

Bioavailability Control and In-situ Stabilization of Contaminated Sediments Using Carbon Sorbents

RTDF Sediments Remediation Action Team Meeting
Seattle, Washington, October 29-30, 2002

Upal Ghosh

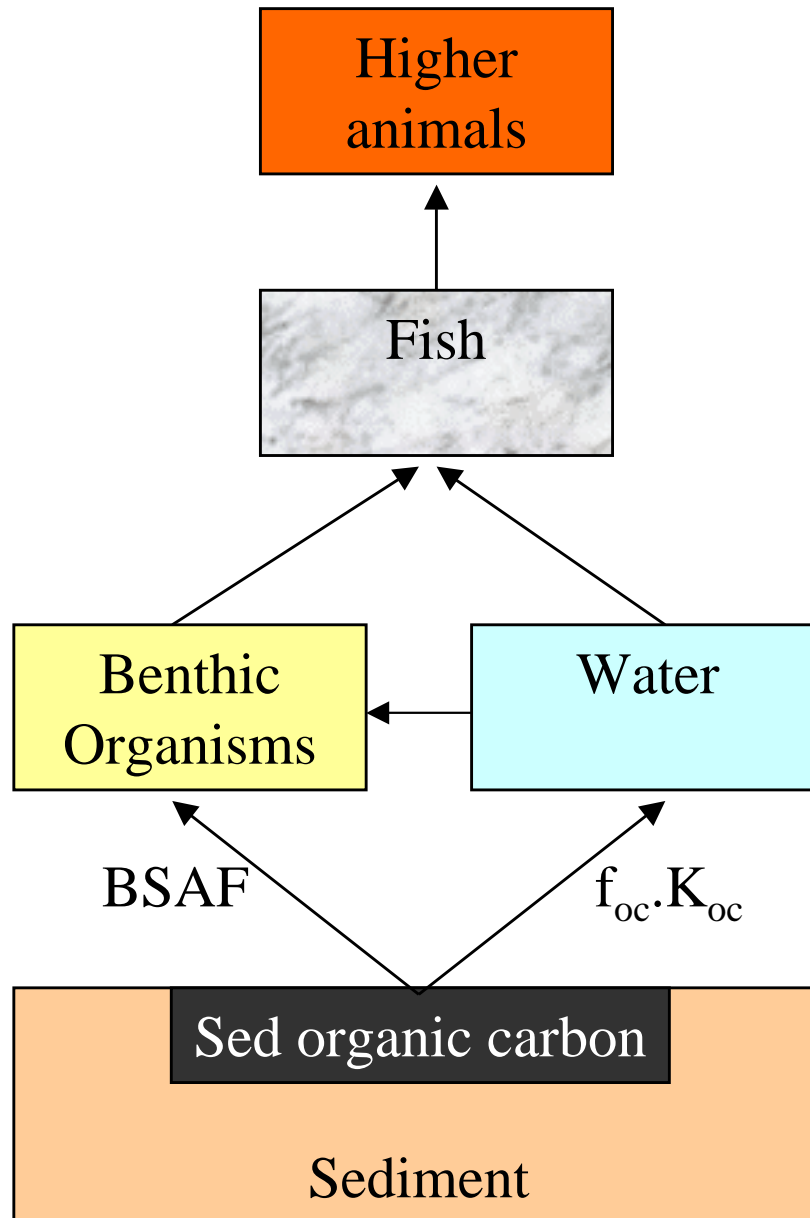
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From Nov 1:

