Trace element, PAH and nutrient distributions in waters affected by the Deepwater Horizon oil spill

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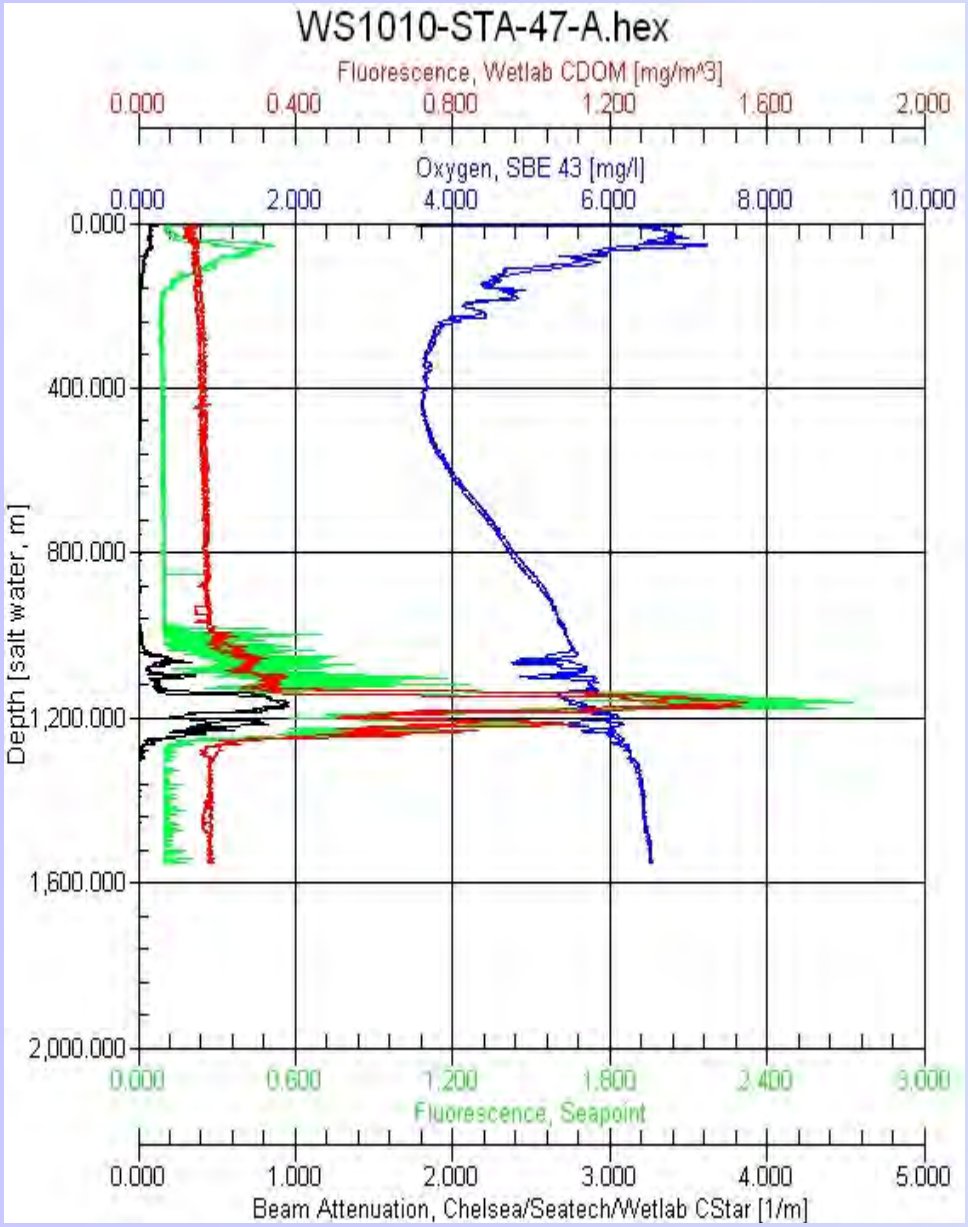
Photo by Arne Diercks

Three Cruises

- Deepwater Horizon explosion: April 20
- R/V Pelican…..early May
- R/V Walton Smith…..late May
- Leak stopped: July 15
- R/V Cape Hatteras…..mid Oct



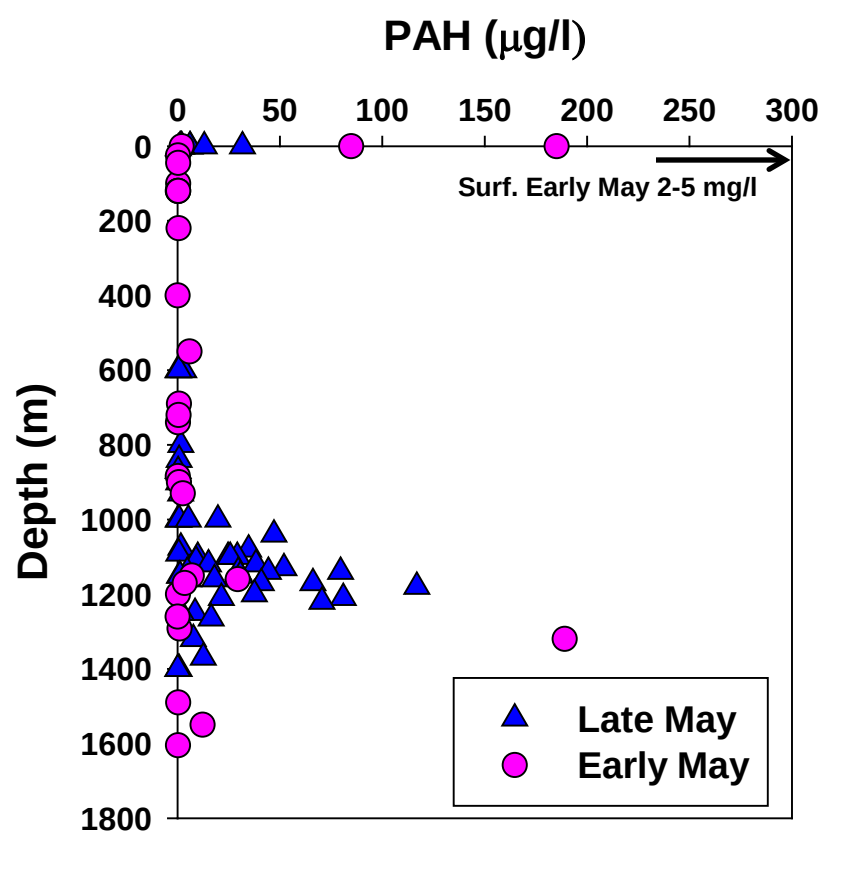
-Sampling depths- elevated CDOM & beam attenuation signals; O_2-depletion.

