Acceptance and Use of Passive Sampler Data in Regulatory Environments

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Things have changed

- Passive sampling is not new.
- There are many applications.
- Passive sampling is not unproven. Particularly for non-ionic organic compounds.
- When properly done, passive sampling better characterizes dissolved phase than media grab samples.
- Passive sampling is being used by Agency PMs and researchers.
- Passive sampling is used in regulatory applications

Passive Sampling is Not New

- 1987 - Södergren, A. (Univ. of Lund, Sweden) Dialysis membranes filled with hexane. (DDX, PCBs, HCB)
- 1990 – Huckins et al. published articles in several peer reviewed journals on SPMDs
- 1990 – Arthur et al. published on the use of SPME fibers (111-TCE, TCE, PCE).
- 1992 – Lebo et al. more SPMDs (PAHs)
- 1994 – Lebo et al. SMPDs for PCDD/Fs.

Passive Sampling is Not New

- 2000 – Adams et al., Polyethylene sheets
- 2001 – Jonker *et al*., Polyoxymethylene (POM) sheets
- 2002 – Booij et al., Spiking PRCs on PE Samplers
- 2004 – 2005 Lohman, Burgess, Vinturella, Fernandez PE Samplers, correlated with tissue uptake studies.
- 2005 – Hawthorne – Isotope Dilution-Flocculation-SPME.

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There are many applications

- Semipermeable Membrane Devices (SPMDs)
- Polyethylene Diffusion Bag Samplers (PDBs)
- Rigid Porous Polyethylene Samplers (RPPS)
- Polar Organic Chemical Integrative Samplers (POCIS)
- Passive In-Situ Concentration Extraction Sampler (PISCES)
- Peepers
- Regenerated-Cellulose Dialysis Membrane Samplers
- Nylon-Screen Passive Diffusion Samplers (NSPDS)
- Passive Vapor Diffusion Samplers (PVDs)
- Polymeric sheets, Gschwend, Fernandez, Burgess, Jonker
- AGI (formerly GORE® Sorbers)
- In situ SPME, Reible *et al.* In vitro SPME, Hawthorne *et al*
- XAD Bead Kinetics Studies