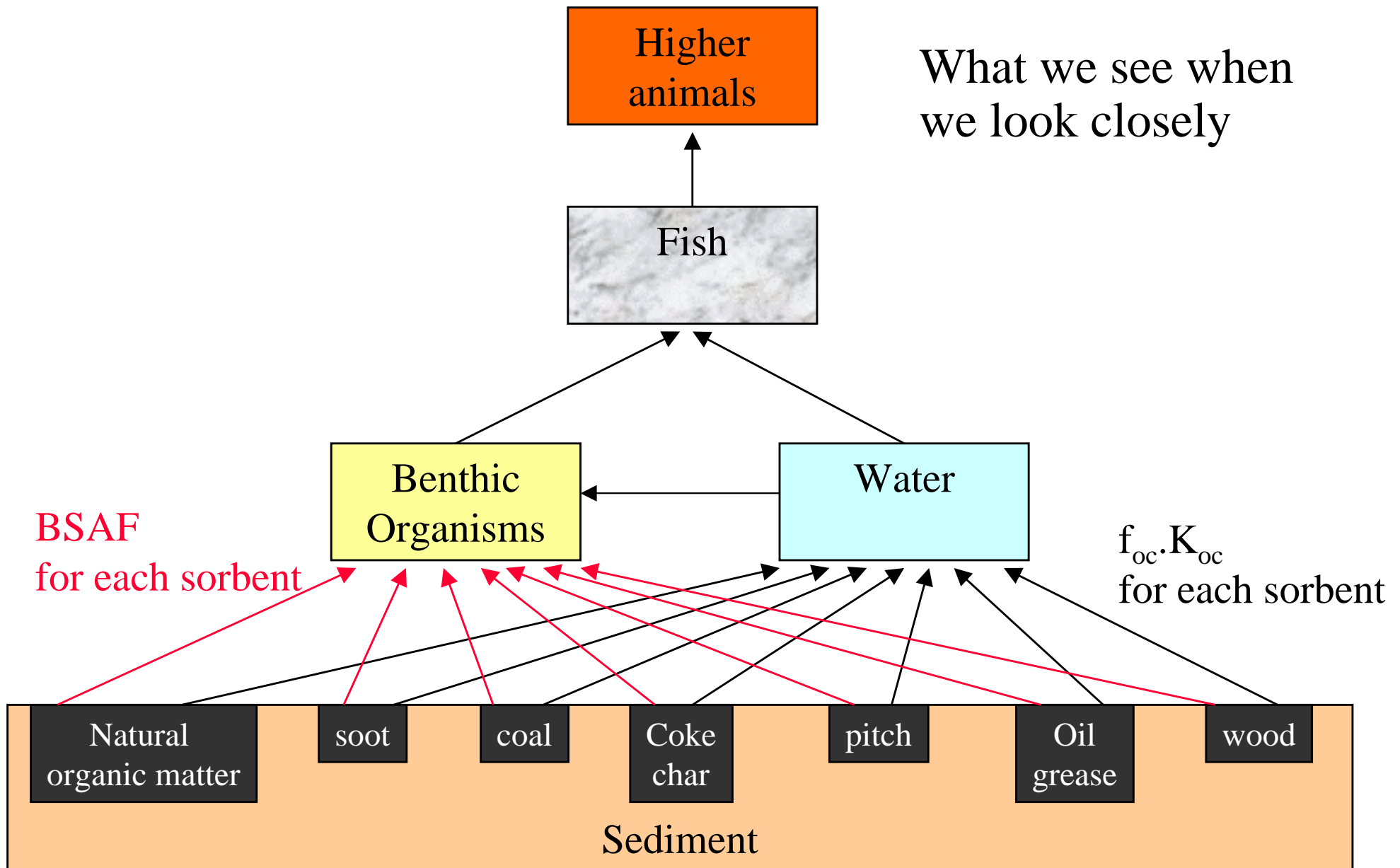
Department of Civil & Environmental Engineering,
University of Maryland Baltimore County, Baltimore, MD

