Global patterns in oceanographic influences on $^{10}\text{Be}$ deposition rates to the seafloor

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The deposition rate of meteoric beryllium-10 ($^{10}\text{Be}$) in marine sedimentary records provides constraints on variations in geomagnetic field intensity over the past ~10 million years. However, dynamic processes within the water column, such as particle scavenging and water mass transport, may increase or decrease the local rate of $^{10}\text{Be}$ deposition to the seafloor relative to its atmospheric production rate. These oceanographic effects on local $^{10}\text{Be}$ deposition can vary with climatic variability and complicate geomagnetic interpretations of sedimentary $^{10}\text{Be}$ data. A detailed characterization of oceanographic influences on $^{10}\text{Be}$ deposition will enable systematic corrections for such effects in the sedimentary record and reduce the uncertainty associated with $^{10}\text{Be}$-derived geomagnetic paleointensity records. Such characterization may even enable the utilization of sedimentary $^{10}\text{Be}$ as a particle flux proxy, analogous to the shorter-lived thorium-230 ($^{230}\text{Th}$) and protactinium-231 ($^{231}\text{Pa}$) proxies, over intervals for which variations in geomagnetic field intensity are independently constrained.

We present new $^{230}\text{Th}$-normalized $^{10}\text{Be}$ deposition records for three sediment cores in the Equatorial and North Pacific and evaluate these data within the oceanographic context of a global compilation of $^{230}\text{Th}$-normalized $^{10}\text{Be}$ deposition rate records. The $^{10}\text{Be}$ data are compared with lithogenic and opal deposition rate records, where available, to investigate scavenging effects. We observe a first order correlation between lithogenic flux (constrained using complementary thorium-232 data) and $^{10}\text{Be}$ deposition. However, the slope of this relationship (i.e., the $^{10}\text{Be}/^{232}\text{Th}$ flux ratio) varies by ocean basin, with North Atlantic records exhibiting lower $^{10}\text{Be}/^{232}\text{Th}$ flux ratios than those from the Southern Ocean and the North Pacific. Sediments with high opal $^{232}\text{Th}$ ratios also exhibit higher $^{10}\text{Be}/^{232}\text{Th}$ flux ratios, suggestive of additional $^{10}\text{Be}$ scavenging by opal, yet opal scavenging effects are insufficient to explain the basin-scale differences in $^{10}\text{Be}$ deposition. Rather, we propose that the high $^{10}\text{Be}/^{232}\text{Th}$ flux ratios observed in Southern Ocean and Pacific sediments, relative to Atlantic sediments, result from a general increase in water column inventories of $^{10}\text{Be}$ as one progresses along the transport pathway from the North Atlantic to the Pacific. This hypothesis is supported by seawater data indicating higher $^{10}\text{Be}$ concentrations in the Pacific relative to the Atlantic.