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Scavenging partition coefficients of trace elements and isotopes in the Pacific Ocean

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Scavenging plays an important role on the redistribution and/or removal of trace elements and isotopes (TEIs) from the water column. We define scavenging as the abiotic processes that remove elements from seawater to particles through adsorption or precipitation onto the particle surface. If the scavenging is reversible, scavenged TEIs can desorb or dissolve back into the dissolved phase, redistributing the dissolved TEI in the water column. The partition coefficient, or K_D, is a common way to represent the relative partitioning of a TEI between the particulate and the dissolved phases and is calculated empirically as the ratio of sorbed (scavenged) TEIs to dissolved TEIs, normalized by suspended particulate matter (SPM) concentrations. While K_D is commonly used by geochemists to express partitioning of radionuclides, it has rarely been calculated for key trace elements. Here we use the weak "Berger" leach to estimate the scavenged portion of 10 trace elements (Al, Cd, Co, Cu, Ni, Fe, Mn, Nd, Pb, Zn) from the U.S. GEOTRACES Pacific Meridional Transect (GP15), and calculate and compare their empirical K_D's to 4 radionuclide K_D's (^{210}Po, ^{210}Pb, ^{230}Th, ^{231}Pa) from the same transect. The TEI K_D's range from just above 10^3 (Cd) to over 10^9 (Mn) g/g. Most TEIs are characterized by increasing K_D's with depth, typically increasing by ~1-3 orders of magnitude from surface to deep, but a few are relatively uniform with depth or even decrease with depth. We also examined how well we could predict a TEI's K_D using particle composition and particle concentration. We find that there are five categories of K_D behaviour: TEIs whose scavenging is 1) best explained by the fraction of MnO_2 ($fMnO_2$; Co, Mn, Pb, Nd, ^{210}Po, and ^{210}Pb); 2) dominated by $fMnO_2$, but for which other particle phases are also influential (Fe, ^{231}Pa); 3) moderately correlated with $fMnO_2$, but show higher correlations to SPM (Cu and ^{230}Th); 4) not correlated with $fMnO_2$ or SPM but correlated with lithogenics and opal (Al); and 5) not strongly correlated with any of the particle phases we measured or with SPM (Ni, Zn).