Iron and Manganese Reduction in Bering Sea Shelf Sediments

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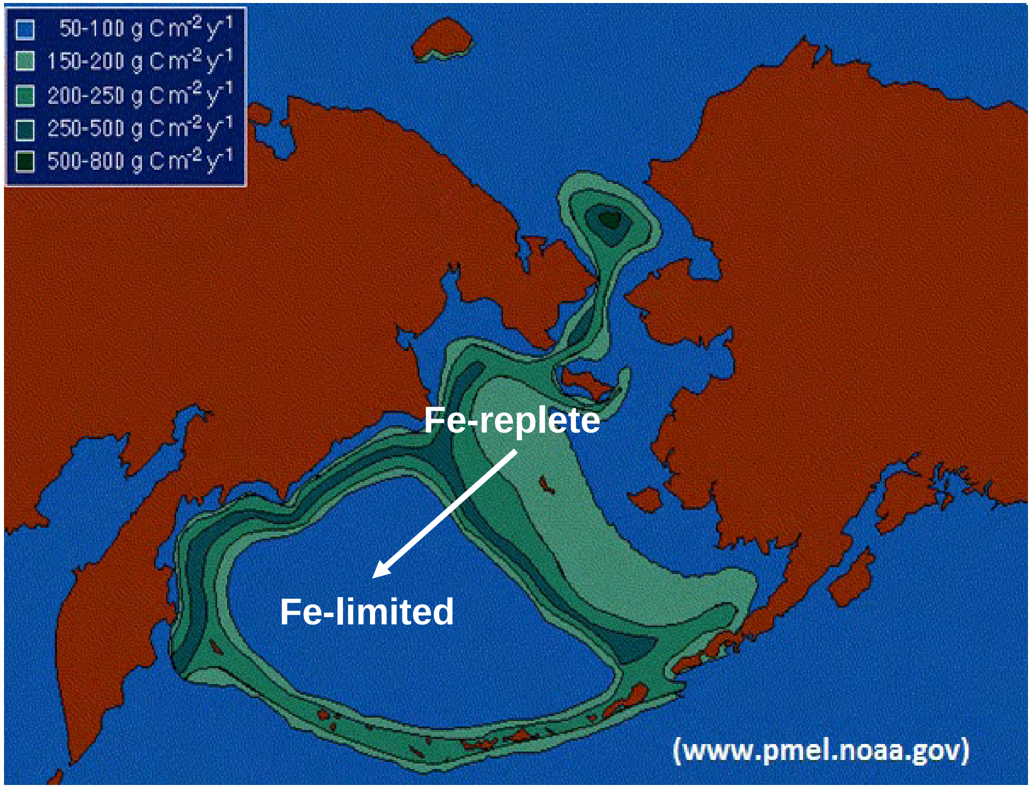
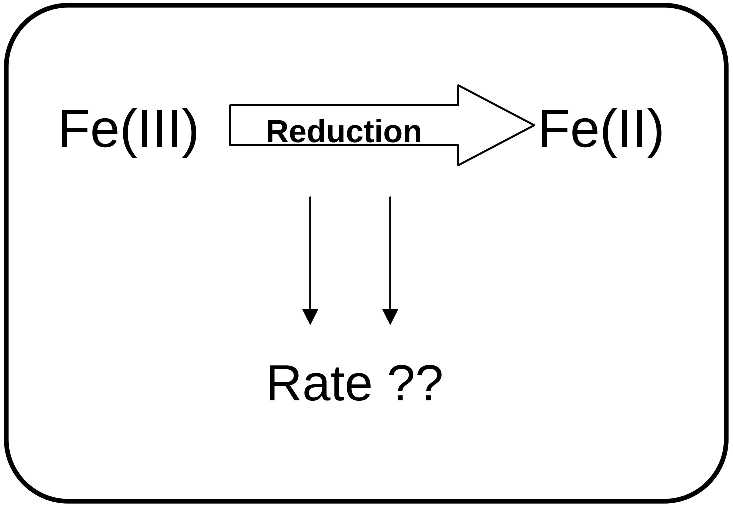
Special Thanks To:

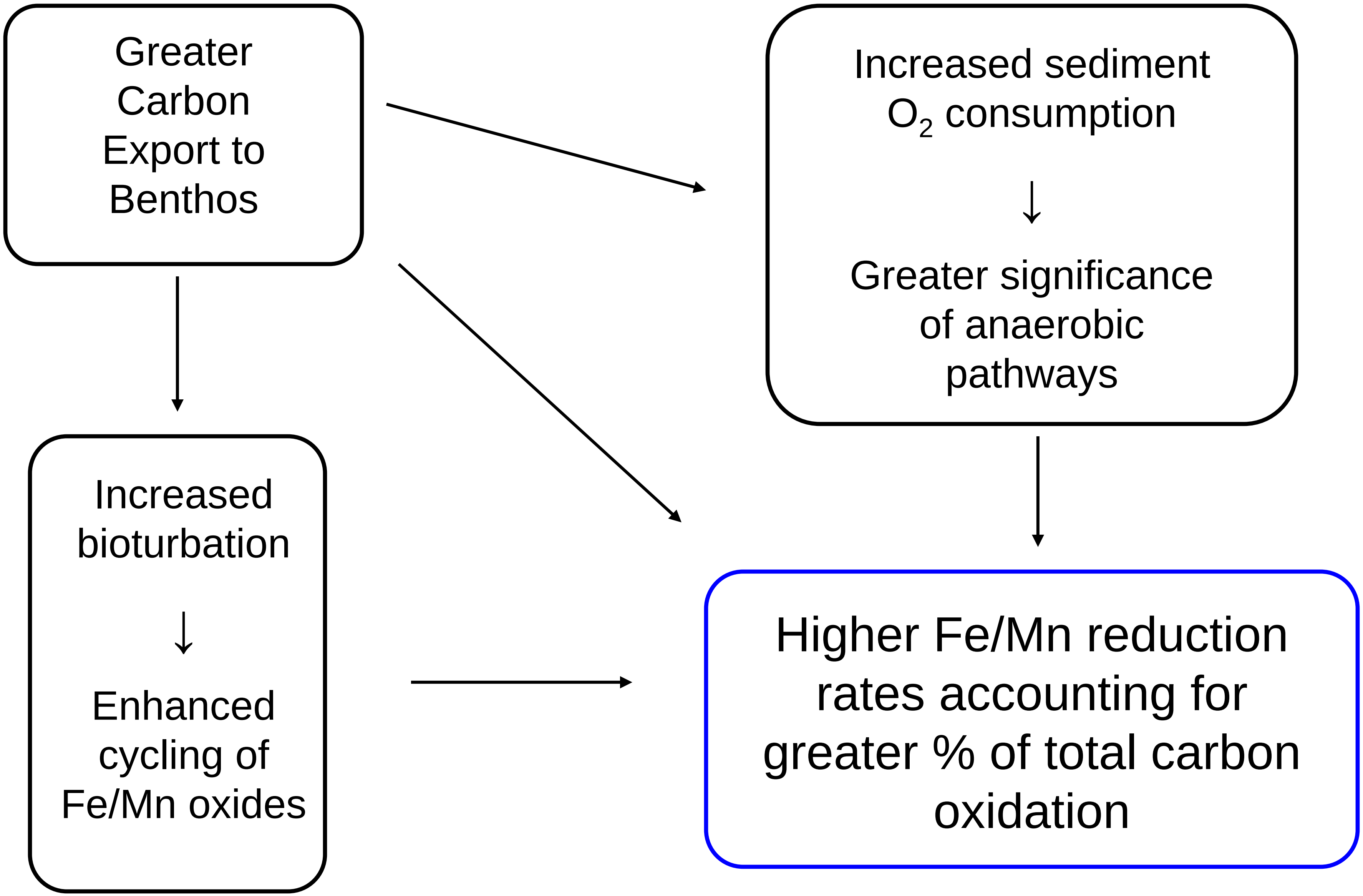
Primary Production and Iron in the Bering Sea