Sediment chemistry and bio-uptake

Traditional view

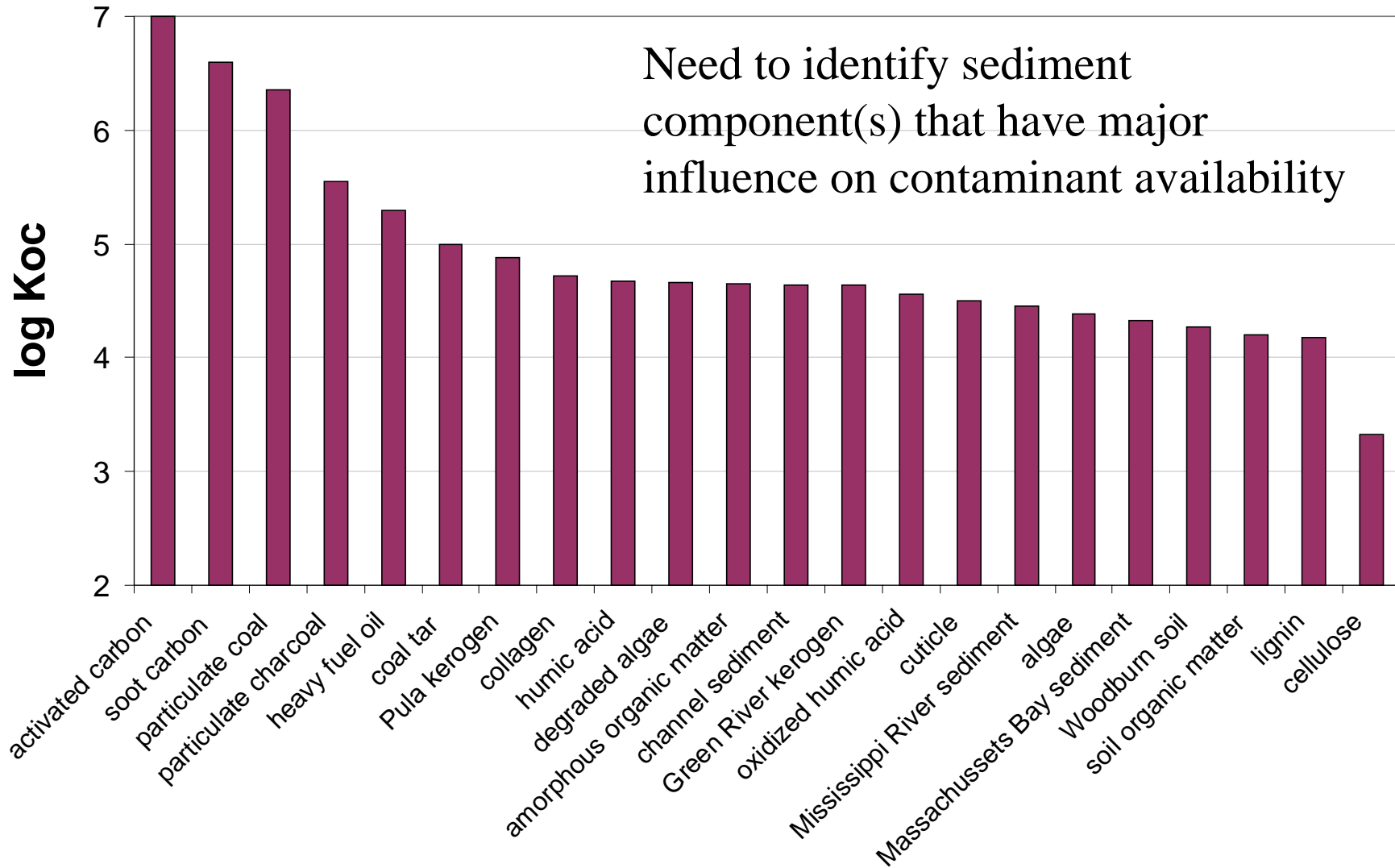


Sediment chemistry and bio-uptake



Sediment-water partitioning of phenanthrene

$$C_s = C_{aq} \cdot K_{oc} \cdot f_{oc}$$



Milwaukee Harbor Sediment



Likely sources of PAHs and coal: coking operations, gas manufacturing, harbor coal transport