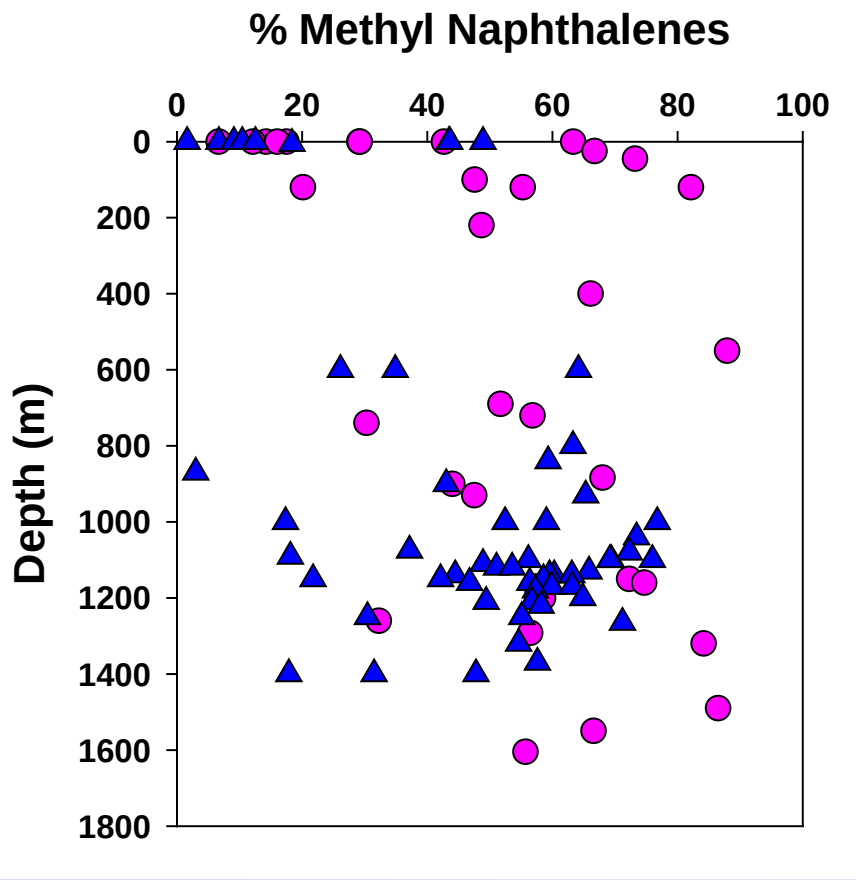
-Metals, nutrients, DOC- 0.45 µm pore size filters

-PAH- no filtration

Polycyclic aromatic hydrocarbons (PAH's)

Macondo well source: ~50% of PAH's were methylnaphthalenes.

