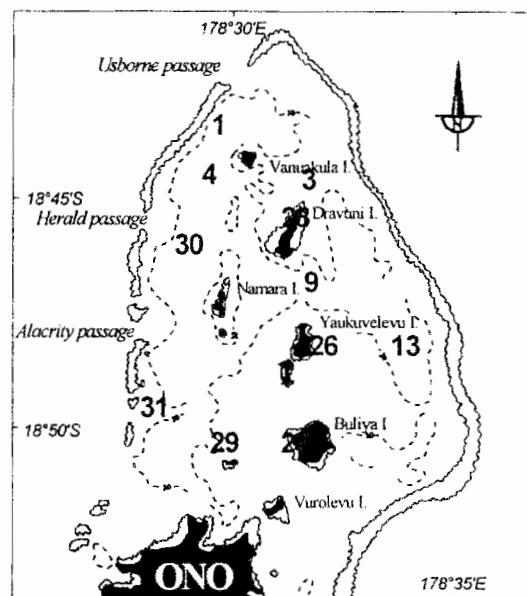


Figure 1: Station locations

Table 1: Characteristics of the prospected stations

Date	station	Z (m)	observations
20/04/93	1	19	fine sand with cyanobacteria
18/04/93	3	11	shells
17/04/93	4	39	coarse sand, shells, coral heads
24/04/93	9	35	coarse sand,, limestone corals
25/04/93	28	24	shells and Halimeda
17/04/93	30	35	very fine sand with bioturbation
26/04/93	26	9	
27/04/93	27	12	
19/04/93	13	36	coarse sand, shells, coral heads
28/04/93	29	8	algae

Total and organic carbon contents/ dry weight sediment were obtained by combustion in a LECO analyzer (after acidification of the samples with 2N HCl for organic carbon. The method consists in measuring the carbon oxidized to CO₂ and CO during dry combustion of the sediment sample in an induction furnace. Calcium carbonate content was calculated from mineral carbon using the molecular ratio 100/12 (ie. CaCO₃/C)

3. Results and discussion

3.1 Phosphorus

Percentages of organic phosphorus (OP) appear in Table 2. For the upper sediment, they varied

between $2 \cdot 10^{-3}$ and $9.8 \cdot 10^{-3}$ % and were in average $5.5 \cdot 10^{-3}$ %. The highest percentages of OP at the sediment water interface (SWI) were observed at station 30 where bioturbation was very important.

In average for the whole lagoon (Table 2 and Figure 2) % OP decreased with depth of the sediment.

For the whole depth of sediment sampled, we can observe 3 parts : the sediment at the SWI (0-0.5 cm), this one just below (0.5-2 cm) and the deepest (below 2 cm) (Figure 3).

Table 2: Percentage of organic phosphorus at different stations and sediment depth (cm) of GAR lagoon

