Theme 2 – Hayes

Fe residence times from radioactive isotope—compile here observation-based estimates (six).

^{234}Th—upper 100 m. 24 day life. Diel vertical migration effects?

^{228}Th- -better at bottom 1000 m. 1.9 years half life.

^{210}Po-^{210}Pb—upper 300 m. good to compare with Th234. More biological uptake of Po than Th. ~monthly time scales

Be7—53 days. Proxy for source of atmospheric Fe. Not a scavenging tracer.

Np/Pu method. Throughout whole water column.

Th-230. 75 kyr. Throughout the whole water column. Good for nepheloid layer scavenging.

 Every source/type of Fe will have a different scavenging residence time. Use Fe isotopes to find out the mixture of sources.

Particle dynamics will be learned about too with these estimates

Th scavenging getting at Fe scavenging.

Reversibility of scavenging. If isotopic ratio is changing while dissolved concentration is not, there must be exchange of Fe in the different pools. Nd isotopes similar effect.

Th scavenging is reversible, this is a metal with a relative high Kd. What will be the case with low Kd metals? If Th desorbs, shouldn't all metals desorb. Seth John-regenerative scavenging of Zn, sort of like reversible scavenging effectively.

Murnane decoupled remineralization from desorption by modling POC and the metal. Do this with other phases. This may be tractable

Not much evidence for irreversible scavenging. Some that are effectively reversible (Th-234). Authigenic mineral formation (co-precip) oyxhydroxide formation. may be a type of this.

Distinguish desorption from particle remineralization? Getting the rates of abiotic scavenging is important for model parameterizations.

Test if modeling of metals are consistent with reversible scavenging or not.

Aggregation/Dissagregation (2nd easiest): Lerner et al paper for aggregation rates. Looking at distribution of particle size throughout water column.

Preformed fractions---need to remove this to interpret local process.

Not enough data to currently set this. 3d ocean circulation is good to define end-member values for preformed metals.

Oxyhydroxide cycling

Modeling hydrothermal oxyhydroxides and coastal/estuarine oxyhydroxide. Source for some elements (Nd) and sink of others (Cu). Putting in an explicit tracer for this would be more expensive than an implicit one.

Many models have figured out Fe source from coasts and hydrothermal vents. Scale this to oxyhydroxide formation. Mn would look different but analogous approach may be possible. Van Hulten has paper published on this.

Bay of Bengal, estuary release of Nd, Mn, Fe—related to oxygen content, high productivity areas. Nd flux from sediments. Regional information of coastal sources.

Kd Approach:

Derive Kd's for all the metals and for all the major particle types.

Continuum of reactivities. REE scavenging show a range. Competition between complexation of with carbonate and adsorption.

Kd's should be scaled with surface area.---Could optical techniques be used to help with this?

Paired experiments to look at relative Kd's (relative to Th).

Weak leaches may not be useful for determining adsorbed fractions. Analytically small and don't know what you are leaching. Synchrotron techniques are hopeful for this—higher analytical cost and sample preparation more difficult. Detection limit not very good. Hard to do for Fe because it doesn't stand out from background. Cu or Zn that are mostly adsorbed may work. Not tractable for open ocean particles.

--Hayes used multiple linear regression—there are other model choicesNon-linear dependencies? Multiple phases together?

Nepheloid layers (easiest problem). Particle concentration. Related to eddy kinetic energy, Paramaterization. Intermediate nepheloid layers. Particle composition of these layers is important for scavenging. benthic storms. Use Th-230 to derive scavenging rates and predict for global budget.

Hopeful in modeling. Use eddy kinetic energy parameterization. Can constrain with beam attenuation data.

Experimental techniques. To go after open questions. Container effects? Representativeness?---Mesocosm experiments are a middle ground. Can derive information from transient tracers (Pb, anthropogenic nuclides (Pu/Np) scavenging).

Are surface sites saturated? Experimental techniques.

"Sinking" of anthropogenic nuclides. Pu is sinking relative to Np. 8 m/yr (only two time points) sinking. Evidence for reversible scavenging? Can we look at this at higher temporal resolution? Some Pu should be getting to deep water.

Scavenging rates and mechanisms: (hardest problem)

-apply Th models to other metals

--use Th for disagg/agg rates. Then combine with scavenging intensities.

DCM minimum. Sounds like it could be solved with multiple 1-D models to test hypotheses. Or if some mixture of processes, we would like to know what is the balance for Fe uptake rates. Data-based comparison of sinking of biological iron. Fraction of Fe lost due to bio assimilation versus scavenging

Ephemeral scavenging process. Blooms—even 1/10 of degree model don't resolve this. Can use satellite data.

There is an isotope effect on Mo during scavenging/redox reactions.