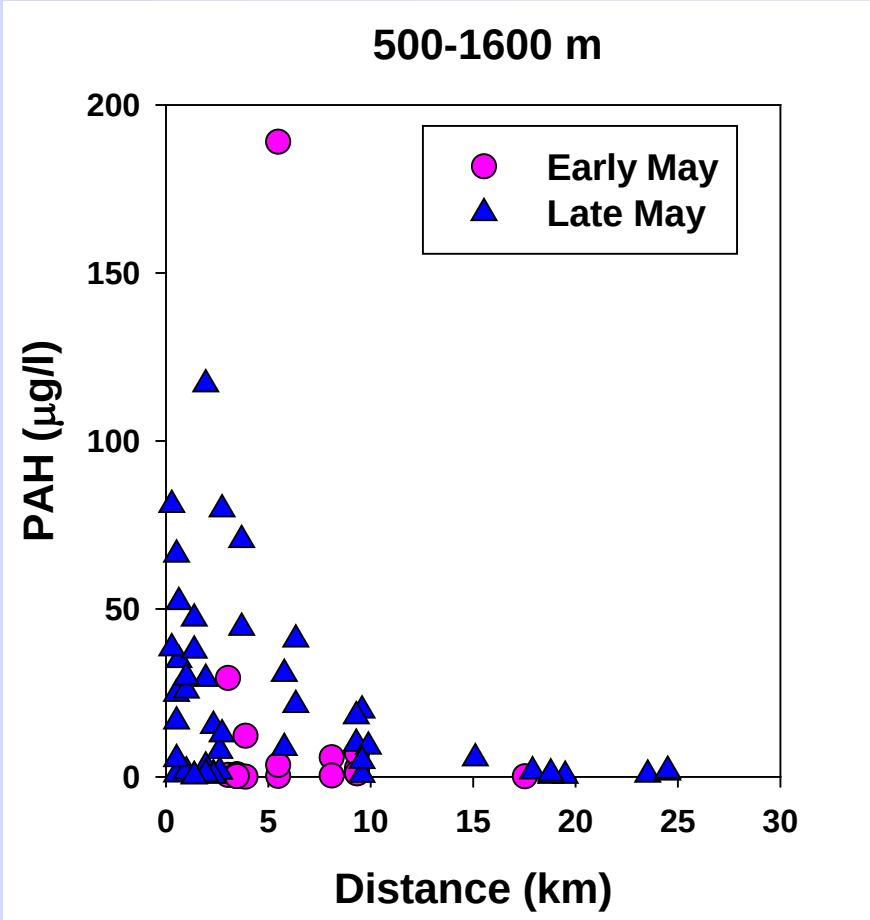


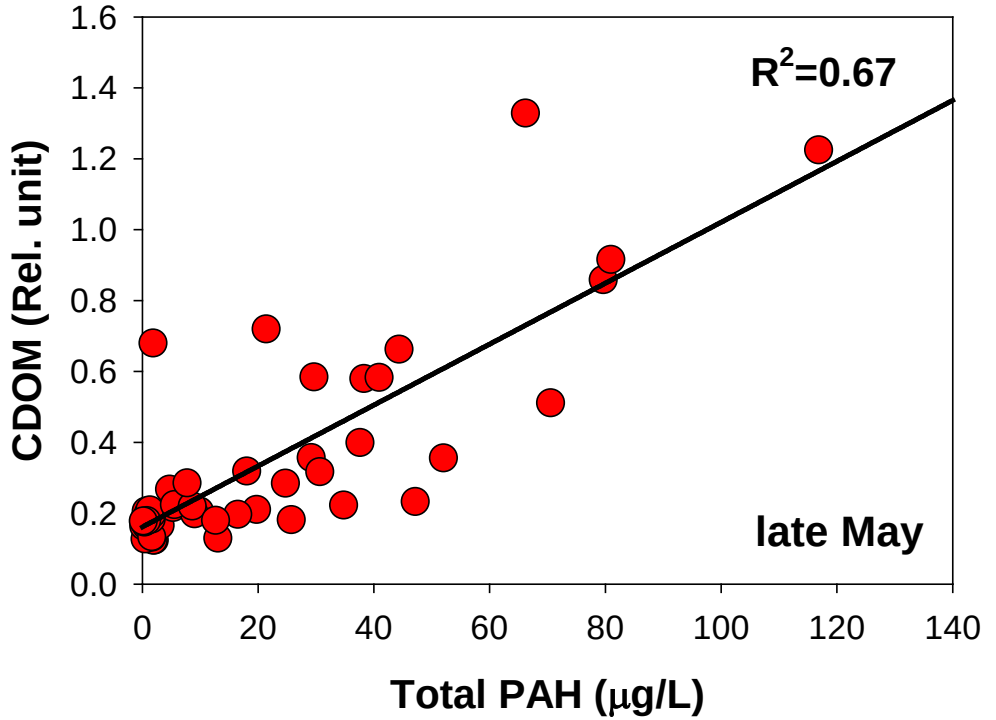


R/V Pelican cruise (Diercks et al., 2010)

PAH's

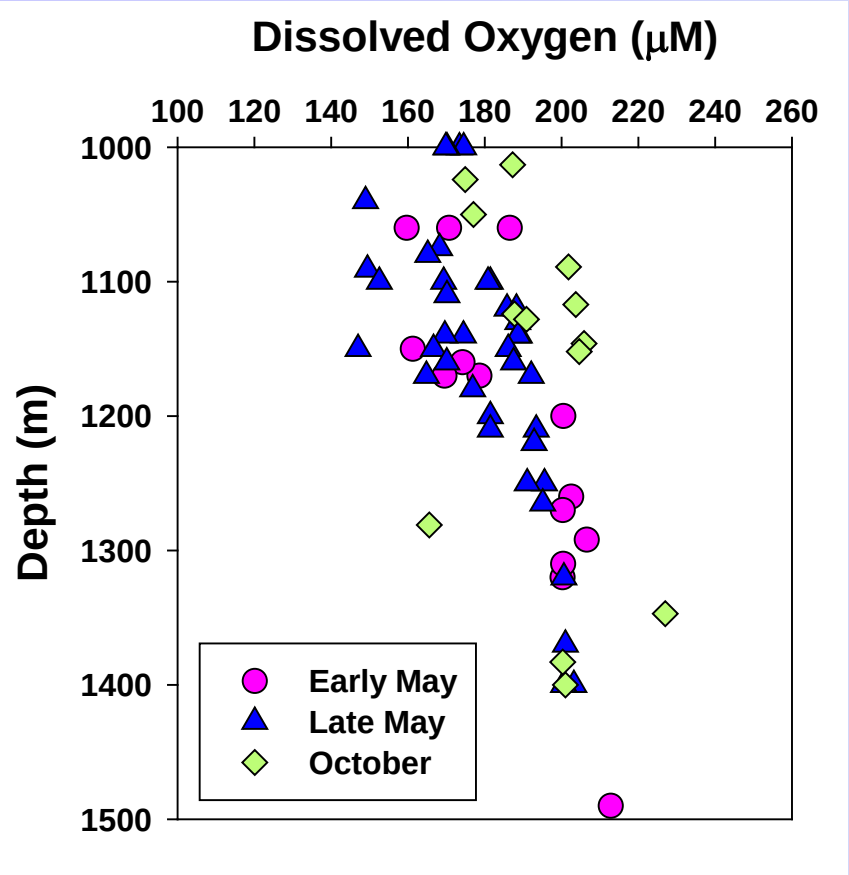
Physiological effects on embryonic & larval marine fish reported at < 5 µg/L.

