Parallel budgets of excess thorium and protactinium in grain-size separates of marine sediments from the North Atlantic over the past 20,000 years

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Abrupt shifts in the Atlantic's circulation regime have been inferred from carbon isotopes within benthic foraminifera, geostrophic gradient shifts captured in oxygen istopes from benthic foraminifera, changes in the burial ratio of $^{231}Pa/^{230}Th$ in bulk sediment, and variations in sortable silts. Drift deposits, those regions of the ocean where the energy of currents slaken and sediment is deposited in excess of the local vertical particle flux, are often selected for $^{231}Pa/^{230}Th$ and other paleoceanographic reconstructions because the sedimentation rates far in excess of he mean ocean, thus allowing for greater resolution of transient climate events than in other seafloor sediment cores. Most of the fine sediment (<20micron) that constitutes a large fraction of mass within these deposits is laterally transported. Previous work suggested the fine fraction of the sediment carries a disproportionately high concentration of excess ^{230}Th, or $^{230}Th_{xs}$, produced by the decay of ^{234}U in sea water and scavenged by settling particles, and extra-terrestrial helium, $^{3}He_{ET}$, two nuclides whose mass flux aids in the reconstruction of past climate events. While the results are consistent with past findings for $^{230}Th_{xs}$, we find a contrasting distribution of $^{231}Pa_{xs}$ that serves as a cautionary tale towards assuming that a similar size-dependence applies to all particle-reactive elements.

This study presents side-by-side size-fraction budgets of $^{230}Th_{xs}$ and $^{231}Pa_{xs}$ over the last deglacial from core CDH19 taken from a North Atlantic drift deposit, on the Bermuda Rise. Our results suggest that $^{231}Pa_{xs}$ is more evenly distributed among size-fractions than is $^{230}Th_{xs}$, possibly indicating that $^{231}Pa_{xs}$ is less susceptible to the biasing effects of particle focusing and more sensitive to the drivers of vertical particle flux. Further, ^{230}Th normalized fluxes of the size-fraction separates imply that the maximum changes in the $^{231}Pa_{xs}/^{230}Th_{xs}$ ratio that occurs across Heinrich Event 1 are evenly distributed across all size fractions.

Element outgassing in BABB: An example from the Havre Trough

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Trace element data have been acquired for glass rinds and corresponding whole-rock samples of back-arc basin basalts from the Havre Trough in the SW Pacific. For most elements the match in compositions between glass and whole-rock pairs is essentially identical to within analytical uncertainties. In other cases, small variations exist that can be explained by the lack of olivine (for example) phenocrysts in digests of the handpicked glass.

In contrast, volatile elements show more marked differences that we attribute to outgassing of the magmas during vesiculation and eruption. Although most researchers would agree that Cd is highly volatile, our observation is that Cd is only slightly enriched in the glass (glass averaging Cd contents only ~7% higher than rock). In contrast, the largest discrepancies between the whole rock and glass compositions are in W (enrichment factor of ~30) and Mo (enrichment factor of ~5), and these elements also show an excellent correlation with each other. Given that these two elements are broadly believed to be less volatile compared with Cd, the most reasonable conclusion might be that the glass rinds lost much of this highly volatile element prior to quenching. Similar comparisons have been made with other elements in order to assess their relative volatilities in this back-arc basin setting.

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