11 Preliminary Data on Particle Flux off the São Francisco River, Eastern Brazil

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11.1 INTRODUCTION

Fresh water and nutrient inputs from the rivers influence the biogeochemical processes in the coastal seas and affect the quality and quantity of material accumulating in marine sediments. The latter results both from the direct inputs of river-derived terrigenous material and from the changes in marine biogenic inputs. Changes in salinity brought about by fresh water, and the introduction of river-derived nutrients have been found to promote the growth of siliceous plankton which increased the fluxes of biogenic opal and organic matter (Ittekkot et al., 1991).

Here we present preliminary data on particle flux in a marine region off the São Francisco River in eastern Brazil (Figure 11.1). The São Francisco drains an area of 631133 km^2 (Paredes et al., 1983). It has an annual mean water discharge of 99 km^3 (Bessa and Paredes, 1990). The annual sediment discharge of 6 x 10^6 t is influenced by the construction of dams and the related retention of sediments in reservoir lakes (Milliman, 1975).

11.2 MATERIALS AND METHODS

A mooring system consisting of two PARFLUX Mark 7G-21 sediment traps was deployed from January 1995 to May 1995 at a location 50 km off the São Francisco River in eastern Brazil (10°56'S, 36°13'W; water depth 2100 m; Figure 11.1). The period of deployment coincided with the period of high water discharge of the river (Figure 11.2). The traps were positioned at water depths of 500 m and 1550 m. Prior to deployment the sampling cups were filled with seawater from 500 m water depth. To avoid organic matter decomposition cup waters were

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poisoned with $HgCl_2$ (3.3 g l^{-1}). The traps were programmed to collect settling particles at intervals of 6 days (Table 11.1).

The samples were wet sieved and the fraction < 1 mm was split with a precision rotary splitter. The splits were filtered and the filters dried at 40°C. Material from one split was used for calculation of the total flux and for the analyses of total carbon, total nitrogen, carbonate and biogenic opal. Total carbon and nitrogen were analyzed by high temperature combustion with a Carlo Erba (Milan, Italy) Elemental Analyzer NA-1500. Inorganic carbon was measured conductometrically with a Wösthoff (Bochum, Germany) Carmhograph 6. Biogenic opal was determined photometrically as silicomolybdate complex using a modification of Mortlock and Froelich's (1989) method.

Organic carbon (C_{org}) was calculated as the difference between total carbon and carbonate carbon (C_{carb}) and the organic matter by multiplying organic carbon

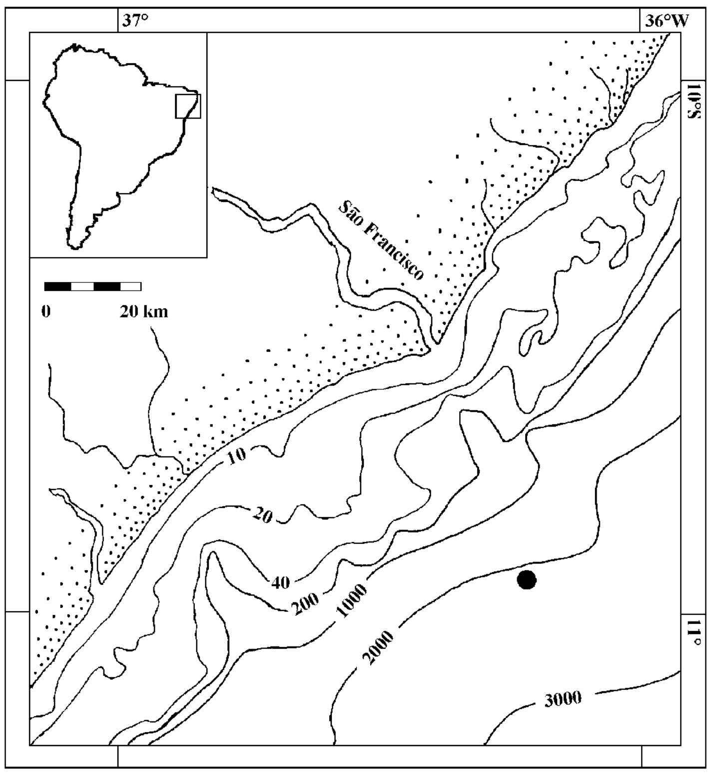

Figure 11.1 Location of the sediment trap system off the São Francisco River, eastern Brazil.

