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Relationships between Oxygen and Alkalinity Benthic Fluxes at Cadiz Bay (S.W. Spain)

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Nutrients benthic regeneration through biogenic decomposition of organic matter in coastal ecosystem is mainly produced by aerobic oxidation and sulphate-reduction pathways (Jorgensen, 1982; Crill and Martens, 1987). The relative contribution of both processes is very variable, depending on many environmental factors, and can be assessed determining the fluxes across the sediment-water interface of both oxygen and alkalinity. This has been frequently realized by means of the chemical concentration profiles in pore water (eg, Aller and Yingst, 1980; Jorgensen and Sorensen, 1985; Crill and Martens, 1987). In this paper, the stoichiometric values of oxygen and carbonate alkalinity "in situ" fluxes are measured in order to evaluate the participation of the two main alternative mechanisms for nutrient regeneration in coastal sediments. The study are carried out over a year period in a site located in the bay of Cadiz.

EXPERIMENTAL

The Bay of Cadiz is a productive shallow coastal ecosystem, receiving a large input of organic matter. The bay has a mixed bathymetry and it is subject to a semidiurnal tidal regime with about 2,70 m average amplitude. These facts generate a complex hydrodynamic and sedimentary behaviour. Sampling station is located in a argillaceous subtidal area (8 m in depth) and it is affected by a moderate flood current system. Its botton contains a large assemblage of infaunal benthos, mostly pollychaeta.

Matter fluxes across the sediment-water interface were determined by means of benthic stirred opaque chambers. They were made of plexiglass and semiellipsoid revolution shape of circular section. These chambers cover 0.385 m^2 of bottom and contain between 65 and 90 L. Chamber incubation of botton lasted 3-5 h. A previously calibrated YSI 5739 polarographic sensor was used for measuring oxygen concentration every 5 min. Alkalinity was determined by Gran titration method in samples withdrawn from the chambers each 15-20 min. Complementary pore water chemical profiles were obtained from 40 mm i.d. cores by centrifugation at 24,000 g.

RESULTS

In relation to the temporal evolution of the oxygen benthic demand and carbonate alkalinity flux (fig. 1a), two facts can be noted: i) both oxygen and alkalinity fluxes show a clear seasonal trend;

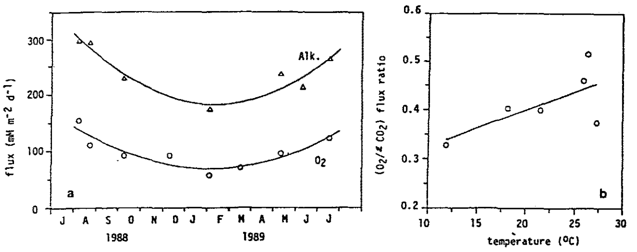

Figure 1

ii) measured fluxes are high, specially in summer. Their values are generally greather than those obtained in other zones at a similar latitude.

Fluxes of ΣCO_2 are always greather than oxygen fluxes. According to Redfield's ratios and assuming that organic matter decomposition would occur exclusively via aerobic pathway, the $O_2/\Sigma CO_2$ fluxes ratio would have a value of 1.3. Values obtained for this ratio in Cadiz bay are always smaller than 0.5. This denotes the importance of anaerobic degradation processes. On the other hand, an increase of ($O_2/\Sigma CO_2$) fluxes ratio with temperature has been found (fig. 1b). This suggests that the aerobic pathways contribution in degradation processes is greater in summer, in spite of the oxygen concentration in the water column being apprecibly lesser than in winter. Two explanation can be suggested: i) benthic macrofauna density is greather in summer (about 250 specimens m^{-2}), and also their activity. In this way, Revsbech *et al.* (1983) have reported the existence of oxic microenvironment at depths below the oxic layer, due to the macrofaunal irrigation in the sediments; ii) The increase of the temperature in summer, acelerating the benthic metabolism, is specially important in the sediment surface. In this layer the aerobic degradative processes take place; therefore these can be enhanced.

