A Perspective from the Clyde Estuary, Scotland

Sediments in A Changing Environment: 7th International SedNet workshop, Venice 6th April 2011

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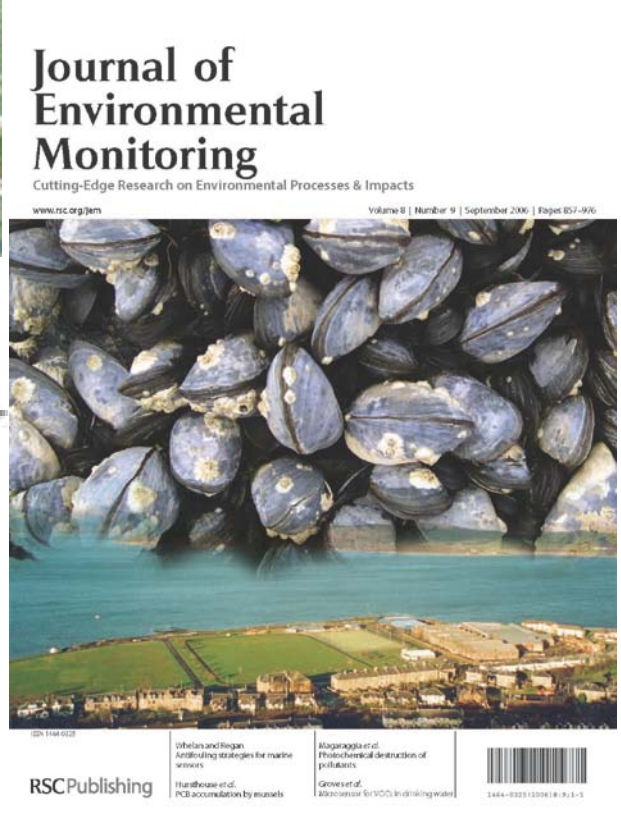
- **Q1. predicting potential impact: storage (and remobilisation) of sediment & associated contaminants in e.g. the intertidal region?**



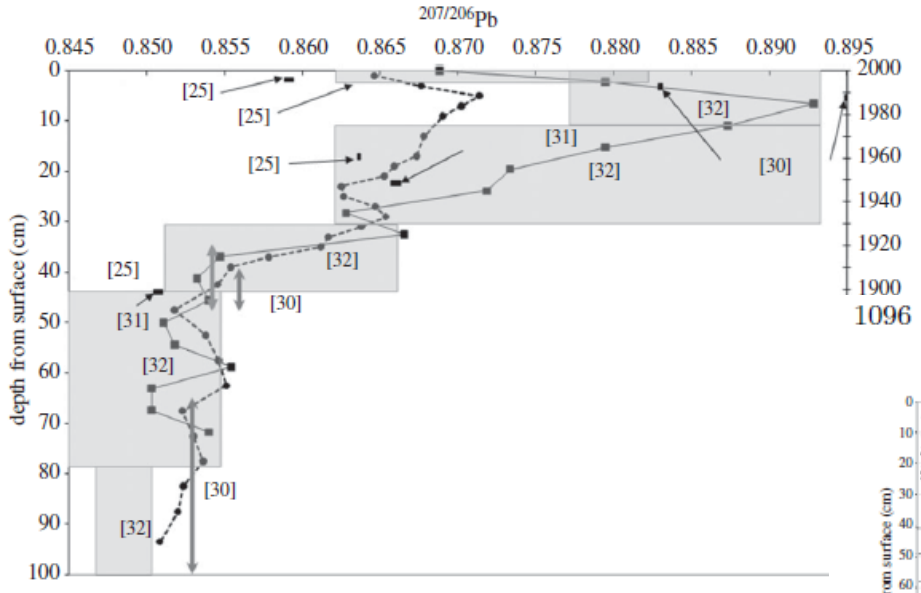


Figure 5. A composite historical $^{207/206}$Pb isotope profile of Scottish moss [16] with time-resolved data for Scottish peat [30,31,33] and lake sediment [32] compared with a core log from the Clyde estuary. Filled circles, core 4B; filled squares, Scottish moss.