Landtreatment to reduce PAH concentrations in CDF sediment

Manufactured Gas Operations Utica, NY circa 1935

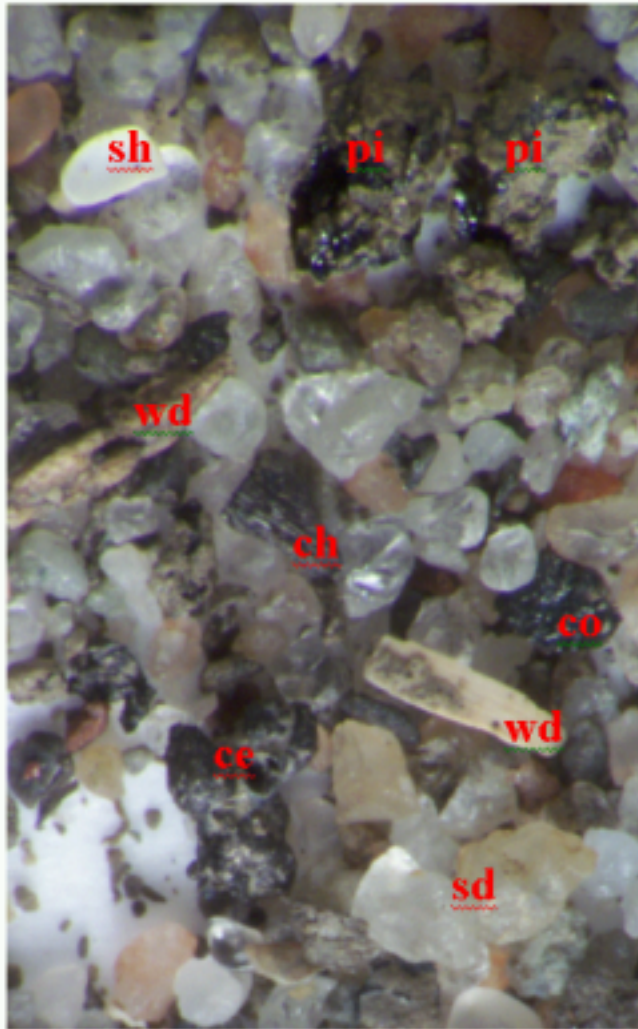


Sediment sampling at Hunters Point

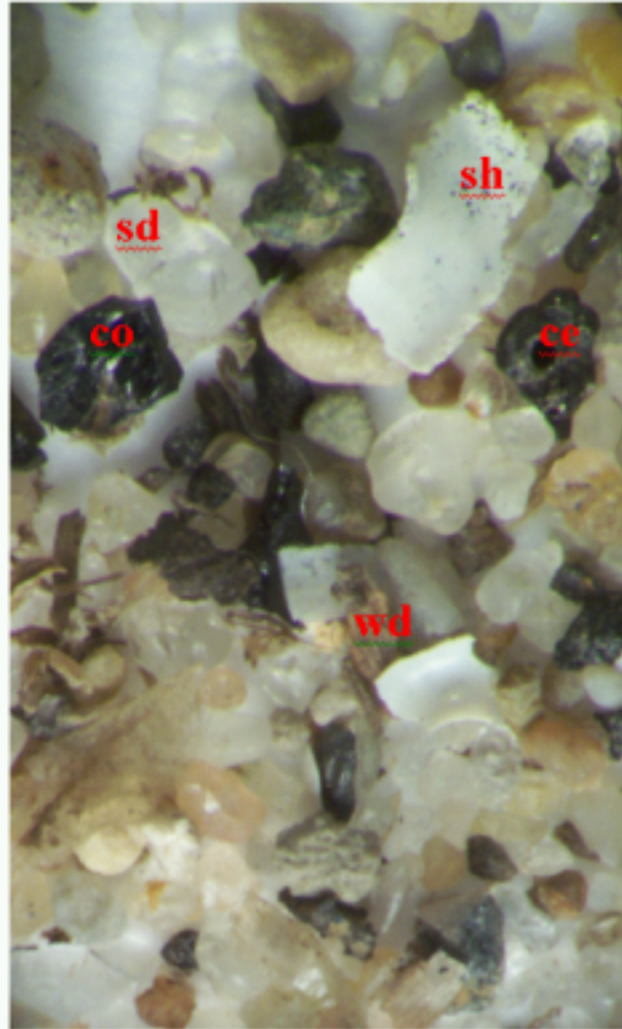


- PCB hot spot in San Francisco Bay
- Samples collected from intertidal zone in south basin

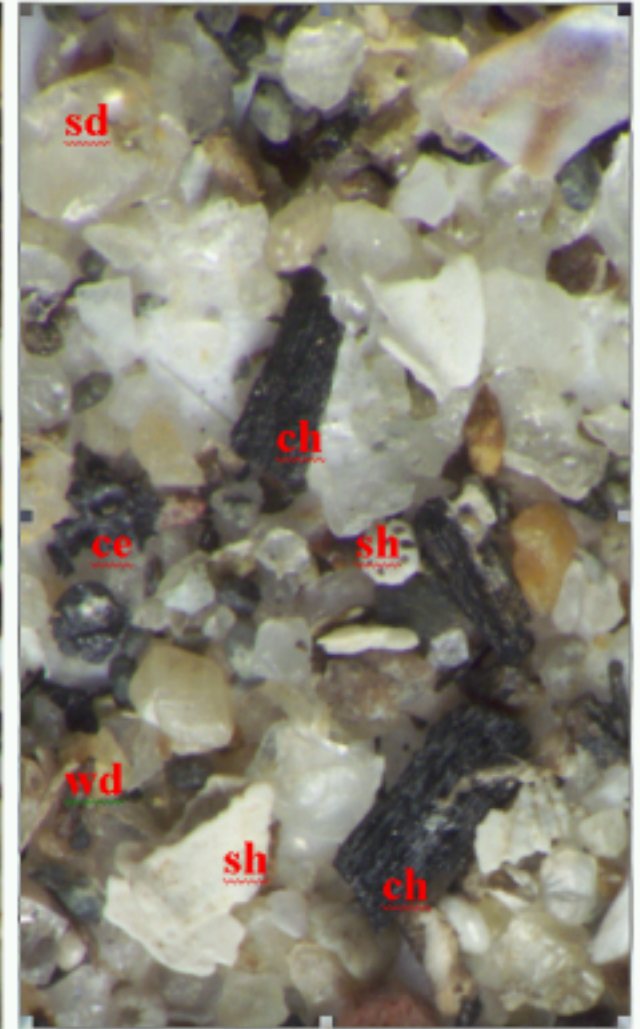
Light microscopy images of sediment particles (250-1000 μ m)



Harbor Point, NY



Milwaukee Harbor, WI



Hunters Point, CA

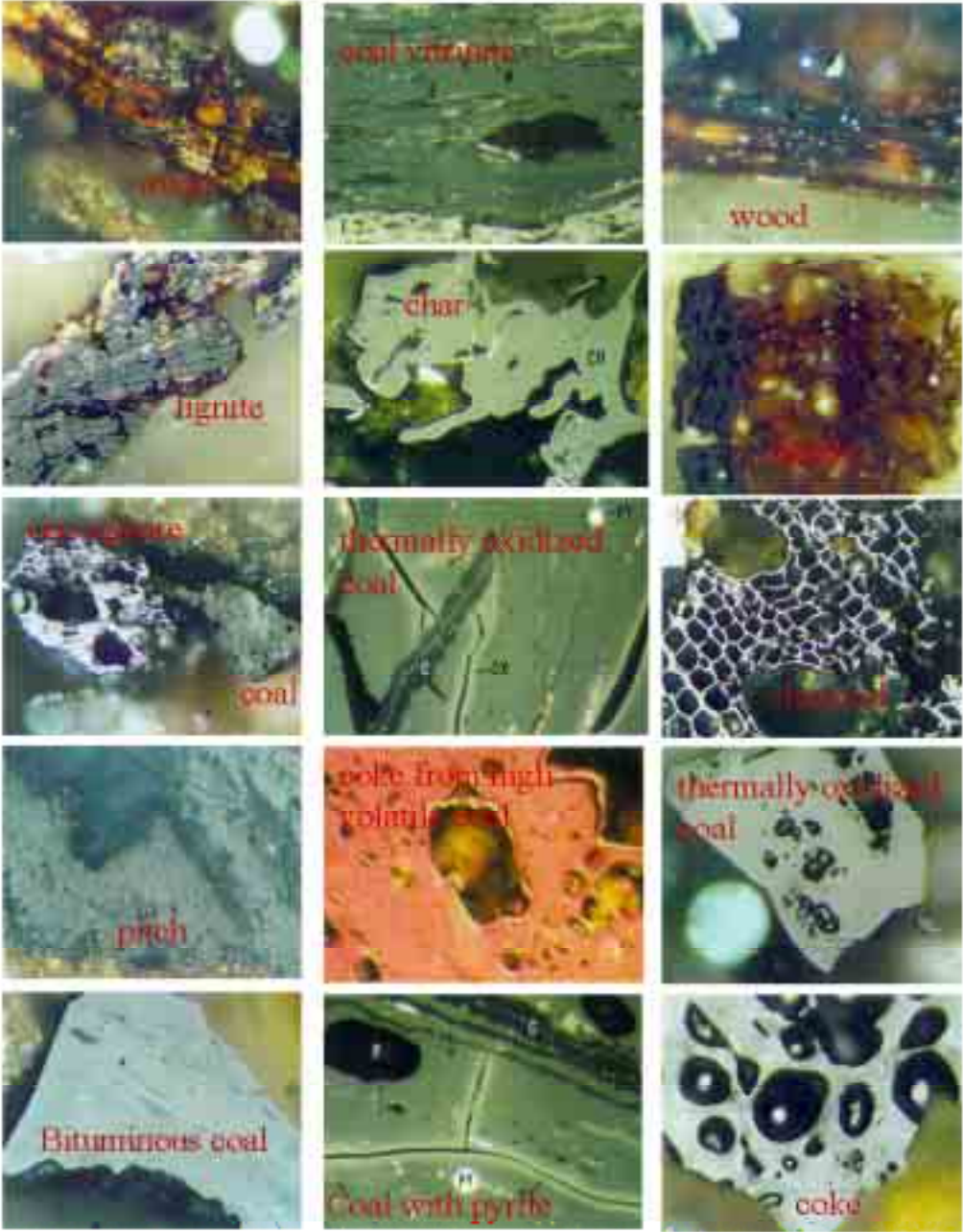
Heavy mineral particles:

