What do deviations from the reversible scavenging model tell us about the removal of trace elements from the ocean?

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In 1954 Ed Goldberg introduced the concept of scavenging to characterize the processes that remove insoluble trace elements from the ocean. He envisioned that dissolved metals would react with functional groups distributed throughout the surfaces of mineral (oxyhydroxide and silicate) and organic phases and thus be removed from the ocean by gravitational settling. Subsequently, it was determined that the reaction with particle surfaces is a reversible process with kinetics that are fast relative to the sedimentation of particles, leading to specific predictions for the distributions of trace elements in the ocean.

In some cases the distributions of particle reactive tracers are consistent with the predictions of reversible scavenging; for example, tracers such as radiogenic ^{230}Th that are produced uniformly throughout the ocean have concentration profiles that in many cases increase linearly with depth, whereas tracers such as ^{232}Th that are introduced exclusively at the sea surface have concentration profiles that are constant over depth.

Departures from these simple profiles are fairly common and they inform us that other processes are active in certain regions. Anomalies in the upper water column suggest an additional removal process associated with the deep chlorophyll maximum whereas anomalies in the deep ocean indicate both sources and sinks of trace elements that cannot be explained by simple one dimensional reversible scavenging models. We will present specific examples from GEOTRACES expeditions to recommend features that may be targeted for more elaborate 3-D modeling.