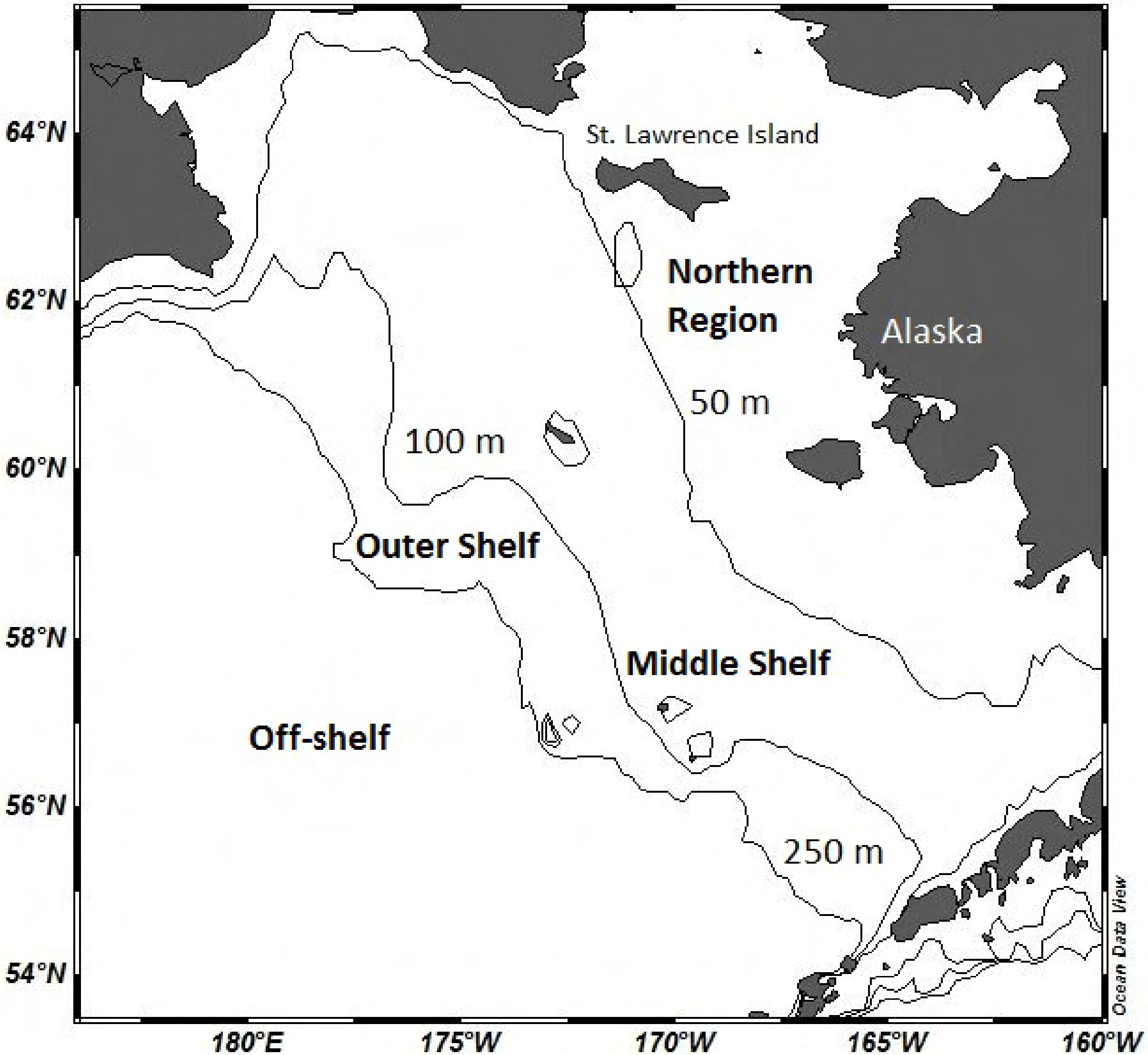


- Shelf sediments may be a significant source of Fe to surface waters (Hurst et al. 2010)



- Surface waters in the off-shelf region are Fe-limited (Aguilar-Islas et al. 2007)


Greater Carbon Export to Benthos
Increased sediment O_2 consumption
↓
Greater significance of anaerobic pathways
Increased bioturbation
↓
Enhanced cycling of Fe/Mn oxides
Higher Fe/Mn reduction rates accounting for greater % of total carbon oxidation



Expected Order:

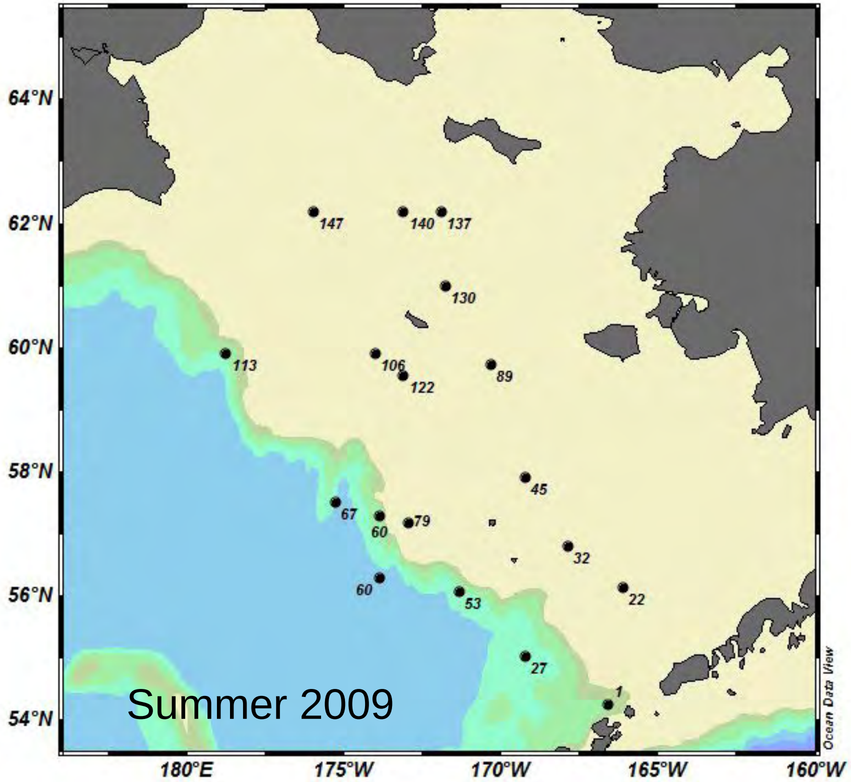
Northern Shelf
↓
Middle Shelf
↓
Outer Shelf
↓
Off Shelf

