Abstract

The presented PhD thesis aims to determine the activity levels and the distribution of alpha-emitting americium radionuclide, ^{241}Am, in dated sediments from the southern Baltic Sea. The accumulation rates determination allowed to assess the status and historical variability of bottom sediment contamination with ^{241}Am. The contamination of the Baltic Sea with radioactive substances occurred due to the global fallout of atmospheric nuclear weapon tests and the Chernobyl disaster. Although radioactivity levels decrease due to radioactive decay, the radionuclides' ecological half-lives in the entire Baltic Sea are prolonged due to slow water exchange and rapid sedimentation – also, ^{241}Pu decay, leading to the ingrowth of ^{241}Am activities over time. The knowledge of the quantity of ^{241}Am in the sediments of the Baltic Sea is limited. Thus, this study aimed to determine ^{241}Am in sediment cores collected from various locations of the southern Baltic Sea. Time-based distributions were derived from age-depth profiles using the ^{210}Pb dating method and further validated by ^{137}Cs profiles. The estimated accumulation rates differed among the three Baltic basins, ranging from 1.07±0.11 mm·year^{-1} to 4.34±0.33 mm·year^{-1}. The activities of ^{241}Am were measured by alpha spectrometry after radiochemical separation and purification. The results showed geographical divergences in the concentrations of ^{241}Am, varying from 0.020±0.001 Bq·kg^{-1} at the Gotland Basin to 3.19±0.23 Bq·kg^{-1} in the Gdańsk Basin. These findings enhance our understanding of the radioactive contamination levels in the Baltic Sea and serve as a crucial reference dataset for future assessments and management strategies to mitigate the environmental impact of radionuclides in the region.

The thesis is organized into six chapters, with the initial three chapters focusing on the theoretical aspects of the research. The first chapter presents the presence of americium in the marine environment. It covers the discovery and production of americium, its properties, and the primary sources of americium in the marine environment. The chapter also discusses the behaviour of ^{241}Am in the marine environment, including its transport, fate, and bioaccumulation. In addition, the potential health risks of exposure to americium are addressed, and the methods used to test for its presence and geochronological dating are also discussed. Chapter two provides a detailed analysis of the geographic locations studied. It includes describing specific areas such as the Bornholm Basin, the Gdańsk Basin, and the Gotland Basin.

The chapter outlines the unique features of each area, highlighting their importance to the overall study. It also identifies the research needs, discusses the materials used in the study, and outlines the objectives and scope of the research work. The chapter serves as a basis for understanding the environmental context crucial to subsequent analysis and findings. The third chapter outlines the specifics of the step-by-step process designed to accurately determine ^{241}Am in marine sediments. This chapter shows the practical part of the research. Chapter four focuses on the processing and interpretation of the collected information. This chapter introduces the principles of data analysis, including aspects such as radiochemical recovery, minimum detectable activity (MDA), activity concentration, uncertainty analysis, and validation. This chapter is crucial to understanding the study's results and providing the necessary analysis for accurate interpretation. Chapter five is dedicated to the presentation and discussion of the findings. It is a closer look at the data. Lastly, chapter six closes the thesis by summarizing the essential findings and insights derived from the study. It offers a final assessment and draws conclusions based on the research outcomes, concisely summarizing the investigation.

Keywords: americium ^{241}Am, radioactive contamination, nuclear weapon tests, Chernobyl accident, bottom sediments, southern Baltic Sea