Vane et al, *Chemical signatures of the Anthropocene in the Clyde estuary, UK: sediment-hosted Pb, Pb-207/206, total petroleum hydrocarbon, polyaromatic hydrocarbon and polychlorinated biphenyl pollution records,* PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A-MATHEMATICAL PHYSICAL AND ENGINEERING SCIENCES 369 (1938) , 1085-1111 , 2011

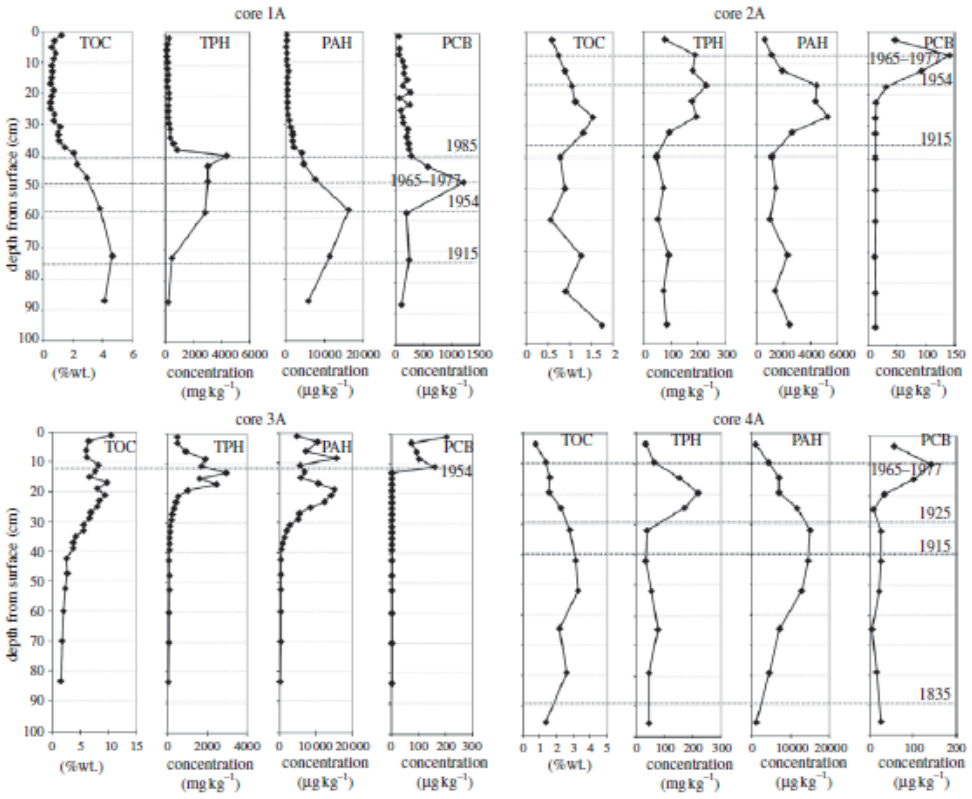
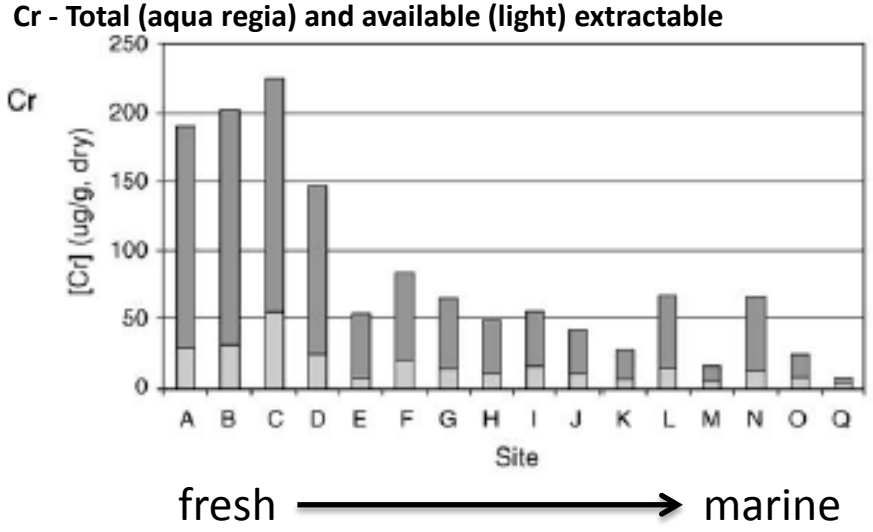


Figure 6. Organic contaminant depth profiles of sediments from Clyde estuary. Abbreviations: TOC, total organic carbon; TPH, total petroleum hydrocarbons; PAH, polyaromatic hydrocarbons; PCB, polychlorinated biphenyls. Rationale for dates: 1750 = pre-industrial from $^{207/206}$Pb; 1915 = peak coal production; 1954 = onset of PCB production in UK; 1965–1977 = peak PCB production; 1985 from peak $^{207/206}$Pb values. PCB concentration data not shown for core 7A due to interferences.

