



# THE FATE OF LONG-LIVED RADIONUCLIDES $^{137}\text{Cs}$ AND $^{90}\text{Sr}$ IN THE BLACK SEA AFTER CHERNOBYL NPP ACCIDENT RESULTS OF TWENTY-YEAR OBSERVATIONS

Nikolai A STOKOZOV<sup>1</sup>, Viktor N EGOROV<sup>1</sup>, Gennady G POLIKARPOV<sup>1</sup>, Natalay Yu MIRZOEVA<sup>1</sup>, Sergei B GULIN<sup>1</sup>

<sup>1</sup>Institute of Biology of the Southern Seas (IBSS) Ukrainian National Academy of Sciences  
Department of Radiation and Chemical Biology  
e mail stokozov@shadow sevskey net

The presentation summarizes studies of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  pollution of the Black Sea Basin carried out by Institute

of Biology of the Southern Seas during 1986-2005 following the Chernobyl NPP accident. Its goal was to assess inflows of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  from the Dnieper and the Danube Rivers outflow through the Bosphorus Strait, inventories in bottom sediments and temporary evolution of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  inventories in the Black Sea water column. Besides the temporary evolution of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  profiles in the Black Sea deep-water basin, was used to estimations of a large scale vertical water mixing.

It has been estimated that the atmospheric fallouts during the first days of May 1986 have deposited 1 7 2 4 PBq

of  $^{137}\text{Cs}$  on the Black Sea surface (nearly 2% of total  $^{137}\text{Cs}$  release in the environment). Therefore  $^{137}\text{Cs}$  inventory in the 0-50 m layer have increased by a factor of 6-10 and the total  $^{137}\text{Cs}$  inventory in the whole basin have increased at least by a factor of 2 in comparison with the pre Chernobyl value - 1 4 +/- 0 3 PBq.  $^{137}\text{Cs}$  input from the Danube and the Dnieper Rivers was insignificant in comparison with short-term atmospheric fallouts. The results of observations and mathematical modelling are testified that in the surface layers 0-50 and 0-200 m of the Black Sea deep water basin in 1986-2000 an exponential decreases of the  $^{137}\text{Cs}$  inventories with an effective half-lives of 5-6 years and 9-13 years respectively have been observed. The process of vertical water mixing has been observed mainly in the 0-200 m layer. The contribution of Chernobyl origin  $^{90}\text{Sr}$  from atmospheric fallout was estimated around in 0 1 0 3 PBq. Pre accident  $^{90}\text{Sr}$  level nearly 20 Bq m<sup>3</sup> was reached by 1988. At the same time an active input of  $^{90}\text{Sr}$  from the Dnieper and Danube Rivers has been observed. The total amount of  $^{90}\text{Sr}$  delivered by the two rivers into the Black Sea was estimated to be nearly 0 1 PBq in the 1986-1995.

Under conditions of insignificant river input and sedimentation on particles, the decrease of the  $^{137}\text{Cs}$  inventory

in the surface layers has been influenced mainly by three processes: vertical water mixing, outflow through the Bosphorus Strait (275 TBq during 1986-2004 or 2 2 5% from  $^{137}\text{Cs}$  inventory in the 0-50 m layer annually) and radioactive decay. In the case of  $^{90}\text{Sr}$  until 1994-1995 these processes have been compensated by river inputs from the Dnieper and the Danube Rivers.

Time series (1986-2000)  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  vertical profiles (as profiles of conservative elements in the marine environment) were smoothed with a help of sigmoidal functions. Changing of the

depth of the gradient layer from time was used as an indicator of vertical water mixing intensity. The depth of the gradient layers has increased with velocities about 10-12 m y<sup>-1</sup> and 30-35 m y<sup>-1</sup> in the Central Western Black Sea and in the Rim Black Sea Current Region respectively. By applying one dimensional diffusion equation the vertical turbulent diffusion coefficients were estimated as 0.1-0.2 and 0.3-0.8 cm<sup>2</sup> sec<sup>-1</sup> within the Black Sea halocline.

**Keywords** *the Black Sea, <sup>137</sup>Cs and <sup>90</sup>Sr, vertical water mixing*