MEASUREMENTS OF RADIOACTIVE CONTAMINATION IN SEDIMENT OF OUALIDIA LAGOON

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ABSTRACT

The present work is mainly focused on the radioactive contamination and geochronology of sediments of Oualidia lagoon. It is a part of a program to safeguard quality of marine environment.
Tow cores collected from the Oualidia lagoon, were analyzed for 210Pb, 137Cs, and 226Ra concentrations to establish sediment chronologies and unravel the history of lead pollution.
The levels of radioactive contamination by naturel radio-isotopes (210Pb, 226Ra) and artificial radiocesium (137CS), were evaluated in sediment of Oualidia lagoon. Radionuclide analysis was performed in CNESTEN by gamma spectrometry system with an Hp--Ge detector of 20% relative efficiency, the sediment core was dated by means of excess 210Pb, and the obtained ages were validated by using; 137Cs.
The results of sediment samples showed that there is no detectable anthropogenic input of naturally occurring radionuclide, except for 210Pb, which is present in the dissolved form and has its origin from atmospheric 222Rn.

Keywords : Sediment, Oualidia lagoon, Dating, Gamma Spectrometry, Radionuclides

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INTRODUCTION

Oualidia Lagoon is located on the Atlantic coast of Morocco between Al Jadida and Safi. The lagoon is approximately 7 km long and 0.5 km wide. The main human activities in this area are fisheries, aquaculture, and seaweed stock. Aquaculture activities are very important, especially oyster farming, which has been conducted since 1970 and the lagoon has been used as the waste-disposal site for their effluents. Consequently, A rapid deterioration of the water quality of the lagoon has been previously reported as a result of continued discharge of domestic and agricultural effluent through the various streams and water bodies running towards the lagoon area (Maanan et al., 2014). In this study, naturally occurring radionuclides and Cs-137 were measured in sediment samples from Oualidia Lagoon in order to establish the state of radioactive contamination in this ecosystem. Radionuclide analyses were performed by alpha and gamma spectrometry, and the sediment core was dated by means of excess ^{210}Pb and Cs-137 (Mejjad, 2013).

Figure 1.- Map of the Oualidia lagoon showing the sampling point.

A sediment core freshly retrieved

SAMPLING AND SAMPLE TREATMENT

Surface sediment and a sediment core of 26 cm depth were retrieved from a shallow marginal area belonging to the Oualidia lagoon in September 2012. The sediment core was sectioned into 1 to 2 cm slices and the resulting sub-samples were weighed and dried in an oven, using a constant temperature of 80°C during 24 h. Dry samples were weighed again and the content of water in each stratigraphic level was calculated for the three cores. Bulk densities were determined from water content and particle density of each slice. Finally, dried sediment was gently ground in a mortar and homogenised for subsequent alpha and gamma emitters analyses. The surface sample was dried, ground and then sieved using a sieving pile mounted on a vibration shaker to separate the different grain sizes. Gamma emitting radionuclides [^{228}Ac(^{228}Ra), ^{214}Bi(^{226}Ra), ^{212}Pb(^{228}Th),^{40}K and ^{137}Cs] were measured using gamma-ray spectrometer. The detector was a low background CANBERRA high-purity germanium p-type coaxial detector, housed in a 10-cm-thick high-purity lead shield. The relative efficiency was 30% and the resolution was 2 keV for the 1332 keV^{60}Co γ-peak. Weighed samples were introduced into 20 ml nalgene containers and sealed to trap the gaseous ^{222}Rn and ^{220}Rn emanating from *in-situ*^{226}Ra and ^{224}Ra, respectively. The flasks were stored for more than 21 days and then counted for 24 hours each one. ^{210}Pb was determined either through its daughter ^{210}Po, or using a n-type gamma detector.