sand (sd), silt, clays

Light organic particles:

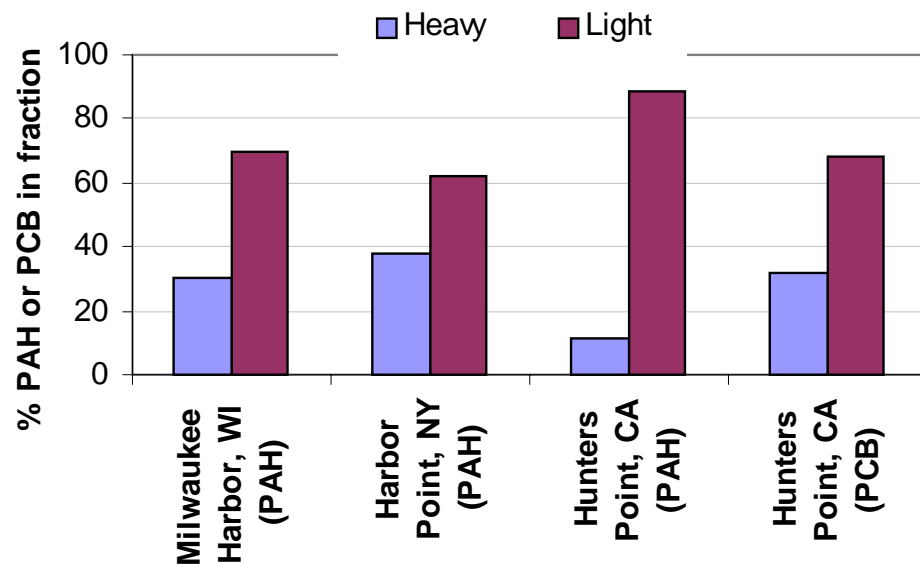
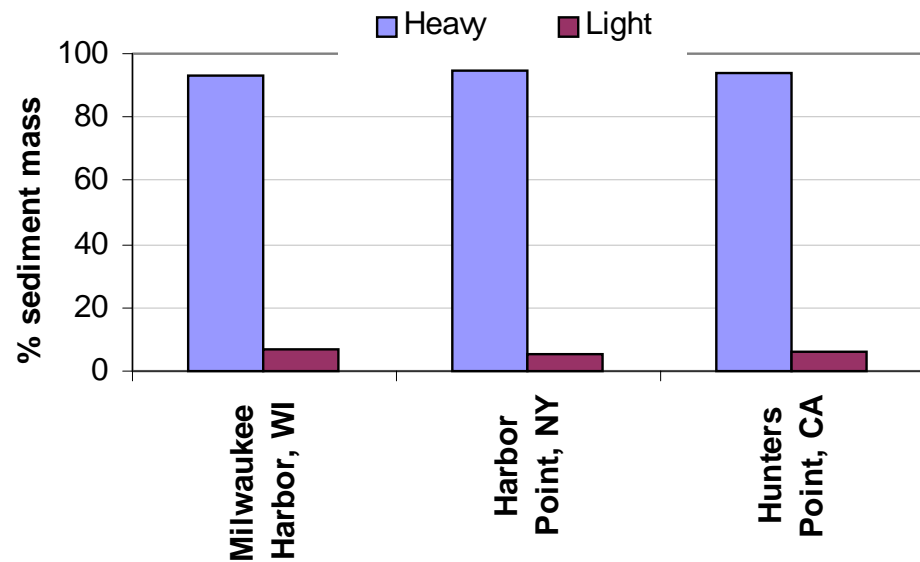
coal (co), cenospheres (ce), charcoal (ch), pitch (pi),
wood (wd),

