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Radionuclide activity-depth profiles in sediments of the Gulf of Venice (Italy)

M. FRIGNANI, L. LANGONE and M. RAVAIOLI

Istituto per la Geologia Marina, CNR, Via Zamboni 65, Bologna (Italy)

The use of radionuclides like Cs-137 and Pb-210 as geochronological tools makes it possible a quantitative investigation of present and recent sedimentation on continental shelves.

In order to obtain the first data on sedimentation rates and mechanisms in the area of fine sediment deposition in the Adriatic Sea north of the Po delta, seven gravity cores were collected in September 1986. A Shipek grab was used at each station to sample the superficial layers. Fig. 1 shows the sample locations (5-7 km offshore).

The cores were sectioned into 1-3 cm thick slabs. Cs-137 activity was determined by direct gamma counting of dried sediment using an intrinsic germanium detector and a multichannel analyzer. The Po-210 method was used for Pb-210 analyses, assuming secular equilibrium between the two isotopes. The dry density of samples was determined from the weight percent water composition.

Comparison between core and grab samples reveals that a small portion (a layer 0.5-1.5 cm thick) of superficial sediments was lost in most cases during core collection. This topmost layer, which is present only in core 57, should contain Cs-137 and Cs-134 from the Chernobyl accident.

Fig. 2 shows the activity-depth profiles of Cs-137 and excess Pb-210 (over a background of supported radioactive lead of 0.7 dpm/g dry weight) for core 35.

Cs-137 depth profiles show some interesting similarities but are hardly interpretable. Generally speaking cores present at least three peak activities and this makes it difficult to assess even an approximative chronology.

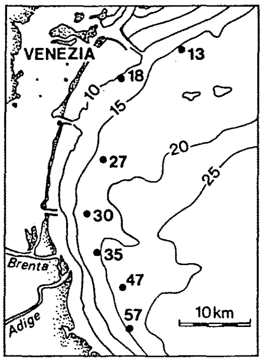

Fig. 1

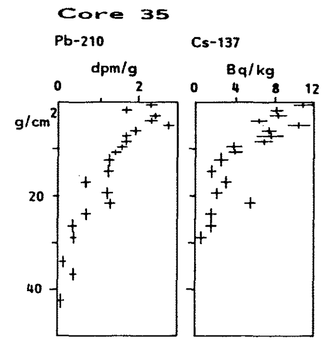

Fig. 2

Furthermore significant amounts of Cs-137 can be found at depths comparable with those of the excess Pb-210. This may be due to diffusion phenomena through the interstitial waters. The lack of similarity to the fallout profiles supports the hypothesis that the Cs-137 in cores originates from the river inputs.

Since radioisotope activities in the superficial layer are not homogeneous we can exclude that mixing (bioturbation and resuspension) occurred in recent times. Moreover no significant presence of benthic fauna was noticed during grab sampling.

Pb-210 depth profiles show an approximately exponential decline with depth even if there are significant increases in concentration at certain levels. This may be due to some variations of the sediment deposition rates and/or to inputs of particulate matter from different sources. Core 30, located off the harbour of Chioggia, shows the most irregular profile.

At this stage it is only possible to obtain apparent accumulation rates because we do not know yet the role played on modifying the profile by short time scale phenomena. The accumulation rates can be calculated from the slope of the semilogarithmic plots of activity versus depth, assuming a constant initial concentration of unsupported Pb-210 (Table 1). A constant flux model (Appleby & Oldfied, 1978) should give, in this case, more reliable data but accurate Pb-210 inventories are needed. Moreover we are not sure to what extent the assumption of the two models are compatible with the actual fenomenology.

TABLE 1. - Apparent accumulation rates and radionuclide inventories in cores.

CORE	Accum. Rates g/cm²yr	Cs-137(') dpm/cm²	Pb-210 dpm/cm²
13	0.61	8.7	43.4
18	0.96	14.8	61.1
27	0.41	7.6	35.9
30	1.04	20.5	77.7
35	0.54	8.3	45.2
47	0.54	16.7	88.9
57	0.82	17.5	107.3

(') Corrected taking into account the lost topmost levels.

Cores 13, 27 and 35 show Pb-210 inventories in the order of those derived from the fallout input (13-67 dpm/cm²; Appleby & Oldfield, 1983).