Better characterizes dissolved phase non-ionic organics

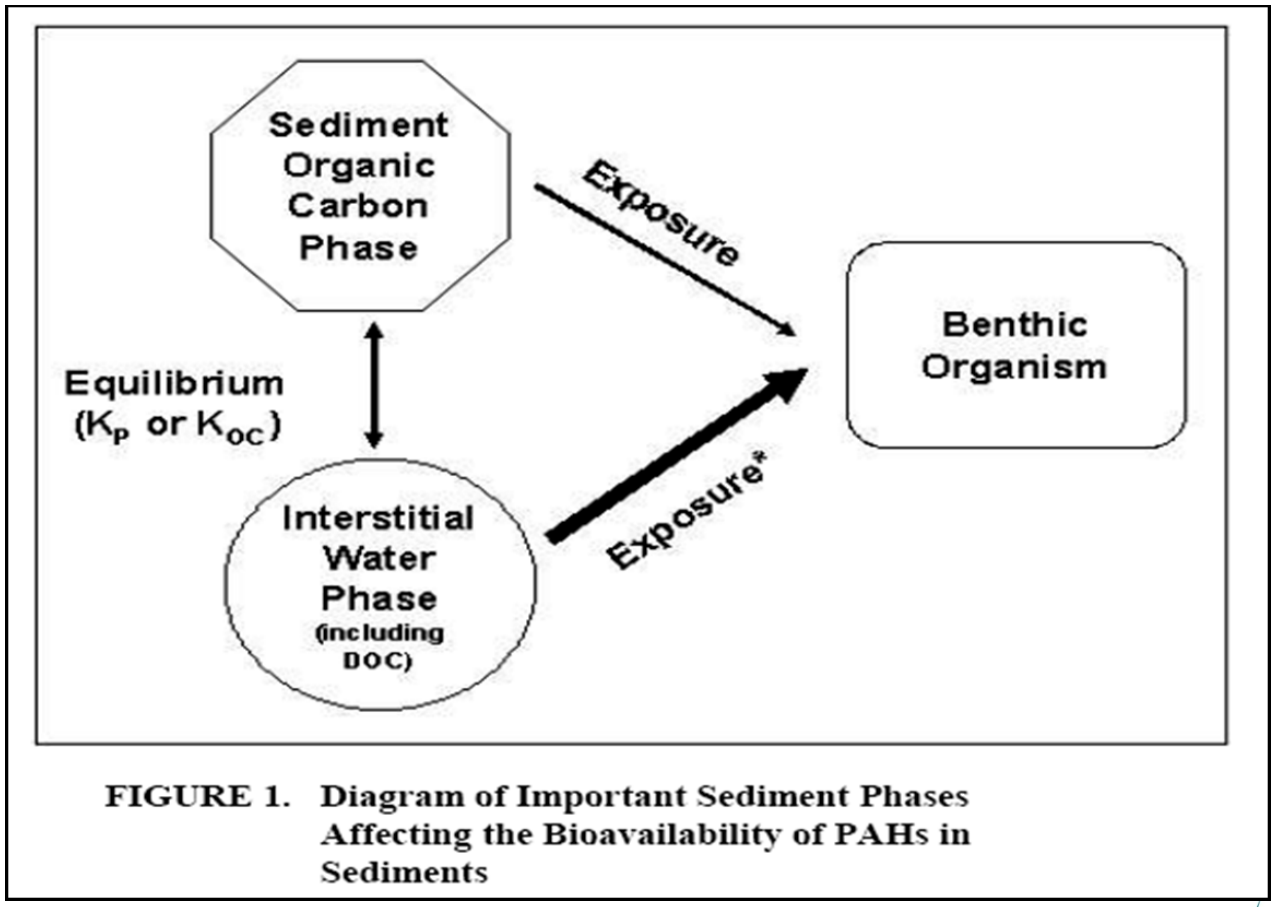

FIGURE 1. Diagram of Important Sediment Phases Affecting the Bioavailability of PAHs in Sediments

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Partitioning cannot be simply modeled – K_{OC} must be measured