Petrography analysis of organic particles



Harbor Point, NY Milwaukee Harbor, WI Hunters Point, CA

Distribution of PCB/PAH in sediments



Three sites show 5-7% wt. lighter density carbonaceous matter (coal/charcoal/wood)

PCBs and PAHs associated with lighter density fraction (60-90%)

Lesson:

Over time PCBs [and PAHs] preferentially accumulate in coal/charcoal/coke where they are strongly bound and less bioavailable

See:

Ghosh et al., 2000, *ES&T*, 34, 1729-1736

Ghosh et al., 2001, *ES&T*, 35, 3468-3475

Talley et al., 2001, *ES&T*, 36, 477-483.

Our experimental strategy:

- PCB/PAH particle-scale measurements
- PCB flux and aqueous equilibration
- Mass transfer of PCB/PAH to sorbent and binding energy
- PCB bio-uptake:
 - Three organisms: amphipod, worm, and clam
 - Two sorbents: coke and regenerated activated carbon
 - Variables: dose, contact time, particle size
- Sorbent type & PCB assimilation efficiency by clams
- Organism survival, growth, reproduction, stress

Link chemistry and bio-uptake



- *Hypothesis:* The bioavailability of PCBs, PAHs, & DDT, depends on particle type to which they're bound
- Can we change PCB bioavailability?
- New strategy for sediment management by in situ stabilization

Benthic organisms in Hunters Point sediment accumulate PCBs

Sediment-sorbent contact



- Sediment-sorbent contact experiments to assess effect of particle size, dose, and contact time on PCB availability
- Sorbent dose: 2x & 5x TOC
- Sorbent size: 100-250 μm & 63-100 μm
- Contact time: 1 month & 6 months

