DISTRIBUTION OF TOTAL BETA RADIOACTIVITY, SR-90 AND CS-137 CONTENT IN THE ROMANIAN AND NW BLACK SEA SECTOR BETWEEN 1994-1995

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Abstract

Total beta radioactivity and Sr-90 in abiotic (sediment, sea water) and biotic components (seaweeds, molluscs, fish) of the Romanian Black Sea coast between the Danube mouth and the southern limit (Mangalia), and from the shoreline up to 60 nautical miles offshore were continuously monitored during 1994 and 1995. Highest Sr-90 concentrations were found in sediments (8.6 Bq/Kg dry) and in the green seaweed *Bryopsis plumosa* (12.1 Bq/Kg f.w.). The results of radiometric research on bottom sediments collected from the north-western sector of the Black Sea in July-August 1995 showed values of total beta radioactivity between minimum detectable limits (< 20 1) and 818 Bq/Kg dry, and Cs-137 contents between 2 and 201 Bq/Kg dry.

Key-words: Radioactivity, radionuclides, monitoring, Black Sea

After the Chernobyl nuclear accident, the Black Sea due to its geographical location was contaminated by radionuclides originating from atmospheric fall-out and through riverine input [1]. A network of stations has been used for the characterization of marine radioactivity in the Romanian Black Sea sector between 1994 and 1995 (Fig.1).

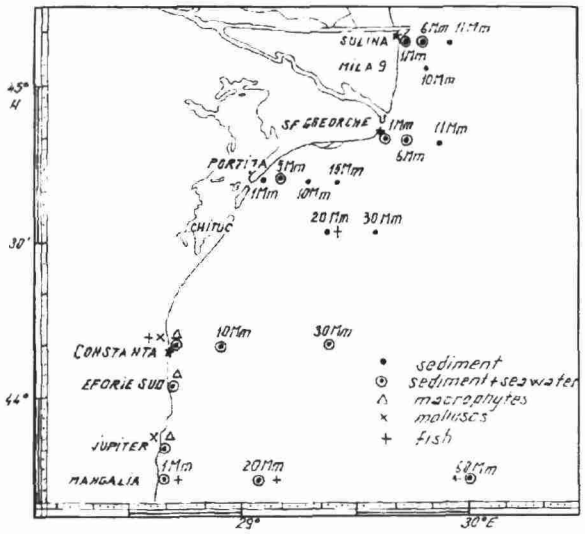

Fig. 1. Station network along the Romanian Black Sea coast.

Material and methods

Emerged and submerged sediments, seawater, common macrophytes, molluscs and fish were measured in the Romanian Black Sea sector for total beta radioactivity (K-40 reference) and Sr-90 in accordance with contemporary techniques [2] using specific low level radiometric equipment. The distribution of both parameters was computed as average values by stations (for sediments and seawater) and by species for marine biota for the two years considered. The International Programme "Investigations between the Danube River and the northwestern Black Sea/EROS 2000" [1] provided bottom sediment samples during the second cruise of R/V *Professor Vodyanitskyi* in July-August 1995. The cruise covered the Crimean coastal waters, the mouths of the Danube, Dniester, Dnieper rivers and the Romanian shelf and offshore areas. Among current monitoring activities for marine radioactivity [3,4,5,6,7], total beta and Cs-137 measurements for 26 sediment samples from the NW Black Sea sector were also made. The main instruments used in the radioanalyses of samples have included NIM instruments, NE 102A detector (total beta), and HPGe detector (10% relative efficiency and 2 keV resolution at 1333 keV) and ORTEC-NORLAND 5500 multichannel analyser for gamma spectrometric determinations. Gamma analyses were based on measurements of a minimum of 40000 sec. The results have a confidence interval of 68%.

Results and discussion

The fluctuations in the dynamics of sediment **total** beta activity (Fig.2) are mostly a result of the hydrological factors typical for the area, the dispersion and diffusion processes in the water mass [8], and the sizes and density of the particles which are deposited. Consequently, in many cases at the greatest depth investigated, the beta activity is more intense than near the river sources,

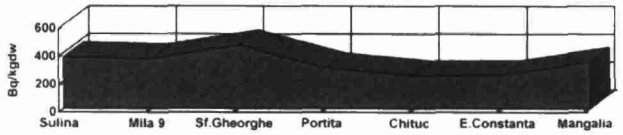

Fig. 2. Mean total beta radioactivity of sublerged sediments along the Romanian Black Sea coast during 1994-1995.

The total beta activity of eight species of macrophytes (green, red), three species of molluscs and seven species of edible marine fish (benthic and pelagic) typical of the Romanian littoral was measured (Fig. 3). In the NW Black Sea the total beta values ranged between < 20 1 and 818 Bq/Kg dry. Significant results (Fig. 4) were registered at the Dnieper mouth (stations 6, 7), Danube mouth (stations 18, 19, 20), Portita (station 22) and on the shelf (stations 13, 14, 15). In front of the Dniester mouth, only the minimum detectable levels were registered in shallow waters (less than 25 m depth). Significant natural contributions were registered in offshore stations at depths exceeding 100 m (stations 2, 3, 26).

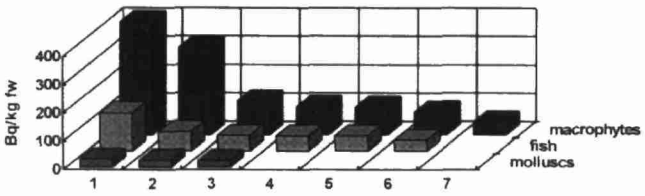

Fig. 3. Mean total beta radioactivity of biota along the Romanian Black Sea coast during 1994-1995.

Macrophytes : *1 - Bryopsis plumosa; 2 - Enteromorpha intestinalis; 3- Cladophora sericea; 4- Enteromorpha linza; 5- Ceramium rubrum; 6- Uvaria oxysperma; 7- Ceramium eleganfs.* **Molluscs** : *1-Rapan tomasiana; 2- Mya arenaria; 3- Mytilus galloprovincialis.* **Fish**: *1- Platichthys flesus lusus; 2- Engraulis encrasicolus ponticus; 3- Gobius melanostomus; 4- Sprattus sprattus phalericus; 5- Atherina mochon pontica; 6- Merlangus merlangus euxinus.*

The variability of Sr-90 content in sediments from the Romanian marine sector (Fig. 5) generally follows dynamics similarly to those of total beta activity. The average values of Sr-90 for the macrophytes decrease similarly to those of total beta activity. For marine fish the highest content was found in benthic species (Fig. 6). The results were in good agreement with other data both for the Black Sea [9] and the Baltic Sea [10].

The rather long period since the Chernobyl accident has enabled marine processes to influence the Cs-137 concentrations on the shelf (stations 14, 15) and in offshore river mouth areas (station 5). Nevertheless, the lowest Sr-90 concentrations (5.5-18.5 Bq/Kg dry) were noted at the Dniester mouth (stations 9,10,11) and in deep waters (stations 2, 3, 26, 28). The higest Cs-137 concentrations are frequently found at depth of 20-40 m (stations 6, 17, 22, 15) [7]. Local peculiarities can lead to exceptions at shallower depths (station 14) or in deeper waters (station 16). Where the depth exceeds 100 m (stations 3, 26, 28), the frequency of low values increases and is constant in deep waters (station 2). The stratification of water masses can prevent Cs-137 from interacting with the deep bottom [7]. A small difference was found at station 2 between the Cs-137 concentrations in the surface and deep bottom layers (6-4 Bq/Kg dry); this fact indicates the existence of relatively constant conditions in the deep sea. At depths