Determination of Baseline Natural Radioactivity Levels in the Suez-Canal Water Stream

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Aim of the Work

This work aims at measuring the natural or background radioactivity levels in the Suez canal water stream. These data serve as a reference or baseline activity level of the canal water before any radiocontaminants are intentionally or accidentally released to the canal. The purpose of this environmental monitoring is also to describe the impact of a given nuclear facility (e.g. nuclear powered ships),at a specific time and location, and to obtain data that can be used as a basis for emergency action. In addition a radiological map can be depicted for radioactive distribution along the canal stream. Water,sediment , beach soils and different species of fishes have been collected along the canal,from Port-Said in the north to the Suez in the South of the Canal. The physical ,chemical and laser fluorimetric analyses of the water samples have been carried out. The mechanical and X-ray diffraction analyses of the sediments have also been performed. The radionuclide concentrations (K-40 ,U-238 ,Th-232 and Cs-137) have been determined using γ spectrometric analysis. The above mentioned investigations have been carried out in Egypt. Neutron activation and delayed neutrons analyses, have been carried out for the different sediment samples at the Mainz Triga reactor ,Gutenberg university, Germany. The obtained data show that the natural radioactivity levels of K-40, U-238 and Th-232 in the Suez-canal stream are comparable with the average international value levels (UNSCEAR DATA). Man-made Cs-137, which is a result of global fall-out,has been observed in some samples in very low concentrations(less than 3 Bq/Kg).

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Introduction and Literature Review

INTRODUCTION

Until the beginning of this century man's only exposure to ionizing radiation originated from natural sources which in most habitats near sea level,results in a total body dose of about 100 mrad/year (1).In a few places known for their abnormally high radioactivity the whole-body dose can be ten or more times higher than the average sea-level figure.

Our knowledge of the natural radioactive background serves as a reference starting point if we wish to evaluate the contribution of the additional sources of ionizing radiotions that result from man's exploitation of the atom. The phenomenon of natural radioactivity was first discovered by Bequerel just before the end of the 19 century. The phenomenon of natural radioactivity has been used ,for example,to reveal the structure of the atomic nucleus,to estimate the age of the earth,and to measure the rates of sediment formation on ocean bottoms. With the advent of man utilization of nuclear energy,studies of the natural levels of radioactivity have become necessary to understand fully the environmental influences of the radioactivity produced by the atomic energy industry. Only by having knowledge of the amounts of natural radioactivity and manner in which it varies , the intelligent interpretations of monitoring data can be ensured, whether in the vicinity of a nuclear facilty, on land,in the oceans,in the atmosphere,or in the tissues of man. Under the terms of global law,impact studies are required before undertaking any major construction work. An environmental radioecology reference survey is also necessary for nuclear facilities to provide a qualitative and quantitative assessment of artificial radionuclides at the site. The qualitative and quantitative knowledge of natural radioactivity in the ecosystems is important in itself since it is related to the most abundant radionuclide K-40 and other radionuclides (Ra-226 and Pb-210) liable to cause radiation protaction problems under extreme conditions. This information is also valuable in understanding the geochemical cycle of certain stable elements (isotopes or chemically similar elements) and provides background data for determining the relative impact of artificial radioactivity from authorized waste discharge from nuclear plants,nuclear powered ships,fall-out from weapon testing and nuclear accidents. An assessment of the interaction between man and the natural - radiation environment requires a good understanding of the distribution and abundances of the naturally occurring radioelements uranium and thorium and K-40 in rock, water, soil, air, biota and food.

LITERATURE REVIEW

I] ORIGIN OF THE ELEMENTS :

One theory of the origin of the elements was originated by G.Gammow and R.A.Alpher and is known as the big-bang theory (2). They originally postulated that in the begining of our universe all matter in it existed as neutrons in some super giant nucleus (the ylem) which exploded. During the explosion neutrons were converted through β-decay ($t_{1/2}$ 11 min.)to protons, and the protons combined with neutron and other protons to start the process of forming heavier elements. In this fashion all the elements were formed in a matter of less than an hour by a process of neutron capture.

Out of this expanding cloud the stars and planets were formed through condensation process. Through hydrogen and helium burning,neutrons are formed. A few of the reactions can be cited;

$$^{2}H + ^{3}H \longrightarrow ^{4}He + n + 17.59 \text{ Mev.}$$

$$^{2}H + ^{2}H \longrightarrow ^{3}He + n + 3.27 \text{ Mev.}$$

$$^{3}H + ^{4}He \longrightarrow ^{6}Li + n - 2.73 \text{ Mev.}$$

and many others certainly occur. As the heavier elements form in the stars,the neutron production increases considerably,since such reactions become more prevalent that heavier elements are the ones involved in the charged particle and γ-induced reactions. The mode of production of the elements changes from that of helium capture to that of neutron capture, so that the elements from iron to bismuth can be formed by a slow process of neutron capture (n,γ reactions), interrupted by β-decay whenever this is faster than the next capture step. Such a process is known as the slow, or s-process. The reaction probability for the capture of neutrons increases with the atomic number of the element. Despite the abundances of the elements decrease with increasing atomic number, the probability of the formation of heavier elements increases with the atomic number. The s-process can not explain the formation of the elements heavier than bismuth as the transbismuth elements have a number of short-lived species which would prevent the possibility of the formation of thorium and uranium in the amounts observed in nature. The abundance of the heaviest elements are believed to occur through another process. The supernova (explosion of star) stage is a very short-lived one during which neutron production is extremely intense and provides a method whereby the earlier barrier of the short-lived isotopes between polonium and francium is no longer effective and the heaviest elements are rapidly synthesized. This mode of element formation is known as the rapid or r.process. The intensity of the neutron flux as well as the very short time preclude the possibility of β-decay as a competitor to neutron capture in the r.process. This can result in a different isotopic distribution of the element for the r-process compared to that formed in the. s- process.

III] CLASSIFICATION OF THE RADIONUCLIDES:

The radionuclides present in nature can be classified into two groups (2,4,5):

A) Naturally occuring radioactive nuclides

B) Arificially occuring radioactive nuclides

A) NATURALLY OCCURING RADIOACTIVE NUCLIDES :

The naturally occuring radioactive nuclides can be