EDDIES total 234Th methods


We followed recently improved methods for the determination of total 234Th on 4L samples collected on standard CTD casts (Benitez-Nelson et al. 2001; Buesseler et al. 2001). Since the cruises were relatively short, our efforts were focused on collecting and processing as many samples as possible at sea, and then returning samples immediately to WHOI for determination of 234Th activities via beta counting. For the 234Th flux approach, it is vitally important to have a precise and accurate determination of total 234Th, particularly in areas where the disequilibrium, i.e. difference between 234Th and 238U, is expected to be small, such as in the Sargasso Sea. We do this by: 1) measuring 234Th via low background beta counting to a counting error that is generally <2%; 2) determining the background of other possible beta emitters by recounting each sample after 5-6 months, at which point 234Th has decayed; and 3) using a 230Th yield monitor to correct measured 234Th activities for systematic and non-systematic inefficiencies in the isolation of Th from seawater (Pike et al. 2005). While on average 234Th yields with this method are high (close to 95% in this study), there is an expected distribution of yields around the mean and a small number of “flyers” with systematically low yields. This distribution is larger than our counting error, and low yields would lower apparent 234Th activities and bias fluxes too high. This illustrates the necessity of using a yield monitor in order to develop a data set of the highest quality. Thorium-234 data are decay corrected to the time of sampling, and errors are propagated from the initial and final measurement of 234Th, as well as the error on the 230Th yield correction. This propagated
error on total $^{234}$Th averages ± 3-4% for the entire data set. Uranium-238 can be estimated from salinity, and in the open ocean this relationship is thought to hold within ± <1% (Chen et al. 1986) though differences between groups and settings can be larger (>3%; Pates and Muir 2007; Rutgers Van Der Loeff et al. 2006). Unpublished data from this lab suggests that the U-salinity relationship of Chen et al. (1986) fits Bermuda waters quite well. Five to ten deep water samples (4000m) were analyzed on each cruise and these showed a $^{234}$Th/$^{238}$U ratio of 0.992, and a standard deviation of 3.8% (n=30).