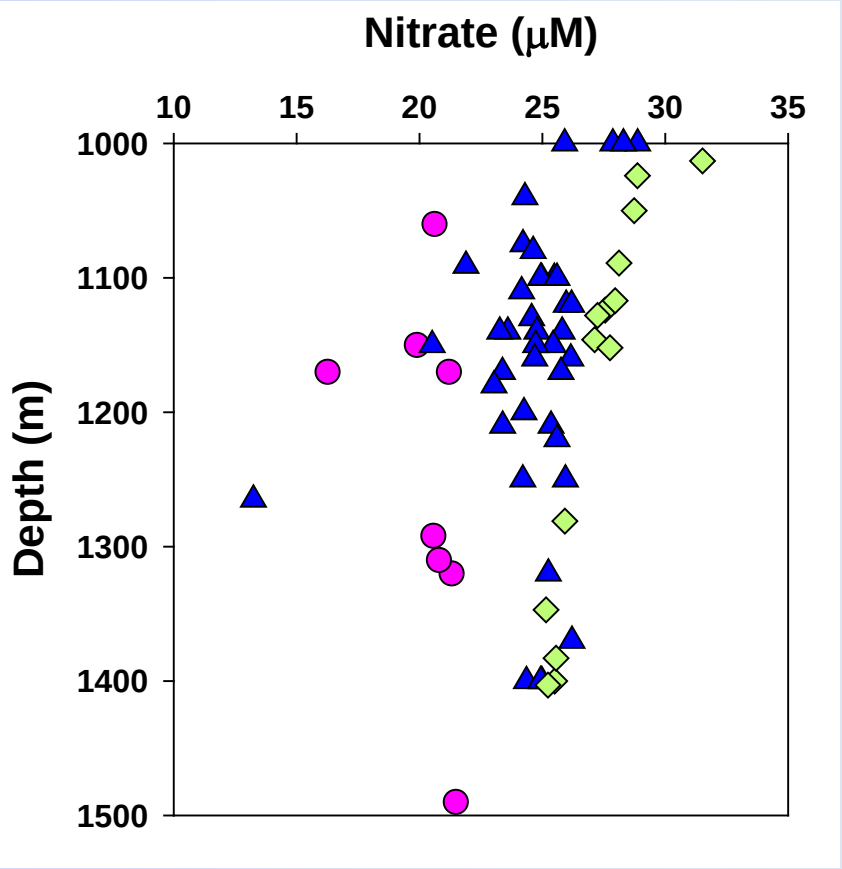




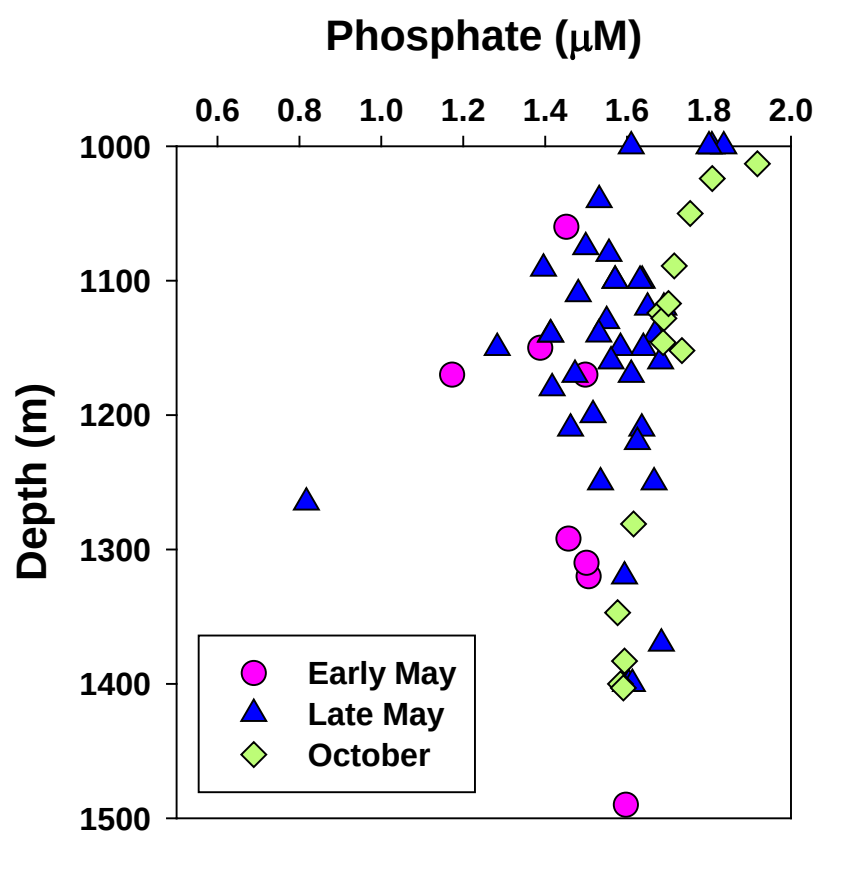
In situ CDOM > 0.2 (Rel. unit) indicative of levels above background.

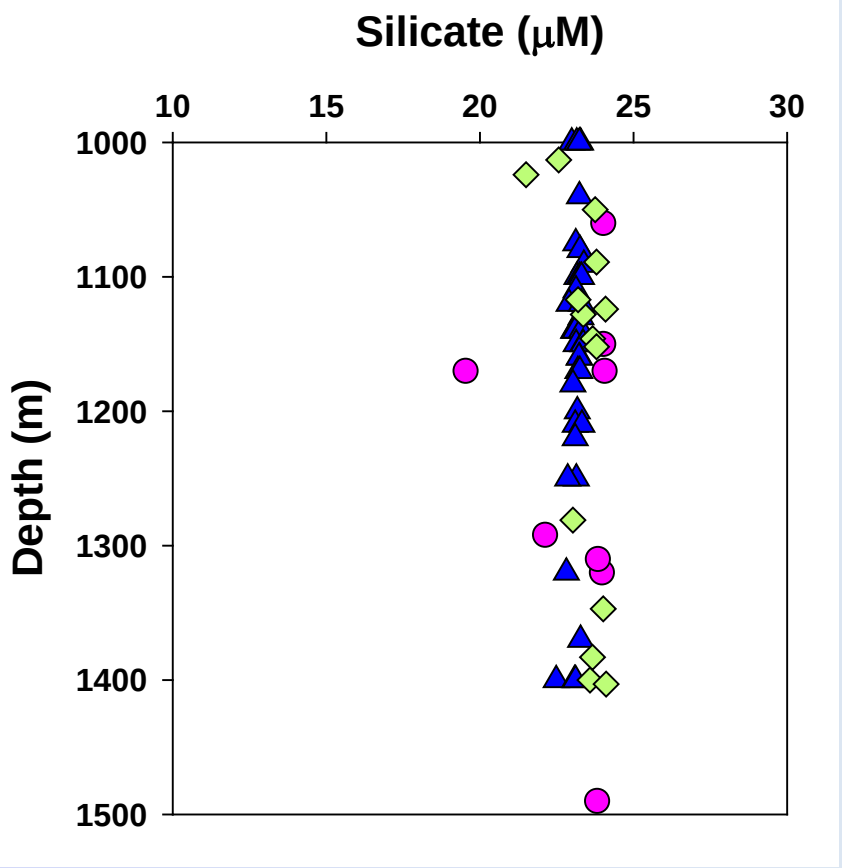
Nutrients


Dissolved Oxygen (μM)
100 120 140 160 180 200 220 240 260
1000 1100 1200 1300 1400 1500
Depth (m)
Early May
Late May
October


Nitrate (μM)
10 15 20 25 30 35
1000 1100 1200 1300 1400 1500
Depth (m)