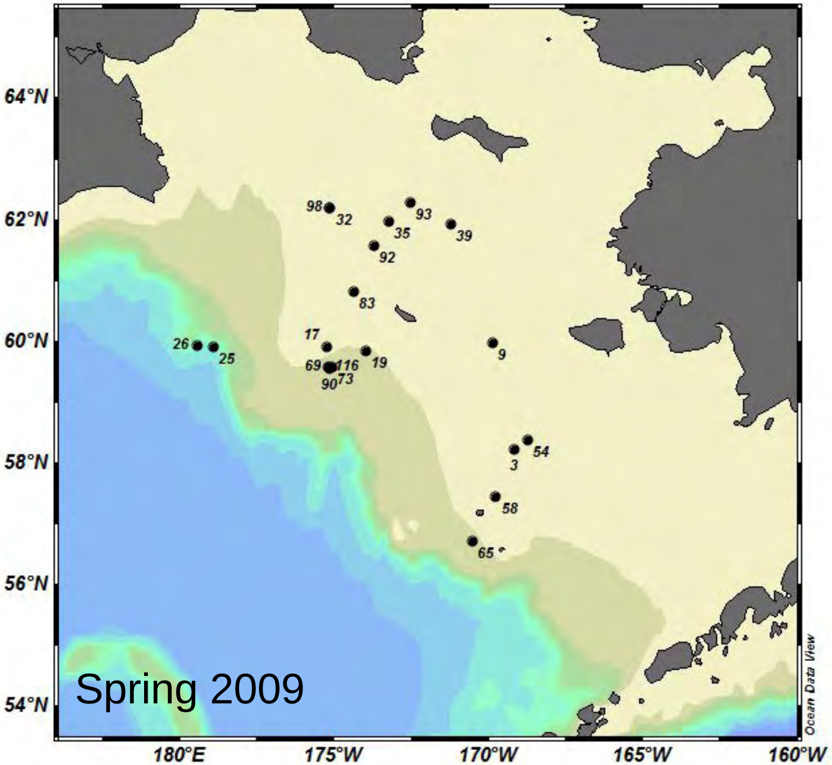
Hypothesis

Fe and Mn reduction rates and the % of total organic carbon remineralized by these pathways will vary regionally in the following order:

Northern shelf > Middle shelf > Outer shelf > Off shelf

- 20 stations sampled aboard the USCGC Healy (HLY0902: April-May 2009)

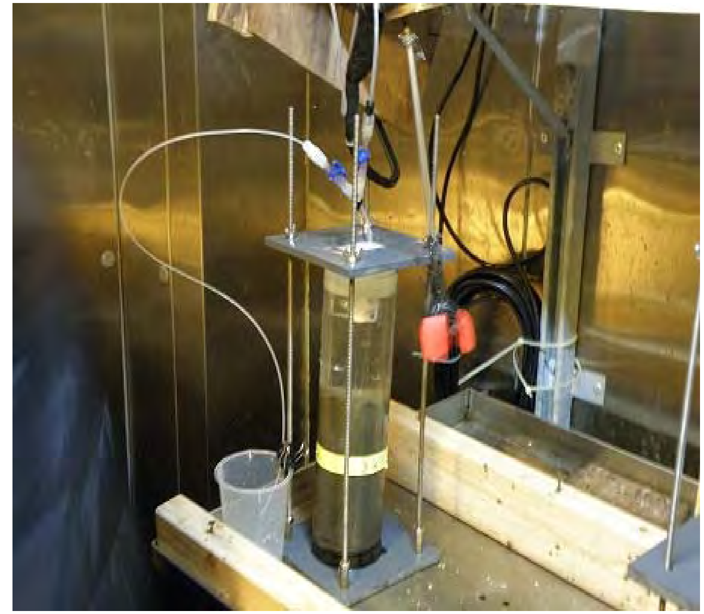




- 19 stations sampled aboard the WHOI R/V Knorr (KNR195-10: June-July 2009)

Up to 16 cores collected at each station

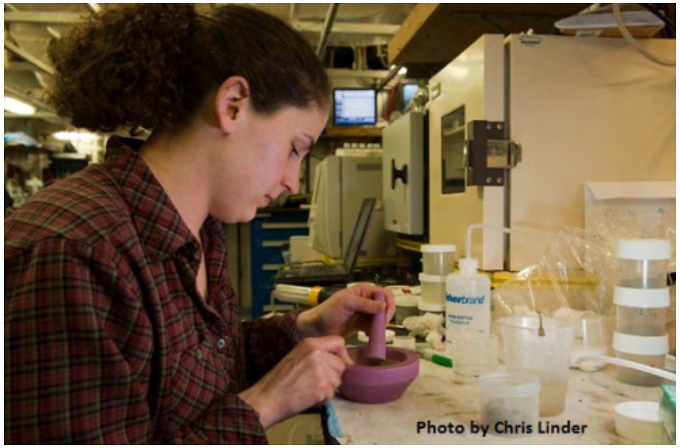
Flux core set-up



Sediment O_2 consumption rates used to estimate total carbon oxidation rates

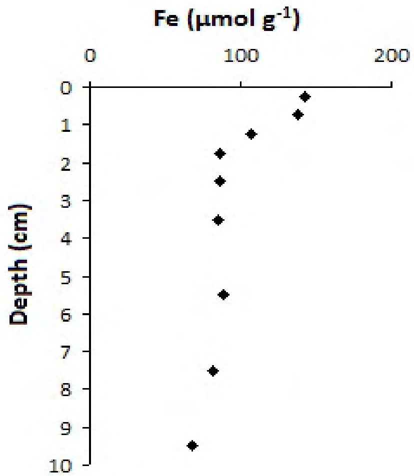
Sediment samples were frozen for later analysis of Fe and Mn

