L-V6

DETERMINATION OF SOURCES OF ORGANIC MATTER IN THE NEAR-SHORE MARINE ENVIRONMENT (GULF OF TRIESTE, NORTHERN ADRIATIC) USING THE ELEMENTAL COMPOSITION OF C, N AND P, AND THE ISOTOPIC C COMPOSITION *

J. FAGANELI[1], A. MALEJ[1] and J. PEZDIC[2]

(1) Marine Research Center, Piran (Yugoslavia)
(2) Jozef Stefan Institute, Ljubljana (Yugoslavia)

Measurements of stable C isotopes was shown to be useful tool for studying the organic C flow in marine and fresh-water environments and especially in marine food webs. By measuring the elemental composition of C, N, P and the isotopic composition of C of organic matter in the Gulf of Trieste during 1980-85 we planned to elucidate the sources of organic matter and to trace the organic matter flow in this marine environment. Our primary objectives were to: (1) measure the elemental composition of C, N, P and the isotopic carbon composition in various classes of coastal organic material - sewage effluent, benthic (Fucus virsoides, Ulva rigida) and pelagic (Gyrodinium sp. bloom) autotrophic sources, particulate organic matter (POM), net-zooplankton, the jellyfish Pelagia noctiluca, and surface marine sediments; (2) assess the importance of autochtonous and allochtonous organic matter in organic matter cycling in the marine environment of the Gulf of Trieste and (3), establish the degree of ^{13}C enrichment occurring in various trophic levels in the Gulf.

Our results show a clear shift from higher C:N and C:P ratios of benthic algae, towards lower values of POM and still lower ones for net-zooplankton and sewage organic matter. Thus, considering both C:N and C:P ratios, distinct differences exist between the different classes of organic matter in the Gulf.

Considering our mean sediment C:N ratio of 11.2 it would appear that the surface sediment is somewhat affected by land derived organic matter, although the plot of C:N vs. C:P ratios indicate that the sediment organic matter may be also derived from marine POM and benthic algae. Thus, the C:N and C:P ratios alone cannot provide a definitive answer to the question of the origin of organic matter in the near-shore marine environment of the Gulf of Trieste, especially with respect to terrigenous sources.

Stable C isotope values of benthic autotrophs were distinctly different (-17.04 $\pm$ 0.96 °/oo, n = 33) from the examined phytoplankton species (-21.6 °/oo), while POM was more ^{13}C depleted (-23.0 $\pm$ 1.83 °/oo, n = 5). $\delta^{13}C$ values of net-zooplankton (-19.89 $\pm$ 2.25 °/oo, n = 5) and Pelagia noctiluca (-18.51 $\pm$ 1.12 °/oo, n = 4), as their consumers, tended to be ^{13}C enriched relative to food resources. Since the animals $\delta^{13}C$ value reflect the $\delta^{13}C$ of food-carbon sources one can expect more negative $\delta^{13}C$ values in animals feeding on organic matter of terrigenous or sewage origin. Our results for net-zooplankton and Pelagia noctiluca, were in the range of ^{13}C enriched offshore animals, indicating only minor incorporation of allochtonous (terrigenous and sewage) C by these animals.

Stable C isotope values of sewage were the most ^{13}C depleted. The intermediate and narrow ranging isotopic values of surface sediments (-20.7 $\pm$ 0.5 °/oo, n = 4) indicate integration of $\delta^{13}C$ composition from diverse resources, of which sewage organic matter, treated and untreated (-24.5 °/oo) and other riverine POM, and C_3 terrestrial plants seem to be of lesser importance. If we apply the two source mixing model to surface sediments in the Gulf of Trieste where an intermediate value (-20.7 °/oo) was found, a simple 50:50 mixture of materials from POM (-23 °/oo) and benthic algae (-17 °/oo) could be presumed. A $\delta^{13}C$ value close to -20 °/oo could also be expected from the flux of zooplankton faecal pellets, since it has been shown that heavier isotopes were preferentially retained in the particulate fraction-copepods and feces. Our results thus indicate that the sources of food net-zooplankton were primarily phytoplankton rather than ^{13}C depleted detritus of terrestrial or sewage origin, although omnivorous feeding of neritic and estuarine copepods is well known.

C:N and C:P ratios and also isotopic C analysis of near-shore organic material alone cannot deffinitively clarify the source of organic matter and organic matter cycling in the marine environment in the Gulf of Trieste. It seems that a promising approach to better characterization of the sources and cycling of organic matter is the combination of isotopic C analysis with C:N and C:P ratios. Our results thus indicate that the organic matter in the near-shore area in the Gulf of Trieste is almost completely marine, produced in situ by phytoplankton and benthic algae.