2 dimensions: contaminant distribution

Assess historical contribution – record exists?

Potential for release related to depth?



3 dimensions: Estuary trends

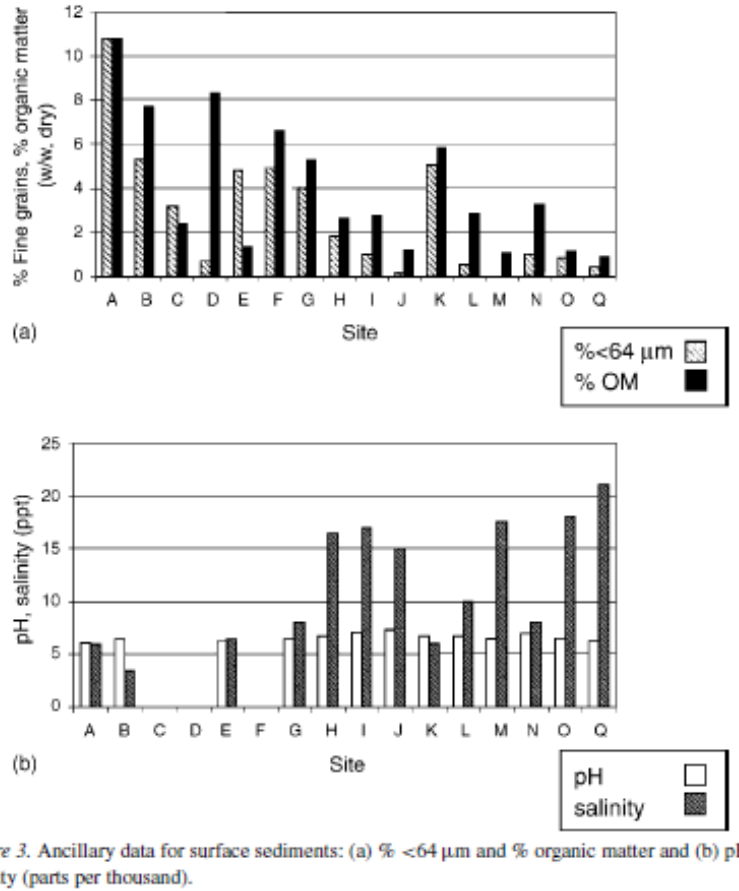
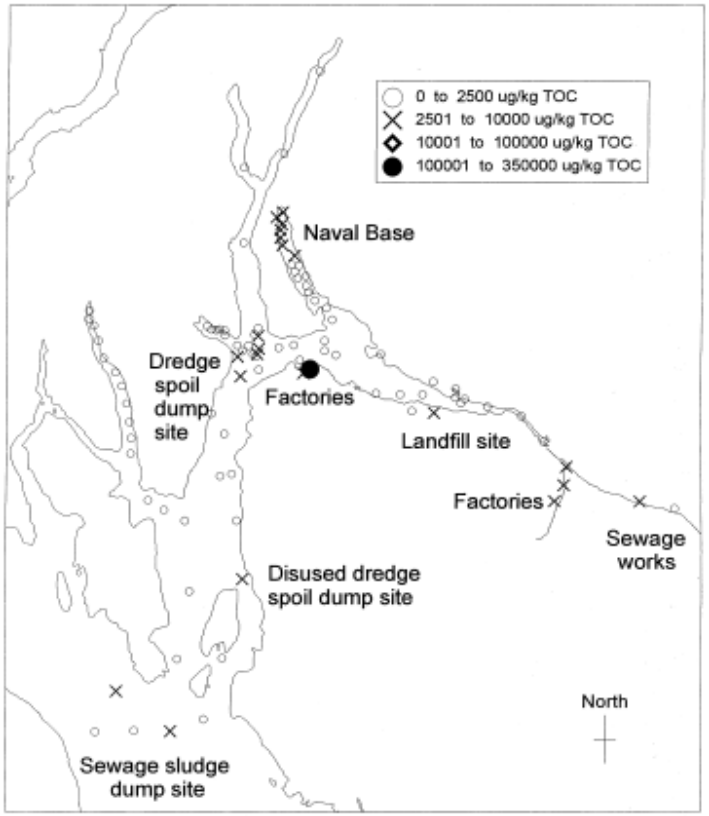


