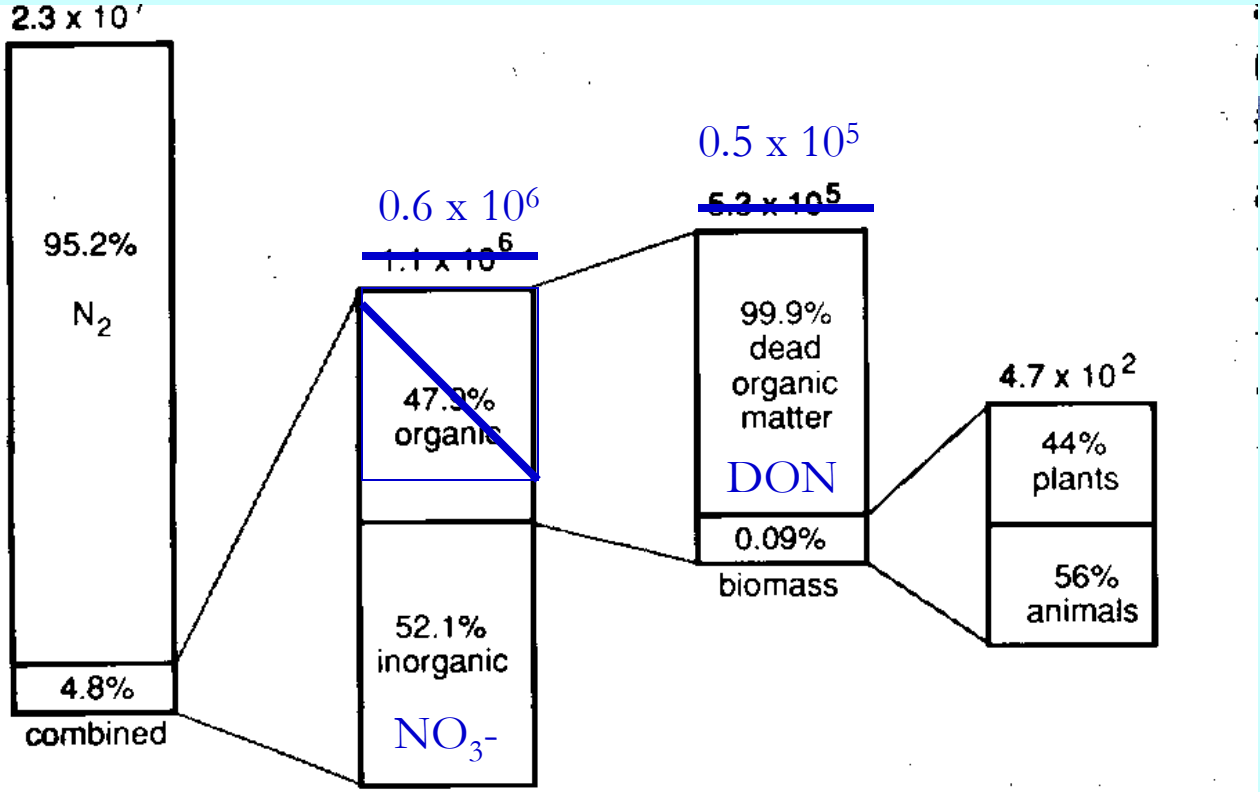
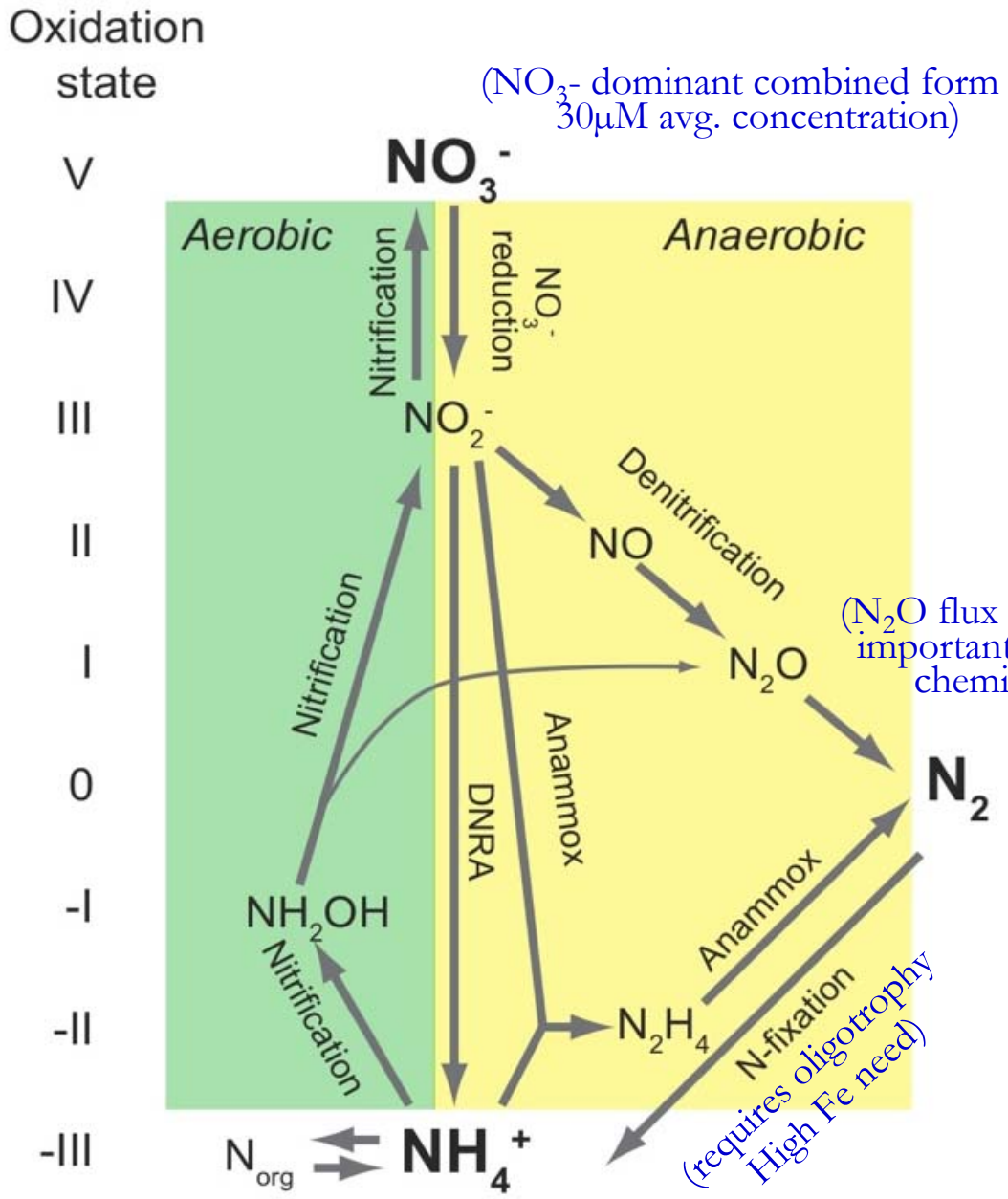


Fig. 12-3 Partitioning of the global inventories of nitrogen in the aquatic system. Units are Tg N. Reprinted from Söderlund and Rosswall (1982) with the permission of Springer-Verlag.

N-Cycling



(NO_3^- dominant combined form ~ 30μM avg. concentration)

(N_2O flux small but important to atm. chemistry)

Table 15.9. Free Energy of N Transformations at pH = 7 (25°C)

Processes		$\Delta G^{0\prime}$ (pH = 7) (kJ mol^{-1})
Nitrification		
(1) $NH_4^+ + 1.5\ O_2$ (0.2 atm)	$= NO_2^- + H_2O + 2\ H^+$ (10^{-7} M)	−290.4
(2) $NO_2^- + 0.5\ O_2$ (0.2 atm)	$= NO_3^-$	−72.1
Denitrification[a]		
(3) $NO_3^- + 1.25\ \{CH_2O\} + H^+$ (10^{-7} M)	$= 0.5\ N_2(g) + 1.75\ H_2O + 1.25\ CO_2(g)$	−594.6
N Fixation		
(4) $0.5\ N_2(g) + 1.5\ H_2(g) + H^+$ (10^{-7} M)	$= NH_4^+$	−39.4
(5) $0.5\ N_2(g) + 0.75\ \{CH_2O\} + 0.75\ H_2O + H^+$ (10^{-7} M)	$= 0.75\ CO_2 + NH_4^+$	−60.3

Anammox

(7) $NH_4^+ + NO_2^-$	$= N_2 + 2\ H_2O$	-357

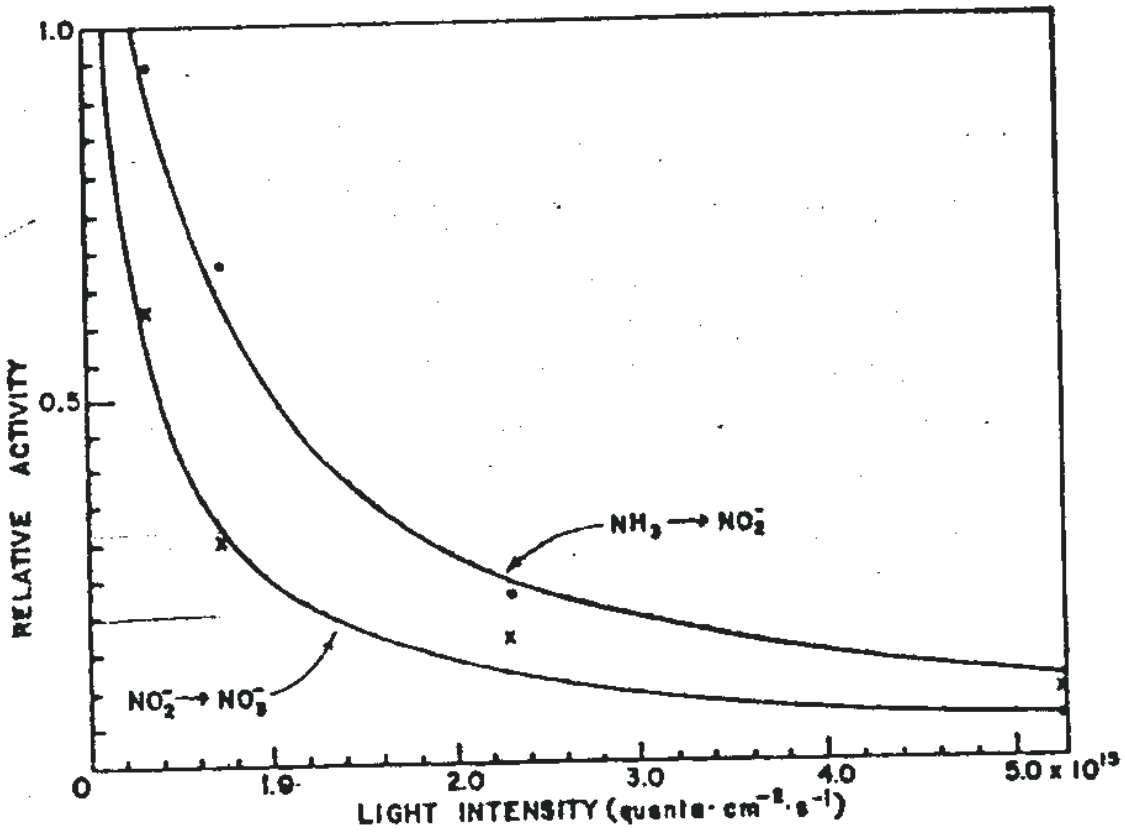


Figure 2. Effect of light intensity on nitrite oxidation and ammonia oxidation. Laboratory incubation of a sample from three miles off SIO, at 75 m depth (below the nitrite maximum). The smooth curves are hyperbolas fit to the data (see text).

N_2O Production as By-product of Deep-Sea Nitrification

Oudot et al 1990

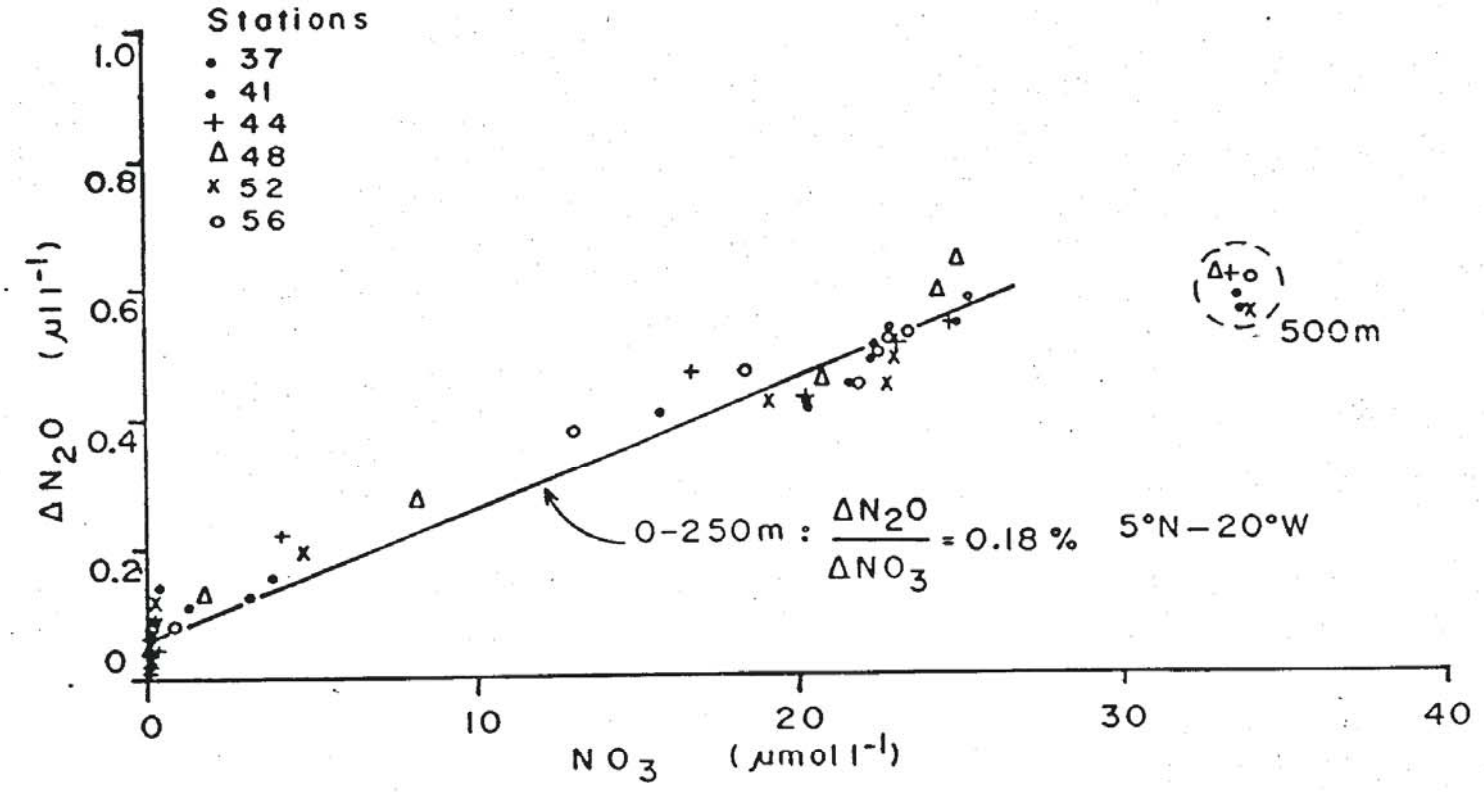


Fig. 9. Plot of apparent N_2O production (ΔN_2O) vs nitrate concentration (NO_3) for all stations in the convergence zone. The slope regression line fitted to the 0–250 m data ($r = 0.986$ for $n = 62$) shows the apparent ratio of N_2O to nitrate production.