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L-VI1

SOURCES, MODE OF TRANSPORTATION AND BEHAVIOUR OF HEAVY METALS IN TWO SEMI-ENCLOSED BAYS OF ITHAKI ISLAND, GREECE. THE ROLE OF DISSOLVED OXYGEN IN THE ACCUMULATION OF THE METALS

S.P. VARNAVAS[1], A.G. PANAGOS[2], G. LAIOS[2] and S. ALEXANDROPOULOU[1]

(1) Department of Geology, University of Patras, Patras (Greece)
(2) Department of Geology, National Technical University, Athens (Greece)

Surface sediments from Vathi and Aetos bays have been analysed in bulk for Al, Pb, Cr, Co, Ni, Cu, Zn, Mn, Fe, using X-ray fluorescence techniques, $CaCO_3$, was determined using acetic acid leach and organic carbon by titrations (method $K_2Cr_2O_7$-$Fe(NH_4)_2(SO_4)_2 6.H_2O$. Also, dissolved oxygen in surface and bottom waters has been measured using a Consort Z 800 portable digital oxygenmeter.

RESULTS AND DISCUSSION

Heavy metals.

Most of the metals analysed, are generally enriched relative to normal shallow water sediments, their degree of enrichment being decreased in the following order Cr> Pb>Ni>Zn>Co.

Chromium varies between 117 and 383 ppm. Its highest concentrations are found in the Aetos bay and the mouth of Vathi bay and they decrease steadily towards its inner part.

There is a negative correlation between chromium and organic carbon as well as between chromium and aluminium, suggesting the association of chromium with other than organic and the clay fraction of the sediments. The maximum values of chromium found in the Aetos bay are much higher than those reported for the Peraeus harbour, the Elefsis and Patraicos bays.

Lead varies between 22 and 106 ppm, its highest values being found in the inner part of the Vathi bay (Fig.1) at the outfall of an olive oil factory. The concentration of lead decrease steadily towards the mouth of the bay. There is a strong positive correlation between lead and organic carbon as well as between lead and aluminium suggesting the association of lead with the organic and clay fraction of the sediments. A number of stations from the mouth of Vathi and Aetos bays are characterized by lower Pb/Al ratios compared with the rest of sediments. A strong negative correlation exists between lead and chromium suggesting the incorporation of the two elements in different sediment fractions.

The degree of enrichment for lead in the Vathi bay is much greater than that reported for Patraicos, Kalamata and Navarino bays.

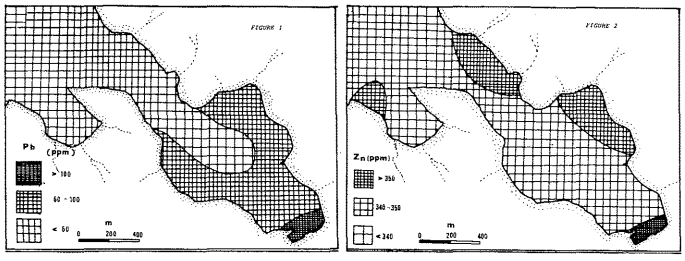
Nickel varies between 102 and 150 ppm, its highest concentrations being found in the Aetos bay, while in the Vathi bay nickel decreases towards its inner part. However, the lowest concentrations of nickel are found outside the Vathi bay. A weak positive correlation exists between nickel and aluminium and nickel and organic carbon, showing a small contribution of these fractions to the total concentrations of nickel. In addition, there is a moderate negative correlation between nickel and chromium showing that nickel is associated with other than the chromium bearing fraction. The highest nickel value found in the Aetos bay is comparable with those reported from Thermaicos, Patraicos, Kalamata and Navarino bays.

The maximum value of zinc (359ppm), is found in the inner part of the Vathi bay at the oufall of the olive oil factory (Fig.2) ; elevated values are also found at a number of near-shore stations in the Vathi and Aetos bays. Zinc behaves differently in the two bays studied. In the Vathi bay, it correlates positively with the organic carbon, showing the contribution of the organic fraction to the total amount of zinc. By contrast, in the Aetos bay, a negative correlation between zinc and organic carbon exists, showing the association of zinc with other than the organic constituents.The maximum value of zinc found in the Vathi bay is similar to those reported for the Patraicos, Kalamata and Navarino bay sediments.

Organic carbon

In the Vathi bay, the sediments are highly enriched in organic carbon, the greater enrichment (5.14 %) being observed in the inner part of the bay at the outfall of the olive oil factory. Generally, the organic carbon decreases steadily towards the outer parts of the bay.

In the Aetos bay, organic carbon is generally below 1%.



Dissolved oxygen

It is observed that dissolved oxygen decreases in both surface and bottom waters towards the inner part of the bay where it reaches its minimum value (5 mg/l). At this zone, no significant variations in dissolved oxygen between the surface and bottom waters occur.

There is a negative correlation between dissolved oxygen in the waters and the concentrations of lead in the sediments. This may be a reflection of the following processes :

i) Lead may be transported to the bay being held in the organic fraction of the sediment (anthropogenic or natural), and/or

ii) Anoxic conditions may favour the precipitation of lead.

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