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TECHNOGENIC AND NATURAL RADIONUCLIDES IN BLACK SEA SEDIMENTS AND ALGAE

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Technogenic and natural emitters have been monitored since 1991 in marine samples from the Bulgarian Black Sea coast by low level gamma and alpha spectroscopy. The radionuclide content was determined in bottom sediment samples from 35 reference locations in the spring, summer and autumn during six consecutive years. Samples were collected and data obtained for the main Black Sea resorts and the main dwelling places along the Bulgarian Black Sea shore. The mean nuclide content depending on the year of sampling is shown in Fig. 1.

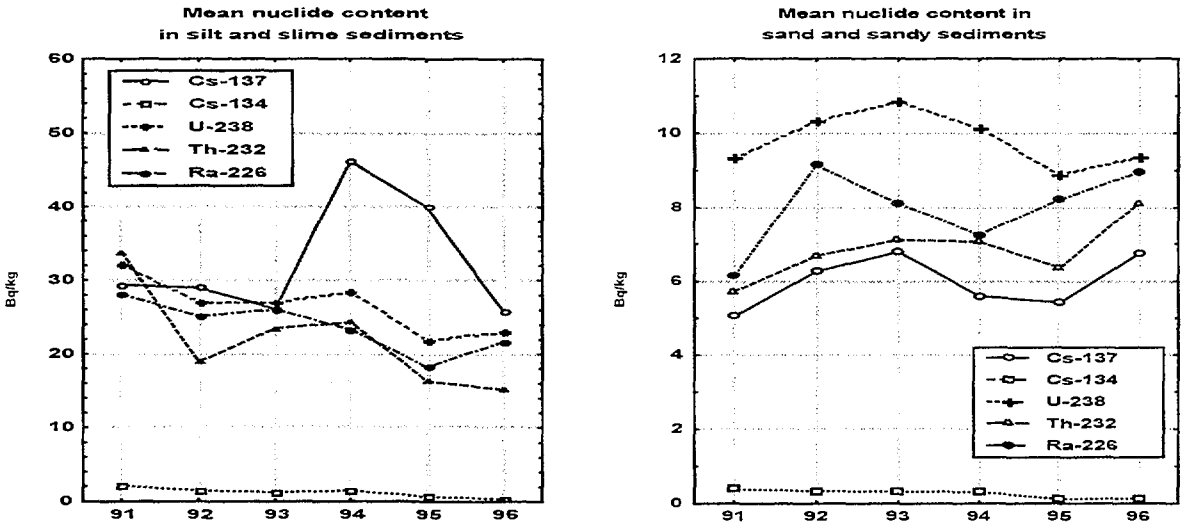

FIG. 1. Average nuclide content in bottom sediments.

The data show that nuclide content strongly depends on the sediment nature as the sandy sediments are within close range, while nuclides in slime and silt vary to a much greater extent. The highest measured cesium and natural nuclide content at the Bulgarian Black Sea coast is at the north locations with slime sediments - Kaliakra and Kavarna. This phenomenon can be attributed both to the sediments type and the shorter distance to Chernobyl.

($^{134}Cs/^{137}Cs$) ratios were calculated for each location to determine the origin of the measured Cs in the Bulgarian Black Sea sediments samples. The calculations made show that 72 % from the whole measured ^{137}Cs in sea-bed sediments is from Chernobyl origin.

The highest values for natural nuclides content (Fig. 1) are in the slime sediments. The obtained results in different seasons for ^{238}U are (5 - 50) Bq/kg;^{232}Th - (4.0 - 35 Bq/kg), ^{226}Ra - (9 - 50 Bq/kg). The data show that there is a similarity between the accumulation of ^{238}U and ^{232}Th in the sediments. The measured U and Th values are within the range of the cited in the literature meaning that there is no serious contamination with U and Th at the Black sea coast.

We have investigated two different type of sediments by alpha spectrometry - slime (Kaliakra) and silt (Bjala) with the highest nuclide content. The content of different U, Th, Ra, Pb, Po and Pu isotopes for Black sea sediment samples are given on Fig. 2.

The values for Pu are close to the lower values of the cited in literature data which is quite clear as there are no plutonium discharge locations at the Bulgarian Black sea coast.