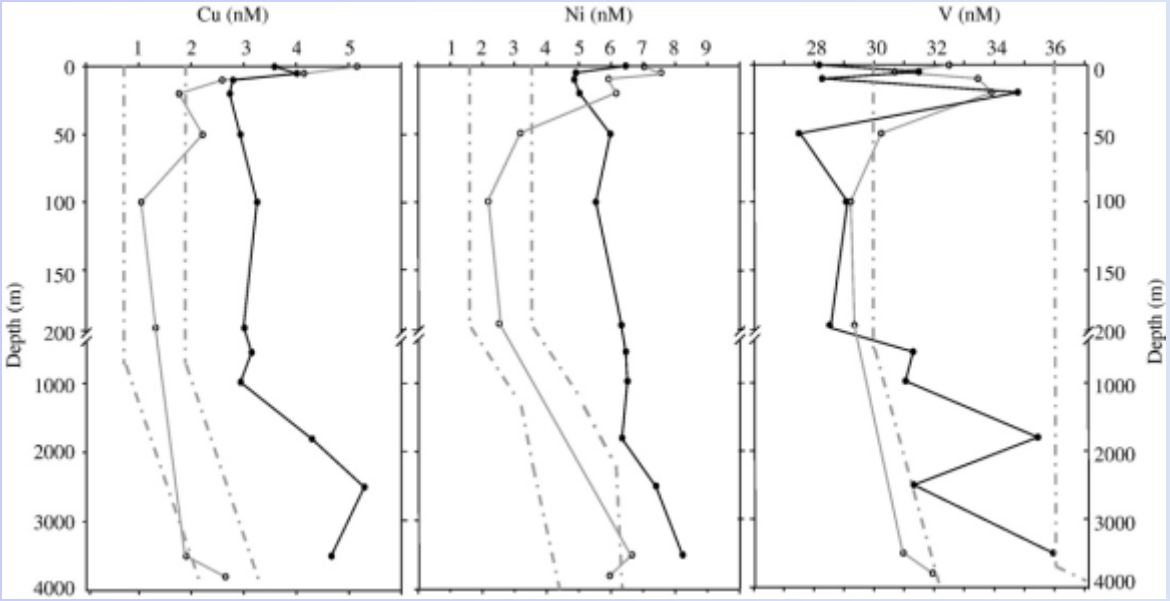
Nutrients


Phosphate (μM)
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1000
1100
1200
1300
1400
1500
Depth (m)
Early May
Late May
October


Silicate (μM)
10
15
20
25
30
1000
1100
1200
1300
1400
1500
Depth (m)

- Trace metals: Some significantly enriched in crude oil (10’s – 100’s of ppm)

- Water column increases reported for some elements following Prestige tanker sinking off Spain (Santos-Echeandia et al. 2008; Pergo, 2003; Pergo and Cobelo-Garcia, 2004)



Metal-Crude Oil

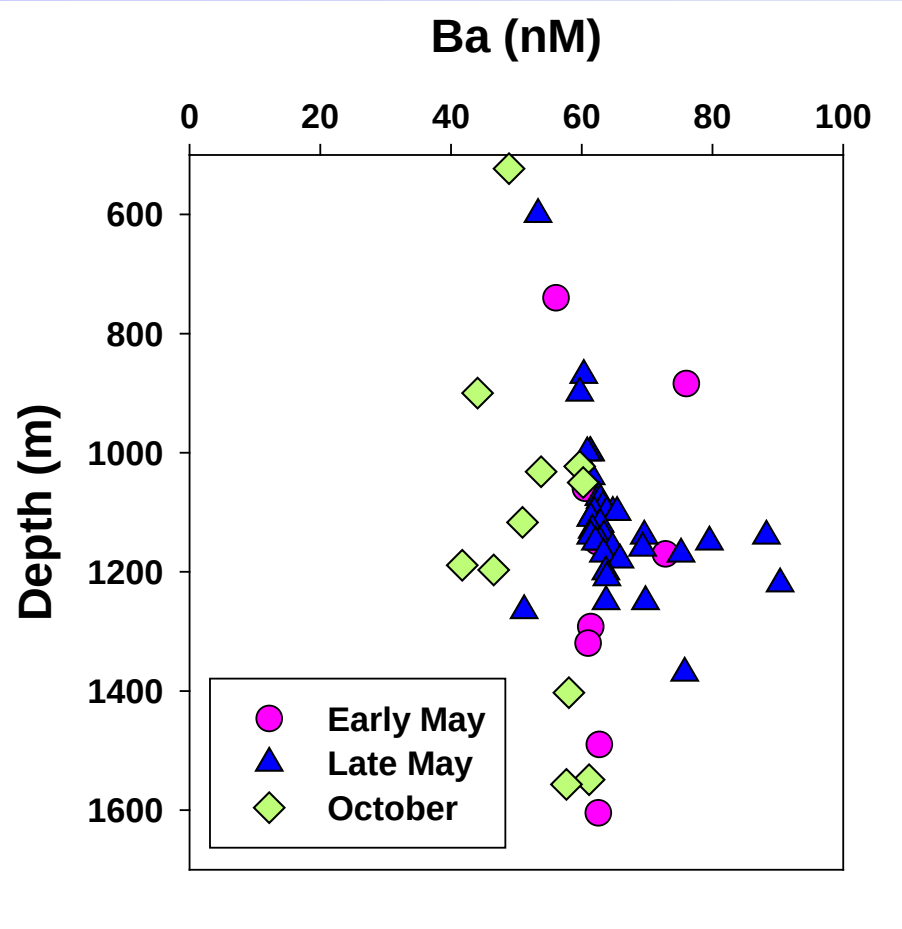
(n=3; ppm)

	V	Co	Ni	Cu	Zn	Ba
Oil	0.69	0.09	1.83	<0.02	<0.09	<0.02
Dispersant	0.003	0.0004	0.02	<0.01	<0.12	<0.03
South Louisiana	0.9*		0.1*			
Previous studies (oil)†	0.6-1200	<0.03-0.6	0.1-96.5	0.02-3.58	0.1-2.5	~0.1