N_2O Production/Consumption in the ETNP

Cohen and Gordon, 1978

An Intense OMZ Region

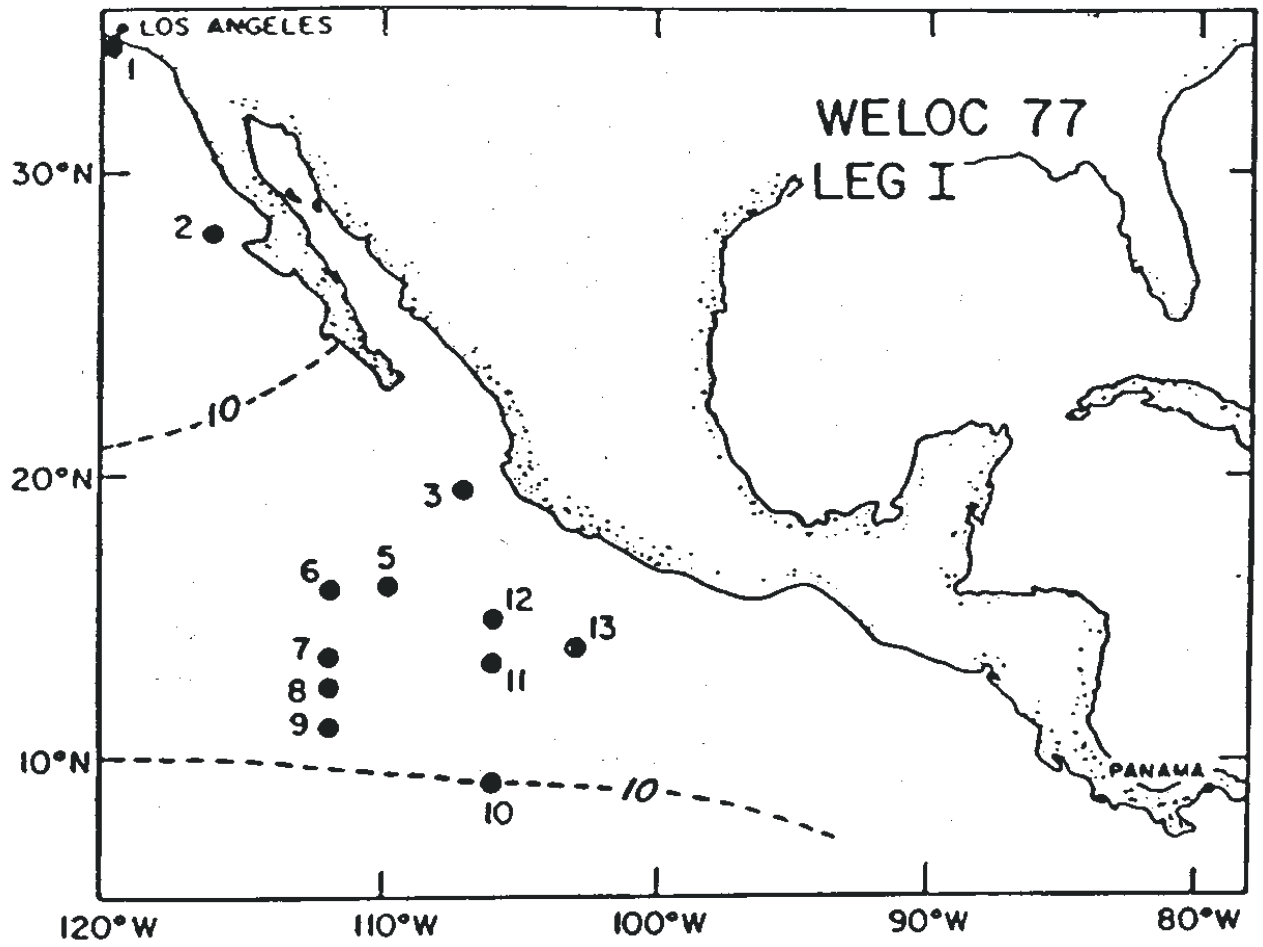
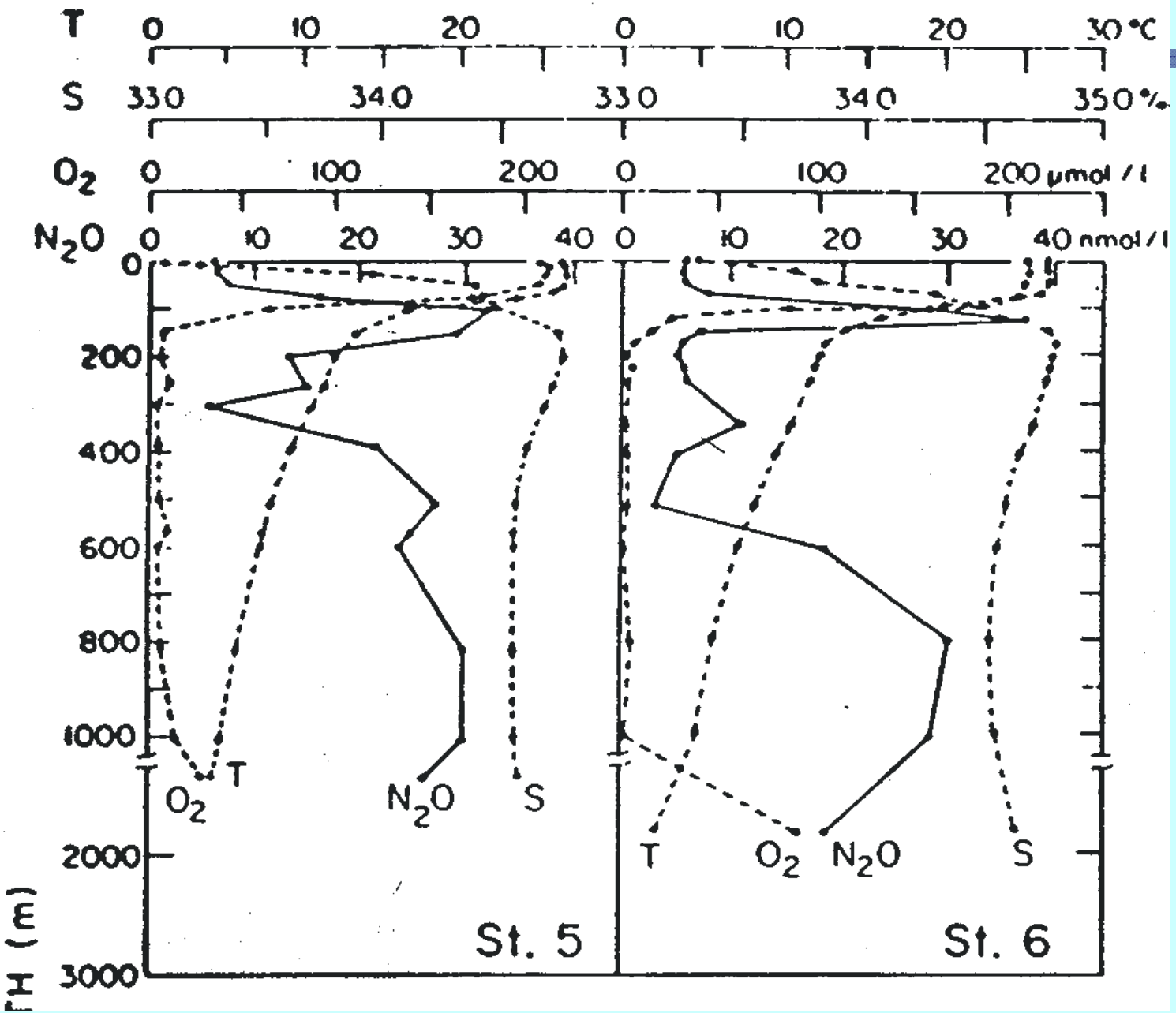


Fig. 1. Station locations for cruise WELOC 77-I. The dashed line delineates the region where intermediate waters contain less than 10 μmol O_2 l^{-1} as determined by the Winkler procedure.