Bioaccumulation studies



Macoma Balthica



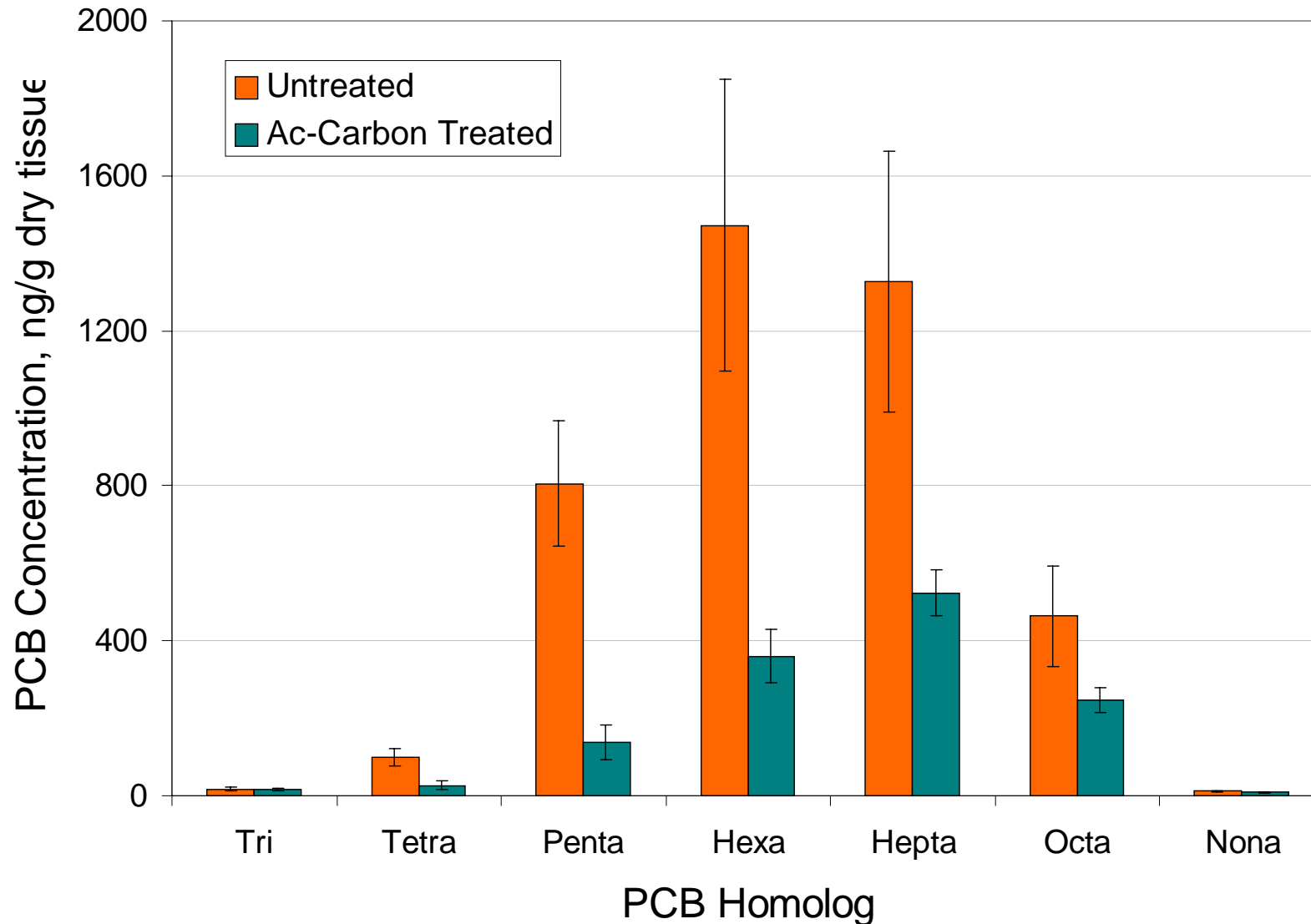
Neanthes arenaceodentata



Leptocheirus plumulosus

- Survival, growth, reproduction, activity
- PCB bioaccumulation

PCB Bioaccumulation in Clams



Overall reduction in PCB bioaccumulation after 1 month contact with Ac. Carbon:
Macoma: 69%
Leptocheirus: 72%

Aqueous equilibrium tests

Measure PCB equilibrium concentrations for untreated and various sorbent-treated sediments:

- 17 ppt seawater + sodium azide
- contact 14 days on bottle roller
- flocculate colloids with alum and centrifuge

3.4 wt% activated carbon:

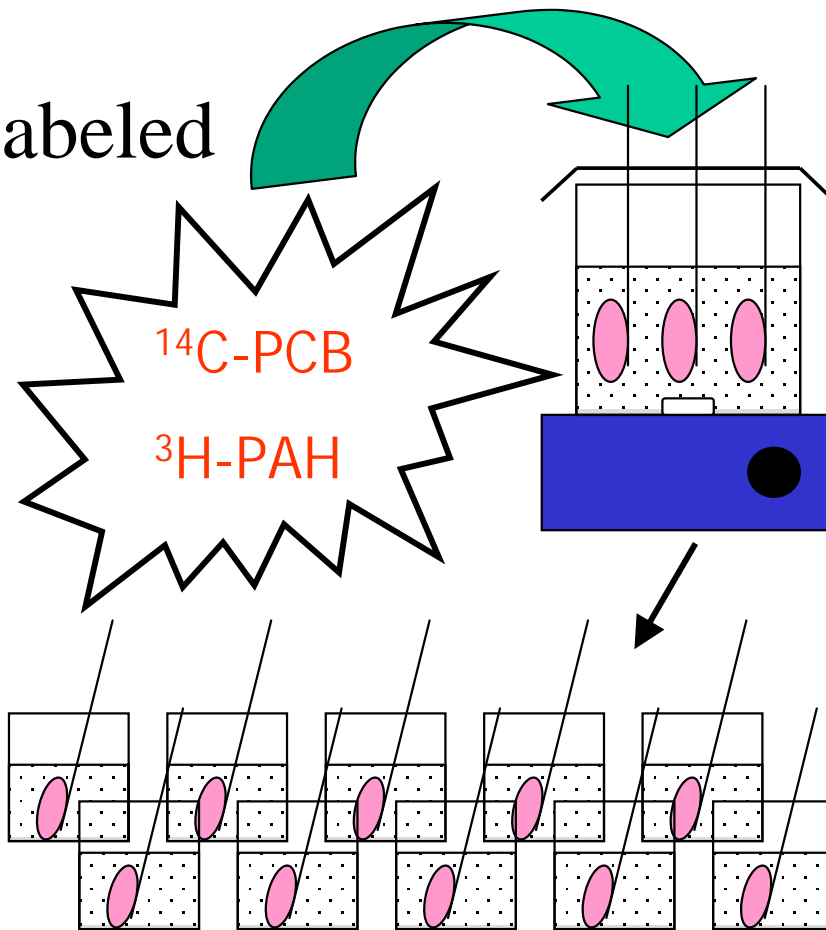
86% reduction in aqueous PCBs



**Alum-flocculation to
remove colloids
(Ghosh et al., ES&T 2000)**

Controlled particle feeding tests: assimilation efficiency

Prepare labeled
particles



Feed clams

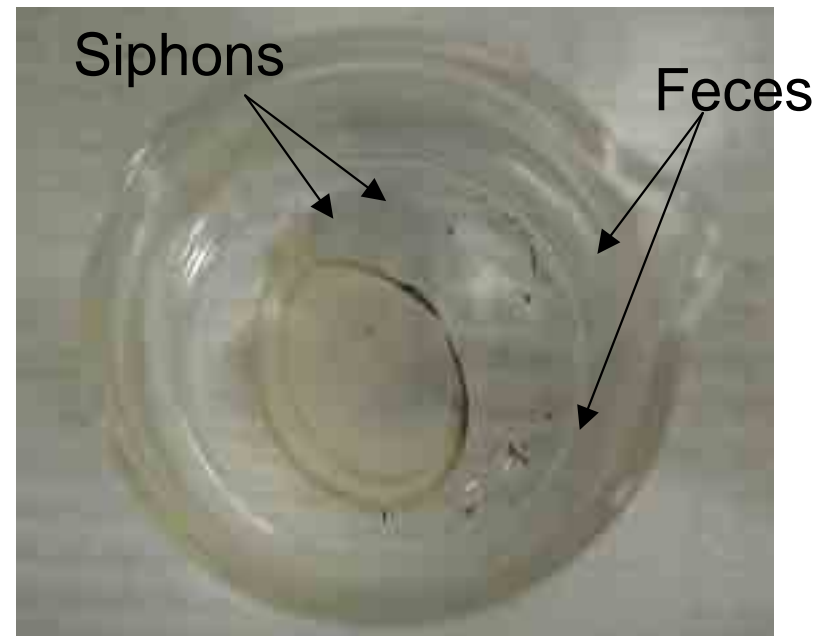
Depurate and analyze
clam tissue and feces