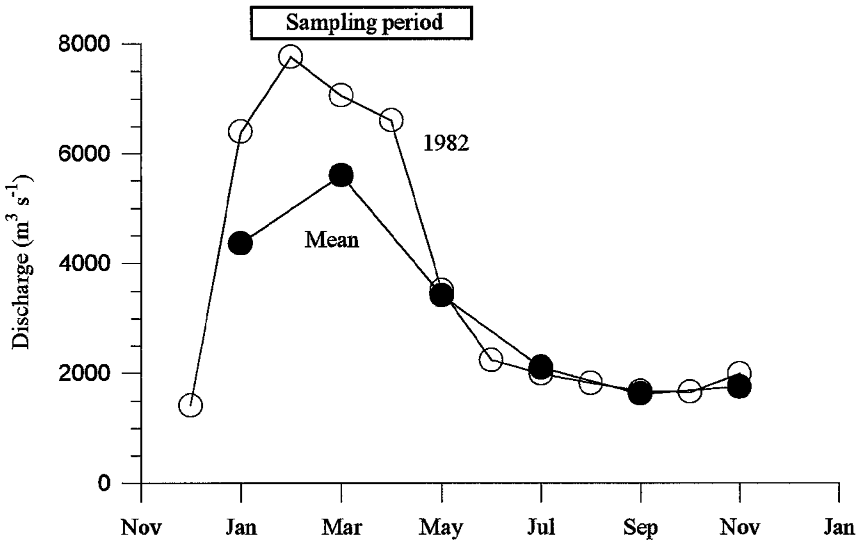

Figure 11.2 Discharge of the São Francisco River, eastern Brazil. Monthly discharge data from 1982 (open circles) from Paredes et al. (1983), bimonthly means (solid circles) from Coleman and Wright (1971). Bar on top of the graph denotes sampling period of the sediment trap system.

content with a factor of 1.8 (Müller et al., 1986). Lithogenic matter flux was estimated by subtracting the sum of carbonate, biogenic opal, total nitrogen and organic matter fluxes from the total flux. C/N, carbonate/opal and C_{org}/C_{carb} ratios were calculated by weight percent.

11.3 RESULTS AND DISCUSSION

The measured total flux for the 4 months of deployment period was 16.5 g m^{-2} in 1550 m water depth. The respective fluxes for carbonate, biogenic opal, lithogenics and organic matter for the same period were 5.5 g m^{-2}, 0.97 g m^{-2}, 8.8 g m^{-2} and 1.2 g m^{-2}, respectively. The observed flux variations were in the range of 42.2 to 292.2 mg m^{-2} d^{-1} for total material and of 18.3 to 95.5 mg m^{-2} d^{-1}, 2.3 to 16.3 mg m^{-2} d^{-1}, 18 to 160.5 mg m^{-2} d^{-1} and 3.3 to 18.8 mg m^{-2} d^{-1} for carbonate, biogenic opal, lithogenics and organic matter, respectively. The respective averages for the period of deployment were 130.9 mg m^{-2} d^{-1}, 43.3 mg m^{-2} d^{-1}, 7.7 mg m^{-2} d^{-1}, 69.7 mg m^{-2} d^{-1}, 9.5 mg m^{-2} d^{-1}. Carbonate, opal and lithogenics and organic matter contributed respectively 34.7%, 5.8%, 51.5% and 7.5% to the total flux.

Maximum fluxes of biogenic and lithogenic components coincided with maximum discharge of the São Francisco during February and March (Figure 11.3). Despite the relatively low primary productivity in the coastal region (60–90 g C m^{-2} y^{-1}; Berger, 1989; Summerhayes et al., 1976) and the fairly low sediment input from the São Francisco River, the measured total flux of 16 g m^{-2} during the four month of deployment lies at the higher end of the annual fluxes measured in other marine regions of the world.