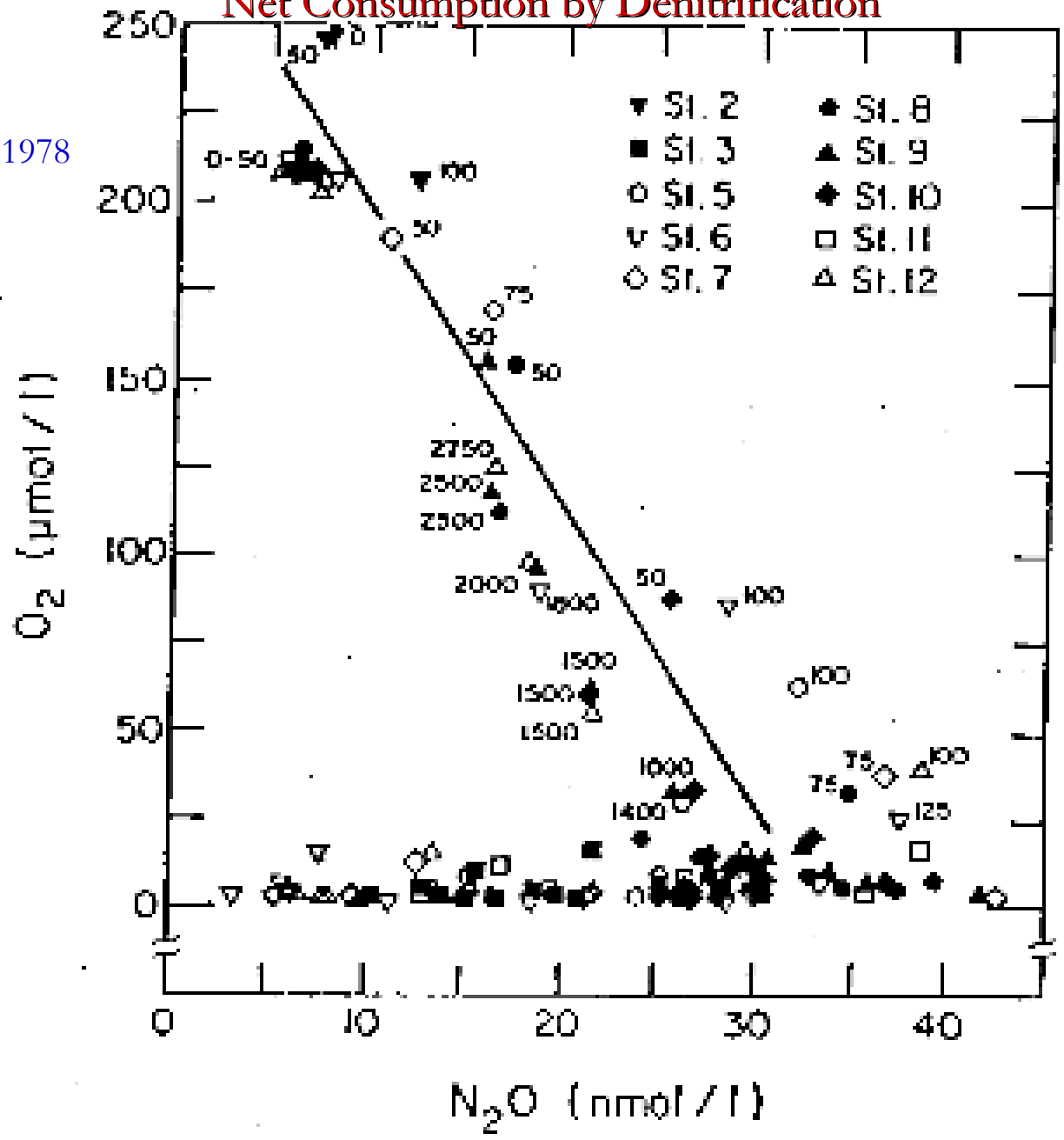
Cohen and Gordon, 1978



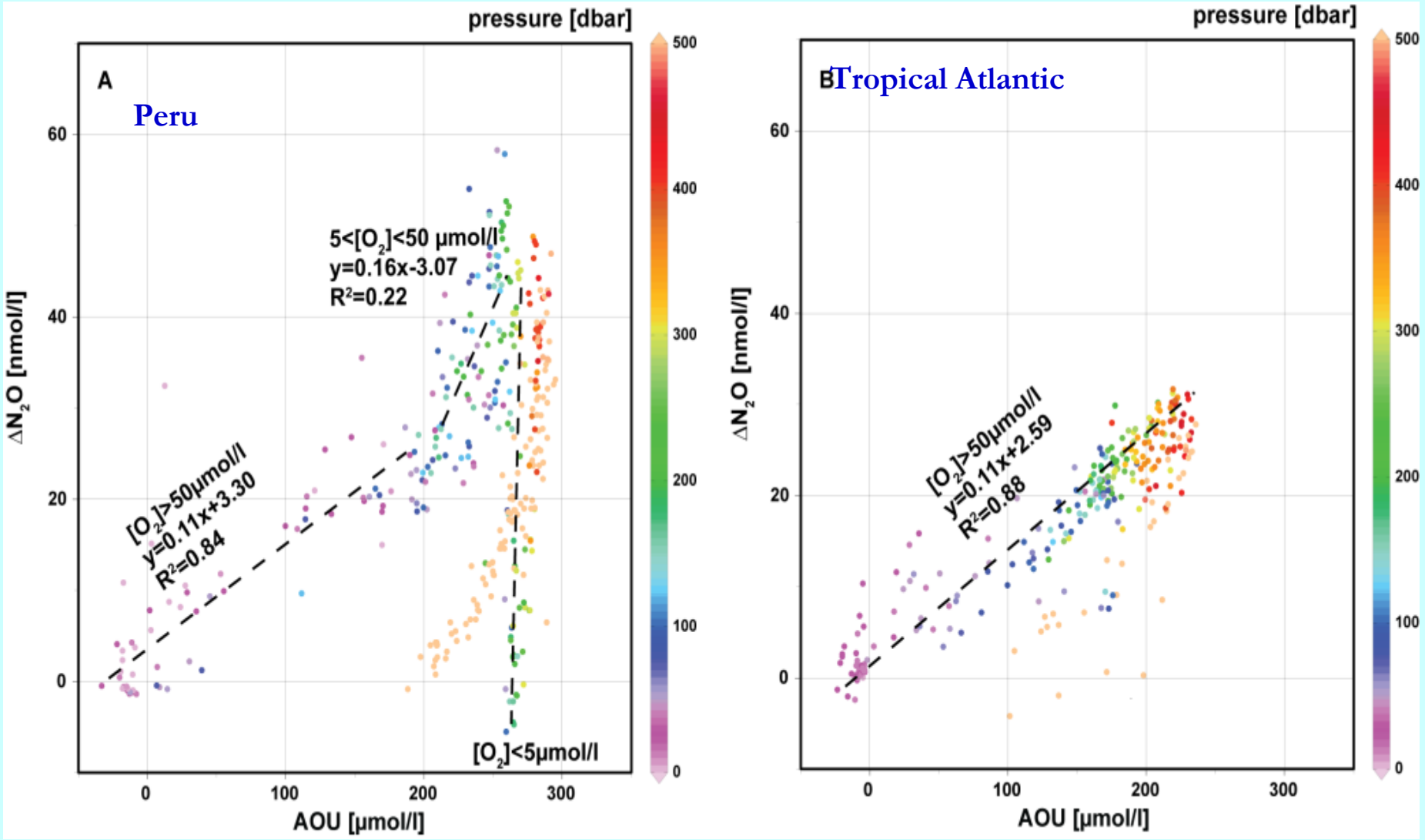
N_2O Production as By-product of Deep-Sea Nitrification

Net Consumption by Denitrification

Cohen and Gordon, 1978



Recent Comparison of Peru OMZ with Tropical Atlantic



N_2O Supersaturation in Surface Waters of ETNP and ETSP

Influence on Atmosphere?

Cohen and Gordon, 1978

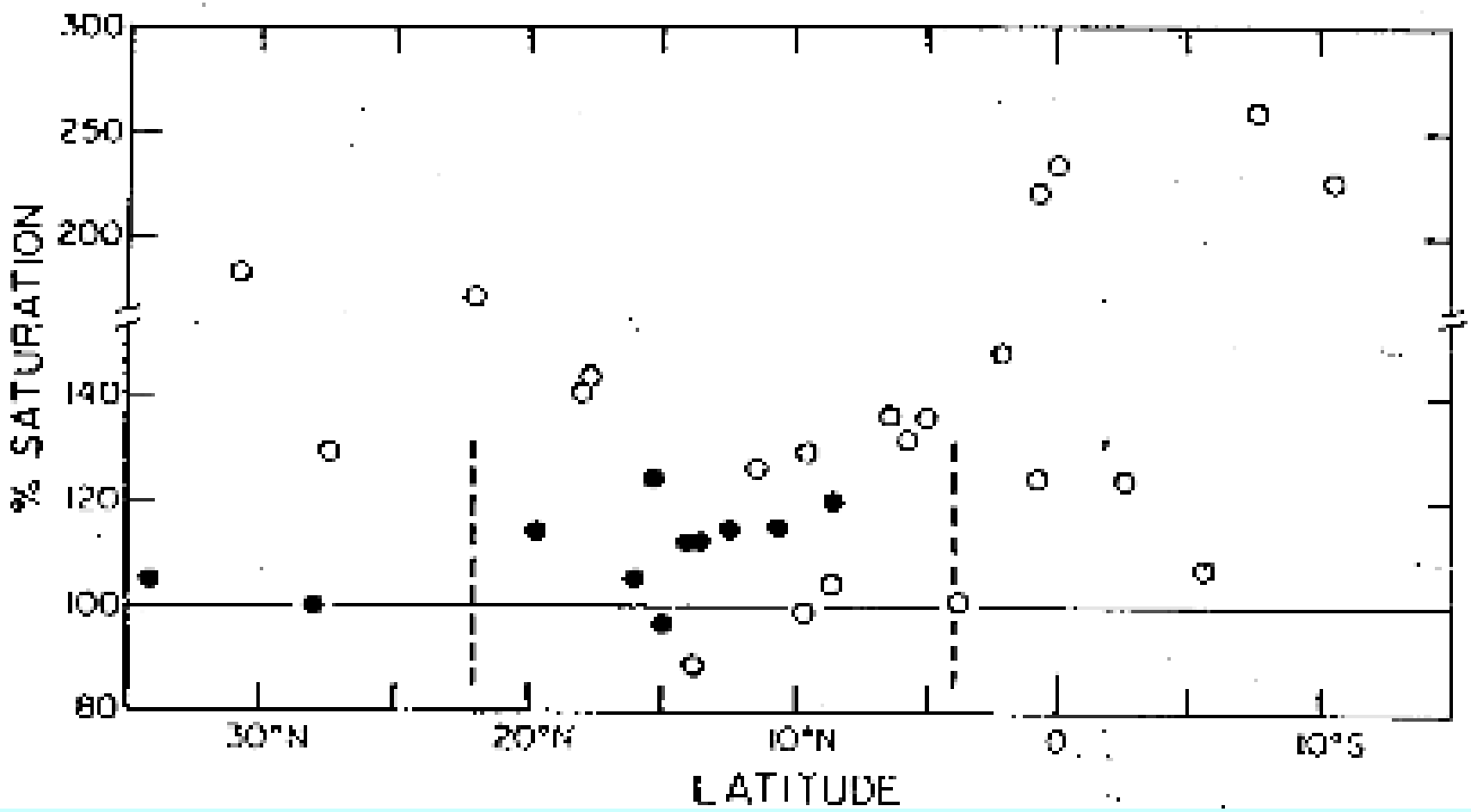


Table 1: N Budget (Tg/yr)	Delwiche (1970)	Liu (1979)	Codispoti & Christensen (1985)	Gruber & Sarmiento (1997)
Inputs				
atmospheric	4.1	49	40	15
runoff	30	17	25	41
N_2-fixation	**10**	**30**	**25**	**125**
Total Inputs	**44.1**	**96**	**90**	**181**
Outputs				
pelagic denitrification	40	50	60	85
sedimentary denitrification	0	10	60	85
burial & other	0.2	36	38	19
Total Outputs	**40.2**	**96**	**158**	**189**

N Residence Time ~ 3000 yr

Likely Marine N Cycle Controls

Factors Promoting Denitrification

- Suboxic conditions (poor ventilation, high respiration)
- Availability of NO_3^-
- Availability of organic C

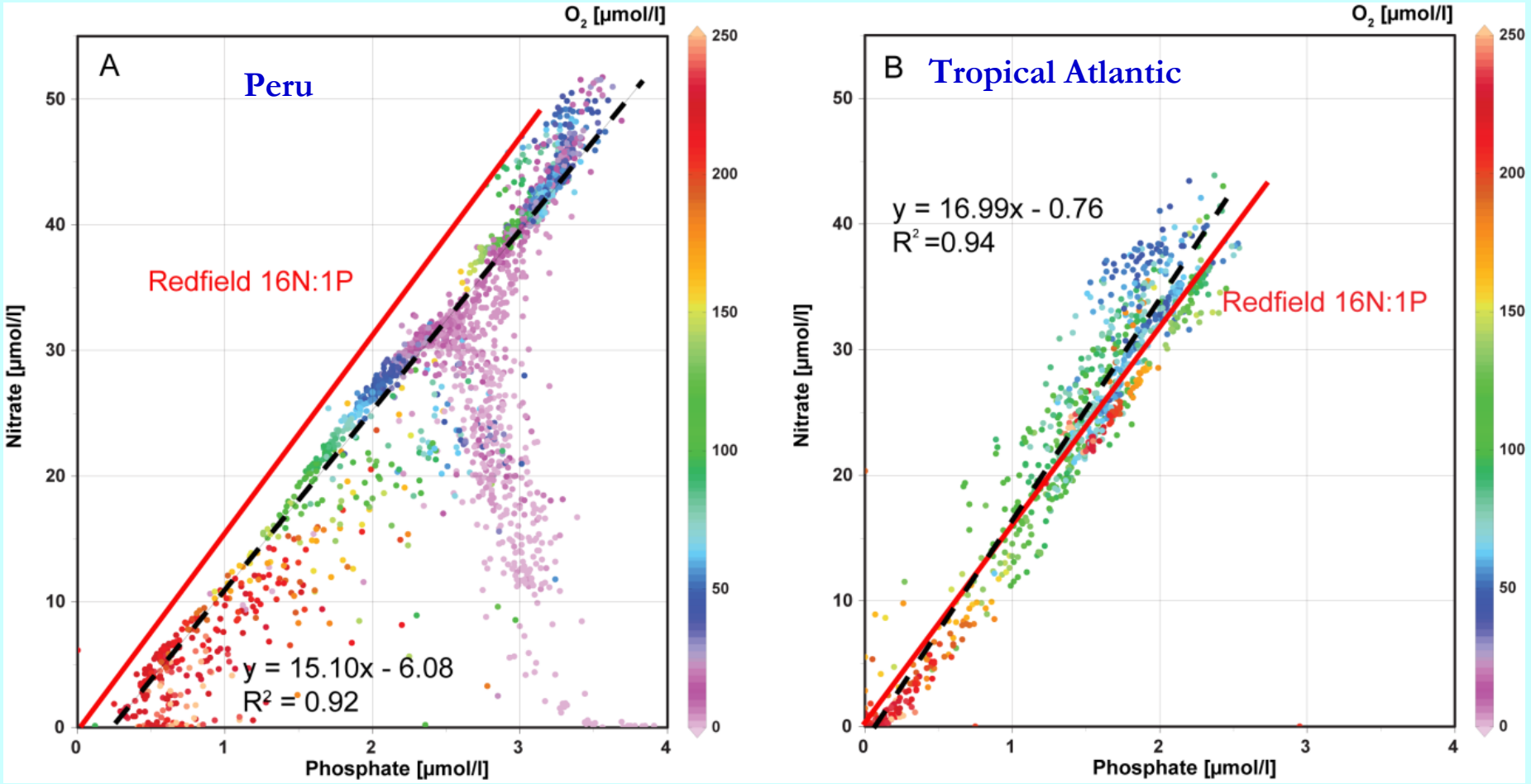
Factors Promoting N_2 fixation

- Oligotrophic conditions (Low combined N availability)
- Warm temperatures and water column stability
- Fe and Mo availability
- Low N:P ??? (How important is P constraint?)