* Bieber et al., 1960

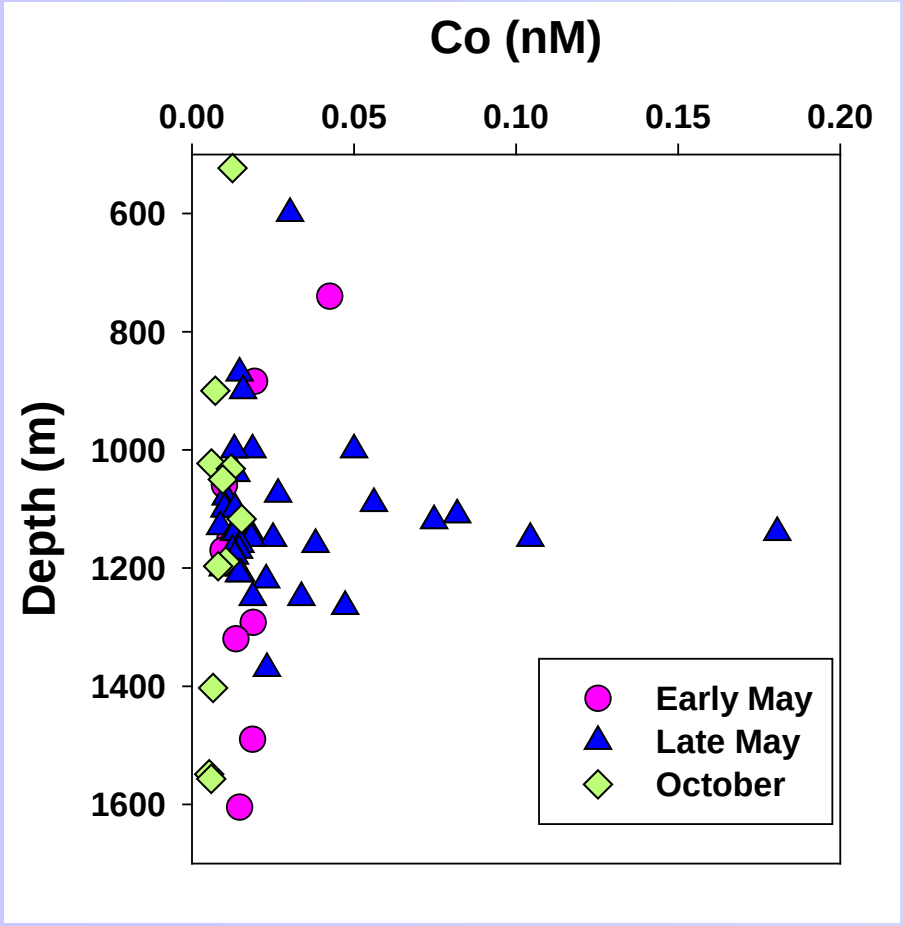
† Dunning and Moore, 1960; Ball et al., 1960; Stigter et al., 2000; Sugihara and Bean, 1962; Santons-Echeandia et al, 2008; All et al., 1982; Duyck et al, 2002

