^{137}CS INVENTORIES IN THE WATER COLUMN AND IN SEDIMENTS OF THE WESTERN MEDITERRANEAN SEA

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With the aim of calculating the inventory of ^{137}Cs in the Mediterranean Sea, a study was carried out in the Western Mediterranean on present levels and inventories of this radionuclide in the water column and in sediments of the open sea environment. In recent years only few data have been published on the subject (CALMET and FERNANDEZ, 1990; IAEA MEL, 1991). Two sampling campaigns have been carried out in 1991 and 1992, collecting water and sediment samples, covering most of the Western Mediterranean basin. All the sampling stations were located in areas with water depth greater than 800 m. A Rosette sampler, equipped with a CTD probe and 12 X 30 litres Go-Flo bottles, was used to determine the hydrological characteristics of the water column and to collect water samples representative of the different W-Mediterranean water masses. Sediment samples were collected by a modified Reineck box-corer. The samples were sectioned onboard in layers 1 cm thick. ^{137}Cs was determined by γ-spectrometry: a) on 100 l of unfiltered seawater, after pre-concentration on AMP and b) on dried and blended sediments.

The vertical profiles of ^{137}Cs in the water column are shown in Fig.1. The concentration of ^{137}Cs in sea-water decreases from the surface to depth. A slight increase in ^{137}Cs concentration is observed near the bottom, likely due to resuspension of sediment from the sea-floor. The shape of these vertical profiles is very similar to that reported for the Western Mediterranean Sea in the pre-Chernobyl period (FUKAI *et al.*, 1980, BALLESTRA *et al.*, 1984), but in the 1991-92 samples a decrease in ^{137}Cs concentration in surface waters and an increase in the underlying water masses is observed. The inventories of ^{137}Cs in the water column (Fig.2) range from 2.2 to 6.8 kBq/m^2, in relation to water depth. However, the inventories of ^{137}Cs in the layer 0-600 m (corresponding to the layer Modified Atlantic Water + Levantine Intermediate Water) are rather homogeneous in the Western Mediterranean, with a mean value of 1.7±0.3 kBq/m^2.

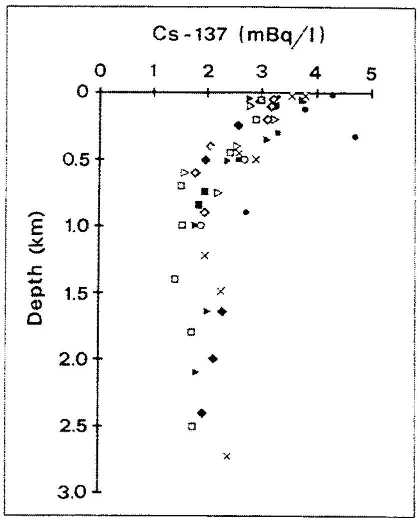

Fig.1 - Vertical profiles of ^{137}Cs in the water column.

The inventories in the Western Mediterranean Deep Water (layer 600 m to bottom) are proportional to the depth of the water column, ranging from 0.7 kBq/m^2 at 830 m to 4.8 kBq/m^2 at 2770 m. ^{137}Cs in sediments has been presently measured at two stations, the first one located SW of Sardinia and the second one in the channel between Ibiza and the Spanish coast, at water depths of 1025 m and 828 m, respectively. ^{137}Cs is only detectable in the first 10 cm. Its concentration decreases regularly from a surface value of 6 - 7 Bq/kg. The inventories of ^{137}Cs are very similar at these two sites (233 and 228 Bq/m^2), and correspond to about 5% of the cumulative fallout deposition at the latitude of the Mediterranean and to about 6-9% of the total inventory at these stations.

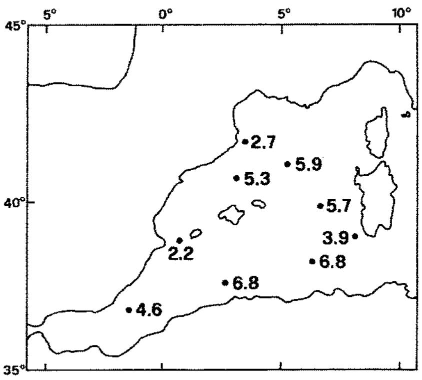

Fig.2 - Inventories of ^{137}Cs (kBq/m^2) in the water column

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BIOACCUMULATION AND RETENTION OF RADIONUCLIDES IN MARINE BIVALVES

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A series of laboratory radiotracer experiments has been conducted in which the accumulation and retention of radioisotopes are quantified for marine mussels (*Mytilus edulis*), marine clams (*Macoma balthica, Mercenaria mercenaria*) and oysters (*Crassostrea virginica*).^{110}AG, ^{241}AM, ^{109}Cd, ^{14}C, ^{57}Co, ^{51}Cr, ^{210}Pb, ^{75}Se and ^{65}Zn were examined. For each animal species and radioisotope, the relative contributions of dissolved and particulate sources are quantified. To determine the importance of the particulate (i.e., food) source term, the assimilation efficiencies of ingested radioisotopes were determined for up seven different food types (the diatoms *Thalassiosira pseudonana* and *Phaeodactylum tricornutum*, the chlorophytes *Chlorella autotrophica* and *Nannochloris atomus*, the dinoflagellates *Prorocentrum minimum* and *Alexandrium tamarense*, the prasinophyte T*etraselmis levis*, and the prymnesiophyte *Isochrysis galbana*). The effects of food quantity and temperature on assimilation efficiencies were also determined. Studies investigating the bioaccumulation of radioisotopes from the dissolved phase measured the effects of salinity and dissolved organic carbon on the bioavailability of the radioisotopes to the animals.

Overall conclusions includes the following : (1) assimilation efficiencies in bivalves for ingested radionuclides ranged from nearly zzero for ^{241}AM to over 90% for ^{75}Se; (2) metal assimilation was related to ingestion rate which is dependent on food quantity, with assimilation efficiencies decreasing inversely with algla food densities; (3) metal assimilation varied between food sources and was related to the distribution of the metals in the algal cells, with the cytosol fraction being most assimilable; this is similar to earlier findings with marine copepods and bivalve larvae (REINFELDER and FISHER, 1991, 1994); (4) assimilation of essential elements (e.g., Se, Zn) was related to carbon assimilation; (5) for most radioisotopes, increasing salinity had a small dampening effect on metal accumulation rates from the dissolved phase; (6) oysters retained certain metals (especially ^{110}AG and ^{65}Zn) much longer than did clams and mussels, perhaps explaining the very high concentrations of these metals in oysters in nature (NOAA, 1989); (7) the distribution of radionuclides in the bivalves was strongly dependent on the dominant source term, with most dissolved radioisotope localizing in shell and most ingested radioisotope in soft parts (particularly viscera),as noted in earlier studies (e.g., BJERREGAARD *et al.*, 1985; FISHER and TEYSSIE, 1986); (8) those elements which display low assimilation efficiencies in the bivalves are probably accumulated in these animals predominantly from the dissolved phase, whereas elements with high assimilation efficiencies are probably obtained primarily through trophic transfer, consistent with earlier conclusions of earlier work (LUOMA *et al.*,1992). The results are being used to develop both equilibrium and kinetic models of radioisotope accumulation in marine bivalves, which are being tested in bivalve field transplant experiments.

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