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Influence of particle composition on thorium cycling along the U.S. GEOTRACES North Atlantic Section

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Our current knowledge about the behaviour of particle-reactive substances in the ocean stems largely from measurements of thorium radio-isotopes (Th-228, Th-230, Th-234) on seawater samples. The oceanic Th database has increased dramatically over the recent years, thanks in particular to the GEOTRACES program, an international study of the marine biogeochemical cycles of trace elements and their isotopes. Here we present an analysis of data collected at several stations of the U.S. GEOTRACES North Atlantic section (section GA03). Data originating from eleven stations situated west and east of the Middle-Atlantic Ridge are analyzed. First, at each station, the rate parameters of a single-particle class model of Th and particle cycling in the ocean water column are estimated from a least-squares fit to an eclectic data set, including (i) measurements of Th-228, Th-230, Th-234 activities in different size fractions, (ii) measurements of particle concentration, and (iii) measurements, or observational estimates, of the activities of the radio-active parents Ra-228, U-234, and U-238. Among our most salient results is a significant decrease in the apparent rate constant of Th adsorption (k1) with depth, with maxima in the mesopelagic zone (ca. 100 - 1000 m) and minima below, at most stations. Second, we explore whether our k1 estimates can be related to changes in particle composition, both along the water column and laterally along GA03. We apply (i) multiple linear regression to quantify the amount of variance in k1 that can be explained by linear regression against particle composition data, and (ii) relative importance analysis to determine the relative contribution of different particulate phases to the explained variance in k1. Finally, the implications of our results for the interpretation of field Th isotope data and for the description of particle scavenging in ocean-biogeochemistry models are clarified.