The carbonate/opal ratios of settling particles varied between 3.9 and 8, and the C_{org}/C_{carb} between 0.66 and 1.81. The average C_{org}/C_{carb} value of 1.0 is lower than that measured in the Bay of Bengal, a marine region affected by some of the largest rivers of the world (Ittekkot et al., 1991; this volume, Chapter 15) and are similar to or slightly higher than those measured at deeper traps (3000 m) in offshore regions (e.g., this volume, Chapter 7). Peak C_{org}/C_{carb} ratios of up to 1.8 between February and the middle of March coincided with the minimum carbonate/opal ratios (Figure 11.4). In general, peak total fluxes and the fluxes of individual biogenic and abiogenic components occured in the middle of March. However, for organic matter, nitrogen and biogenic opal the increase in fluxes occured three weeks earlier with increasing fresh water discharge from the São Francisco River. As has been observed in several other regions the fresh water input appears to promote the growth of siliceous plankton and enhance the sedimentation of both biogenic opal and organic matter (e.g., this volume, Chapter 15). Similar plankton bloom and particle flux patterns have been observed in the northern North Sea (Kempe and Jennerjahn, 1988) and the Black Sea (Hay et al., 1990).

Inner shelf sediments adjacent to the rivers of eastern Brazil between 8° and 24°S have a mean C_{org} content of 1.4% (Jennerjahn, 1994). Assuming that the lithogenic material collected in the trap originates from the São Francisco or its delta, the fluxes of organic matter from this source can be calculated by multiplying the fluxes of lithogenic matter with the average C_{org} content of the deltaic and shelf sediments. This will further allow estimation of the organic matter derived from autochthonous production. The results of this exercise are presented in Figure 11.5. In general, the contribution of allochthonous organic matter to total organic matter was about 19% with the maximum value in association with the peak total flux. However, its contribution to total C_{org} was comparatively smaller at the end of February and at the beginning of March, when C_{org} fluxes and the ratios of C_{org}/C_{carb} as well as carbonate/opal were higher.

These preliminary results suggest that despite the low sediment discharge, the São Francisco is of importance in the production and sedimentation of organic matter along the Brazilian continental margin.