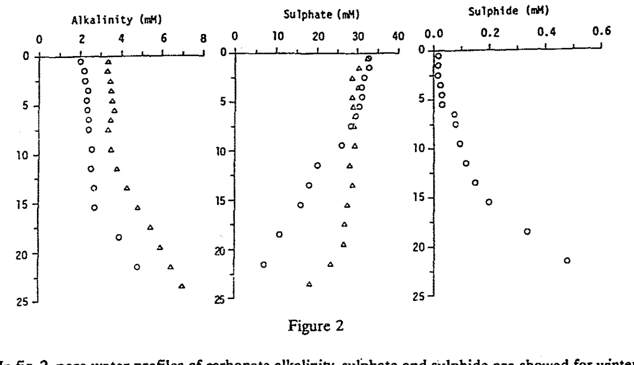

Figure 2

In fig. 2, pore water profiles of carbonate alkalinity, sulphate and sulphide are showed for winter (▵) and summer (○). Low gradient concentration upper 10 cm of sediment can be observed. Similar variations are encountered by other authors (Goldhaber et al., 1977) and they are related with the influence of benthic macrofauna irrigation. For this reason, diffusive fluxes calculated by means of vertical profiles in interstitial water are very low in relation to "in situ" fluxes.

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Influence of Meteorological Conditions and the Rhone River Discharge on the Distribution of Iron, Manganese and Copper in the Gulf of Lion

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The Gulf of Lion, extending from the Gulf of Marselia to the Spanish fronteers, receives fresh water principally from the Rhone River. The spreading of the river water in the gulf dpends on the meteorological and climatological conditions in the area. One of the most important characteristics of the meteorology of the area is the presence of a strong NW wind "Mistral"which drives away the surface water in the coastal area giving rise to the advection of the bottom or subsurface water (Minas, 1986). This upwelling brings to the surface deep water of differing chemical composition and may result in the limitation of the surface spreading of the panache of the Rhone (Aminot, 1986).

In the period from 14 to 26 September, 1984, 28 surface water samples were taken from the Gulf and the Rhone Delta. Besides two samples were taken at the river-sea connection and a vertical profile was performed in the open Mediterranean water (Fig. 1). The unfilterd water samples were analyzed, under clean laboratory conditions, for their Fe, Mn and Cu content. Filtered samples of particularly turbid water were also analyzed.

Salinity measurements (Aminot et al. 1986) showed that the dispersion of the Rhone river water extends in a SSW direction represented by the stations 11, 35, 46, 47, 49 and 50. The relation between salinity and Fe, Mn and Cu along the axis of dispersion shows a massive elimination of the three elements during the first stages of mixing (84, 44 and 83.0 per cent for Fe, Mn and Cu respectively). The perfect agreement between the metals and turbidity indicates that suspended matter is the main vector in the transport of these elements in the Rhone water. Data of the filtered samples show that at station R1 (salinity less than 1) dissolved (0.45 um) Fe represents less than 1% of the total while dissolved Mn and Cu represented 37 and 38% of the total metal.

In the Gulf, according to hydrological characteristics and trace metals distrbution, illustrated here by iron, three sectors are identified (Fig. 2):

1- the southern near coastal zone (st. 1, 2, 3): not affected by upwelling and characterized by intermediat salinity (38. 07-38.10), high water temperature (18 c) and relatively low Fe concentration (4. 66 ug/l) but showed marked S-N increase;

2- the eastern and northern zone (st. 4-9): highly influenced by water advection which lead to a marked temperature decrease (14), a significant salinity and turbidity increase and the highest Fe concentrations (31. 75 ug/l).

3- the central part of the Gulf and the open Mediterranean water: characterized by moderate salinity (38.1) excepting st. 52, very low turbidity and the lowest Fe concentration (0. 92 ug/l).

Data of the vertical profile indicate a marked enrichement of the surface water in Fe, Mn and Cu as has been previously observed by Kremling (1981).

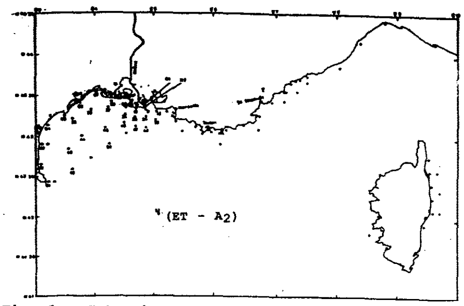

Fig. 1 - Intersit II - Sampling in the Gulf of Lion

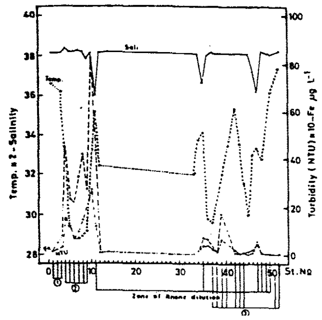

Fig. 2 - Geographic Distribution of Salinity, Temperature, Turbidity and Iron in the Gulf of Lion

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