Stat	depth	hsed							
		0-0.5	0.5-1	1-2	2-3	3-4	4-5	7-8	0,5-8
13	36	$4.4 \cdot 10^{-3}$	$4.3 \cdot 10^{-3}$	$4.5 \cdot 10^{-3}$	$2.1 \cdot 10^{-3}$	$1.8 \cdot 10^{-3}$	$3.3 \cdot 10^{-3}$	$5.0 \cdot 10^{-3}$	$3.5 \cdot 10^{-3}$
3	11	$6.5 \cdot 10^{-3}$							
1	19	$5.4 \cdot 10^{-3}$	$3.7 \cdot 10^{-3}$	$4.0 \cdot 10^{-3}$	$0.0 \cdot 10^{-3}$	$3.4 \cdot 10^{-3}$	$5.1 \cdot 10^{-3}$	$1.8 \cdot 10^{-3}$	$3.0 \cdot 10^{-3}$
4	40	$6.5 \cdot 10^{-3}$	$6.0 \cdot 10^{-3}$	$9.6 \cdot 10^{-3}$	$6.1 \cdot 10^{-3}$	$5.6 \cdot 10^{-3}$			
31	39	$2.2 \cdot 10^{-3}$	$6.0 \cdot 10^{-4}$	$3.4 \cdot 10^{-3}$	$3.9 \cdot 10^{-3}$	$3.8 \cdot 10^{-3}$	$7.0 \cdot 10^{-3}$	$4.0 \cdot 10^{-3}$	$3.8 \cdot 10^{-3}$
30	40	$9.8 \cdot 10^{-3}$	$6.8 \cdot 10^{-3}$	$5.7 \cdot 10^{-3}$	$6.4 \cdot 10^{-3}$	$6.5 \cdot 10^{-3}$	$4.0 \cdot 10^{-3}$	$5.9 \cdot 10^{-3}$	$5.9 \cdot 10^{-3}$
9	35	$6.6 \cdot 10^{-3}$	$6.0 \cdot 10^{-3}$	$5.1 \cdot 10^{-3}$	$4.0 \cdot 10^{-3}$	$3.2 \cdot 10^{-3}$	$2.4 \cdot 10^{-3}$	$3.0 \cdot 10^{-3}$	$4.0 \cdot 10^{-3}$
28	22	$2.8 \cdot 10^{-3}$	$1.4 \cdot 10^{-3}$	$1.2 \cdot 10^{-3}$	$0.0 \cdot 10^{-3}$	$1.2 \cdot 10^{-3}$	$0.9 \cdot 10^{-3}$	$4.1 \cdot 10^{-3}$	$1.5 \cdot 10^{-3}$
26	9	$4.1 \cdot 10^{-3}$	$3.9 \cdot 10^{-3}$	$1.5 \cdot 10^{-3}$	$1.5 \cdot 10^{-3}$	$2.2 \cdot 10^{-3}$	$1.5 \cdot 10^{-3}$	$1.0 \cdot 10^{-3}$	$1.9 \cdot 10^{-3}$
27	12	$4.4 \cdot 10^{-3}$	$4.3 \cdot 10^{-3}$	$3.3 \cdot 10^{-3}$	$2.2 \cdot 10^{-3}$	$2.5 \cdot 10^{-3}$	$1.3 \cdot 10^{-3}$		$2.7 \cdot 10^{-3}$
29	8	$7.8 \cdot 10^{-3}$	$6.2 \cdot 10^{-3}$	$3.1 \cdot 10^{-3}$	$1.2 \cdot 10^{-3}$	$1.8 \cdot 10^{-3}$	$0.7 \cdot 10^{-3}$		$2.6 \cdot 10^{-3}$
Av.		$5.5 \cdot 10^{-3}$	$4.3 \cdot 10^{-3}$	$4.1 \cdot 10^{-3}$	$2.7 \cdot 10^{-3}$	$3.2 \cdot 10^{-3}$	$2.9 \cdot 10^{-3}$	$3.5 \cdot 10^{-3}$	

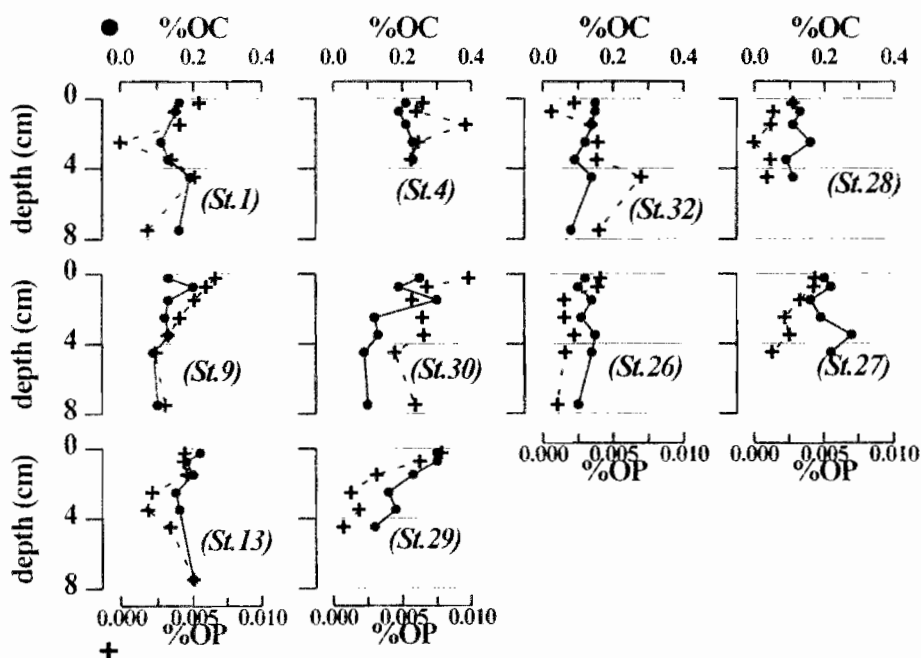


Figure 2: Profiles of organic carbon (OC) and phosphorus (OP) in the sediments of the GAR lagoon