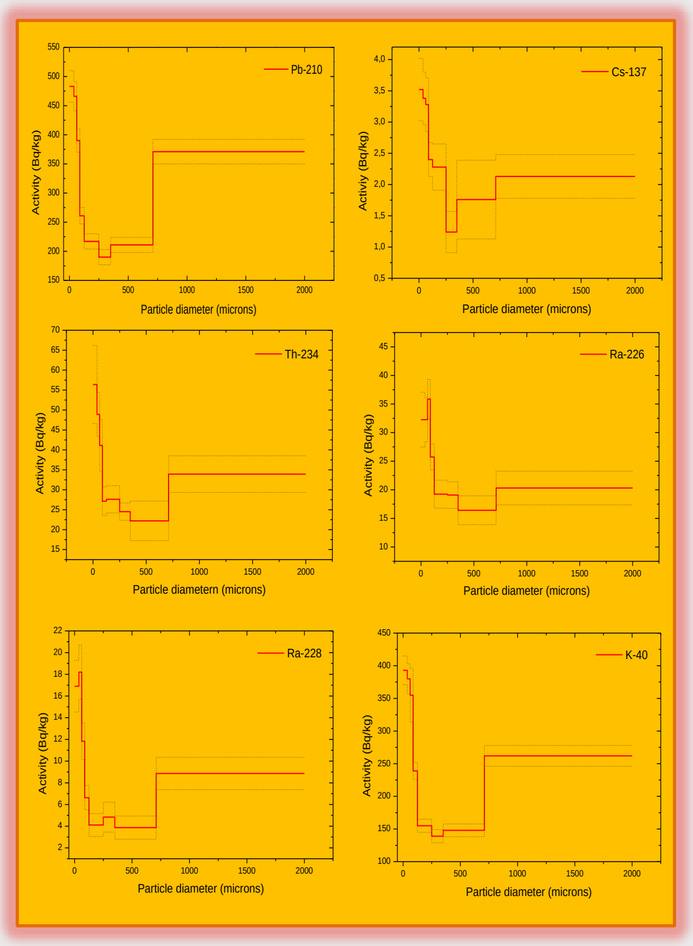

Figure 2.- Radionuclide acttivities vs particle size. The dotted lines are 1-sigma uncertainties.

DATING THE SEDIMENT CORE

Figure 3 depicts the vertical distribution of excess ^{210}Pb calculated by subtracting the depth averaged concentration of ^{226}Ra, supposed to be in equilibrium with supported ^{210}Pb, from total lead-210. The profile exhibit an exponential decay of concentrations with depth, but was qualified as being incomplete, since excess ^{210}Pb concentrations did not decline to zero in the deepest layers. The application of CRS model (Constant Rate of Supply) requires the total ^{210}Pb inventory which cannot be calculated due to the incompleteness of the profile. In this way, the experimental data of Figure 3 were extrapolated to construct estimates of $^{210}Pb_{xs}$ in deeper layers of the core. The total inventory for $^{210}Pb_{xs}$ was 63014 ± 1248 Bq.m^{-2}. Sedimentation rates were quiet uniform along the core as can be seen in Figure 4, with some exceptions such as a visibly fast sedimentation recorded at 11 cm depth corresponding to the year 1999 ± 2. Additionally, the annual ^{210}Pb input onto the sediment was estimated from the product of λ and the total inventory and the value found was 1960 ± 40 *Bq.m^{-2}.y^{-1}*.

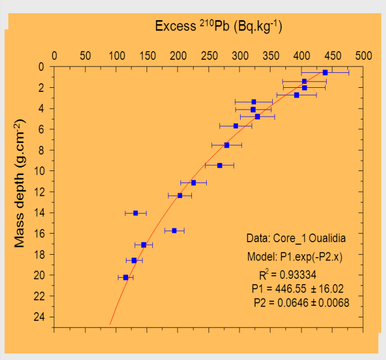

Figure 3.- Vertical profile of excess ^{210}Pb concentration, in Bq.kg^{-1} dry weight, in the sediment core from the Oualidia Lagoon. The points are the experimental data, with their 1-σ error, and the line is the best fit to an exponential decay function

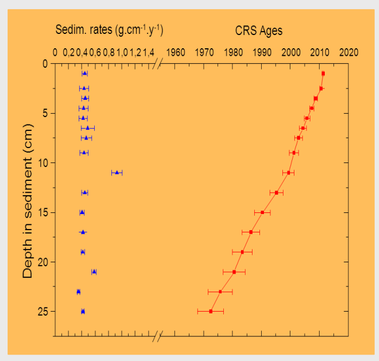

Figure 4.- Profiles of calculated sedimentation rates and ages versus depth using the CRS model.

Chronology Validation

137Cs, which is an artificial radionuclide resulting from nuclear bomb testing and detonations since early 1945, can be used to identify the period of maximum atmospheric fallout. The vertical distribution of concentrations of 137Cs is plotted in Figure 5. Concentrations ranged between 1.5 and 3.9 Bq.kg-1 without revealing any defined peak that can be used as time marker. However, 137Cs concentrations present a growth trend in deep layers below 17 cm reaching the maximum value at the deepest section of the core. According to CRS ages, the basal layer corresponds to the year 1972 ± 4 so that the peak of maximum global fallout of 1963 should be below this layer, but still beyond the length of the core. This could possibly be a validation of the ages provided by 210Pbxs dating of our core.

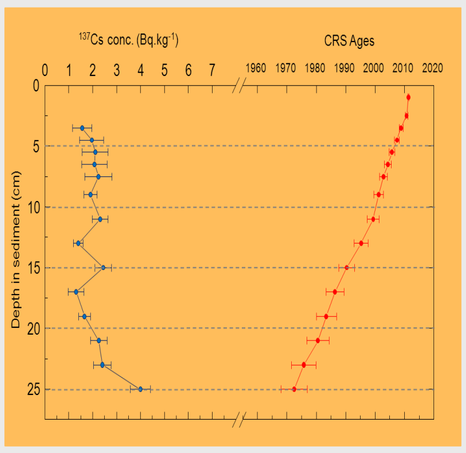

Figure 5.- Vertical distribution of concentrations of 137Cs in the sediment core from ElOualidia lagoon along with the ages provided by the CRS model. Values for upmost layers were below LD.

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