

ANTHROPOGENIC RADIONUCLIDES IN SURFACE SEDIMENTS OF THE TOULON-BAY AREA (FRENCH MEDITERRANEAN COAST).

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Abstract

In the frame of an integrated coastal area and river basin approach, an environmental assessment was carried out in the Toulon Bay area as defined by the Regional Water Master Plan. Part of this assessment concerns anthropogenic radionuclides within the sediment compartment. In surface sediments, ¹³⁷Cs is the only artificial radionuclide which was regularly detected by gamma spectrometry. ¹³⁷Cs and silts fraction (4-63 µm) are closely correlated, revealing that ¹³⁷Cs arise mainly from a diffusive source (i.e. atmospheric inputs).

Keywords: Surface sediment, radionuclides, Mediterranean sea, Toulon Bay contract

Introduction

In the Toulon area, a Regional Research Contract (Toulon Bay Contract) concerning Toulon harbor and its catchment basin was initiated in 1998 [1]. The main objective was to assess a balanced water resource management and to propose an integrated coastal management.

Since 1984, the site harbor has been sheltering six French Navy nuclear-powered submarines. The arrival of the *Charles de Gaulle*, a new nuclear-powered aircraft carrier, led us to carry out a study of anthropogenic radionuclide contents in surface sediments of this area.

Materials and methods

The study area

The area includes the harbor and the surrounding coastal area between the longitudes 5° 52.586 E and 6° 01.282 E, as defined in the Water Master Plan instituted by the French Water Act (1992). It represents a coastline of about 70 km for a marine water surface area of about 60 km² and a catchment area of 340 km².

Sampling and analytical methods

51 stations regularly distributed on the study area were sampled in April 2000 (Fig. 1). Within this area 50 sediment samplings were realized in September 1997 in the Eastern part of the Bay which is affected by the releases of the Toulon sewage outfall (Fig. 2). Thus this last area represents a zoom within the area studied in 2000.

Samples were collected with grab corers (Shipeck and Orange Peel) and Eckman box corer depending on station depths. They were dried (80 °C) and measured by gamma spectrometry (N type hyper-pure Ge detector). Particle-size was measured using a Coulter LS 230 laser diffraction granulometer.

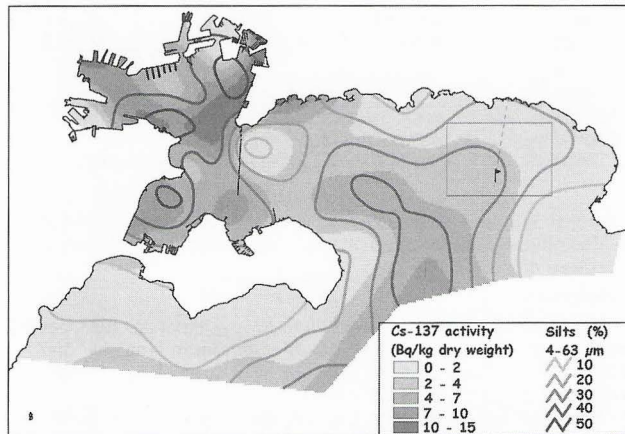


Fig. 1. Distribution of ¹³⁷Cs and silt fraction in surface sediments of the Toulon Bay obtained by numerical interpolation (Spline method, Arcview®).

Results and conclusions

¹³⁷Cs was the only artificial radionuclide systematically detected in the sediment samples. Indeed, due to its relatively long half life (30 years), it is the only radionuclide arising from atmospheric deposits (bomb fallout and Chernobyl) still detected by gamma spectrometry.

In 2000, ¹³⁷Cs levels in Toulon area atmosphere do not exceed 1µBq.m⁻³. ¹³⁷Cs levels in sediment range between 0.28 (± 0.09) and 12.20 (± 0.90) Bq.kg⁻¹ dry weight. In the literature it is generally reported that ¹³⁷Cs demonstrate high affinity for clay minerals [2], [3]. Indeed, spatial distributions obtained by numerical interpolation

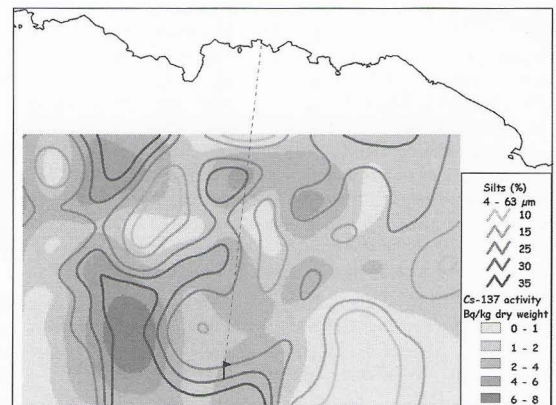


Fig. 2. Distribution of ¹³⁷Cs and silt fraction in surface sediments around the Toulon-East sewage outfall (————), obtained by numerical interpolation (Spline method, Arcview®)

methods (Figs. 1 and 2) highlight the positive correlation between ¹³⁷Cs contents and silt fractions (4-63 µm) and the negative correlation to raw sands (200-2000µm). The harbor area which is characterized by fine-grained sediments due to the low dynamic in the current conditions has the highest ¹³⁷Cs contents in relation to the high specific surface area of the smallest particles.

The scale of observation is of peculiar interest. As a matter of fact, in 2000 stations surrounding Toulon-East sewage outfall, exhibited relatively low ¹³⁷Cs concentrations (1,2 to 2,8 Bq.kg⁻¹ dry weight) and silts fractions (20,1 to 32,7%). In 1997 a higher range of variation in both ¹³⁷Cs levels and silt contents were found in an area included between these stations (respectively 0,68 to 7,7 Bq.kg⁻¹ dry weight and 9,7 to 62,6%). If repeated this kind of study, should allow to resolve the fractal dimension of the distribution of these parameters in this area.

¹³⁷Cs levels found in the study area at both periods (1997 and 2000) are within the range reported for Mediterranean Sea coastal sediment only affected by atmospheric fallout i.e. 2 to 20 Bq.kg⁻¹ dry weight [4], [5]. Radionuclides such as cobalt, silver, manganese were not detected demonstrating the lack of contamination by nuclear releases in that area

Acknowledgement. This work was supported by the SIAT Contract, and IRSN Rademer programme. Sampling in 1997 was carried out by IFREMER. Special thanks to L. Saey, for his helpful technical assistance during fieldwork.

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