Reconstructing the marine Os record: Lessons from pelagic sediments

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Our recent work performing bulk sediment analyses of Cenozoic and late Cretaceous deep sea sediments reveals clear whole ocean shifts related to impact events, flood basalt volcanism and long-term climate evolution. In addition, new high resolution records reveal systematic offsets in $^{187}Os/^{188}Os$ between widely separated sites, suggesting regionally heterogeneous $^{187}Os/^{188}Os$ in the open ocean on the order of 5%. This finding is significant because it implies that the Os isotope systematics of pelagic sediments record both whole ocean reservoir shifts in response to changing global inputs, as well as regional contrasts that are potentially useful for reconstructing ocean circulation. Thus, marine Os isotope records may be conceptually more analogous to marine carbon isotope records, than to either marine Nd or Sr isotope records. In order to further explore this possibility three important issues must be addresses. First our ability to distinguish between lithogenic, particulate extraterrestrial and hydrogenous components of sediment Os budgets must improve. Second, multiple high resolution records of Os isotope variations from nearby, well-correlated sites must be used to better understand the nature of very brief transient excursions in $^{187}Os/^{188}Os$. Third, direct analyses of Os in pore fluids is needed to evaluate the potential influence of diagenetic Os redistribution. New and recently published data from the deep sea sediments recovered by ocean drilling will be used to illustrate the importance of these topics. Importantly our work integrates data from a variety lithologies.

Rapid Os isotope analyses of carius tube digestions by sparging

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We have developed a method that integrates carius tube digestion of sediment samples with Os isotope analysis by sparging. The objective of merging carius tube digestion with the sparging method was to develop a procedure that eliminated the need for all post-digestion Os separation. To achieve this goal required abandoning digestion solutions based on nitric and hydrochloric acids in favor of nitric acid hydrogen peroxide mixtures. The sparging method involves direct introduction of OsO_4 vapor into the plasma with an Ar carrier gas bubbled through solutions resulting from carius tube digestion. Not only does this approach eliminate the need for laborious Os separations, it has rapid sample through put, 4 -5 analyses per hour, relative to N-TIMS. Using an Element2 single collector ICPMS for analysis routinely yields precisions between 0.5% and 1.5% 2 sigma uncertainties for $^{187}Os/^{188}Os$ ratios measured on 100 pg of analyte. Tests have been conducted using a variety of marine sediments including glacial diamictites, composed almost exclusively of silicate detritus, deep sea oozes, composed of >90% $CaCO_3$, and organic-rich sediments, strongly enriched in authigenic Os. Comparisons of carius tube digestions to total digestion by NiS fire assay indicate that the nitric peroxide mixtures liberate nearly all of the Os contained in the samples, including >50% of the of silicate associated Os contained in the glacial diamictites.