Natural radionuclides in the North-Western Mediterranean Sea

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Abstract

Preliminary results are reported on concentrations of natural uranium and thorium decay series isotopes in the Mediterranean Sea in the vicinity of the Rhône river discharge area. Characteristic features of radionuclide distribution are briefly discussed showing their partitioning between the dissolved and particulate phases.

Résumé

Les résultats préliminaires des concentrations des isotopes des séries naturelles de l'uranium et du thorium en Mer Mediterranée au voisinage de l'embouchure du Rhône sont présentés. Les caracteristiques de la distribution des radionucleides sont brievement discutés en montrant leur répartition entre les phases solubles et particulaires.

Natural radionuclides have been widely used in marine sciences for studying large scale water movements, diffusion and advection processes, transport of dissolved and particulate matter, sedimentation rates and a number of other physical chemical and biological processes. To take full advantage of these useful tracers a detailed knowledge of their concentration levels, isotopic ratios and distribution patterns in the aquatic environment studied is needed. In order to fill this gap in the north-western Mediterranean Sea and to get a better insight into the processes occurring in the Rhône river estuary a cruise was organized in April-May 1982 on the R/V "GAUSS". Filtered sea water and particulate matter were taken for uranium and thorium isotope measurements as well as for lead-210 and polonium-210. Concurrently, measurements are being carried out on plutonium and americium isotopes in the same samples. From the data already obtained the following findings can be reported.

The concentrations of uranium range from 3.55 to 3.93 $mg.m^{-3}$ with the average 3.8 $\pm$ 0.1 $mg.m^{-3}$. Particulate uranium amounts to 0.4 $\pm$ 0.3 $\mu g.m^{-3}$ at the surface and the solid particles contain on average 1.1 $\pm$ 0.7 $\mu g\ U.g^{-1}$. Elevated concentrations of particulate U were at times recorded in the subsurface 100 m - 500 m water layer.

The average $^{234}U/^{238}U$ ratio in sea water is 1.15 ± 0.03, i.e. typical of ocean waters. Concentrations of dissolved radium vary from 70 $dpm.m^{-3}$ on the surface to 150 $dpm.m^{-3}$ in deep water. Particulate radium concentrations seldom exceed 1 $dpm.m^{-3}$. Higher values are found near the Rhône discharge area and further seaward no particulate radium in surface water could be detected (<0.2 $dpm.m^{-3}$). The radium content of surface water particles range from 0 to 3.9 $dpm.g^{-1}$ with the average 1.4 ± 1.6 $dpm.g^{-1}$. Pronounced particulate Ra maxima were found at 250 m at some stations whereas values as high as 38 $dpm.g^{-1}$ were recorded. Similar maxima were recorded for ^{210}Pb, ^{239}Pu and ^{241}Am. Particulate polonium exhibits fairly uniform distribution in surface water, averaging 23 ± 3 $dpm.m^{-3}$ whereas great variations were noted for dissolved polonium (21 - 164 $dpm.m^{-3}$). Suspended particles carry 71 ± 15 $dpm.g^{-1}$. The polonium content of suspended matter increases with depth to attain the highest value at the bottom (∿ 590 $dpm.g^{-1}$ at 2500 m). While in deep water ^{210}Po and ^{210}Pb are in radioactive equilibrium, this is not the case for ^{210}Pb - ^{226}Ra, where the deficiency of ^{210}Pb is maintained throughout the whole water column and reaches up to 40% below the upper mixing layer.

The mean concentrations of particulate thorium are 0.07 ± 0.05, 0.10 ± 0.11 and 0.69 ± 0.33 $dpm.m^{-3}$ for ^{232}Th, ^{230}Th and ^{228}Th, respectively. From the preliminary measurements of dissolved thorium it appears that particulate thorium represents only a small proportion of the total amount.

Our measurements, although not performed in the direct river/sea interaction area, as indicated by the salinity data, do provide evidence of the land impact on the sea area studied. The proportion of particulate U, Ra, Th, Po and Pb isotopes are generally higher close to the river discharge and diminish seawards. Also, the $^{228}Ra/^{226}Ra$ ratio which is about 0.7 in the river mouth area, decreases steadily to reach 0.2 in the open sea. More detailed conclusions will be drawn when all measurements have been terminated.

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Paper presented by R. Bojanowski (IAEA)

Discussion

M. BRANICA: How do you explain the different $^{234}U/^{238}U$ ratios you found in sea water and water from the Rhône river?

R. BOJANOWSKI: The $^{234}U/^{238}U$ ratio we found in the vicinity of

the Rhône river mouth is typical for open ocean water whereas river water $^{234}U/^{238}U$ ratios can vary over a wide range depending on the geological nature of the drainage area.

N. FISHER: Have you calculated the concentration factors of ^{210}Po and ^{210}Pb in suspended particulates of surface water?

R. BOJANOWSKI: The data we obtained allow calculating such figures for all stations and in fact range from 0.4×10^7 to $\sim 1.5 \times 10^7$ on a dry weight basis.