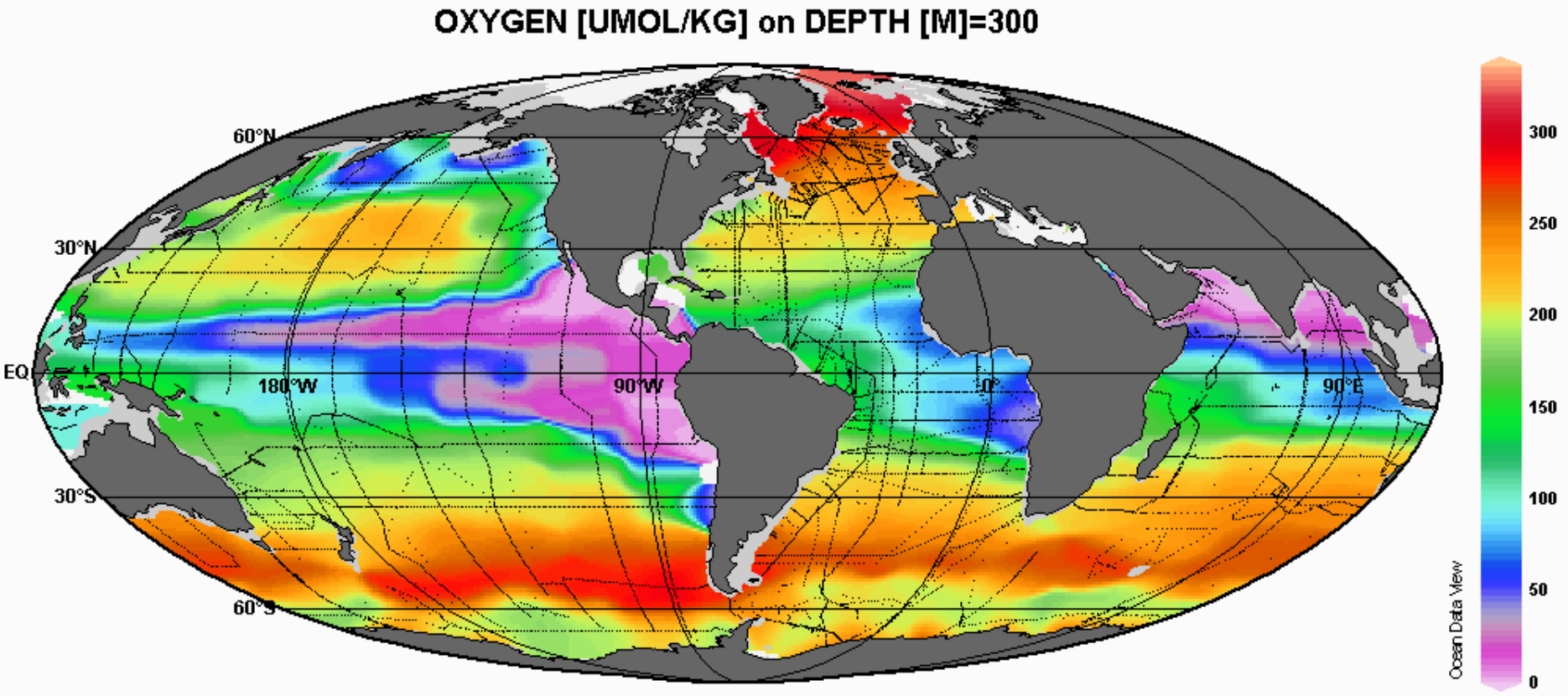
Source/Sink Balance $\Rightarrow$ Combined N Inventory $\Rightarrow$ Export Prod.

Control for Atmospheric CO_2? **Coupling to P?**

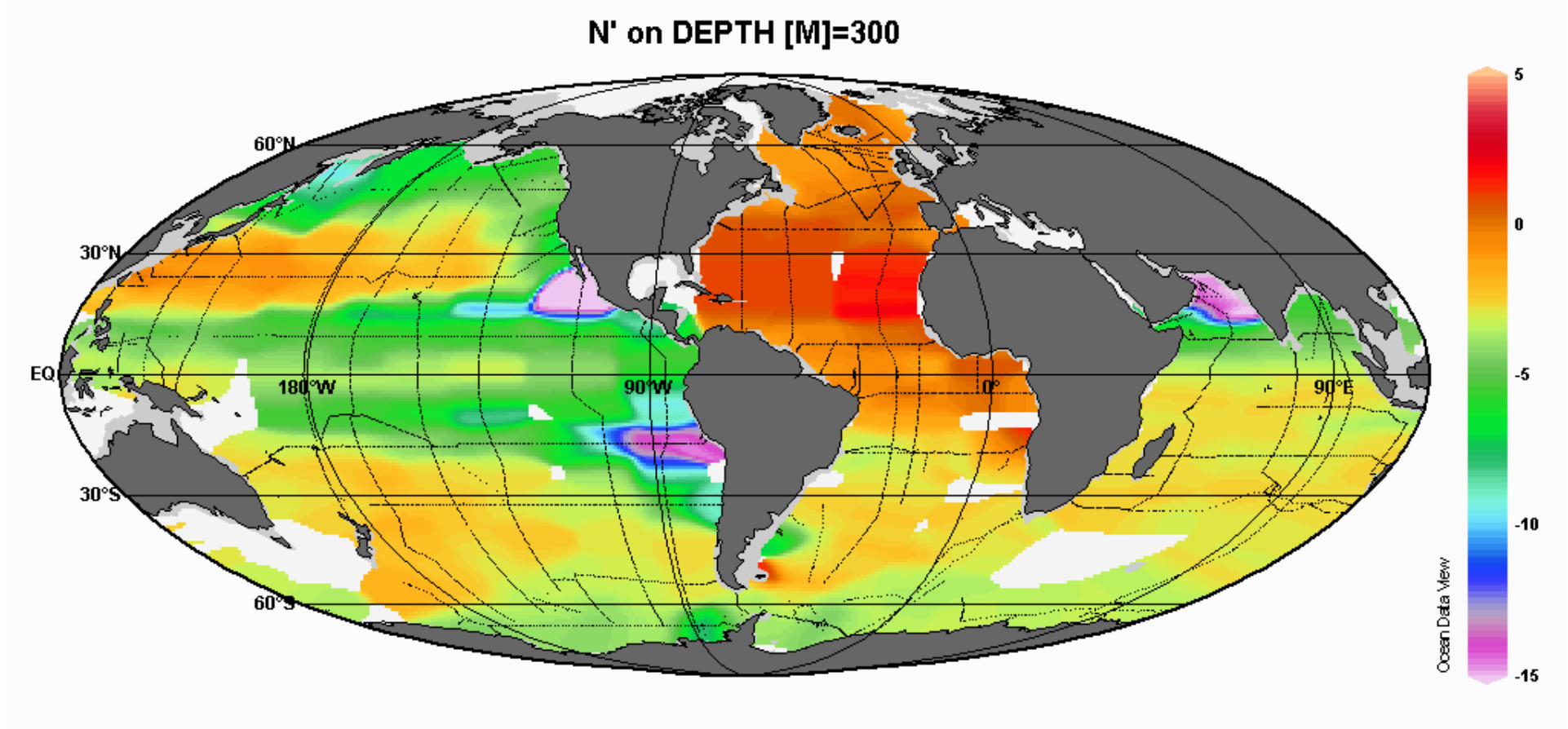
Deviations from Redfield



Geographic Separation between N Source and Sink

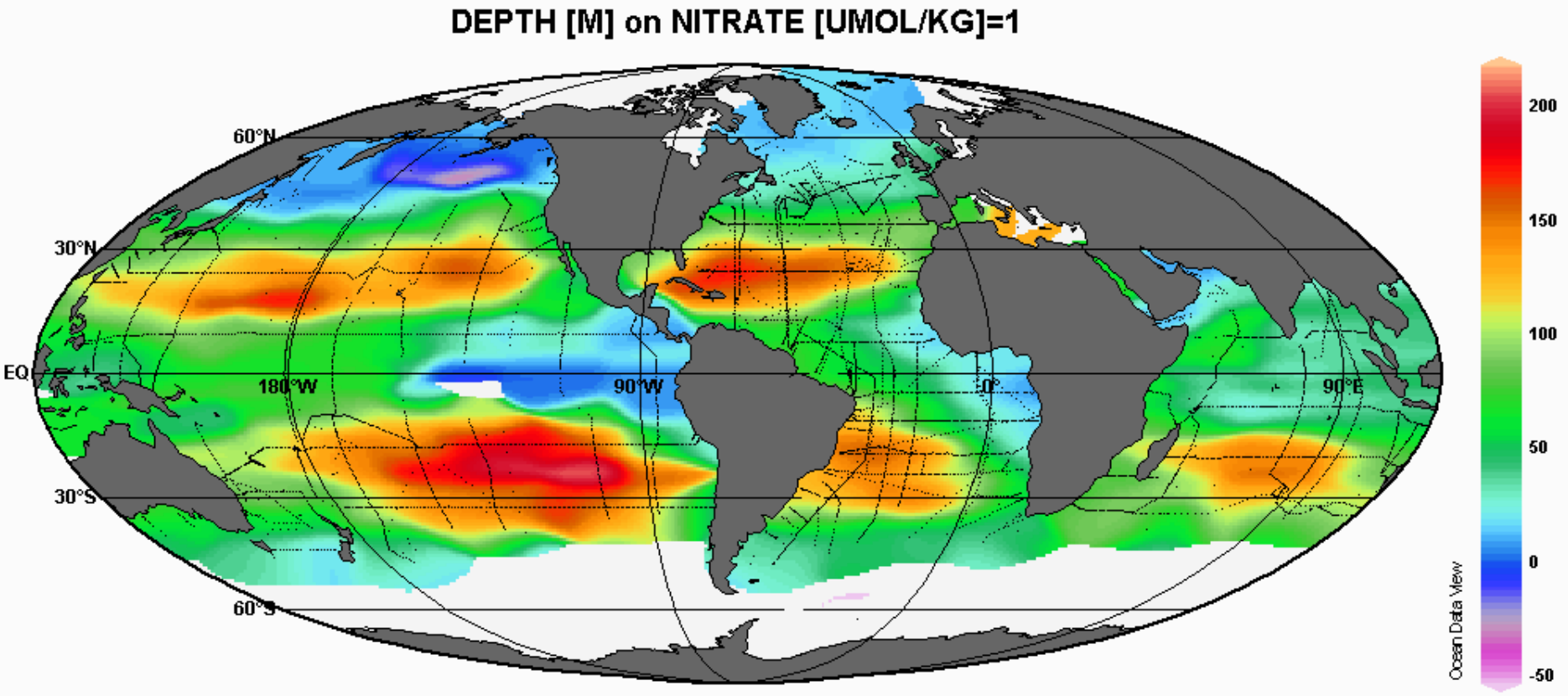


Global Distrubution of NO_3^- Anomalies

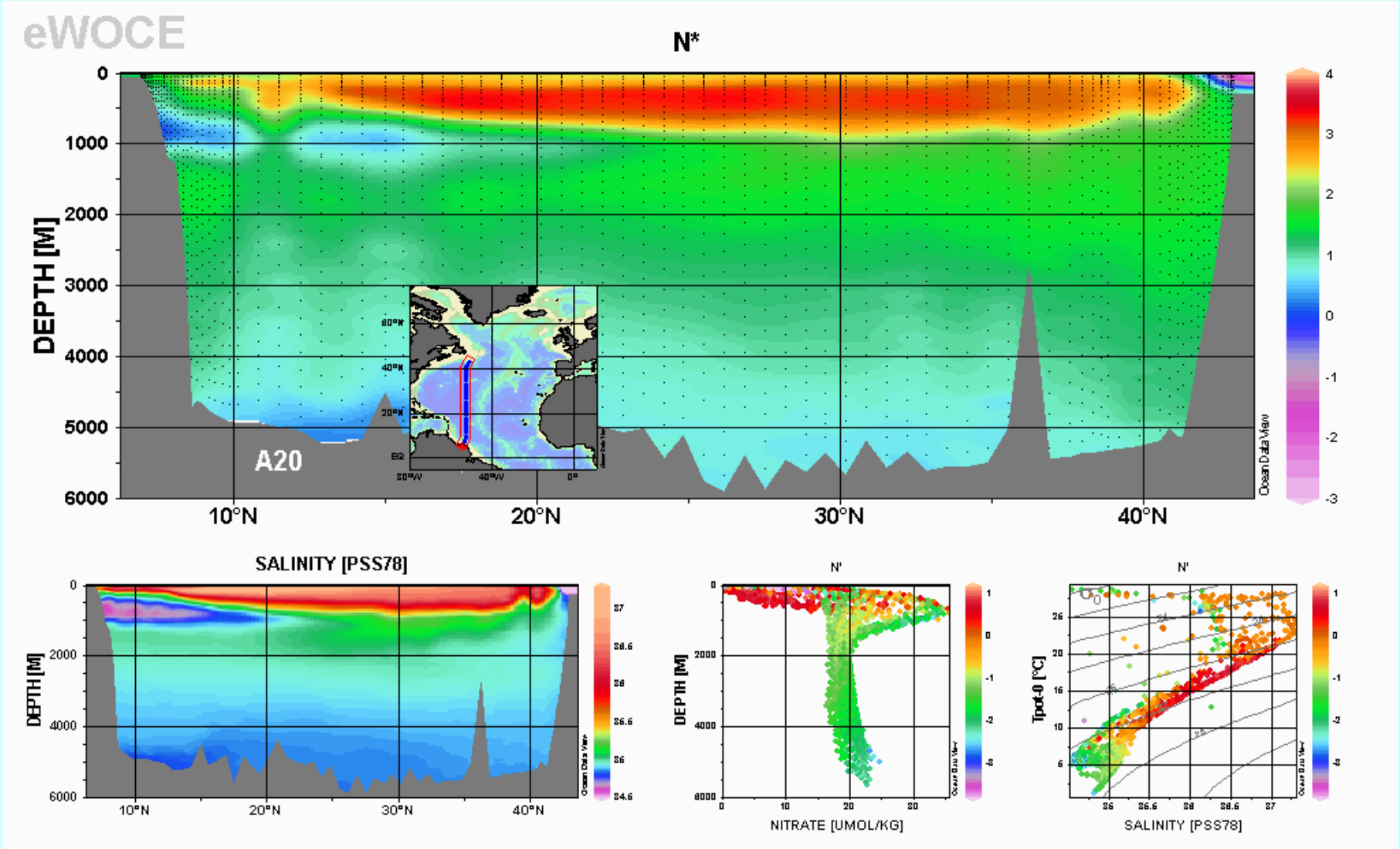


$$N' = NO_3^- + NO_2^- - 16 \times PO_4^{-3}$$

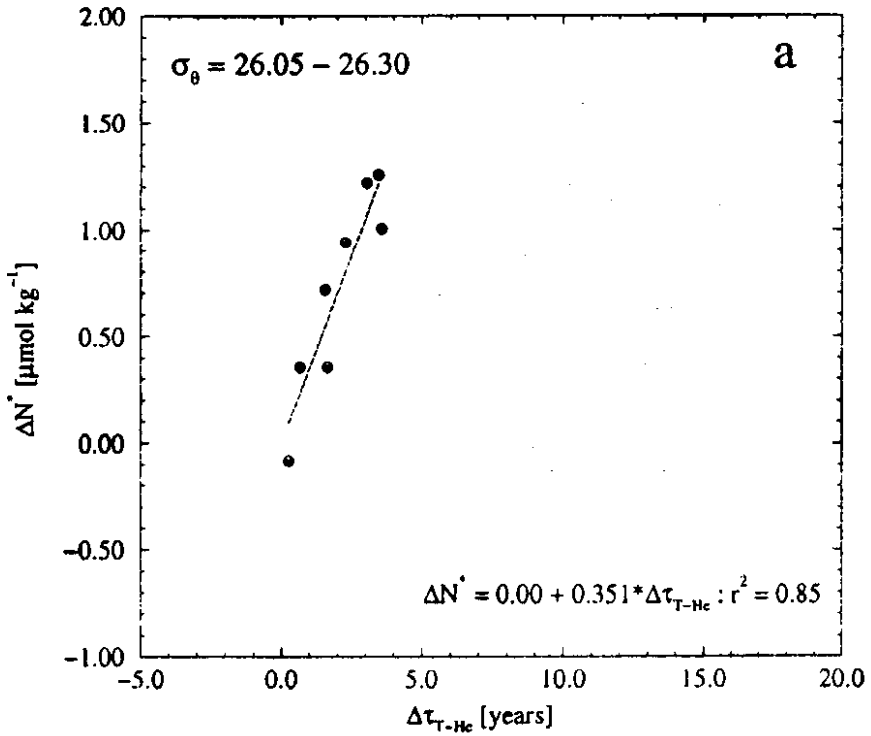
Depth of Nitracline as Indicator of N-rich and N-poor regions

