DETERMINATION OF TRITIUM IN NATURAL WATERS

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A study of the tritium content of precipitation and of river water samples, collected during a seasonal maximum of tritium concentration in 1976 is given. The measurements were made for precipitation in Belgrade from April to December 1976, and for river water from the Sava (in Belgrade), the Tisa at 137 km, and the Danube at 1425 km, 1174 km, 861 km from the confluence. The maximum monthly value of the tritium content of precipitation is 135 TU, and the Danube at 1425 km has a maximum of 196 TU (627 pCi/l). In general, there is no correlation between the amount of precipitation and river water with tritium content.

Introduction

Investigation of the amount and distribution of artificially produced tritium (by a number of different types of nuclear activity) can be used to study some dynamic phenomena. Man-made $^3$H has been dispersed throughout the earth's atmosphere and its participation in the hydrological cycle is regulated by natural processes. About half of the stratospheric inventory is transferred to the troposphere in the spring and summer months of each year, resulting in a continuing seasonal cycle of tritium precipitation with a maximum in summer and a minimum in winter.

Tritium, as a constituent of the water molecule, is the ideal geochemical tracer for water. Its concentration is not changeable by interaction with aquifer material. On the other hand, contamination of natural water by tritium produced in reactors as a fission product (with a yield of about 0.01%) appears to be a major problem.

This paper describes preliminary experiments on the determination of tritium levels in natural waters. The tritium deposited in the Danube, the Sava, the Tisa and in precipitation were determined and the main results obtained on samples collected for the period April – December 1976 (for precipitation) and during three summer months (river waters) are presented.

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Experimental

Collection of samples

Samples were collected monthly from precipitation. Some individual rainfalls also were used. The samples were taken at two meteorological stations in Belgrade, 5–7 km in distance, with some altitude difference (111 m).

About fifty samples of river waters have been analyzed for their tritium content. These samples were ten day averages collected during three summer months (May–July). The samples were from the location where the quality of waters is usually controlled.

Measurements

It was necessary to concentrate tritium in natural water at least 10-fold to permit measurement of its radioactivity by liquid scintillation counting. For this purpose, samples were prepared. The experimental procedures employed for the electrolytic enrichment and counting are well known.

Results and discussion

Precipitation

The results for tritium content are presented in Fig. 1. The full line is for the meteorological station at a 111 m lower altitude than the station represented with a dotted line.

It can be seen in Fig. 1 that a regular seasonal pattern of variation in the $^3$H/$^1$H ratio exists. The tritium content of precipitation for the period mentioned above showed a gradual increase from 100 TU to about 135 TU at the beginning of June and then a decrease through its lower level to 40 TU in December.

It is seen from Figs 1 and 3 that there is no correlation between the amount of precipitation and its tritium content. The dilution factor for the first period (up to September) is 2–3, and after that increases to a value of 7.5 at the end of December.

An attempt was made to trace air masses in order to locate the source of the individual rains or snows, and at the same time to find a possible explanation for the marked variation in the tritium content. A careful analysis of known meteorological conditions (in the first ten day periods of June and September) suggest that whenever the tritium content of the rainfall is low, it is apparent that the air trajectories show a southerly or westerly flow (at the beginning of September) and for high content (first ten days of June) show a northerly flow. Further work would probably contribute additional valuable information on this problem.