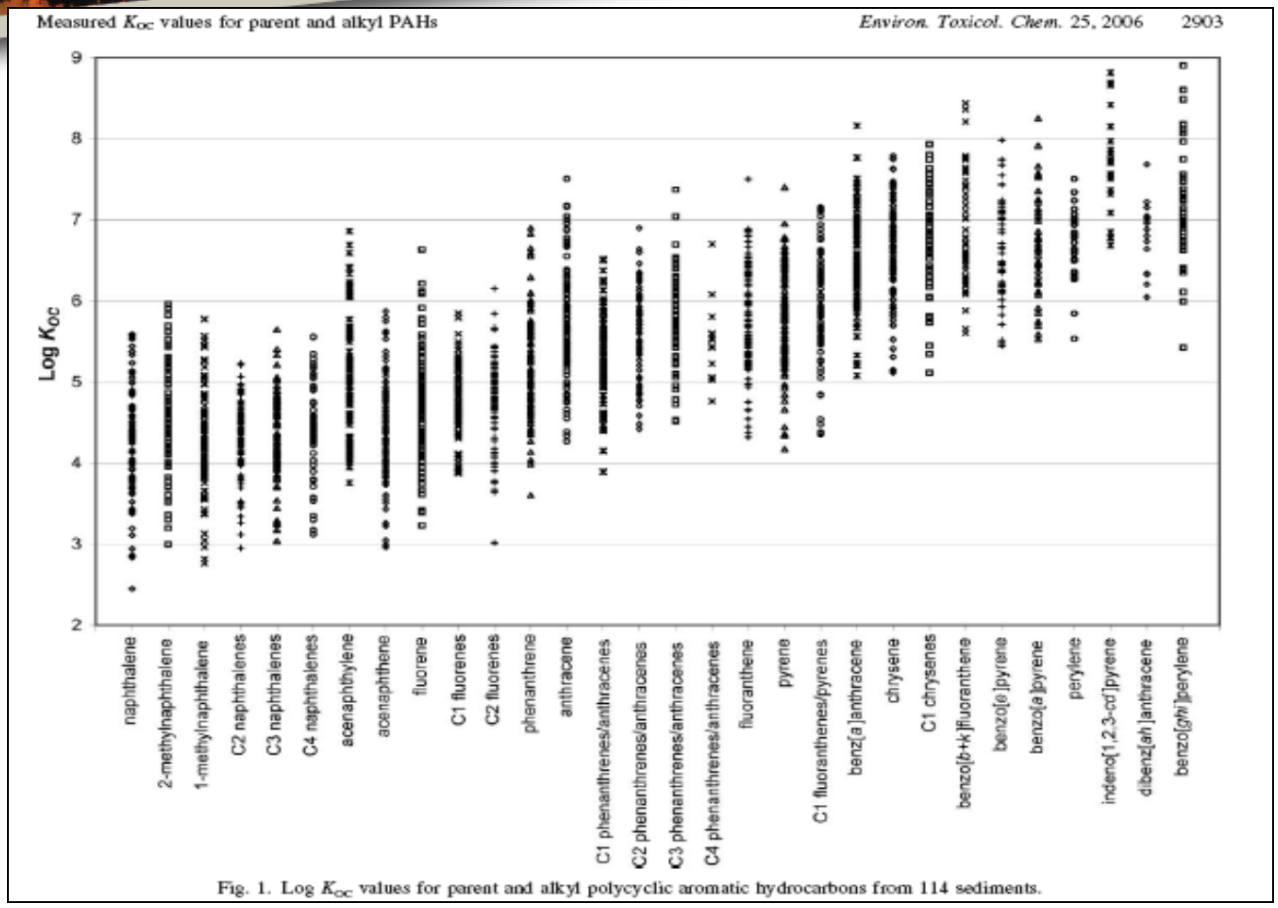

Fig. 1. Log K_{OC} values for parent and alkyl polycyclic aromatic hydrocarbons from 114 sediments.