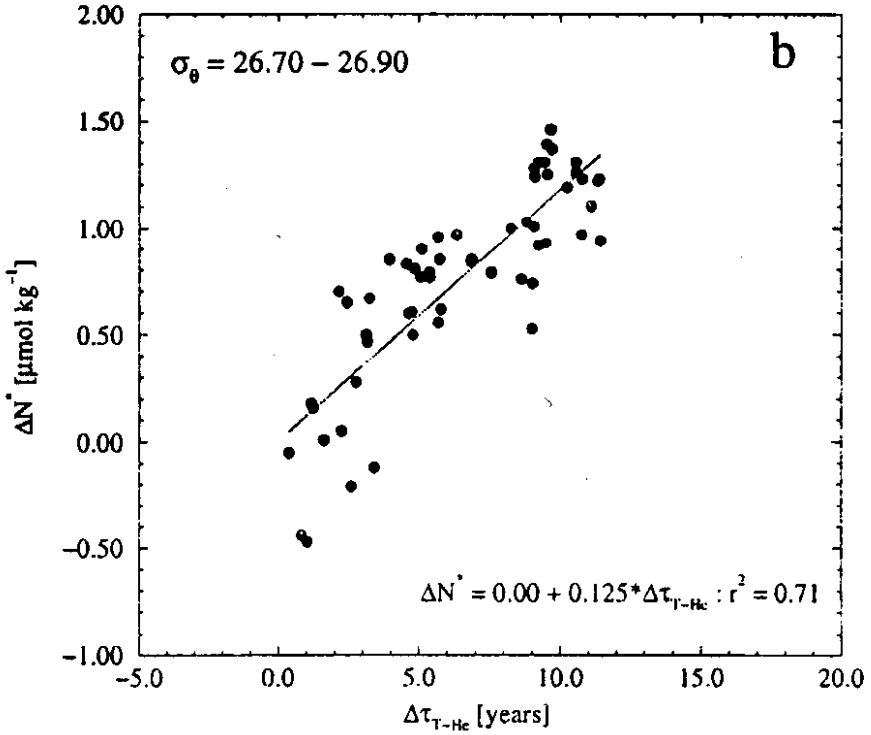


N_2 Fixation Effects: Sargasso Sea

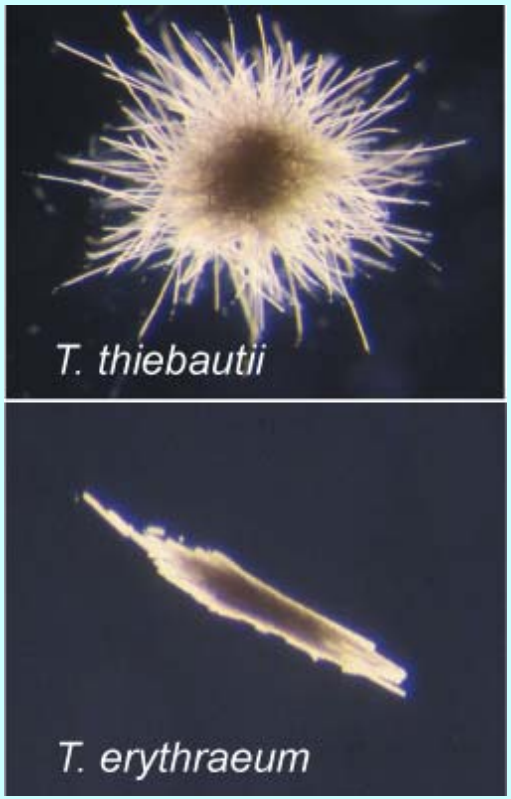


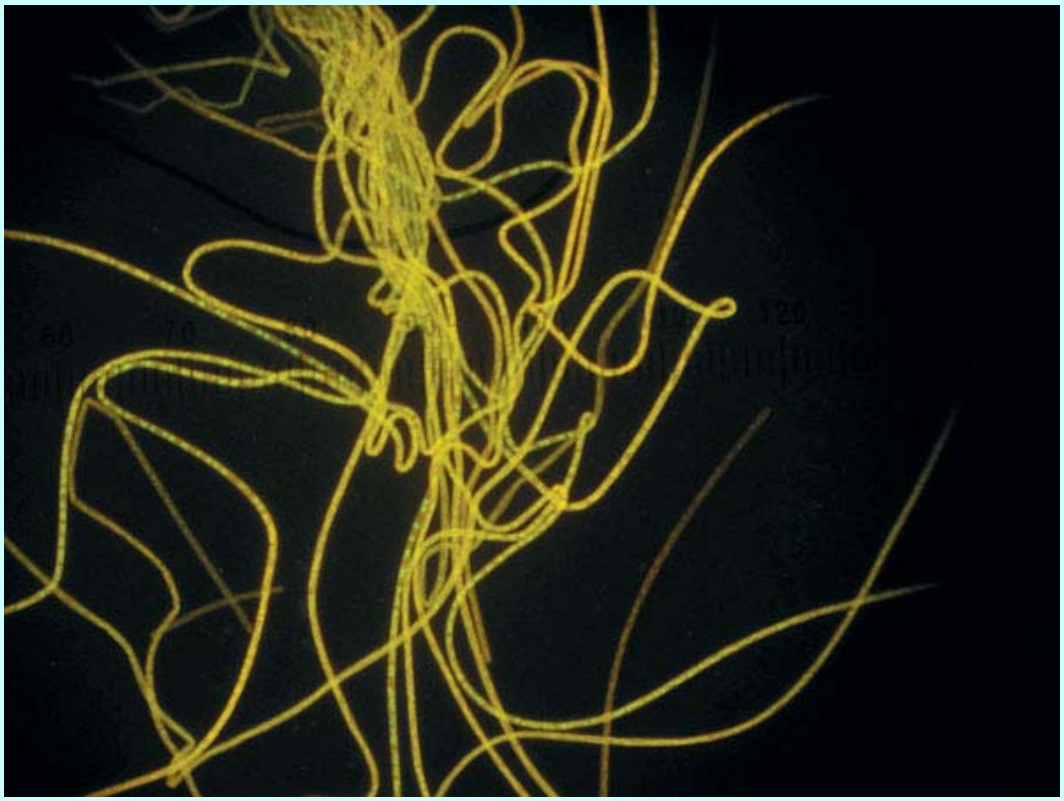
Estimation of N_2-fixation rate





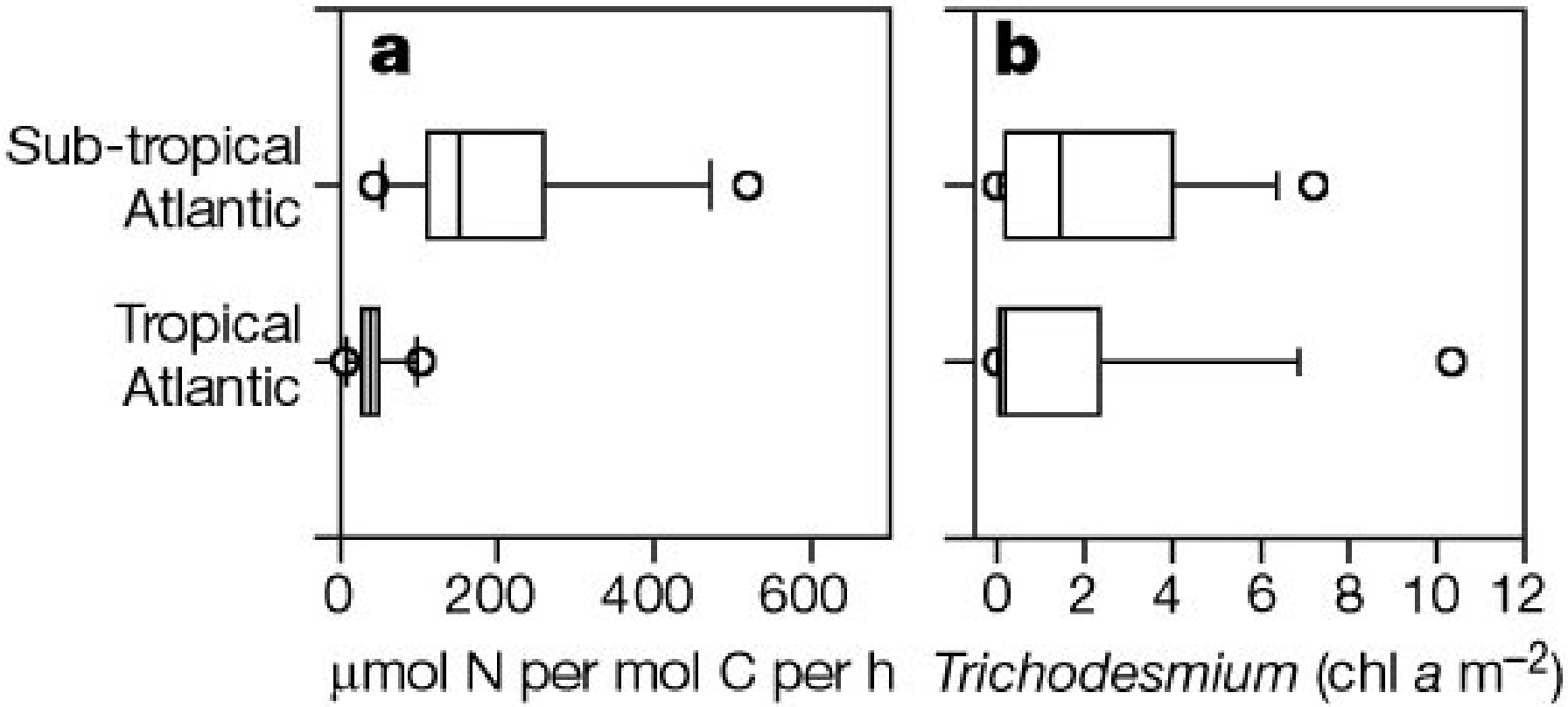
Trichodesmium -Primary Oceanic N_2 Fixer





Nature **411** , 66 - 69 (2001); doi:10.1038/35075041 **Phosphorus limitation of nitrogen fixation by *Trichodesmium* in the central Atlantic Ocean**

SERGIO A. SAÑUDO-WILHELMY*, ADAM B. KUSTKA*, CHRISTOPHER J. GOBLER†, DAVID A. HUTCHINS‡, MIN YANG*, KAMAZIMA LWIZA*, JAMES BURNS§, DOUGLAS G. CAPONE§, JOHN A. RAVEN & EDWARD J. CARPENTER¶