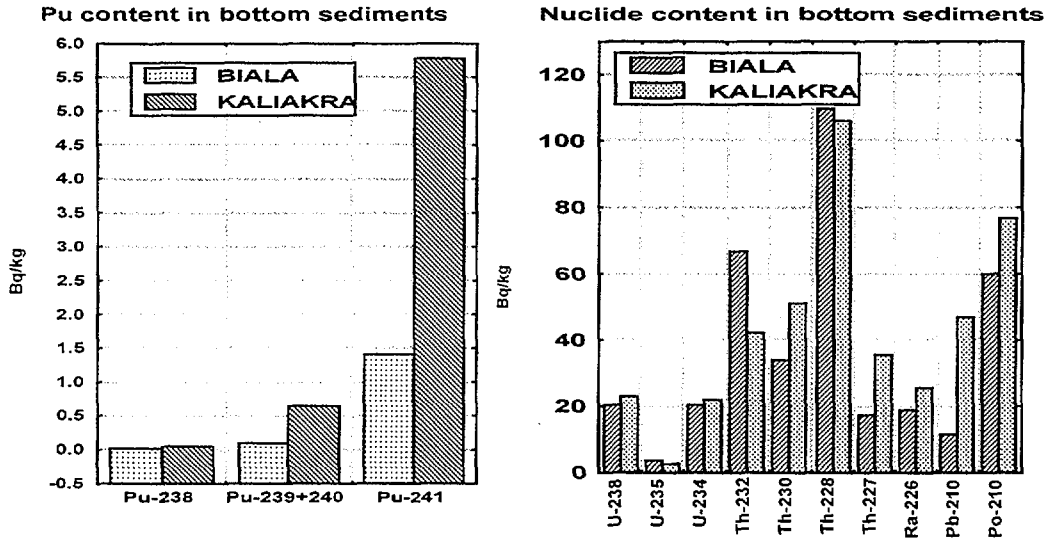

FIG. 2. Alpha nuclide content in Biala and Kaliakra sediments

Nuclide content was measured in nine different macrophytic algae species (Fig. 3) (five green: *Cladofora Laetevirens, Ulva rigida, Enteromorpha Intestinalis, Bryopsis Plumosa, Limnaea;* two brown: *Cystoseira Crinita* and *Cystoseira Barbata;* two red: *Ceramium rubrum* and *Corallina Mediterranium)* from five sampling locations for five consecutive years. The obtained range for ^{137}Cs in algae is 1.7 - 26 Bq/kg. The average values for the natural nuclides are: ^{238}U - 3 -44 Bq/kg; ^{232}Th (1.4 - 12) Bq/kg; ^{226}Ra (1- 52) Bq/kg.

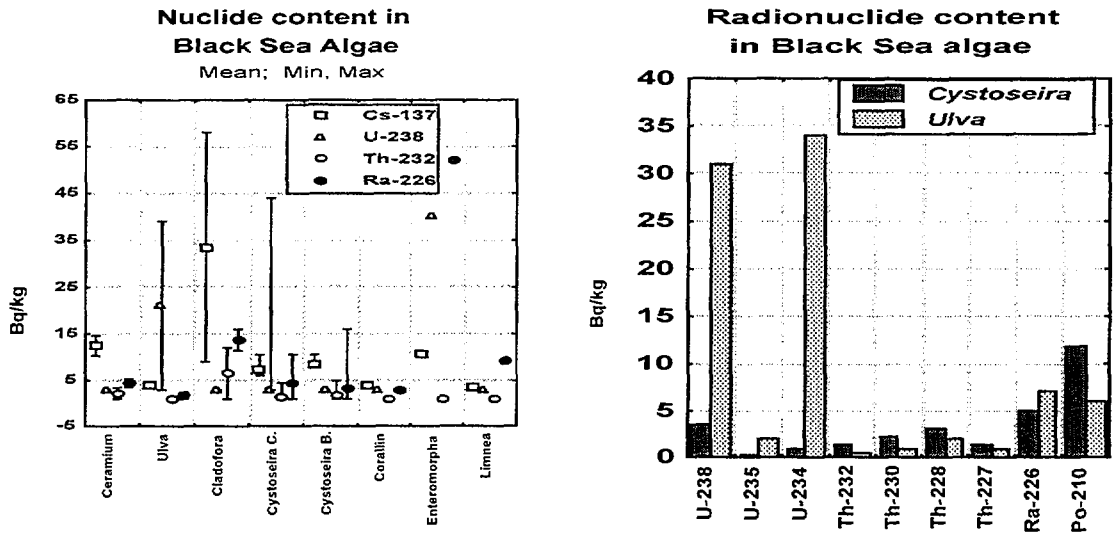

FIG. 3. Nuclide content in Black sea algae, measured by gamma and alpha spectroscopy.

The Cs content in the green species does not change greatly from site to site. Most of the natural radionuclide content is close to LLD while in *Bryopsis Plumosa* ^{226}Ra and ^{210}Pb and ^{232}Th concentrations are with two orders of magnitude higher then in the other algae species.

Natural nuclide concentrations were measured in two different types of algae are by alpha spectrometry (Fig. 3) and the data show that *Ulva* accumulates U more than *Cystoseira*, while the opposite is valid for Th. Ra is accumulated more efficiently than U by marine sediments and also by the brown algae. The Ulva, on the contrary, accumulates more U than Ra. The measured ^{210}Po content in Black sea algae is in the range cited in literature, the brown Cystoseira seems to accumulate ^{210}Po more than the green species.

This work establishes a data base for radioecological estimation of the Chernobyl impact on the sea bed sediments and the natural nuclide content along the Bulgarian Black Sea coast.