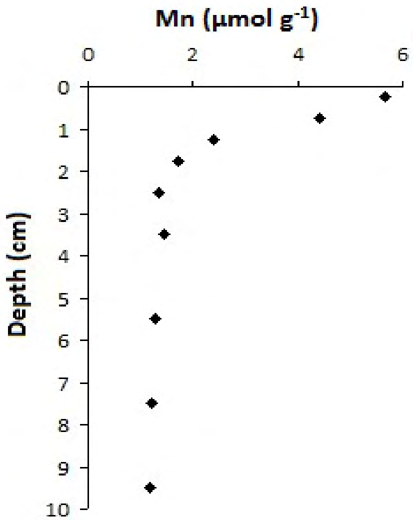
^{234}Th→
tracer used to determine bioturbation rates



Fe & Mn oxides extracted using an *acidified ammonium oxalate* method (Phillips and Lovely 1986, Davenport 2008)

Flame AA Spectrophotometer

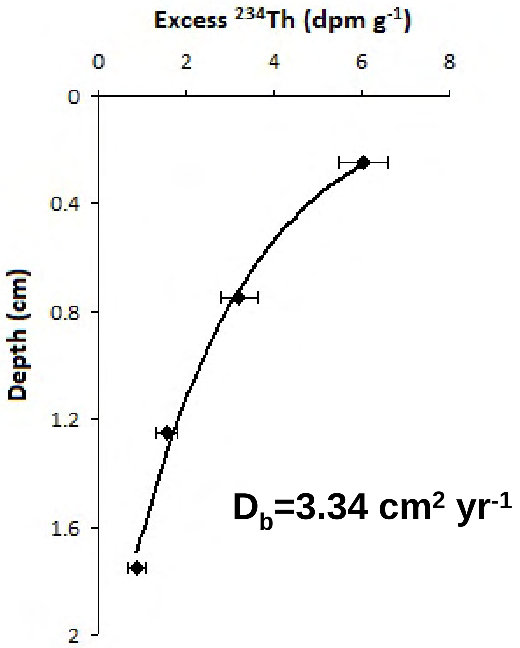


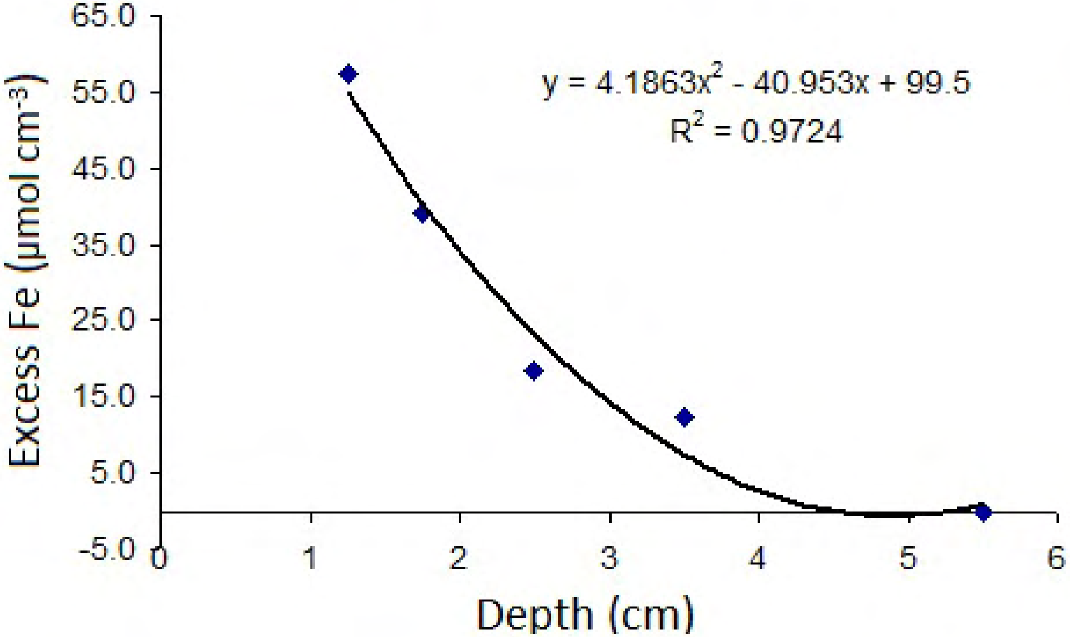


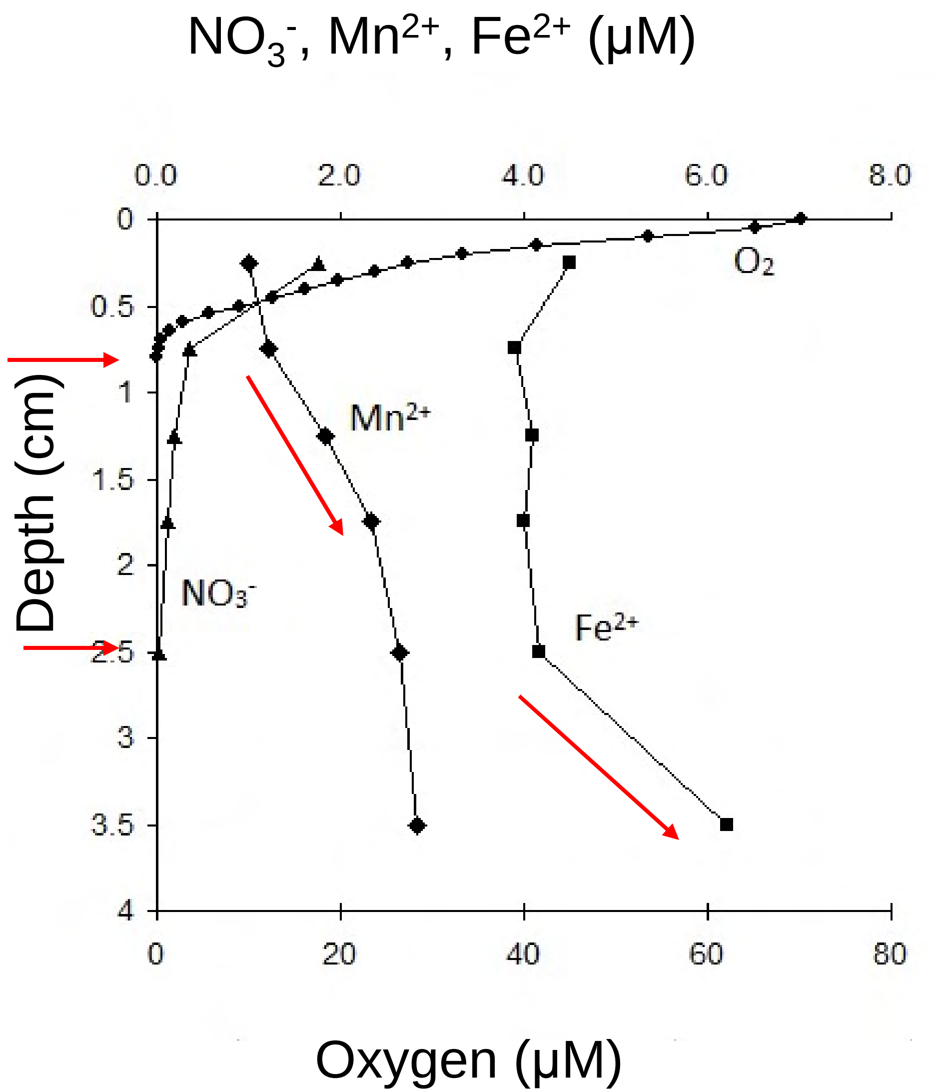
$$D_b \int_{z_1}^{z_2} \frac{d^2C}{dz^2} dz = \int_{z_1}^{z_2} \Sigma R_{(z)} \, dz$$