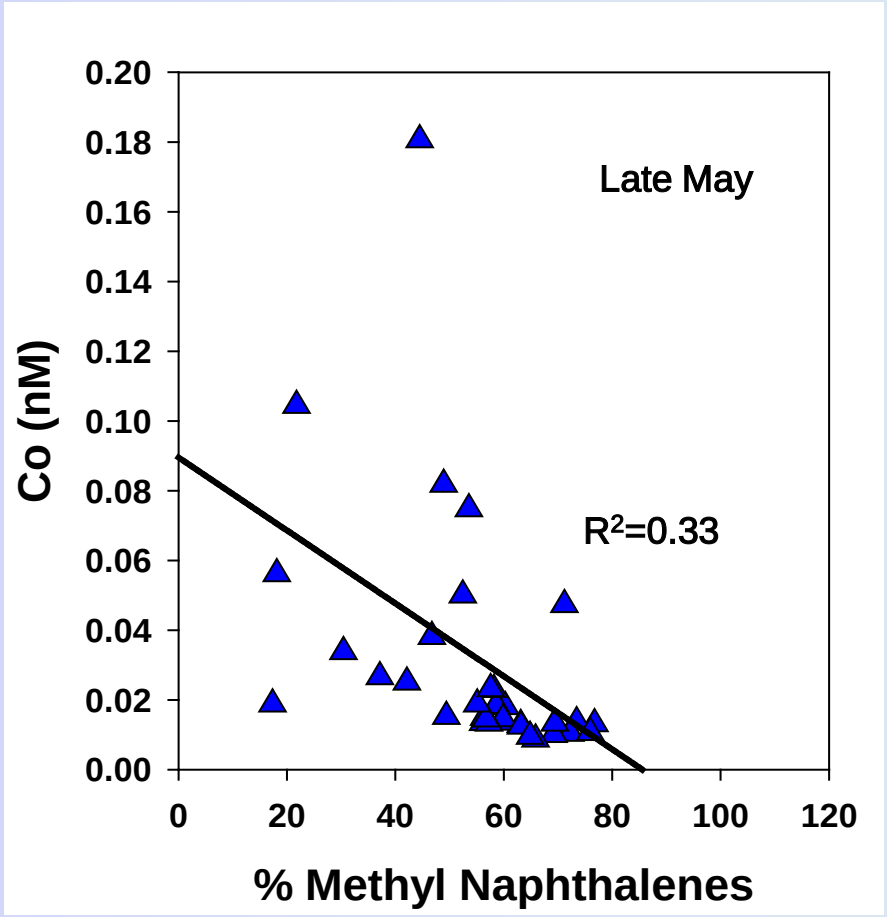
Trace elements



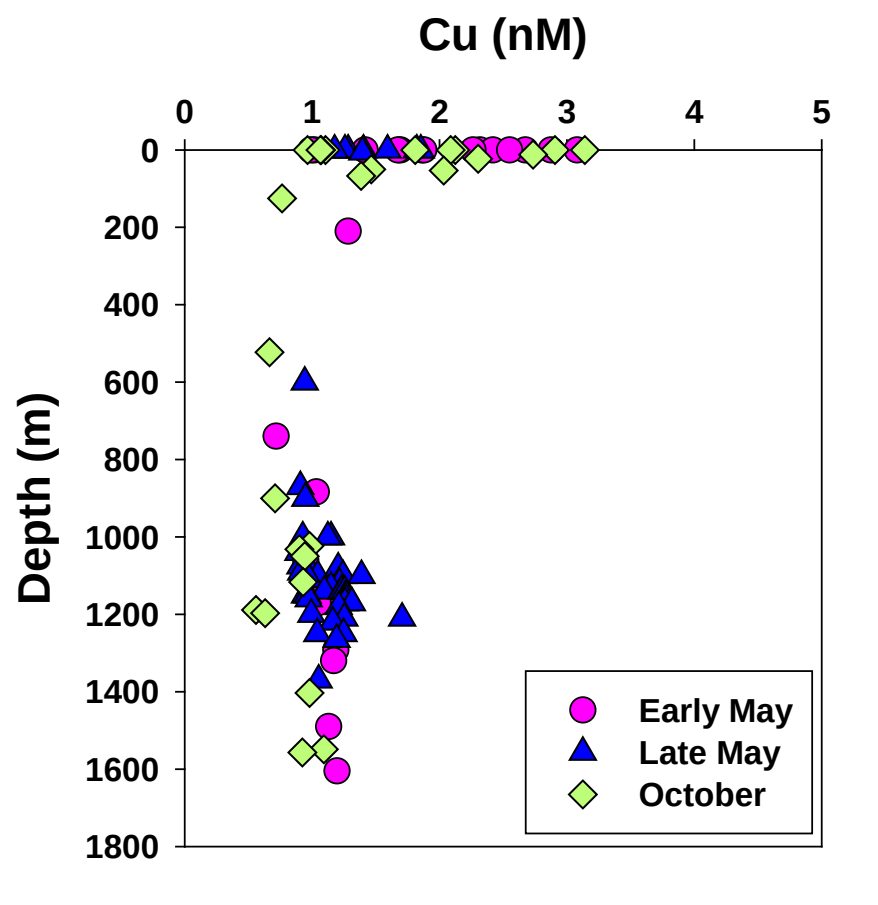
Trace elements

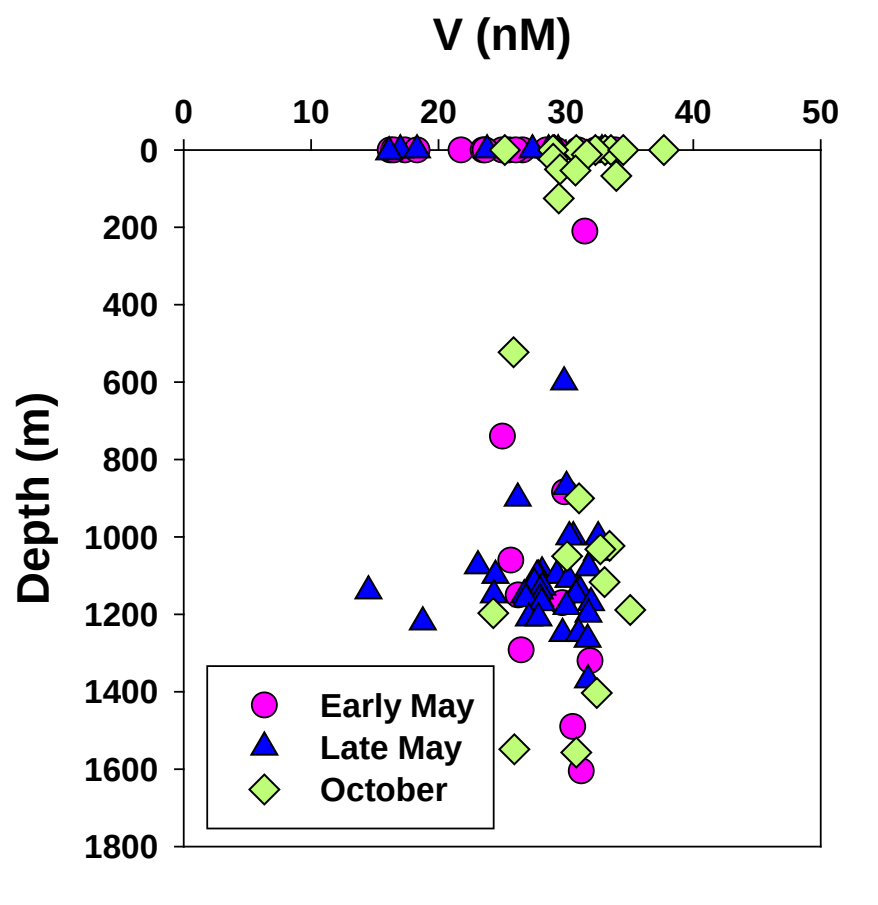
Depth -1000~1400 m



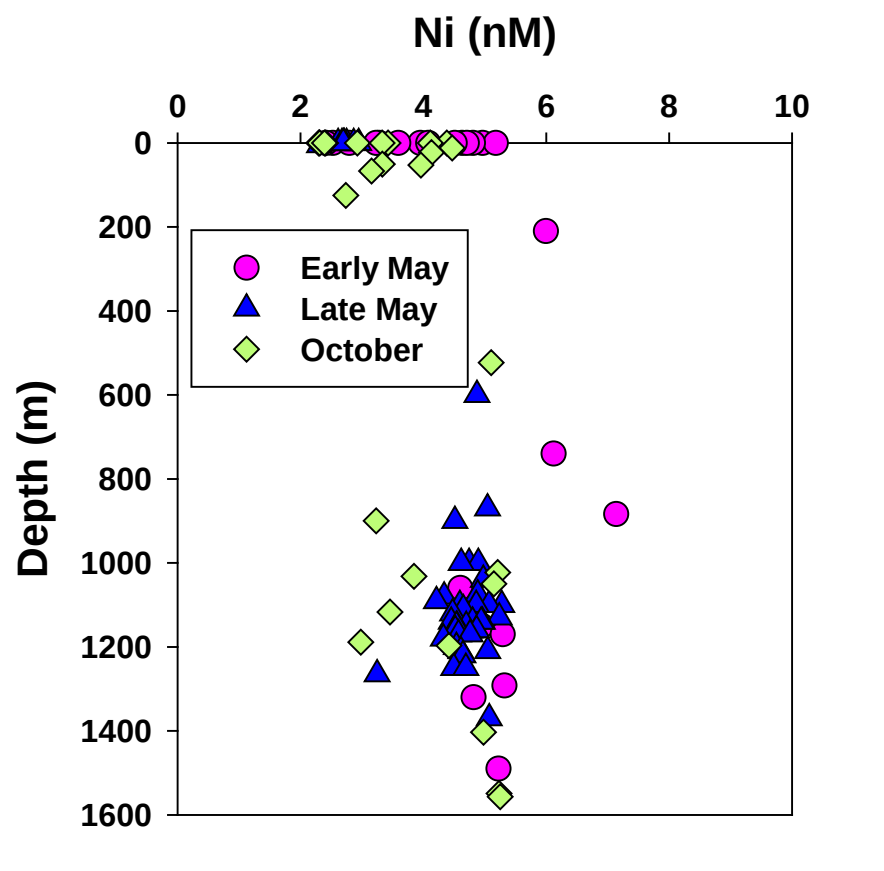


Trace elements

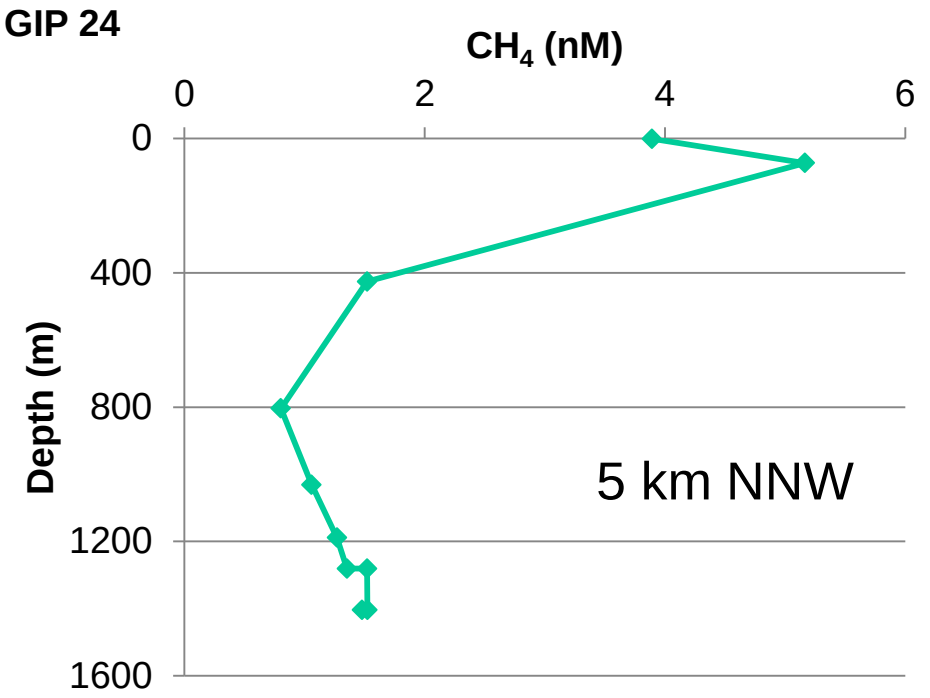


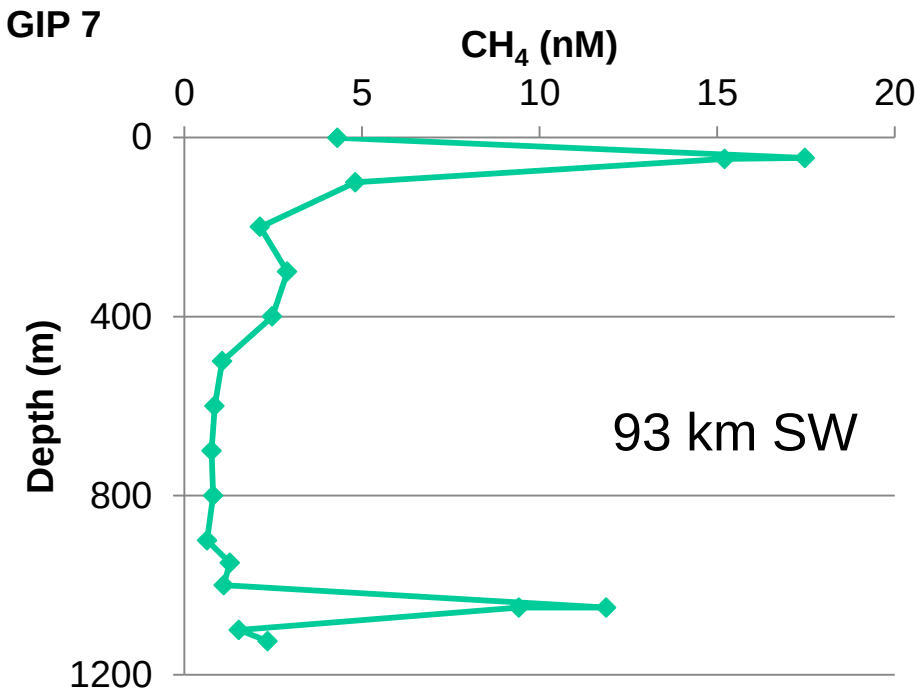


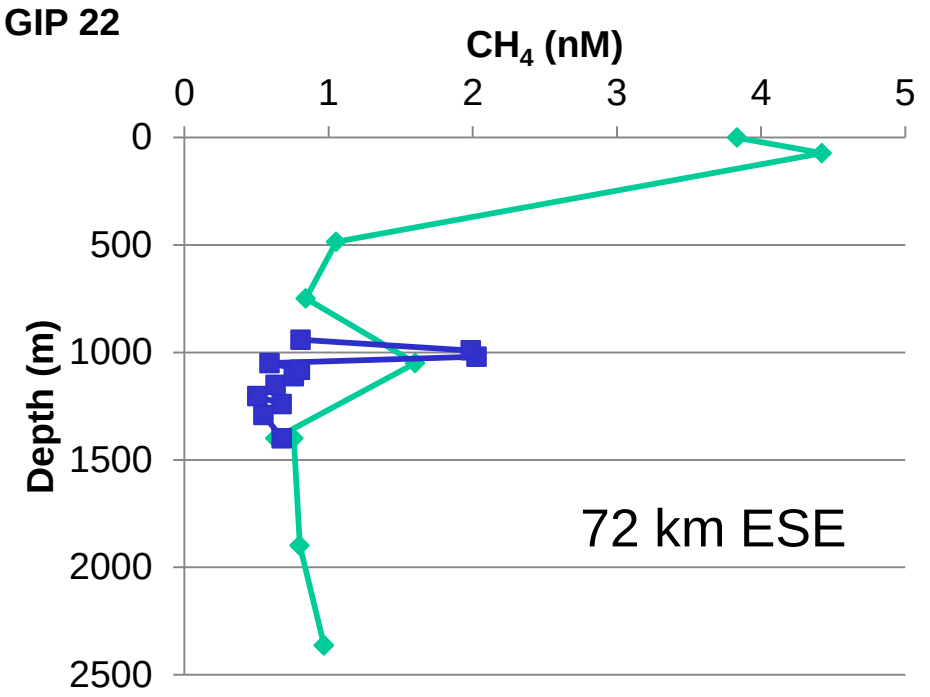
Trace elements



Mid-October 2010
R/V Cape Hatteras







Conclusions

Significant (>5 µg/L) subsurface PAH to ~15 km from wellhead.

• PAH's show fractionation consistent with relative solubilities/volatilities of constituents.

•Correlated depletions in NO_3, PO_4, and O_2 in subsurface plume; no effect on Si.

• Increased Ba and Co in subsurface plume; but not for V and Cu.

In mid October:

• Near return to normal for methane levels near wellhead.