Hawthorne et al., 2006

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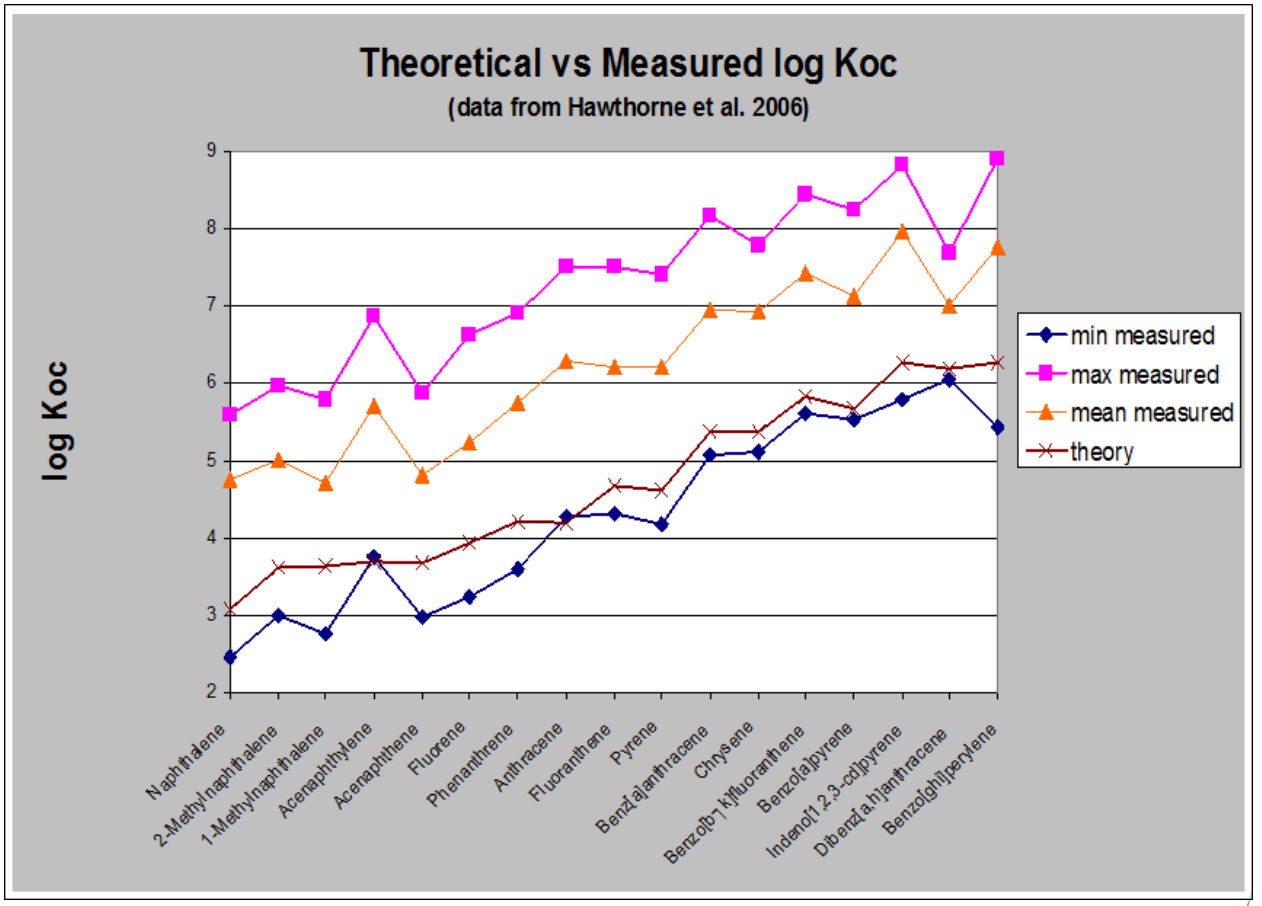
In vitro SPME is better at characterization of dissolved phase



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Passive is better at predicting PAH accumulation by softshell clams