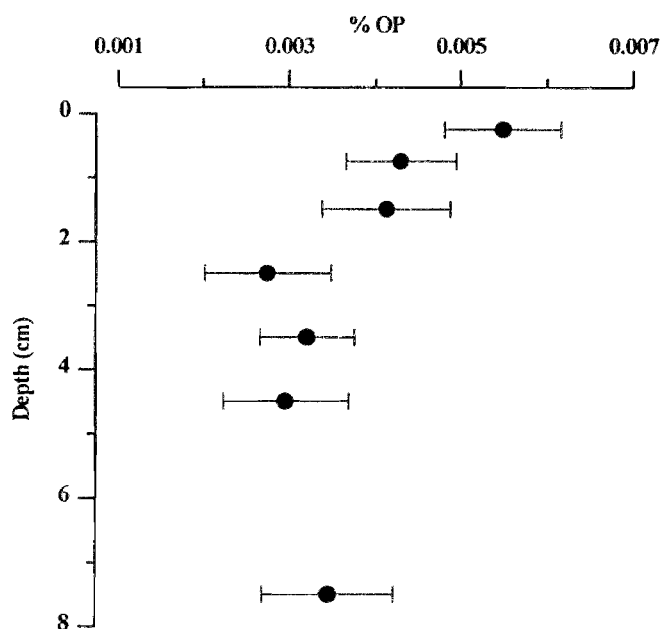


Figure 3: Average ± SE of percentage of organic phosphorus in GAR lagoon sediments

3.2 Carbon

The results of total Carbon, mineral Carbon and carbonates percents of the surface layer appear in Table 4.

The mineral carbon percents vary between 11.26 and 11.58 except at station 27 where it was only

10.65%. At this station, the carbonates were low (only 88.7%) if we compare with the ones of other stations (93.8 to 96.8 %). Organic carbon is more interesting for the aim of our study. The results for all studied sediment depth appear in Table 4.

Table 3: Percentages of organic carbon, organic nitrogen (OC, ON), mineral carbon (MC) in the 0-0.5 cm sediment depth layer

Stat	depth	% C	% OC	% ON	C/N	% MC	% CaCO ₃
1	19	11.6	0.16	0.043	3.7	11.44	95.3
3	11	11.78	0.24			11.54	96.2
4	39	11.64	0.21	0.008	26.7	11.43	95.2
9	35	11.7	0.13	0.012	10.5	11.57	96.4
13	36	11.72	0.22			11.5	95.8
26	9	11.64	0.12	0.023	5.3	11.52	96
27	12	10.85	0.2	0.024	8.5	10.65	88.7
28	24	11.69	0.11	0.026	4.3	11.58	96.5
29	8	11.56	0.3	0.027	10.9	11.26	96.8
30	35	11.51	0.25	0.025	9.3	11.26	93.8
31	39	11.72	0.15			11.57	96.4
average		11.6	0.19	0.024	9.9	11.4	94.9

Table 4: Percentage of organic carbon at different stations and sediment depth (cm) of GAR lagoon

St.	depth	hsed							
		0-0.5	0.5-1	1-2	2-3	3-4	4-5	7-8	0.5-8
13	36	0.22	0.18	0.20	0.15	0.16		0.20	0.18
3	11	0.24							
1	19	0.16	0.15		0.11	0.13	0.19	0.16	0.15
4	40	0.21	0.19	0.21	0.23	0.23			0.15
31	39	0.15	0.15	0.14	0.12	0.90	0.14	0.80	0.12
30	40	0.25	0.19	0.30	0.12	0.13	0.90	0.10	0.16
9	35	0.13	0.20	0.13	0.12	0.13	0.90	0.10	0.13
28	22	0.11	0.13	0.11	0.16	0.90	0.11		0.12
26	9	0.12	0.10	0.14	0.11	0.15	0.14	0.10	0.12
27	12	0.20	0.22	0.16	0.19	0.28	0.22		0.21
29	8	0.30	0.30	0.23	0.16	0.18	0.12		0.20
Av		0.19	0.18	0.18	0.15	0.16	0.14	0.12	0.15

In the upper 05 cm, % of OC varied between 0.11 and 0.30. The maximum was at station 29 where numerous macro-algae were observed. The 28, 26, 31, 1 and 9 group represent stations where the % OC was < 0.17 %. In average for the whole lagoon, the values decreased with the sediment depth (Table 4) even if this trend was not true at each station. We observe 3 groups: the 0-2 cm, 2-5 cm and 7-8 cm ones (Figure 4).

