GEOCHEMICAL INDICATORS OF RIVERINE INFLUENCES ON TROPHIC GRADIENTS IN THE NORTHERN MEDITERRANEAN SEA

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Abstract

Studies of sediment and suspended particulate matter (SPM) have been made on the western Adriatic shelf, the northwestern Mediterranean margin and the Aegean Sea, to identify and geochemically characterise trophic gradients influenced either by river nutrient inputs or where production is controlled by vertical circulation, as in pelagic environments. Gradients in west Adriatic shelf sediments calculated as rain rates of C_{org}, Si_{bio} as well as rates of oxygen consumption show a well defined southward gradient. SPM studies of C_{org}, P_{org} and Si_{bio} in the three areas identify standing crop : these show a general decrease southwards although certain pelagic areas can also show high values. These elements by themselves cannot be used to discriminate between environments either influenced or not influenced by riverine nutrient inputs. To do this requires information on two indicator elements, Al and Mn. The former broadly relates to river discharge and bottom sediment resuspension. Mn on shelves is also river derived but is redox cycled depending on the rain rate of organic matter.

Key-words : Primary production, continental margin, particulates

The Mediterranean Sea is characterised by oligotrophism that increases from west to east. However, several areas, particularly at its northern margin and especially the Gulf of Lions, the western Adriatic and Northern Aegean Seas show moderate to high levels of primary productivity and chlorophyll concentrations such that there is also a north to south gradient of increasing oligotrophy. This latter trend to a significant extent is induced by nutrient discharges from the coastal zone, particularly from the rivers Rhone and Po and others entering the north Aegean. This paper is an attempt to explore the effect of increased biological productivity on the composition and concentrations of elements in suspended particulate matter (SPM) from these three areas, as well as identifying particulate elements that enable discrimination between primary produced by riverine discharge and that produced within the pelagic environment.

Given that there is likely to be considerable seasonal and interannual variation in SPM element concentration, a study has also been made on the compositional trends of biogeochemical elements in the surficial sediments of one of these areas, the western Adriatic shelf, in order to relate them to the distributionsof SPM elements in the overlying waters.

Materials for study

During the MTP-I project (1993 - 1996) selected stations, mostly representing transects crossing the shelf and upper slope within the Gulf of Lions and western Adriatic, have been sampled at different seasons. These investigations were constituent parts of the EUROMARGE - NB, EUROMARGE - AS and OTRANTO projects.

Within the Adriatic, 5-6 transects normal to the coast as well as spot stations have been sampled on its western shelf (mostly between 20-70 m), from the River Po outfall to south of Pescara during two contrasting seasons. The results can be used to assess the southward dispersal of riverine discharge and the effect this has on trophic systems within the western limb of the Adriatic cyclonic gyre. Discharge of SPM through the Strait of Otranto has been studied from a transect across the strait sampled at two contrasting seasons, August 1993 and November 1994. Such a data set for the Adriatic provides a means of assessing the southward gradient of oligotrophy from an area of comparatively high productivity in the north. Coupled to this, box cores have been sampled at eight stations, many of which underlie the SPM transects. Two of these stations, however, are located in the mid- and southern Adriatic basins, and essentially represent an end member of the trophic gradient within the Adriatic.

In the northwestern Mediterranean, SPM was sampled seasonally, as depth profiles (8-10 depths) on transects normal to the coast off Marseilles and Banyuls-sur mer, as well as a transect intersecting the Balearic Islands. Given an easterly flow of upper waters in the Gulf of Lions, only the transect off Banyuls-sur-mer is directly influenced by the Rhone discharge and its SPM composition should reflect this.

In the Aegean the composition of SPM in its northern waters relates to a complicated water mass structure as well as to river discharges from northern rivers in Greece, and the influx of Black Sea waters via the Dardanelles. In contrast, water from the Cretan Sea, taken on a transect at approximately 36°N during the PELAGOS 1994 and MATER 1997 projects, is isolated from direct sources of riverine influence. Here the terrigenous, biogenic and authigenic constituents within the SPM relate to mechanisms associated with a pelagic environment, and can be regarded as an end member of the Mediterranean trophic gradient.

Results

Sediments

Depth integrated values of primary production estimates in the Adriatic for two contrasting seasons (Fig. 1) show highest values in April, but there is only a general decrease southwards to Station 5. The correlation between primary production and potential limiting factors (nutrients, chlorophyll-a, PAR) suggests that PAR is the main controlling factor for production on a yearly time scale, as has been observed at Station 2 (off Cesenatico). At northern stations, production can be higher in autumn and spring where smaller light availability is compensated by higher riverine nutrient supply. At the southern stations (*e.g.* Station 5) PAR is the likely controlling factor over the year.

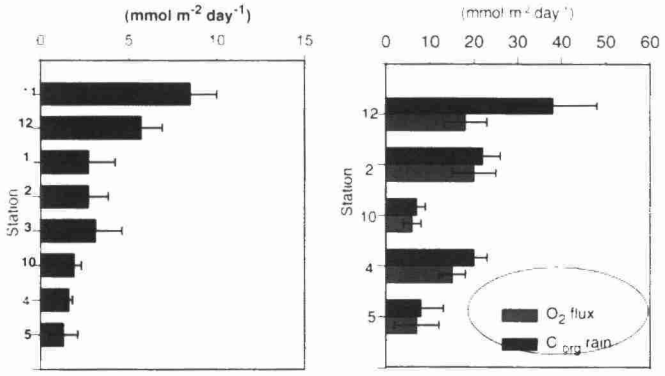

Fig. 1. Calculated oxygen consumption fluxes (left) and Si and Corg rain rates (right) of west Adriatic shelf sediments from north (top) to south (bottom).

Surficial sediments have been analysed for sediment accumulation rates (^{210}Pb), on-deck oxygen penetration depth, C_{org} (C/N atomic ratios) and biogenic SiO_2 concentrations. The relative magnitude of these depends on the combined effects of processes in the water (terrestrial atmospheric input, biological productivity, hydrodynamics) and in the sediments (water exchange reactions, benthic biological activity, organic respiration). Their distributions are important in indicating the gradient of the trophic activity in the overlying waters. In this context a station contrast occurs between the five northern stations (11-3) and the middle shelf (4) and middle and southern basins (10 and 5). Sediment accumulation rates (SAR) show a well defined southward decrease commensurate with dispersal of a major