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# Benthic Nepheloid Layers along the U.S. GEOTRACES GA03 Transect in the Western North Atlantic: Characterization and Influence on $^{230}$Th and $^{231}$Pa Cycling

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Benthic nepheloid layers (BNLs) are particle-rich layers that can extend over a thousand meter or more above the seafloor and are thought to be produced by the resuspension of fine sediments from strong bottom currents. They can often be subdivided into two sublayers: (i) a lower sublayer in contact with the seabed, where particle concentrations are the largest and which roughly coincides with the bottom mixed layer (BML); and (ii) an upper sublayer in which particle concentration decreases up to a clear water minimum (CWM). Although BNLs have long been recognised in vertical traces of optical instruments lowered to abyssal depths, their influence on ocean biogeochemical cycles – on the cycling of particle-reactive metals in particular – remains poorly understood.

In this study, we characterize the BNLs observed between the New England continental shelf and Bermuda and explore their influence on the cycling of $^{230}$Th and $^{231}$Pa – two naturally-occurring particle-reactive radionuclides that have found different applications in chemical oceanography and paleoceanography. To this end, we use concomitant measurements of temperature, salinity, particle concentration derived from light beam transmissometry, and $^{230}$Th and $^{231}$Pa activities in the dissolved and particulate fractions, which have been collected along the western segment of the U.S. GEOTRACES GA03 transect. We estimate that the thickness of strong BNLs (particle concentration > 20 μg $l^{-1}$) varied from about 72 to 1358 m between different deep stations. At all stations, particle concentrations below the CWM were the highest in the BML, whose thickness ranged from 95 to 320 m, and decreased generally with height above the seafloor. A simplified model of particle-radionuclide cycling in the deep water column, which includes a particle source representing sediment resuspension at topographic reliefs and their subsequent lateral transport, is fitted to observed profiles of particle concentration and radionuclide activities at two selected stations. The model can reproduce simultaneously the increase of particle concentration with depth, the low dissolved activities in the BNLs, and the extremely large particulate activities near the bottom. Analysis of $^{230}$Th and $^{231}$Pa budgets reveals that the behaviour of both radionuclides in the BNL is fundamentally different from that envisioned in reversible exchange theory. Sensitivity

tests with the model suggest that lateral particle sources near continental slopes and similar reliefs can produce significant biases in the paleoceanographic applications of both radionuclides, including the $^{230}Th$-normalization method and the interpretation of sediment $^{231}Pa/^{230}Th$ records.