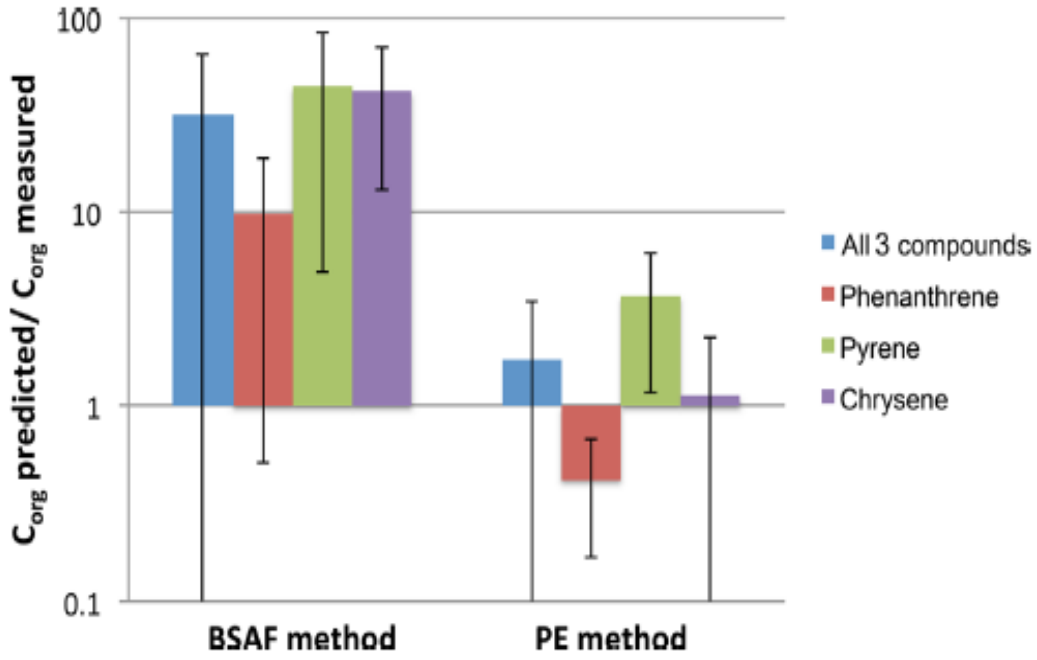

Figure 1. Ratios of concentrations in *Mya arenaria* predicted by biota-sediment accumulation factors (BSAF) or polyethylene (PE) passive sampling methods to those measured in clams from all sites, excluding Island End, where clam and sediments and polyethylene were not colocated ($n = 26$). Colored bars indicate the average of ratios in individual clams ($N = 26$), whereas error bars indicate ± 1 standard deviation of those ratios.

Fernandez, L., Gschwend, P., ET&C (34), 5, 2015

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Progress continues

- Regulators are increasingly recognizing that risk assessments of soil and sediments should account for bioavailability:
- Dutch Soil Quality Assessment Framework
- Ontario Ministry of the Environment (POCIS Study of PPCPs, EDS in Lake Ontario, 2010)
- New Hampshire DES Haz Waste Remediation Bureau Master QAPP includes SOP for Passive Diffusion Bag Sampling for GW. 2012/2015.

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Agencies use forms of passive sampling for regulatory applications

- 2007 -USEPA NRMRL, USEPA Region III, USEPA ORD, USGS, WVDEP, and VADEQ TMDLs for PBTs, developed primarily using passive sampling.
- NYSDEC DER-10 Guidance on conducting acceptable investigations and remediation included PDBs as standard.

Applications in Regulatory Environments

- Palos Verdes Shelf Superfund Site - Region 9 – Part of the Feasibility Study Plan (May 2009) Several publications
- United Heckathorn Superfund Site – Region 9 – Part of the post remediation biomonitoring program
- Sangamo Weston, Inc./Twelve-Mile Creek/Lake Hartwell Superfund Site – Region 4 – SPMDs as part of the Aquatic Biota and Sediment Monitoring program. 2009 (Phase 3)
- Lake Ontario LaMP Program – PISCES samplers used in multiple studies for trackdown of PCB loadings to the lake. USEPA and NYSDEC cooperated mid 90s to early 2000's.

Updates from Palos Verdes

- 2012 ES&T– Fernandez et al. deduced water concentrations from SPME and PE at Palo Verdes Superfund site. Determined that DDX and PCBs exceeded Water Quality Criteria
- Future monitoring to determine the effectiveness of remedial activities.
- 2014 ES&T – Fernandez et al. sediments remain a source of contamination to water column above a pilot sand capped area due to molecular diffusion. (DDX, PCBs in POM, PE)

OSWER Directive 9200.1-110 FS

- December 2012 EPA Published - Guidelines for Using Passive Samplers to Monitor Organic Contaminants at Superfund Sediment Sites – notes passive samplers “are useful new tools for assessing contaminant exposures and evaluating the potential for adverse environmental effects at Superfund sites.”
- “… can provide faster, cheaper, and more scientifically-sound information about the dissolved water column and interstitial water concentrations of hydrophobic organic COC at Superfund sites.”

Closeing thoughts

- Passive sampling is well established in literature, both for exposure assessment and as a potential surrogate for uptake studies
- Guidance is in place for many applications.
- State and USEPA project managers have recognized the value and are applying the approach in multiple regions.
- The validation of passive samplers as a predictor of uptake and exposure has surpassed in several cased the traditional approaches (sediment or water grab sampling and modeling).

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