Figure 3. Ancillary data for surface sediments: (a) % <64 µm and % organic matter and (b) pH and salinity (parts per thousand).

- Release under redox / pH change?
- Where/when?
  - Estuary morphology in relation sediment disturbance



21 CB congeners = CB 31, 28, 52, 49, 44, 74, 70, 101, 110, 149, 153, 105, 138, 158, 187, 128, 156, 157,180, 170 and 189

Fig. 3 Sum of 21 CB congeners normalised to the proportion of TOC.

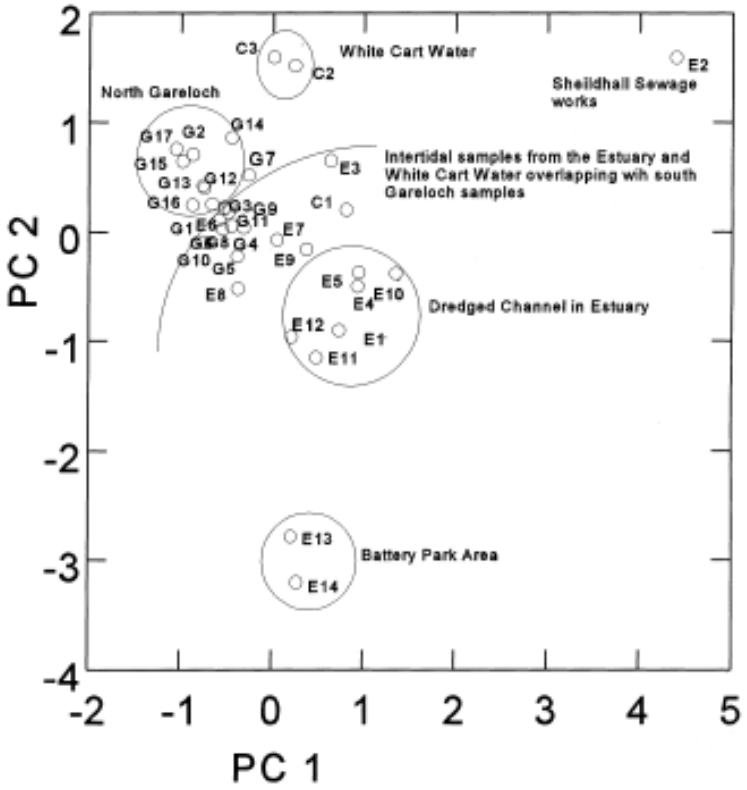


Fig. 6 Principal Component Plot for the Clyde Estuary and the Gareloch samples.

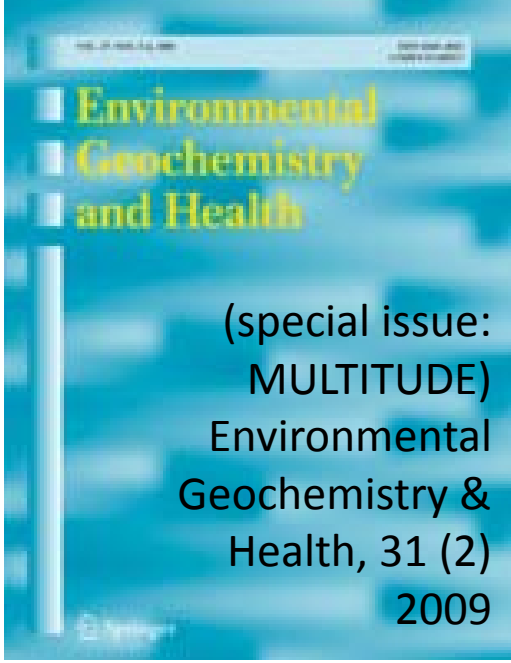
Source identification - historical or active

.....4 dimensions?