Bioturbation

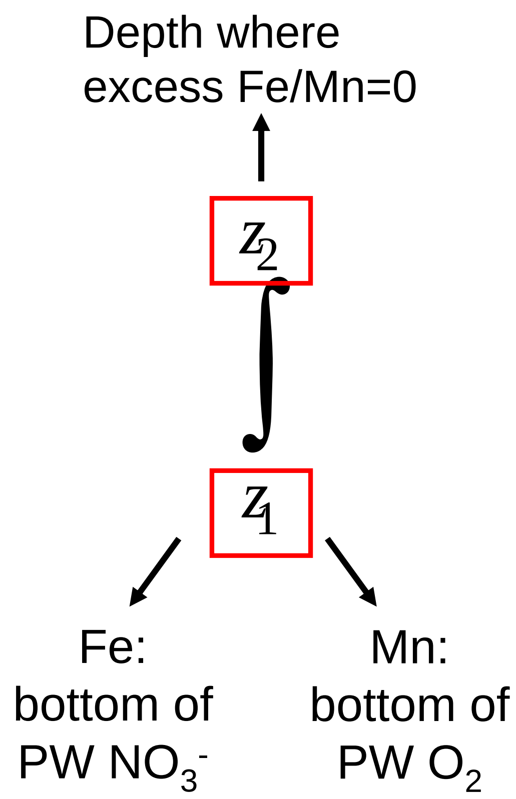
Fe/Mn reduction



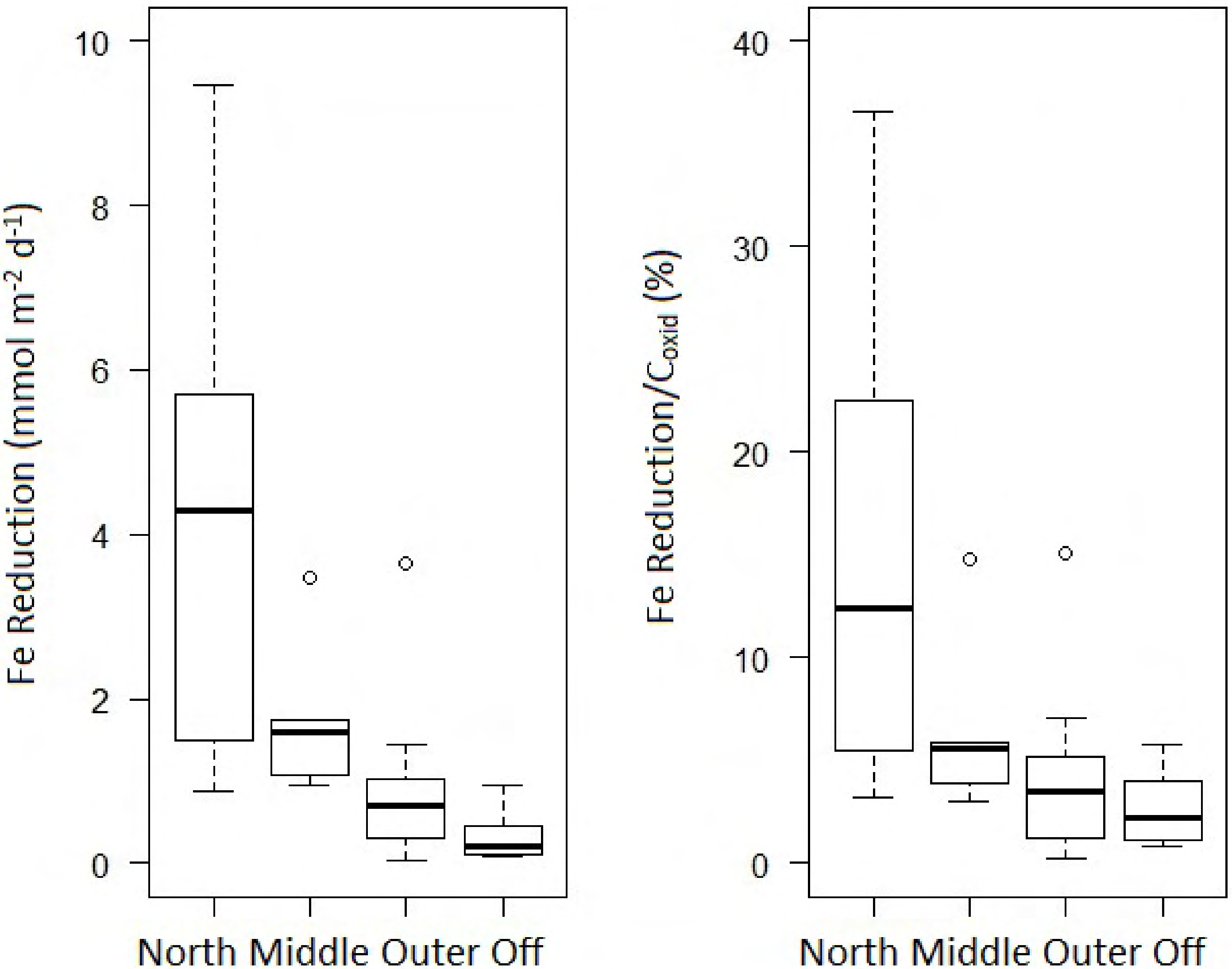


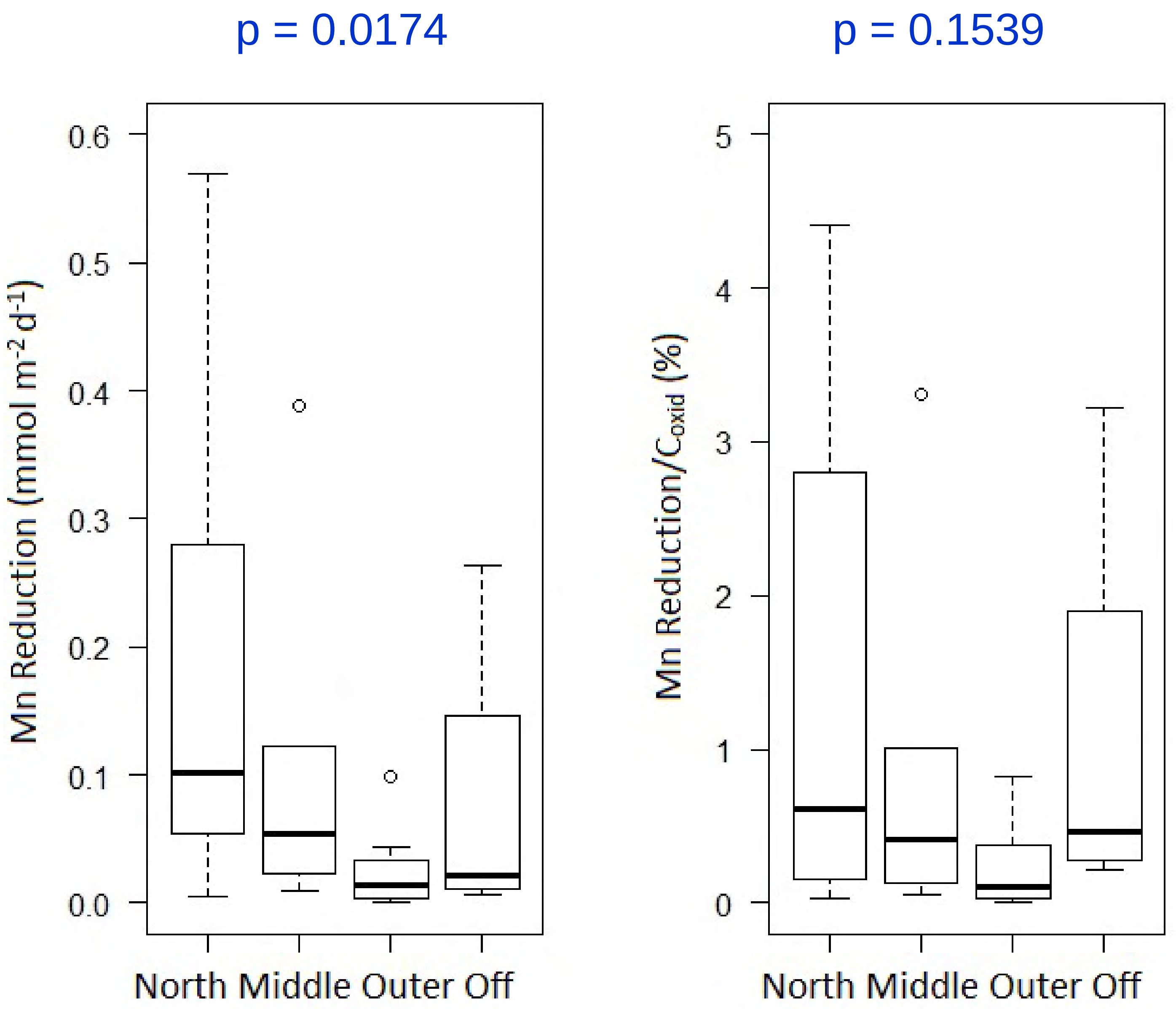


Zone of reduction



$p < 0.0001$ $p = 0.0011$




p = 0.0174
p = 0.1539
Mn Reduction (mmol m-2 d-1)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
North Middle Outer Off
Mn Reduction/Coxid (%)
5
4
3
2
1
0
North Middle Outer Off

Summary of Findings

- Fe reduction is a significant pathway for organic carbon remineralization

