RADIOACTIVITY OF BOTTOM SEDIMENTS SAMPLED IN 1996 FROM THE ROMANIAN SECTOR OF THE DANUBE RIVER

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Abstract

Man-made and natural radioactivity of 23 bottom sediments sampled in spring 1996 along the Danube river from its entrance in Romania to the Black Sea and on the Black Sea Romanian coast, during spring 1996. The sediment samples were collected by the National Institute of Meteorology and Hydrology, Bucharest from the principal cross-sections of the Danube river and from the Black Sea which had been studied before 1977 by the Politechnical Institute of Bucharest [1]. For radioecological purposes, the survey of the Danube river and Black Sea radioactive activities was generally carried out during specific hydrological periods, i.e. in spring, summer and autumn seasons at high and relatively low flow rates, under conditions of high and low water dilution.

More recently, data on 134Cs and 137Cs radioactivity in sediments collected from the same areas during 1993, and on the 134Cs, 137Cs, 226Ra, 239,240Pu, 238Pu and 40K radioactivity in sediments collected in the summer and autumn of 1994 and 1995 from 20 and 21 locations, respectively, have been presented in previous papers [2, 3]. Twelve of the sediments collected during 1994 were analyzed for 210Po radioactivity [4]. The annual averages of 137Cs specific activities in sediments from some of these locations during 1986-1990 [5], and a 137Cs vertical profile in some selected lake sediments of Danube Delta during 1994 [6, 7] have also been determined.

Experimental

The bottom sediment samples were collected from the principal cross sections along the Danube river, from the entrance in Romania to its mouths (delta included), and from the Romanian coast of the Black Sea, during spring 1996 (22 samples). An additional sample was collected at Cernavoda (km 300) from about 300 m along the Danube-Black Sea man-made channel in the vicinity of the CANDU Nuclear Power Plant.

The sediment samples of 1.5-2.5 kg each have been collected from depth of 0-15 cm using a stainless steel cup and then placed in plastic bags. Associated in situ hydrological measurements were made according to the procedures of the National Institute of Meteorology and Hydrology of Bucharest. Sediments were dried in an electric oven at 110°C and then homogenized in an agate mortar. About 100 g of each sample were enclosed in a standard polyethylene box (7.3 cm diameter) and kept inside for one month to permit 228Ra (U-Ra radioactive family) to establish radioactive equilibrium with its decay products.

The gamma ray measurements were carried out by means of a high resolution, low background PC multichannel spectrometer, using a HPGe EG&G ORTEC detector of 30% efficiency and 2.1 keV resolution for the $^{60}$Co 1332.5 keV line. As standards, the reference materials IAEA-135 (Radionuclides in Irish Sea sediment) and IAEA-306 (Radionuclides in Baltic Sea sediment) with certified radioactive concentrations were used. Counting times ranged between 14-24 hours.

Results and Discussion

Table 1 presents the 134Cs, 137Cs, 226Ra, 228Ra and 40K specific activities (Bq/kg dry) in Romanian Danube and Black Sea coastal sediments. In this table, the sampling sites in the Danube delta start with the East Sfantu Gheorghe (km 53), i.e. the split of the Danube into the Sulina and Sfantu Gheorghe branches; Stambulul Vechi (km 4) is located on the Chilia branch while Sulina (km 4.6) and Sfantu Gheorghe (km 8) are located on the Sulina and Sfantu Gheorghe branches, respectively; on the Black Sea coast the sampling sites are noted from north to south with (1), (2) and (3).

In order to calculate the activities of 228Ra and 226Ra, the gamma peaks of 352 keV ($^{214}$Pb) and 609 keV ($^{214}$Bi) for 228Ra, and 593 keV ($^{228}$Tl) and 911 keV ($^{228}$Ac) for 226Ra were taken into consideration.

The following conclusions drawn from the data are summarized below:

1) In all samples analyzed, only the fission products 134Cs ($T_{1/2} = 2.06y$) and 137Cs ($T_{1/2} = 30.17y$) were identified as man-made radionuclides. 137Cs was present in all the samples with specific activity levels between 0.5±0.3 and 86.1±3.0 Bq/kg dry, while 134Cs was measured in the range of 0.6±0.2 to 1.7±0.2 Bq/kg dry only at 5 sampling stations where higher activities of 137Cs were recorded. The activity...