Q2. what factors enhance the mobility of aged contamination in recovering estuarine systems - under changing flow regimes (and all that entails)

- Sediment exposure, re-suspension;
  - Flow regimes – change in patterns, seasonal shift
    - Wetter? More turbulent??
  - Redox cycles – understand impact of pore water/surface water exchange = mass transfer processes, role of oxides
  - Mixing/Cohesion from biological activity
  - Effects on metals v pops differs – photolytic degradation, redox sensitivity
  - Natural organic matter & new sediment inputs – terrestrial/aquatic

Q3. have emerging pollutants "emerged" (what substances should we really worry about in sediment toxicity)?



(special issue: MULTITUDE) Environmental Geochemistry & Health, 31 (2) 2009

e.g. 33 (+ 8) priority substances

(Annex II of the Directive 2008/105/EC - environmental quality standards in the field of water policy)

Metals

POPs

Nanomaterials

Personal care products,

Pharmaceuticals & drugs of abuse

.....(real) priority substances?

(real) priority substances:
are we looking...? ....should we be?

Table 4 – Occurrence of the substances observed in stormwater (in percentage, $n = 6$).

Never		Rarely	Fairly	Often	Reccurent	
0		[0–25]	[25–50]	[50–75]	[75–100]	
Cadmium[a]	4-chloro-3-methylphenol	Pentachlorophenol[b]	Chromium	Isoproturon[b]	Tributyltin[a]	Benzo[g,h,i]perylene[a]
Mercury[a]	Pentabromodiphenylether[a]	4-(para)-nonylphenol[a]	Desethylatrazine	Glyphosate	Dibutyltin	Indeno[1,2,3-cd]pyrene[a]
Nickel[b]	Octabromodiphenylether	4-n-octylphenol			Monobutyltin [MBT]	PCB28
Platinum	Decabromodiphenylether	Metaldehyde			Lead[b]	PCB52
PCB194	Alachlor[b]				Copper	PCB101
Hexachlorobenzene[a]	Aldrin				Zinc	PCB118
Pentachlorobenzene[a]	Endrin				Naphthalene[b]	PCB138
1,2,4-trichlorobenzene[b]	Dieldrin				Acenaphthene	PCB153
1,2,3-trichlorobenzene[b]	DDT-2,4′				Acenaphthylene	PCB180
1,3,5-trichlorobenzene[b]	DDT-4,4′				Fluorene	methylene chloride[b]
Benzene[b]	Isodrin				Phenanthrene	Nonylphenols[a]
Ethylbenzene	Endosulfan alpha[b]				Anthracene[b]	para-tert-octylphenol[b]
Isopropylbenzene	Endosulfan beta [b]				Fluoranthene[b]	4-ter-butylphenol
Toluene	Lindane[a]				Pyrene	Diuron[b]
Xylenes (Sum o,m,p)	alpha Hexachlorocyclohexane[a]				Benzo[a]anthracene	Aminotriazole
1,2-dichloroethane [b]	Chlorfenvinphos [b]				Chrysene	AMPA
Hexachlorobutadiene [a]	Chlorpyrifos[b]				Benzo[a]pyrene[a]	Di(2-ethylhexyl)phtalate[b]
Chloroform[b]	Trifluralin[b]				Benzo [k]fluoranthene[a]	
Carbon tetrachloride[b]	Atrazine[b]				Benzo [b]fluoranthene[a]	
Tetrachloroethylene[b]	Desethylsimazine				Dibenzo[a,h]anthracene	
Trichloroethylene[b]	Simazine[b]					
C10–C13 chloroalkanes[a]						

a Priority hazardous substance.
b Priority substance.

e.g. 88 candidates from urban storm water runoff, Paris

Zgheib, et al, *Partition of pollution between dissolved and particulate phases: What about emerging substances in urban storm water catchments?* WATER RESEARCH, 45(2) p913, 2011

- **Q1. Storage?**
  - Quantification of stored substances in system
  - Fixed?
- **Q2. Mobilisation?**
  - What will change (major parameters and scenarios for site specific locations..... v regional/global trends)
- **Q3. Substances?**
  - Do the traditional pollutants cover the real hazard?
  - Do we understand impact of “common” pollutants (AND mixtures) well enough?

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