- Highest rates of Fe reduction were in regions where we expect highest rates of carbon export

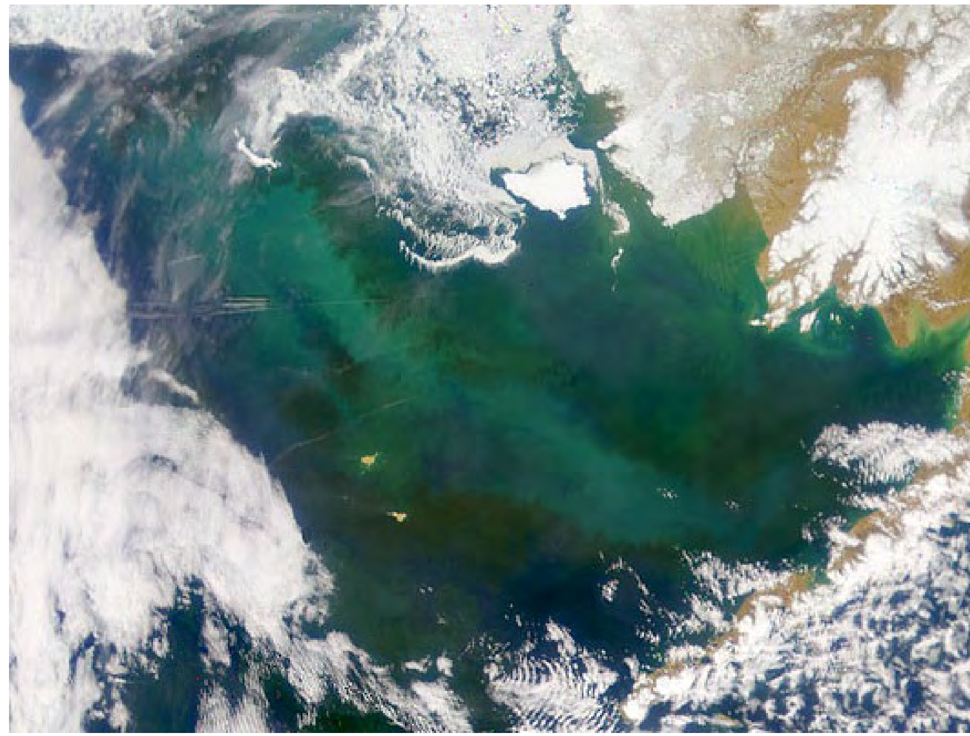
- In contrast to Fe, regional pattern not as strong in Mn with very low rates in all regions.

The Role of Sedimentary Iron Reduction

$Fe(III) \xrightarrow{\text{Reduction}} Fe(II)$

Avg. Rate = 1.74 mmole m^{-2} d^{-1}

Photo by Heather Whitney



(http://earthobservatory.nasa.gov/IOTD/view.php?id=1423)

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