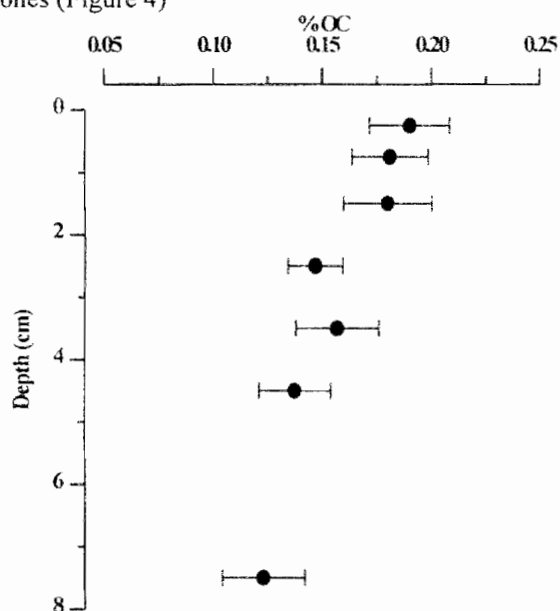


Figure 4: Average \pm SE of percentage of organic carbon (OC) in GAR lagoon sediments

3.3 C/P

C/P ratio appear in Table 5: Organic

The C/P ratio on the upper 05 cm varied between 196 and 679 and was in average 378. The C/P ratio remained constant at stations 1, 9, 30 and 4, and increased at stations 28, 26, 27 et 29. A very high value was observed just below the SWI at station 32 (Figure 5).

4. Comparison with other lagoons

Percentage P and C forms were studied in other lagoons (Table 5).

GAR sediments presented higher OP and lower OC contents than Tikehau and Takapoto atoll. The OC was similar to the OC content of two island lagoon: Moorea (French Polynesia) and Noumea (New Caledonia).

The OC:OP ratio was 4 to five times lower in GAR sediments than in Tikehau and Takapoto sediments.

Table 5: Organic carbon / organic phosphorus ratio at different stations and sediment depth (cm) in GAR lagoon

St	depth	hsed							
		0-05	05-1	1-2	2-3	3-4	4-5	7-8	05-8
13	36	506	420	444	705	873		400	568
3	11	37							
1	19	295	409			377	374	869	507
4	40	325	318	219	375	409			330
31	39	679	2500	412	308	237	20	200	643
30	40	255	281	529	186	20	203	170	262
9	35	196	336	256	299	409	383	333	336
28	22	399	949	917		776	1158		950
26	9	293	257	94	738	679	915	1000	755
27	12	46	514	489	872	1116	1692		937
29	8	384	482	737	129	978	1714		1040
Av		378	549	549	597	605	830	495	633

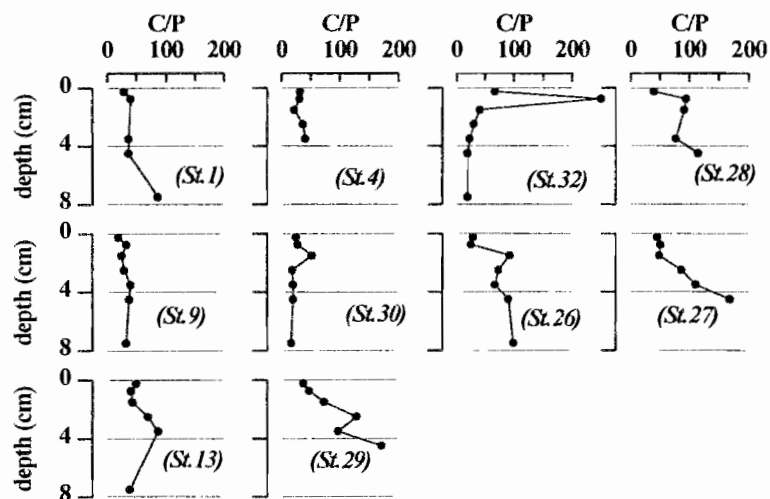


Figure 5: Profiles of C/P ratio in the sediments of the GAR lagoon

Table 5: % of total phosphorus (TP), mineral phosphorus (MP), organic phosphorus (OP), total carbon (TC), organic carbon (OC) in the upper layer of sediments of some coral reef lagoons

Site	% TP	% MP	% OP	% TC	% CaCO ₃	% OC	OC/OP	References
Tikehau (atoll)	026	021	005	112	895	046	92	Charpy-Roubaud et al (unp. results)
Takapoto (atoll)	030	023	007	-	-	033	47	Charpy-Roubaud et al (unpub)
Moorea (island)				115	96	022		Delesalle et al, 1986; Schrimm, 1995
Noumea (island)				112	85	02		Buscail (pers. comm.)
GAR	037	028	009	116	949	019	2	This study

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5. Bibliography

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