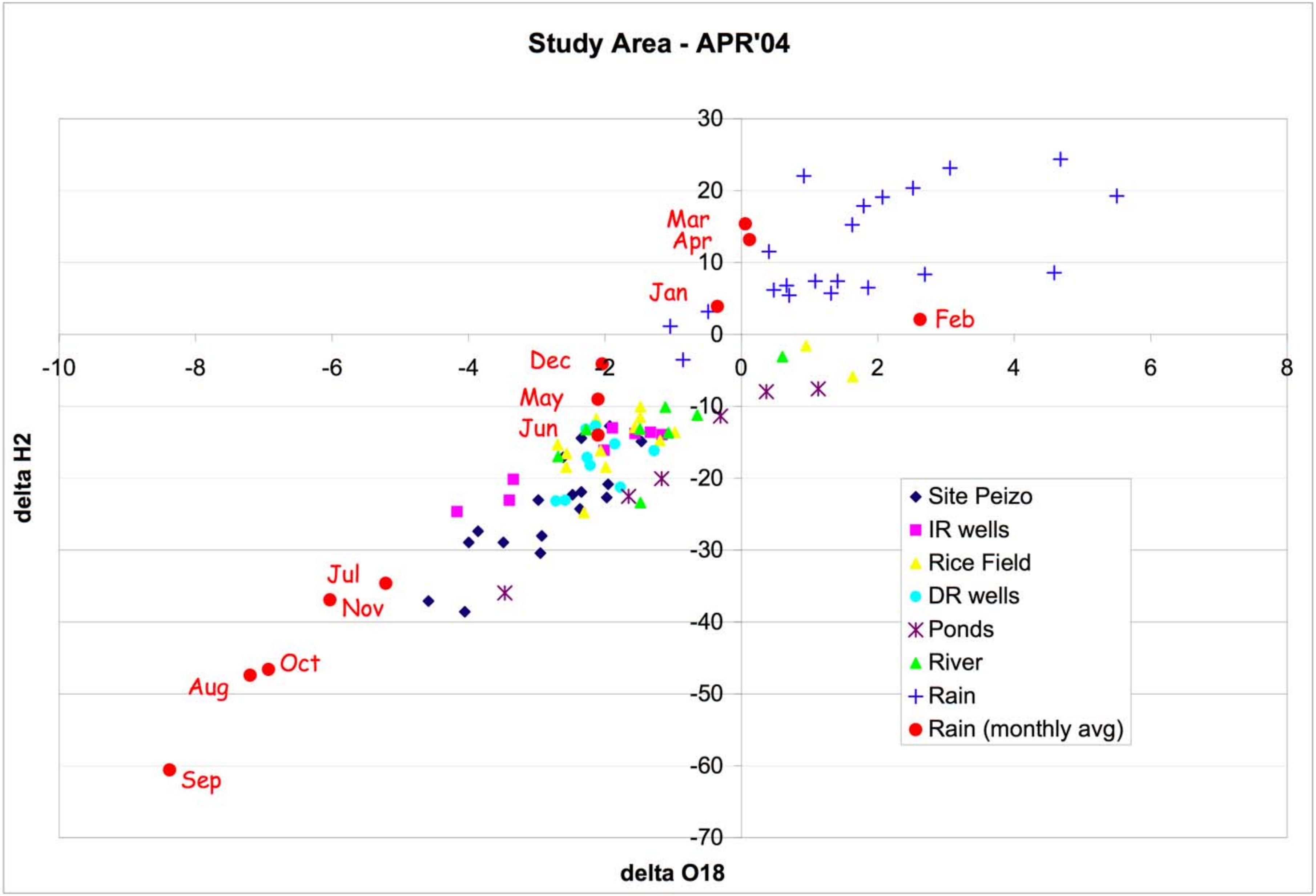
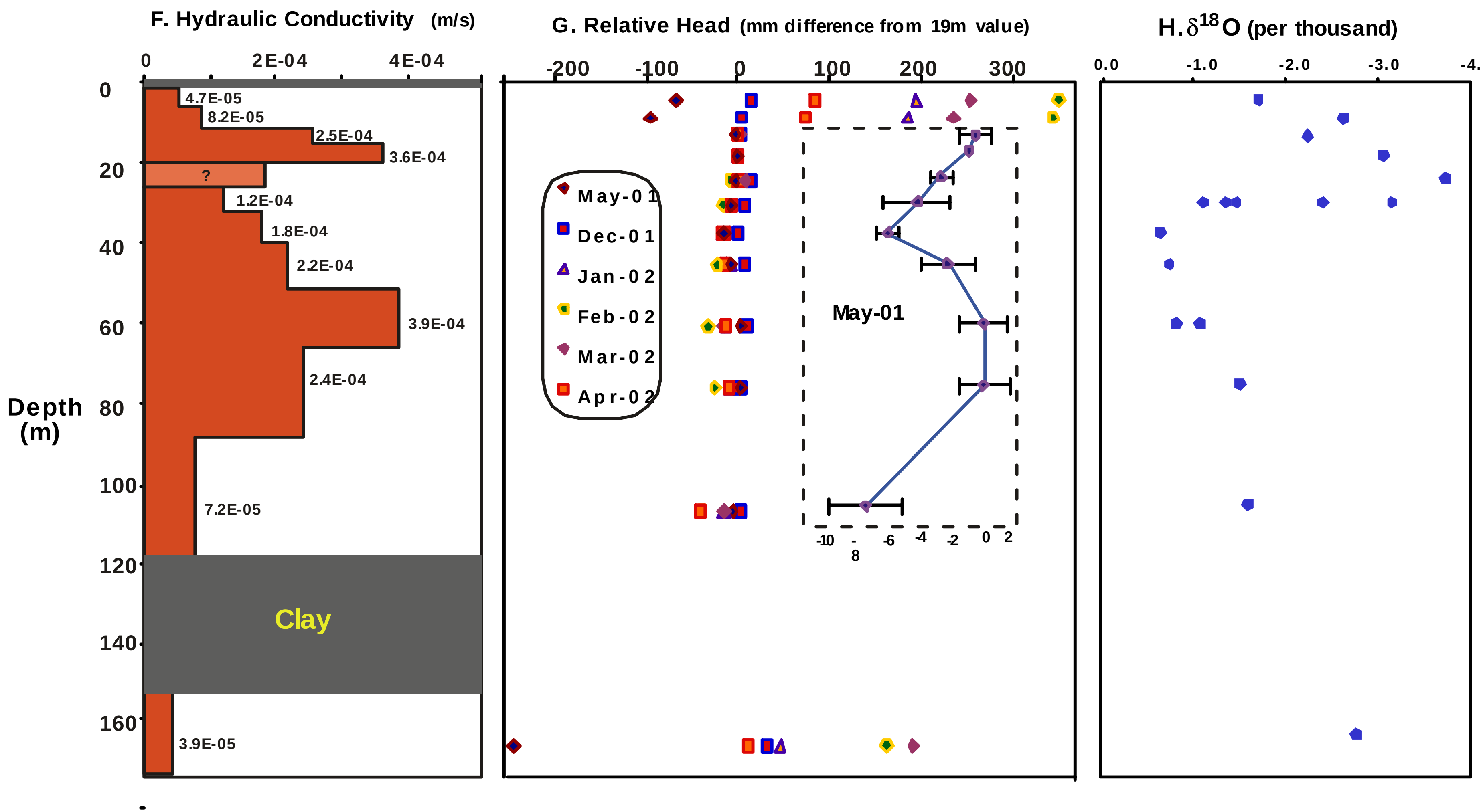
Stable Water Isotopes

The fundamental control on the isotopic composition of precipitation is temperature. With increasing temperature, precipitation becomes enriched in the heavier isotopes, ^{18}O and ^{2}H, in a linear relationship. Temperature affects fractionation at a rate of approximately 0.5‰ for every C° for oxygen. Similar effects are shown with increasing elevation and increased distance from the equator (both of which correspond to lower temperature). Because precipitation becomes progressively enriched in light oxygen as it moves toward the cold polar regions, polar ice constitutes a reservoir of ^{16}O enriched water as compared to sea water.