Depuration beakers

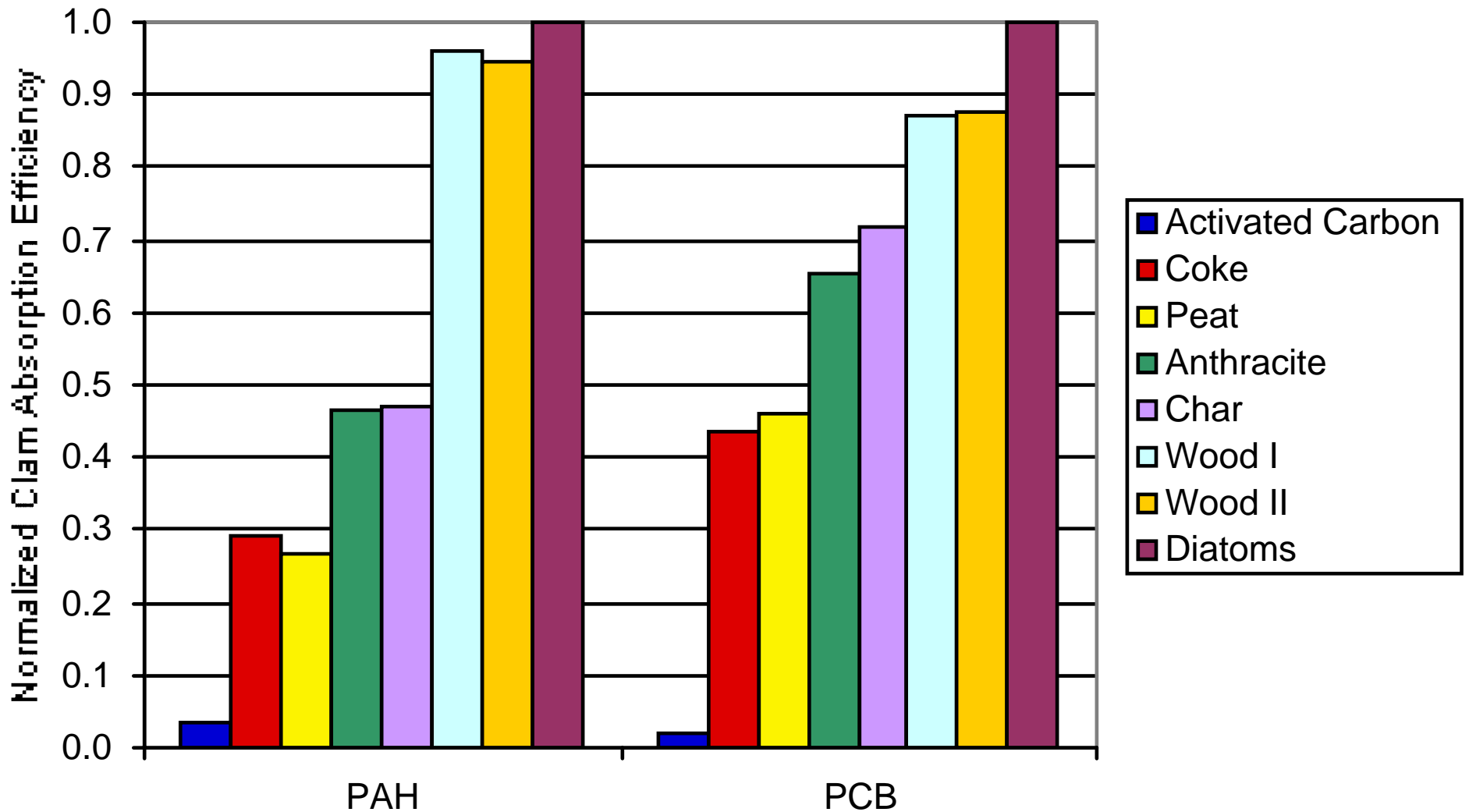
Clam assimilation studies



- Track ^3H -BaP and ^{14}C -2,2',5,5' PCB through a clam
- Feed 8 hours
- Depurate 4 days
- Analyze clam tissue and feces



Assimilation efficiency



Acknowledgements!



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University of Maryland Baltimore County

- Founded in 1966
- Newsweek's top 12 Hot College list for 2003



Engineering Research Center, CEE dept.



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