Biogeochemical cycling of uranium series radionuclides in the NE Atlantic Ocean

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Radioactivity is present in all oceans and naturally-occurring radionuclides, such as 238U, 234U, 230Th, 226Ra, 210Pb, 210Po and 232Th can be useful tracers for large scale biogeochemical cycles. We determined the activity concentrations of these radionuclides in several vertical profiles of the Northeast Atlantic Ocean in dissolved and particulate phases. The distribution of radionuclides allowed the computation of the uranium mean residence time in the ocean at 2x105 years. Most of the uranium in sea water is in the soluble phase and the particulate matter in the NE Atlantic water contains only 0.04% of the total uranium. Thorium is a particle reactive element and most of it is associated with suspended particulate matter and removed from the water column with the sinking particles. The average mean residence time of 230Th in the NE Atlantic water was computed at 32 years. The removal of 230Th with the sinking particulate matter flux maintains a disequilibrium between238U and 234U uranium isotopes originating 234U/238U activity ratios of 0.83±0.10.Radium (226Ra) in sea water mainly originates in the dissolution of radium from the sea floor, thus supporting very low concentrations of dissolved radium in the NE Atlantic surface water which increase towards the sea floor. Lead (210Pb) and polonium (210Po) are particle reactive elements that in the NE Atlantic Ocean originate in atmospheric depositions and in radioactive decay of 226Ra in the water column. The distribution of their activity concentrations allowed modelling the cycling of these radionuclides in the water column and the computation of average residence times of dissolved 210Pb and 210Po in the upper layer at 5y and 1y, respectively, and 0.6y in the particulate phase for both radionuclides. In the deep ocean water layer, soluble 210Pb and 210Po mean residence times were 42y and 2y, respectively. The calculated 210Pb deposition flux at the abyssal sea floor is comparable with the flux derived from the 210Pb-excess inventory measured in NE Atlantic bottom sediments, and about 100 Bq m-2 y-1. The 210Pb atmospheric deposition flux at the ocean surface in this region was estimated at about 74 Bq m-2 y-1 and the 210Pb sink in the Northeast Atlantic is discussed. The overall cycling and activity balance of these radionuclides in the NE Atlantic is outlined.

Key words: Uranium, thorium, radium-226, lead-210, polonium-210, sea water, residence times.

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