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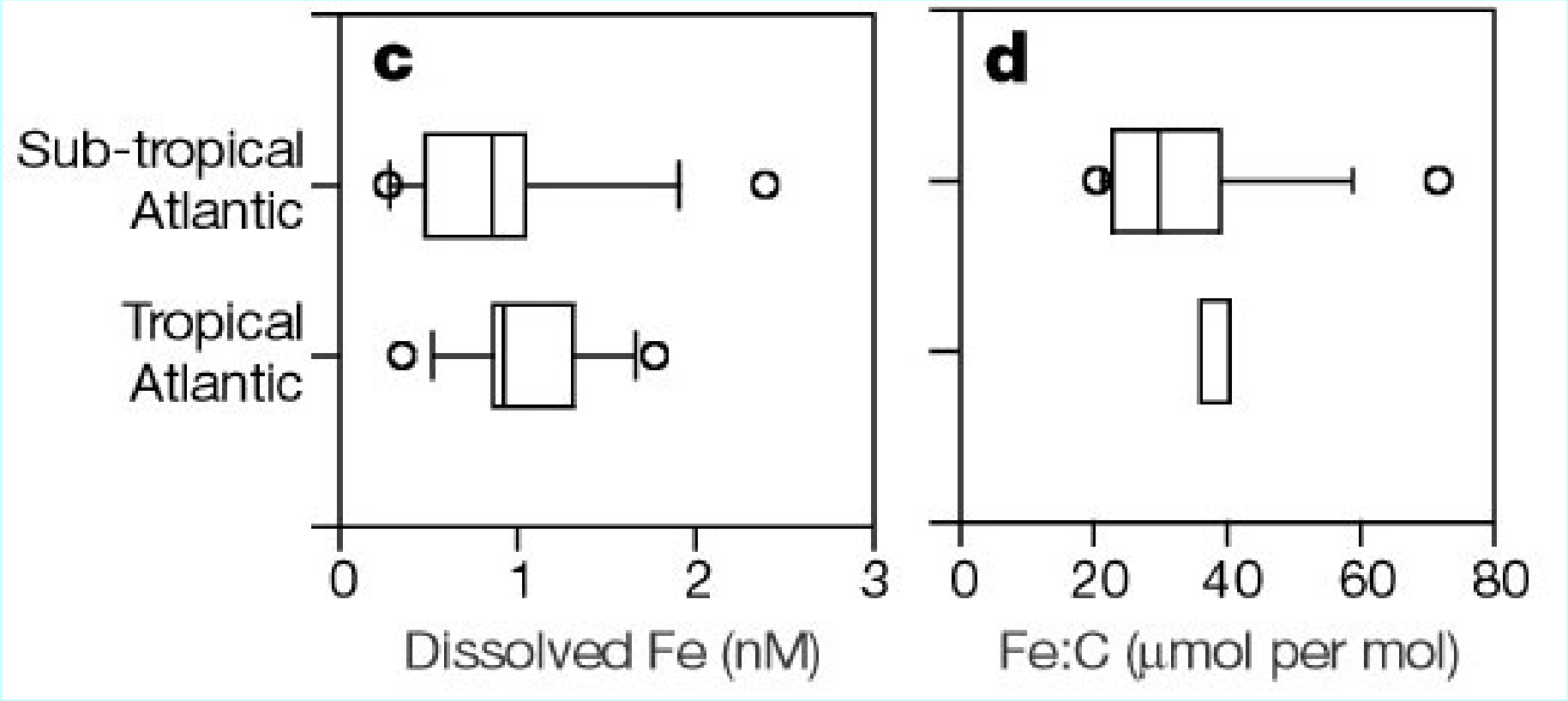

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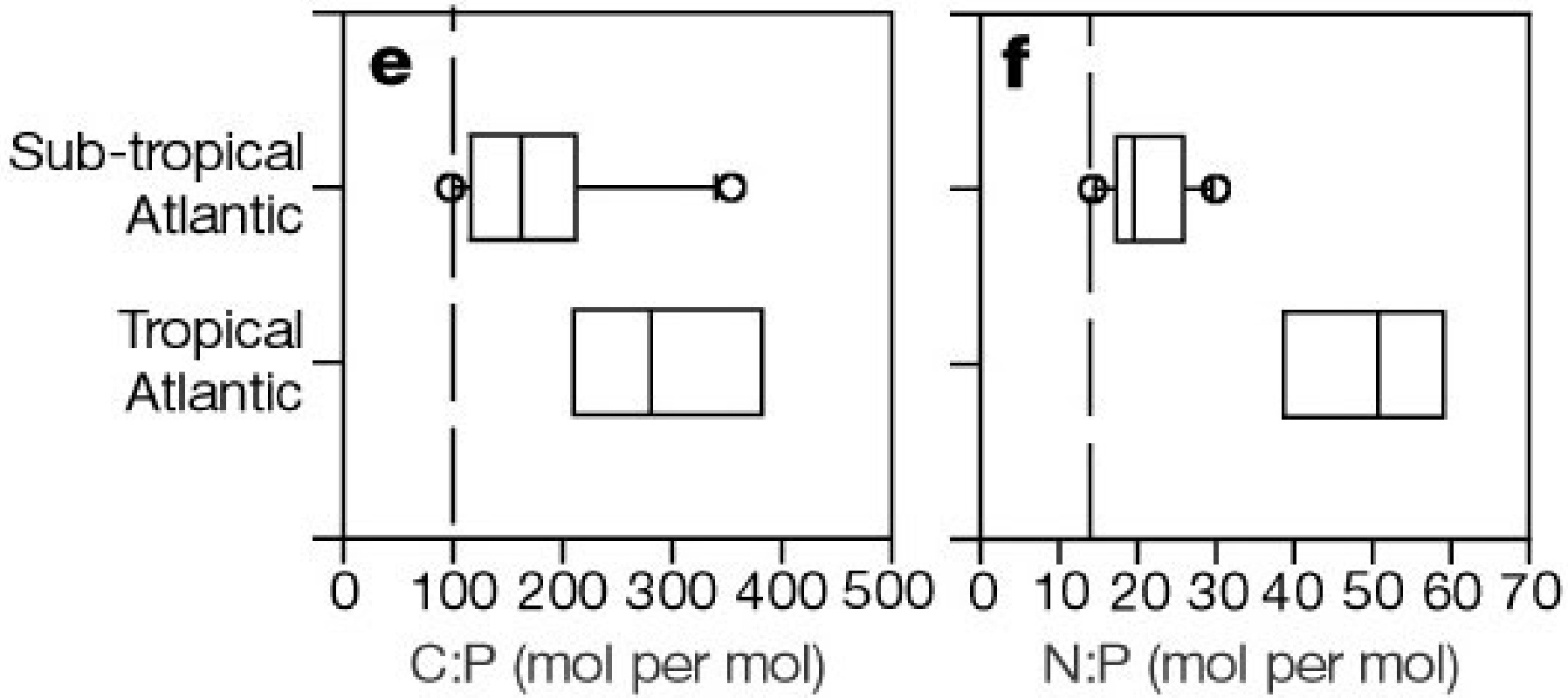

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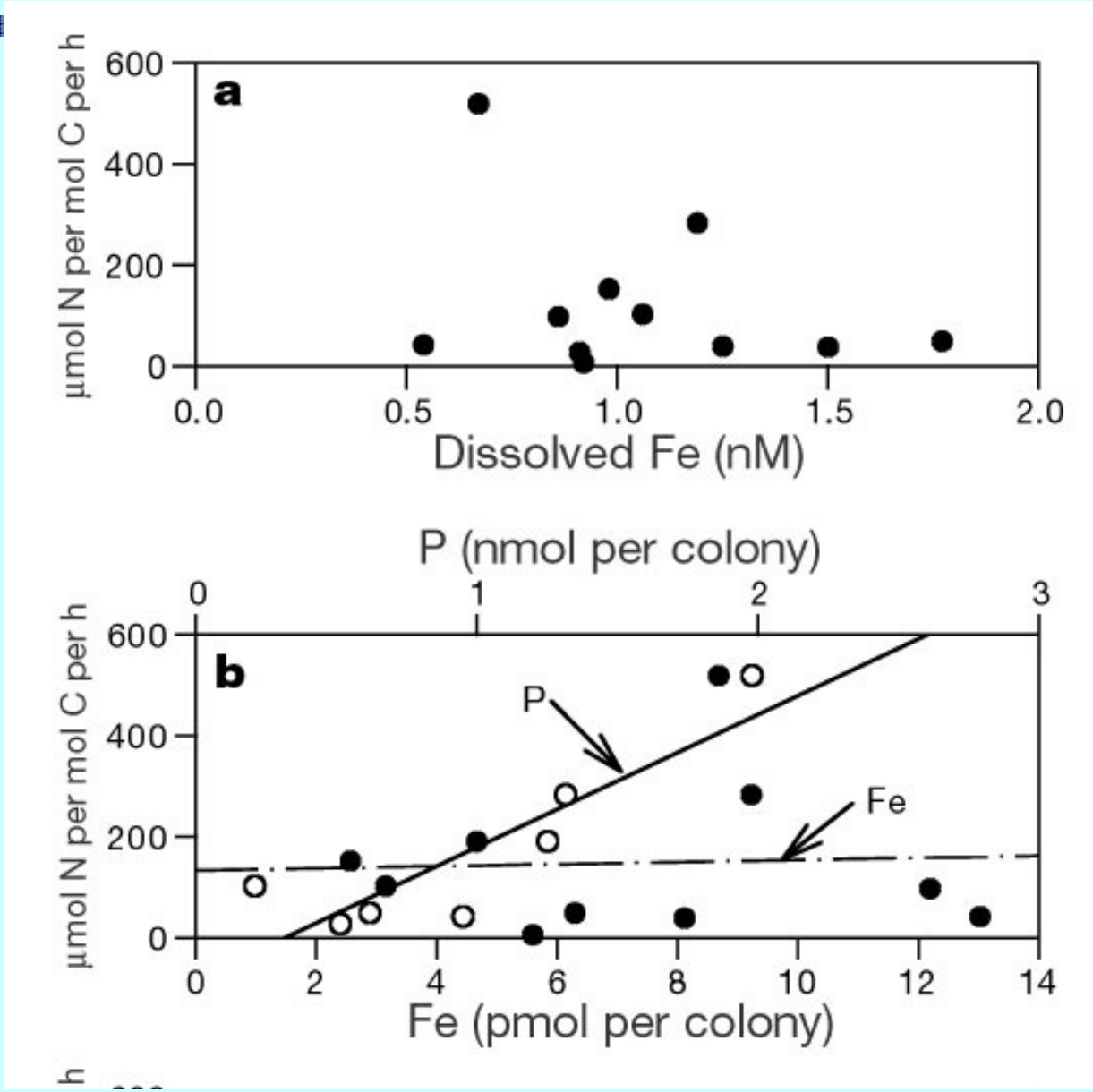
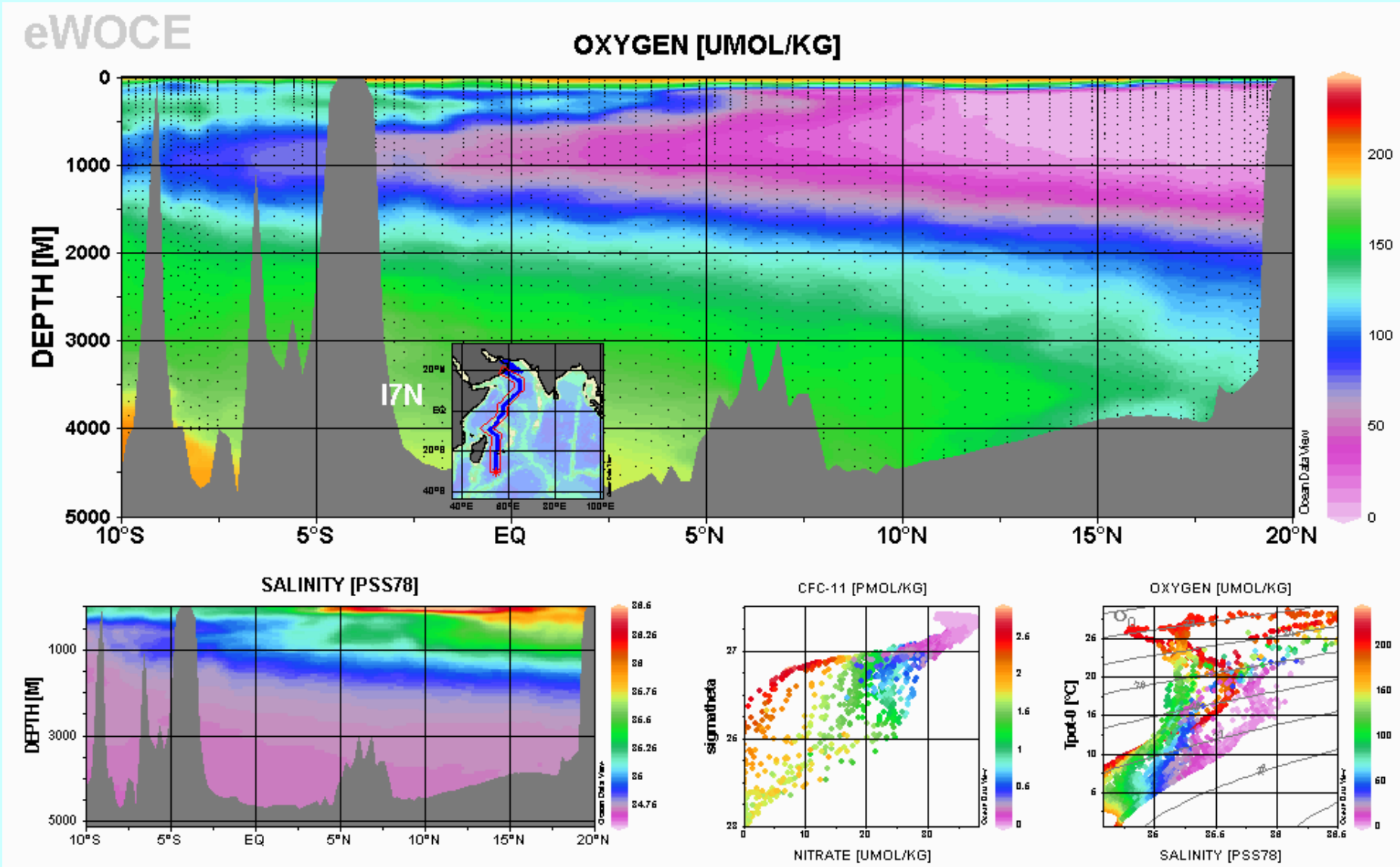
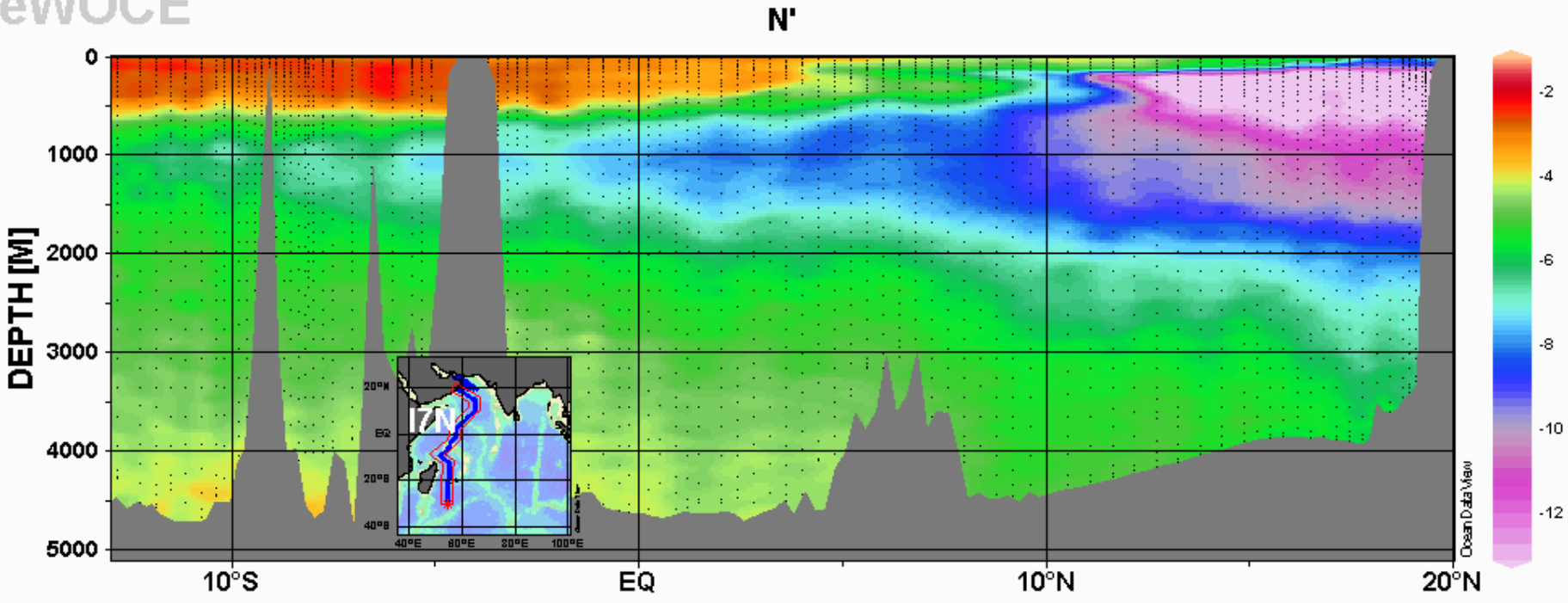
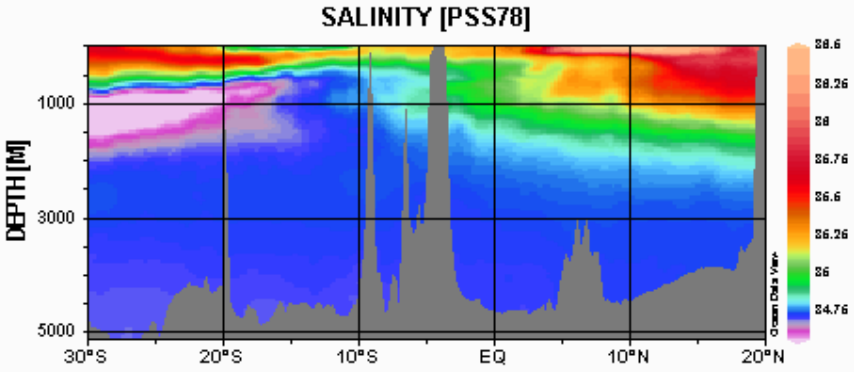


