Vol. 132: 181–190, 1996 | MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser | Published February 29

96 - 2

Diffusional nutrient fluxes at the sediment-water interface and organic matter mineralization in an atoll lagoon (Tikehau, Tuamotu Archipelago, French Polynesia)

Claude Charpy-Roubaud[1,*,], Loïc Charpy[1,*], Gérard Sarazin[2]**

[1]Centre ORSTOM de Tahiti, BP 529, Papeete, Tahiti, French Polynesia
[2]Université Paris 7, Laboratoire de Géochimie des Eaux, F-75251 Paris Cedex 05, France

ABSTRACT: Fluxes of dissolved inorganic N, P and Si from the sediments were calculated using pore water gradient concentration measured using the peeper technique at 8 stations in the lagoon of Tikehau Atoll, French Polynesia. Nutrient concentrations of pore water reached maximum values of 130 µM NH_4, 7 µM PO_4 and 30 µM SiO_2. Fluxes calculated from concentration gradients were positive at all stations. N and P fluxes represented 6 and 4% of the N and P deposition rates and between 0.1 and 6.8% of the N requirements and between 0.1 and 1.7 % of the P requirements of lagoonal primary production. Study of geochemical processes and stoichiometry of the organic matter shows that a great part of deposited organic matter is oxidized in the water column. The amount of organic matter oxidized inside the sediment is estimated to 2.5 mg kg^{-1} in the upper centimeter and 5.2 mg kg^{-1} below. Pore water was supersaturated with respect to aragonite and calcite, and the kinetics of carbonate dissolution were faster than the reverse reaction. The dissolution/precipitation of carbonate plays an important role in the composition of the pore water.

KEY WORDS: Nutrient fluxes · Sediment · Pore water · Peeper · Atoll lagoon · Mineralisation

INTRODUCTION

Nutrient fluxes on coral reef environments have been extensively studied (see reviews of Lewis 1977, Crossland 1983, Kinsey 1985, Atkinson 1989, Boucher & Clavier 1990, Hatcher 1990, Capone et al. 1992). At the level of the whole reef ecosystem (reef flat + lagoon), net community productivity appears to be but a tiny fraction of the gross production rate, implying that reef ecosystems accumulate biomass slowly and export little of it (Hatcher 1990). Atkinson (1989) asked the question: 'Is the rate of nutrient supply greater than the rate of nutrient uptake?'. The answer is more accessible in ecosystems with high water residence times: weeks, months or years. For example, the lagoon of Tikehau Atoll, French Polynesia, has an average water residence time estimated at 176 d (Lenhardt 1991). Its phosphorus budget is largely balanced by phosphate input from oceanic waters (Charpy-Roubaud et al. 1990). If we compare the phosphate input (from oceanic waters) per m^2 of lagoon, 60 µmol m^{-2} d^{-1} (calculated from Charpy-Roubaud et al. 1990), to the phosphate uptake by the phytoplankton + phytobenthos, 600 µmol m^{-2} d^{-1} (calculated from Charpy & Charpy-Roubaud 1989), it is apparent that 90% of the lagoonal phosphate requirements must be supplied by remineralization and recycling processes.

Nutrient mineralization may occur in the water column (excretion and bacterial metabolism), at the sediment-water interface (SWI) or within the sediments. The importance of the recycling of autochthonous material at the SWI and within the sediments can be estimated by measuring nutrient fluxes at the SWI.

*Present address: ORSTOM, COM, Rue de la Batterie des Lions, F-13007 Marseille, France
**E-mail: clcharpy@orstom.orstom.fr