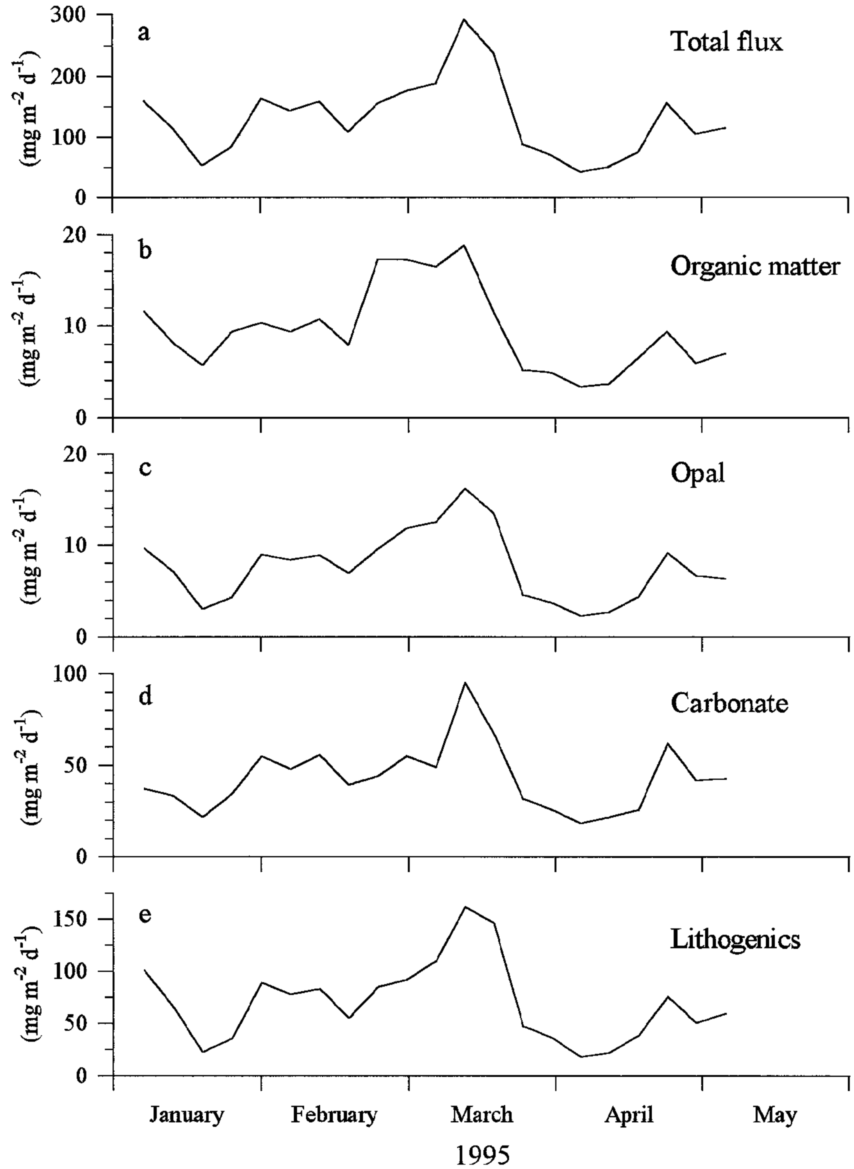

Figure 11.3 (a) Total, (b) organic matter, (c) opal, (d) carbonate, and (e) lithogenic fluxes off the São Francisco River.

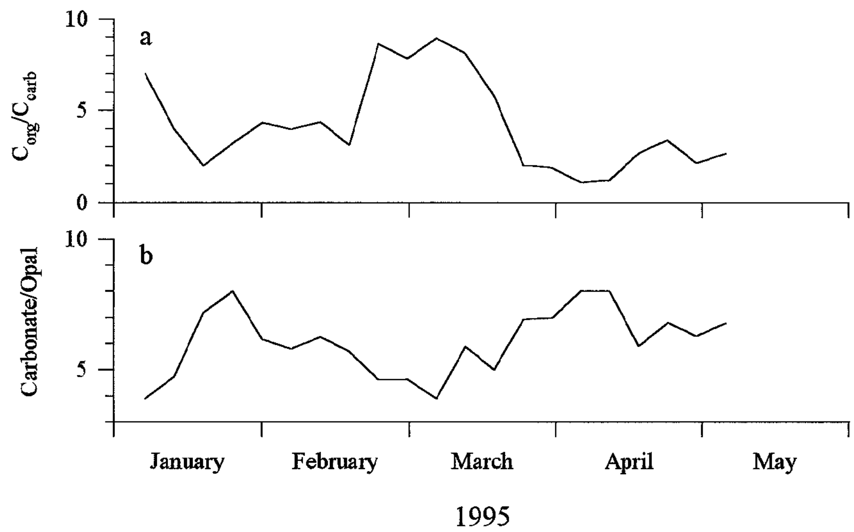

Figure 11.4 (a) C_{org}/C_{carb} and (b) carbonate/opal ratios off the São Francisco.

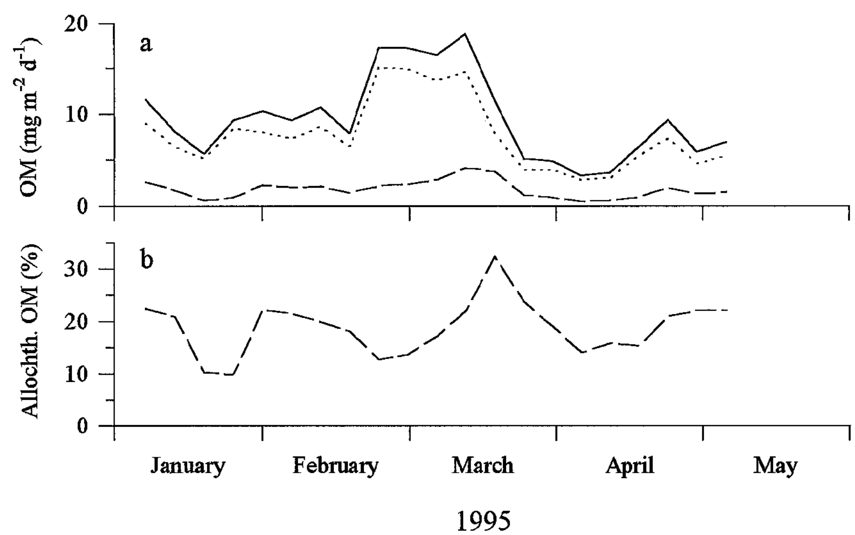

Figure 11.5 (a) Total organic matter flux (solid line), subdivided in autochthonous (dotted line) and allochthonous (dashed line) organic matter fluxes and (b) contribution of allochthonous organic matter to total organic matter off the São Francisco River.

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