PARTICLE COMPOSITION AND ORGANIC CARBON FLUX AT DYFAMED: INSIGHT FROM THE SHORT-LIVED NATURAL RADIONUCLIDES ^{210}PO AND ^{234}TH

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Abstract

Trace metals, minerals, organic carbon, nitrogen, and the natural radioisotopes ^{234}Th, ^{228}Th,^{210}Po, and ^{210}Pbwere measured in sinking particles collected in sediment traps at 200 min the northwestern Mediterranean. Organic biomarkers were used toidentify the types and sources of particulate organic matter and theresults indicate that the distribution of polonium in sinking marineparticles is influenced by fresh phytoplankton-derived material. Wethen compared POC fluxes estimated using ^{234}Th/^{238}U and ^{210}Po/^{210}Pb disequilbria and sediment traps at the same location. The ^{210}Po/^{210}Pb system provided organic carbon flux estimates closer to the flux caught in sediment traps.

Keywords : Particle Flux, Radionuclides, Ligurian Sea, Carbon.

The disequilibrium between polonium-210 and its grandparent lead-210has been proposed as a tracer of the vertical flux of sinkingparticulate organic matter in the ocean. The mechanism of associationbetween ^{210}Po and organic matter is, however, stillunclear. To investigate this association, we measured trace metals,minerals, organic carbon, nitrogen, and the natural radioisotopes ^{234}Th, ^{228}Th,^{210}Po, and ^{210}Pbin sinking particles collected in sediment traps at 200 m in thenorthwestern Mediterranean. Pigments, fatty acids, and amino acids wereused to identify the types and sources of particulate organic matter.Multivariate analyses were used to determine which components ofsinking particulate matter are traced by ^{210}Po and/or by the ^{210}Po/^{210}Pbratio. Statistical analysis of the results indicate that thedistribution of polonium in sinking marine particles is influenced byfresh phytoplankton-derived, nitrogen-rich organic matter as well assulfur-containing amino acids. These findings are consistent withprevious laboratory observations that the distribution of ^{210}Poin biota parallels the distributions of both sulfur and protein ([1],[2], [3]), and indicate that these associations persist as materialsinks through the water column. While this research generally supportsthe use of ^{210}Po as a specific tracer of the flux of organic matter, the signals traced by ^{210}Po/^{210}Pb and ^{238}U/^{234}Th are not as distinct in the field as in laboratory experiments. Further work is needed to determine more precisely what ^{210}Po/^{210}Pb traces, and to develop protocols to increase the correspondence of ^{210}Po/^{210}Pb measurements to biogeochemically important rates and quantities.

In order to test the employment of the ^{210}Po/^{210}Pbdisequilibrium, we then compared estimates of particulate organiccarbon (POC) flux determined from polonium and lead to those calculatedfrom the disequilibrium between ^{234}Th and its parent ^{238}U. Water column thorium and uranium measurements, coupled with measurements of POC/^{234}Thratios on filterable or settling particles, have been used extensivelyto assess the sinking flux of POC (e.g. [4], [5]. In contrast,disequilibrium between ^{210}Po and ^{210}Pb has been infrequently used (e.g. [6]) to assess POC fluxes despite indications that ^{210}Po is assimilated into tissue and may be a better indicator of the fate of OC than ^{234}Th.Here, we compare the POC fluxes estimated from these two isotope pairswith fluxes measured in moored sediment traps below the euphotic zone.The POC flux at 200 m estimated from ^{234}Th and ^{210}Podeficits and the POC/Po or POC/Th on >70 μm filterable particlesmeasured through three seasons (early spring, late spring, summer)ranged from 3.8 - 17.5 mmol C/m^2/d using ^{234}Th/^{238}U and from 4.4 - 7.0 mmol C/m^2/d using ^{210}Po/^{210}Pb disequilibrium. In comparison, sediment trap fluxes of POC at 200 m ranged from 0.3 - 6.0 mmol C/m^2/dover the same interval. Values of POC/Po and POC/Th ratios in sedimenttrap material collected in time series or separated according tosettling velocity were generally lower than values in the >70 μmfilterable particles at 200 m. The variation in POC/Po and POC/Th inmaterial separated according to settling velocity showed no clearrelationship with settling velocity and was controlled more by particlecomposition and degree of degradation. Both ^{234}Th and ^{210}Poshowed sustained water column deficits in late spring and summer,despite low carbon fluxes recorded in the trap. Lateral processes(transport of particles along isopycnals or intrusion of shelf watersto the site) and temporal assumptions (steady-state vs. nonsteady-state) may be responsible for this disparity. Based on theresults of this study, we attest that ^{210}Po/^{210}Pb disequilibrium is as proficient as or better than ^{234}Th/^{238}U in estimating POC flux in the ocean.

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