The highest sedimentation rates and inventories can be noted in the areas that are mostly influenced by riverine discharges and outlets of Venice lagoon. This areas turn out to be shifted southwards with respect to the outlets: this has to be connected to the general circulation of Adriatic Sea (counter-clockwise), which diverts southward the river plumes. The locations 47 and 57, for instance, seem to refer to Adige prodelta.

These first observations will have to be completed with independent indications to identify and analyze the effects of discontinuities in sedimentation and shifts in sediment sources. In particular mineral magnetic measurement (Oldfield & Appleby, 1984) seems to be the technique of choice to reveal stratigraphic anomalies.

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Characteristics of Chernobyl fallout in the Italian coastal marine environment

R. DELFANTI and C. PAPUCCI

ENEA, CREA/STE, C.P. 316, 19100 La Spezia (Italy)

Abstract

Following the Chernobyl accident, investigations were carried out, in order to characterize the behaviour of Chernobyl radionuclides in the Italian coastal environments.

Introduction

The radionuclides released by the Chernobyl accident were injected into the atmosphere with processes substantially different from those of nuclear tests. Consequently, the behaviour of these radionuclides might be considerably different from bomb fallout produced in the period 1945-85.

Selected matrices were then analysed focusing on the accumulation/dilution processes of Chernobyl radionuclides in coastal environments.

The existing National Network for the Survey of Environmental Radioactivity was used as the basis for sampling.

Material and Methods

Surface sea water was collected at an average depth of ~ 5 m.

Particulate matter was separated using 0.45 u membrane filters.

Sediments were taken with a Van Veen grab and with a modified Reineck corer (Papucci et al., 1986).

Mussels were sampled in a protected area of the La Spezia harbour. Some 500 g of soft parts were analized each time on wet matter to avoid losses of volatile elements.

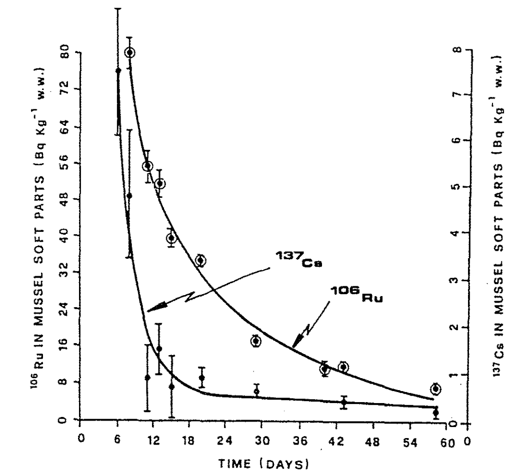
Samples were subjected to gamma spectrometry using HPGe detectors connected to a computerized spectrometric system.

Discussion

In the Ligurian Sea, the maximum concentrations of Chernobyl radionuclides in surface seawater (475 Bqm-3 of 137-Cs and 290 Bqm-3 of 103-Ru) were found in the first days of May 1986.

Particle associated radionuclide from Chernobyl underwent a solubilization that was very rapid for Cesium and slower for Rutenium; this fact allowed a considerable fraction of Ruthenium isotopes to rapidly reach the sea floor in shallow water environments. After 3 weeks contact with seawater only 2-5% of the radionuclides still present were in the particulate form. Similar behaviour was observed by Kempe & Nies (1986) in the North Sea and by Fowler et al. (1986) in the Mediterranean. 137-Cs activity in seawater dropped to 58 Bqm-3 in June and 14 Bqm-3 in October (pre-Chernobyl value: 4 Bqm-3). Radionuclide concentrations in the Adriatic Sea were consistently higher than in the Tyrrhenian Sea.

In the first days of June, most activity in shallow water sediments was due to Ruthenium isotopes; 6-12 months later about 10% of the Cesium isotopes deposited at the sea surface were found in the upper 2-4 cm of sediment.



Change of mussel (soft parts) contents of ^{137}Cs and ^{106}Ru with time.

The depuration curves were calculated by using biological half-lives of 2 and 14 days for 106-Ru and 2 and 63 days for 137-Cs.

Maximum radionuclide concentrations in the soft parts of mussels were found 2-4 days after the maximum radionuclide deposition (137-Cs 7.7 Bq.kg-1,w.w.;103-Ru 235 Bq.kg-1,w.w.). From the radionuclide elimination curve, a two compartment system was identified, with biological half lives of 2 and 63 days for Cesium and 2 and 14 days for Ruthenium (fig.1).

References

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