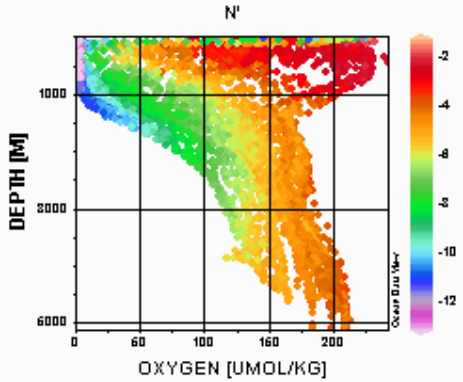
Water Column Denitrification Effects: Arabian Sea

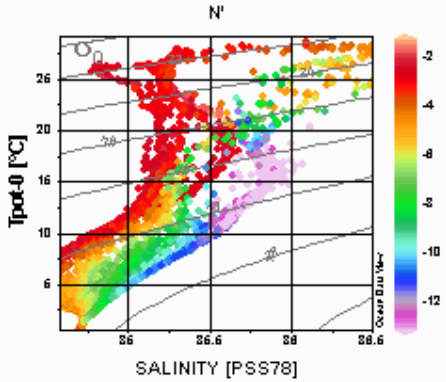


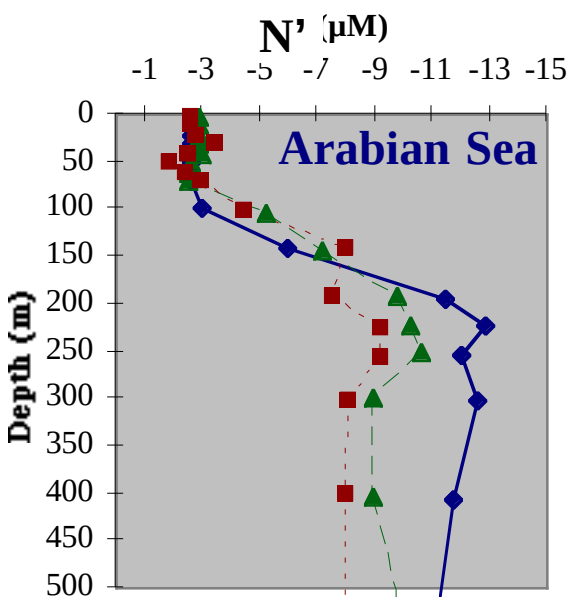
eWOCE

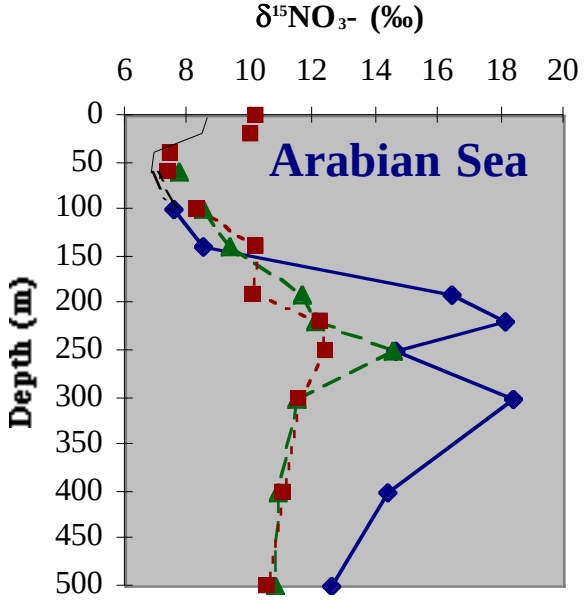

N'
DEPTH [M]
0
1000
2000
3000
4000
5000
10°S
EQ
10°N
20°N
I7N
-2
-4
-6
-8
-10
-12

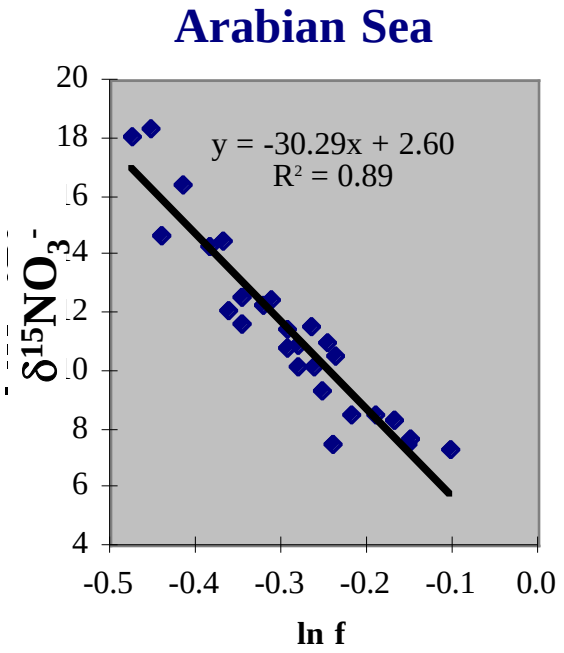

SALINITY [PSS78]
DEPTH [M]
1000
3000
5000
30°S
20°S
10°S
EQ
10°N
20°N


N'
DEPTH [M]
1000
3000
6000
0
60
100
160
200
OXYGEN [UMOL/KG]

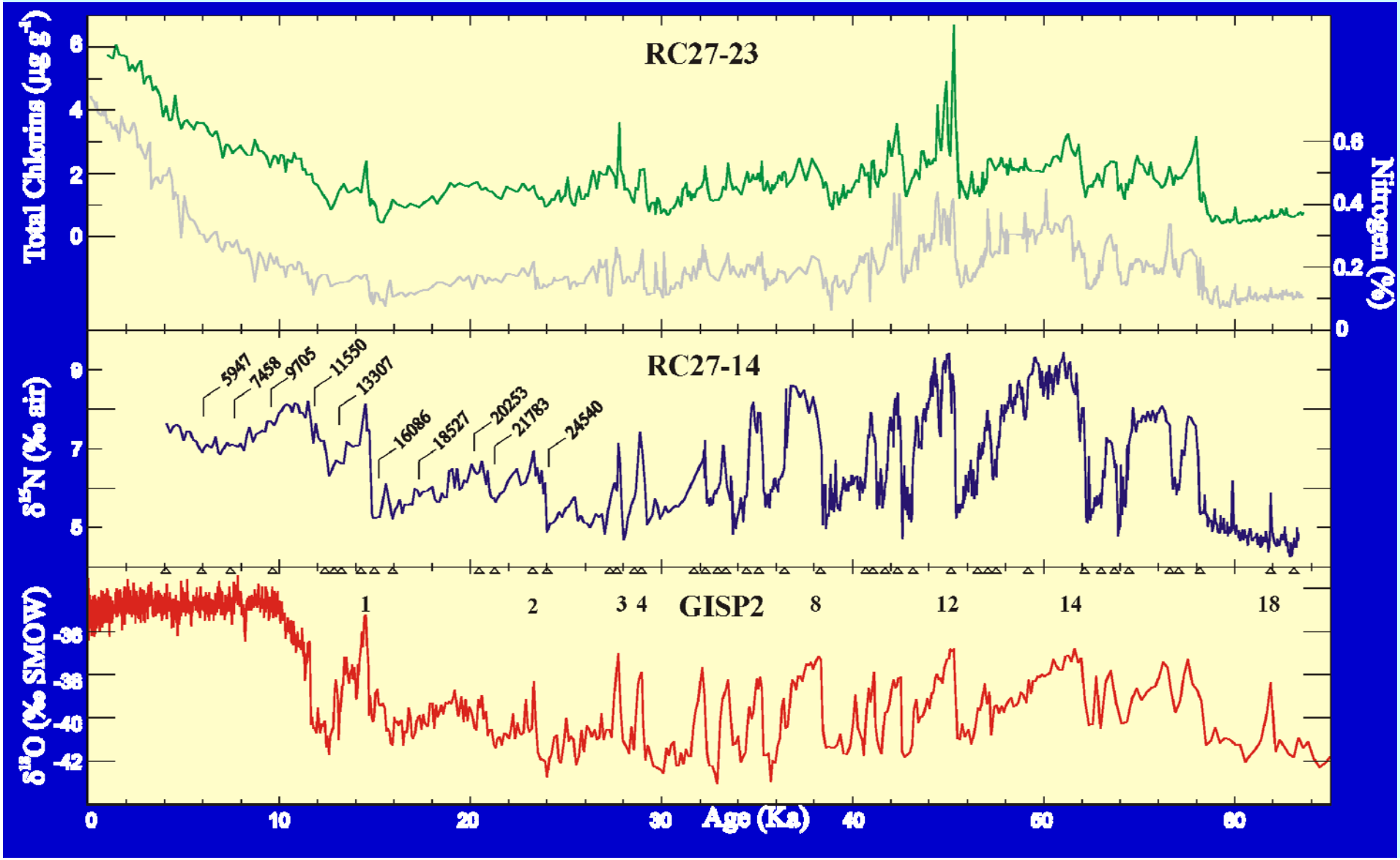

N'
Tpot-0 [°C]
26
20
16
10
6
26
26.6
28
28.6
SALINITY [PSS78]


N' (µM)
-1 -3 -5 -7 -9 -11 -13 -15
Depth (m)
0 50 100 150 200 250 300 350 400 450 500
Arabian Sea

