Analysis of Observations and Methods of Calculating Oceanic Hydrophysical Fields

Time variability of technogenic radioactivity in the Black and Mediterranean Seas*

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Abstract — We analyse the time variability of the fields of Cs-137 concentration in the surface waters of the Black and Mediterranean Seas in 1986-1998. It is shown that more contaminated Black-Sea waters affect the levels of concentration of this radionuclide in the east part of the Mediterranean Sea. We also study the influence of atmospheric processes and water exchange through Bosporus on the radioecological situation in the east part of the Mediterranean Sea and its coastal area.

As long ago as in 1934, in his talk to the meeting of the Division of Mathematical and Natural Sciences of the Academy of Sciences of the USSR, Prof. V. I. Vernadsky said: “At present, the Earth sciences begin to change under the influence of radioactivity just as physical and chemical sciences 24 years ago” [1, p. 659]. Long before the explosion of the first A-bomb, he emphasized the importance of application of radioactive materials for the state needs and social development: “The character of new opportunities created for the mankind in the case of even partial realization [of these plans] would have a mighty effect upon the social development and public life” [1, p. 572].

Testing of nuclear weapon and, later, the development of nuclear power engineering turned into powerful sources of radioactive materials in the environment. Thus, the analysis of the radioactive pollution of the ocean and atmosphere became especially important due to the necessity of guaranteeing the radiological safety of objects in the biosphere.

Investigations originated with an aim of monitoring the level of pollution of waters in the World Ocean with radioactive products formed after submarine testing of nuclear weapons promoted the formation and development of several new branches of oceanology: nuclear hydrophysics, isotopic oceanography, marine radiogeology, and radioecology. The history of development of these directions in the investigation of the ocean is closely connected with the Marine Hydrophysical Institute [2–5].

For a period of 50 years, the development of marine radioecology as a science passed the way from simple understanding of the necessity of measuring the level of radioactive pollution of the World Ocean to the creation of integrated systems of ra-

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dioecological monitoring. At present, there are two basic definitions of monitoring, which actually supplement each other reflecting different sides of the same problem:

1. System of repeated measuring of one or more elements of the environment in space and time according to a prescribed program [6].

2. System of observations capable of detecting changes in the biosphere caused by the human activities [7].

The collection of works [8] published in 1957 by the American National Research Council summarized the achievements of the initial stage of development of radioecology as a science. In the 50s, the main task of American scientists working in the field of radioactivity of the ocean was to develop scientific grounds for the legalization of disposal of radioactive wastes in the ocean which was, in fact, secretly realized in the USA since 1946. The cited book was actually prepared as a manual aimed at the formation of of a certain public opinion. In numerous talks presented at the Monaco International Scientific Conference on the removal of radioactive wastes held by the International Atomic Energy Agency (IAEA) and UNESCO in November 1959, on the basis of the results of experimental and in situ studies, American and British researchers made an attempt to convince scientists from other countries that the disposal of radioactive wastes in the ocean is inevitable [9, 10].

This idea met strong objections of soviet scientists who proposed not to give positive recommendations prior to the accumulation of sufficient amount of necessary data and knowledge. The first collection of papers published in the USSR in 1959 and devoted to the investigation of radioactive pollution of the environment had a symbolic title: “Soviet Scientists About the Danger of Testing Nuclear Weapon” [11].

Just at the end of the 50s, the investigation of the distribution of radioactive fission-produced isotopes in the World Ocean, their sources, migration paths, the forms of existence, and the influence of microorganisms on their redistribution became an important part of the entire complex of marine sciences and united experts of various specialities.

The first large-scale studies of atmospheric fallout over the sea were carried out in the course of the cruise of the R/V Vityaz in 1959–1960 [12]. The vessel left Odessa on October 6, 1959 and arrived at Vladivostok on April 28, 1960. Samples of atmospheric aerosols were taken systematically for the whole cruise. At the same time, the Laboratory of Radioactivity of Seas and Oceans of the Marine Hydrophysical Institute originated its systematic investigations of atmospheric radioactivity over the Atlantic Ocean during Cruises 7 and 8 of the R/V Mikhail Lomonosov. Significant attention was also given to the studies of the Black Sea. For several years since 1959, together with the Khlopin Radium Institute, the Marine Hydrophysical Institute carried out continuous measurements of the radioactivity of air over the surface of the Black Sea [12].

Thus, the radioecological monitoring of the Black-Sea Basin was, in fact, started in the late 50s and early 60s but the term “monitoring” was introduced much later.