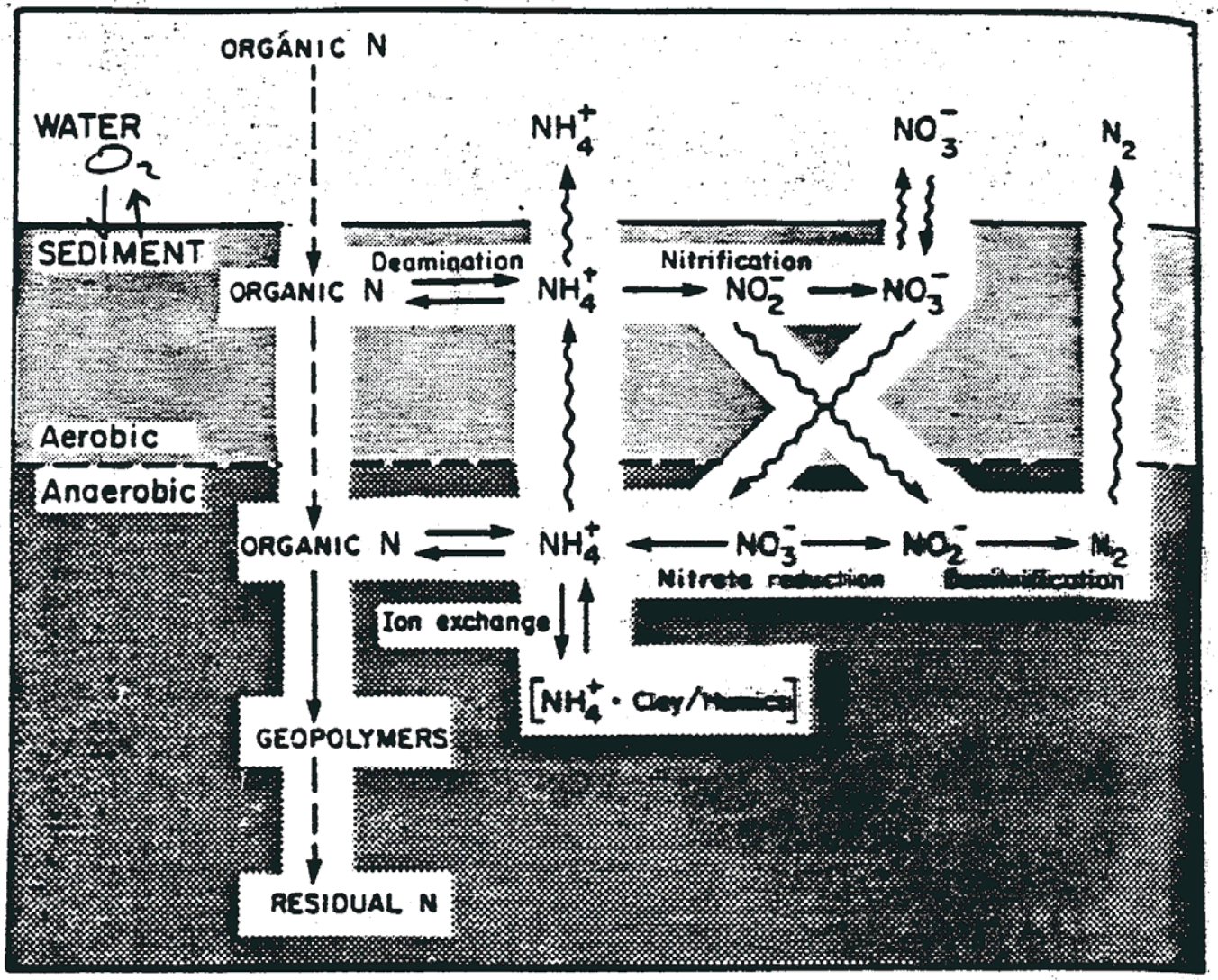

δ15NO3- (‰)
6 8 10 12 14 16 18 20
Depth (m)
0 50 100 150 200 250 300 350 400 450 500
Arabian Sea


Arabian Sea
y = -30.29x + 2.60
R² = 0.89
δ15NO3-
20 18 16 14 12 10 8 6 4
-0.5 -0.4 -0.3 -0.2 -0.1 0.0
ln f

Past Reconstruction of Denitrification Intensity



Sediment Denitrification Effects



100 Tg

Journal of Marine Research

Christensen & Rowe, 1984

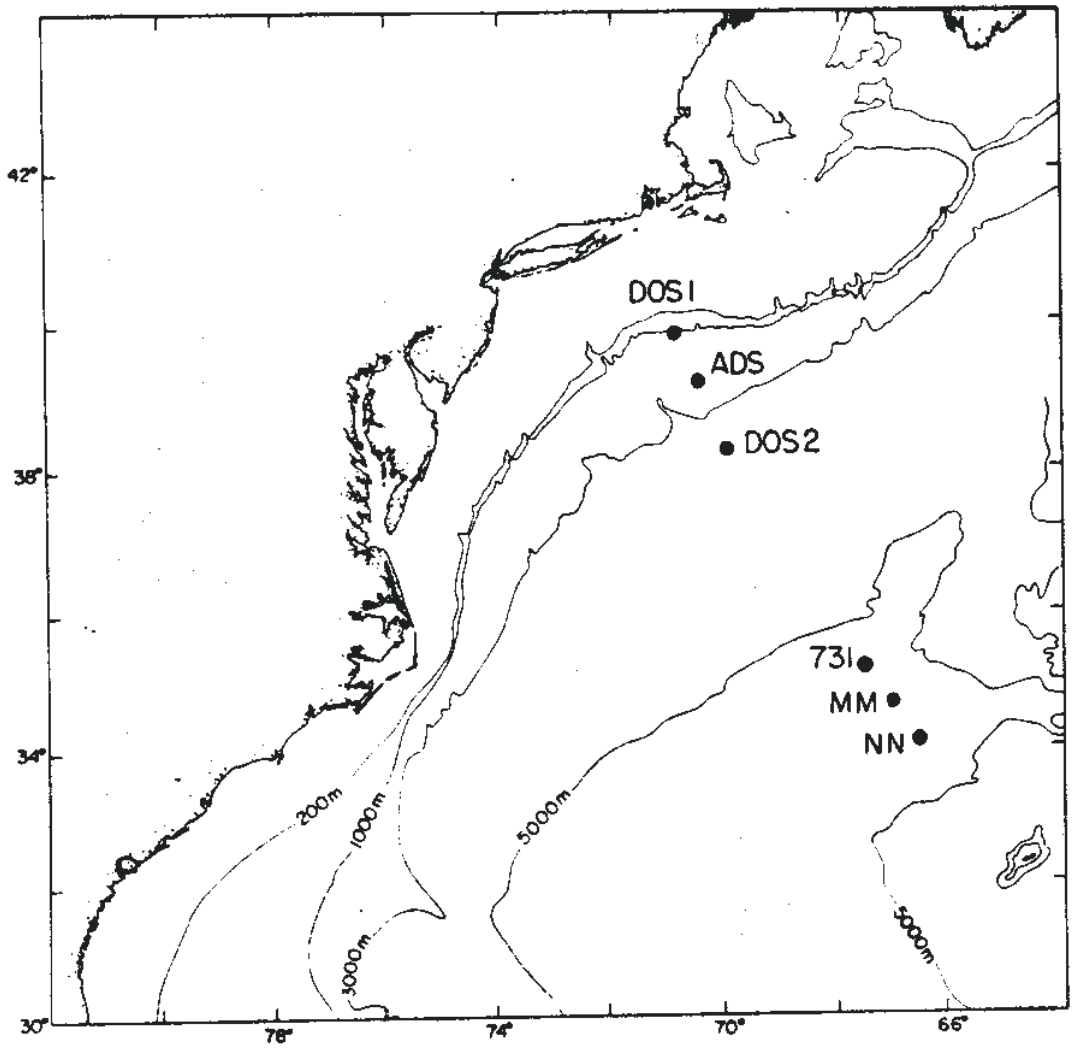
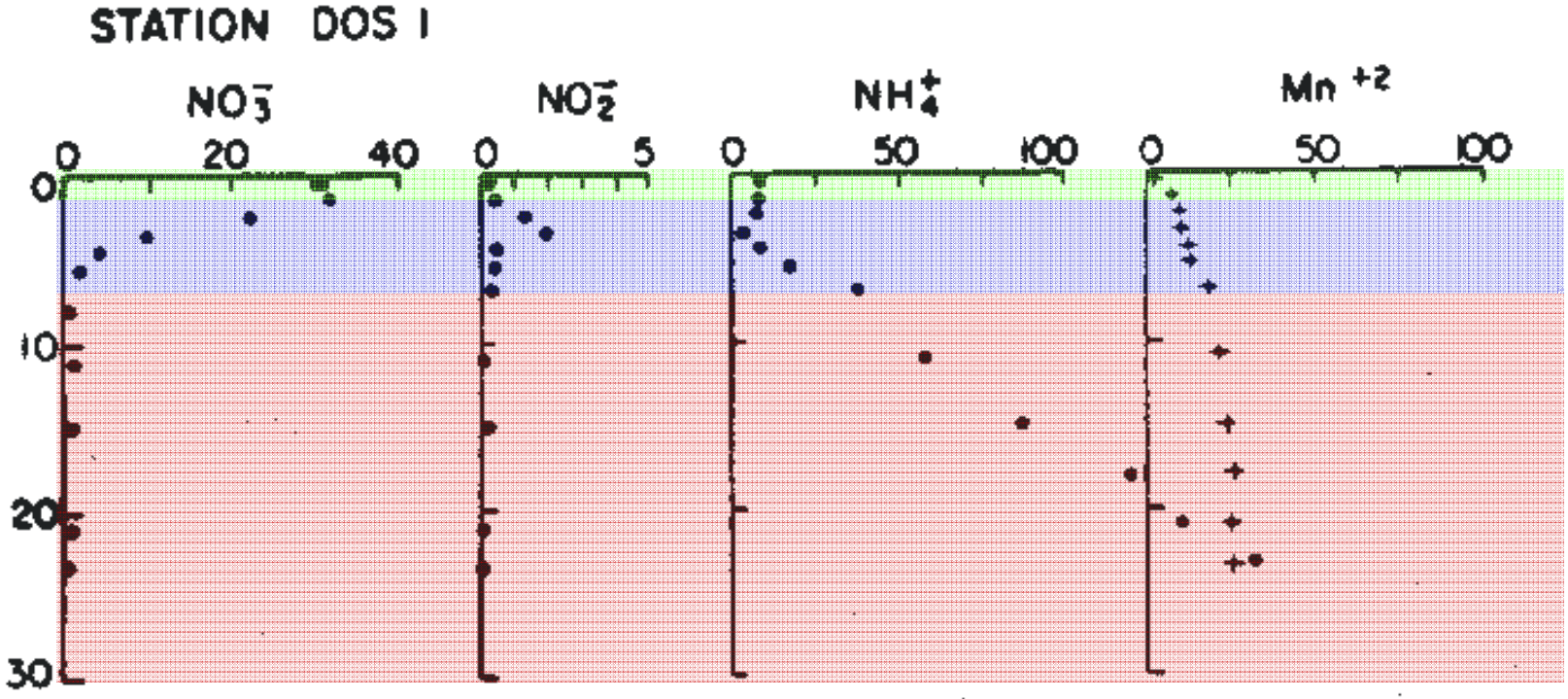
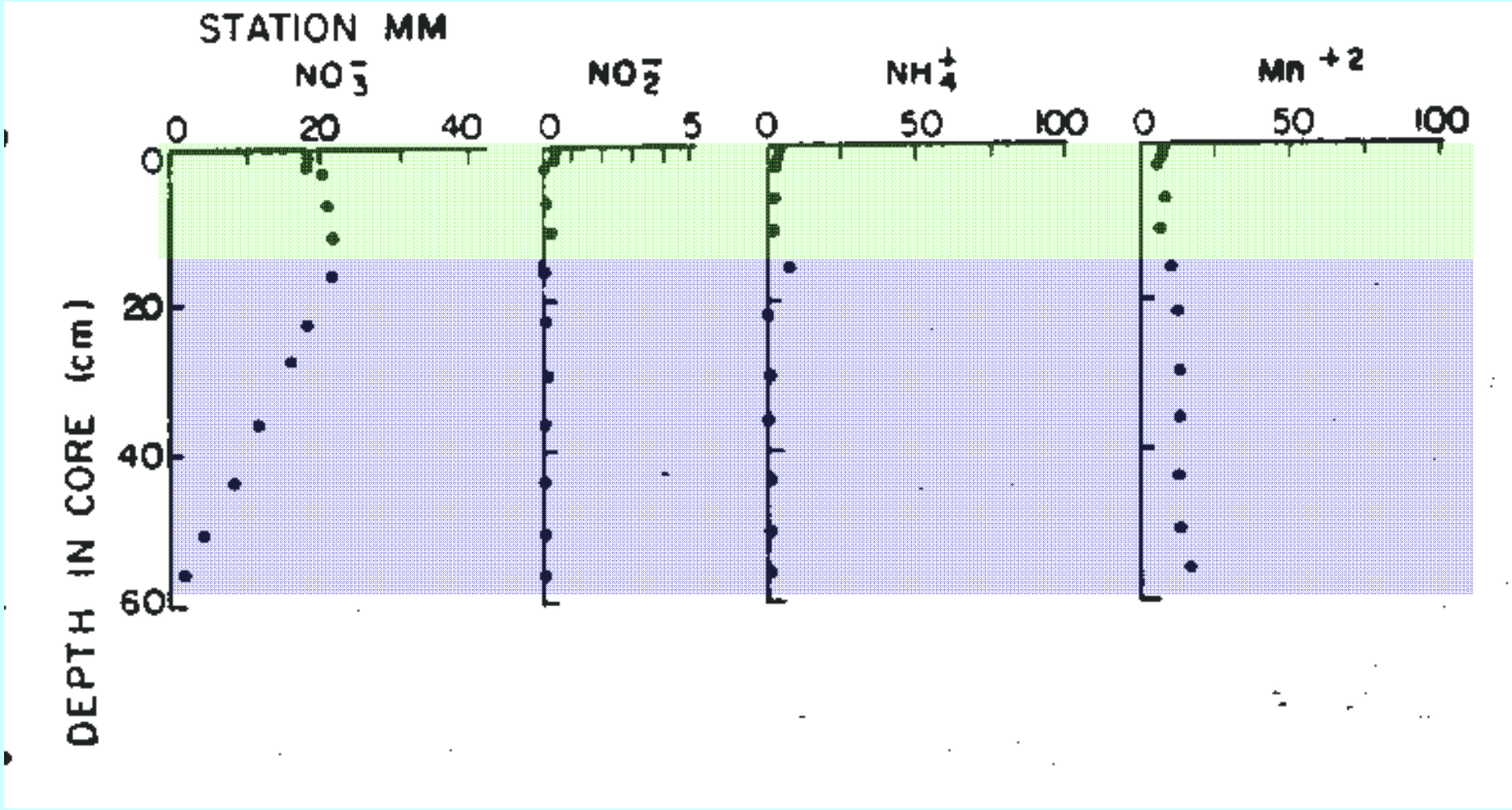


Figure 1. Station locations.

Vertical Segregation of N Transformation Processes by Red-Ox Zone



Vertical Segregation of N Transformation Processes by Red-Ox Zone



Vertical Segregation of N Transformation Processes by Red-Ox Zone