Study Area - APR'04
delta H2
delta O18
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-10
-8
-6
-4
-2
0
2
4
6
8
Mar
Apr
Jan
Feb
Dec
May
Jun
Jul
Nov
Oct
Aug
Sep
Site Peizo
IR wells
Rice Field
DR wells
Ponds
River
Rain
Rain (monthly avg)

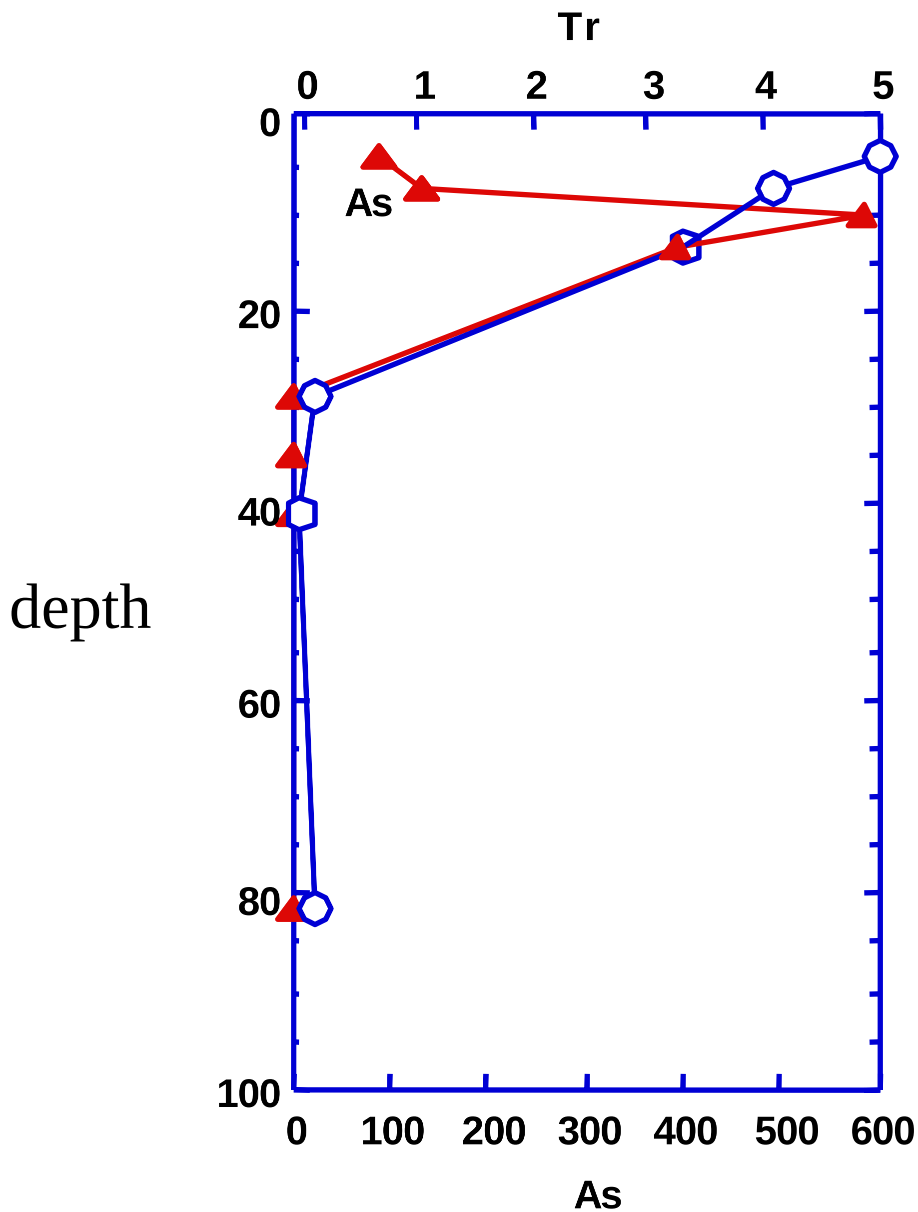

F. Hydraulic Conductivity (m/s)
0
2E-04
4E-04
Depth (m)
0
20
40
60
80
100
120
140
160
4.7E-05
8.2E-05
2.5E-04
3.6E-04
?
1.2E-04
1.8E-04
2.2E-04
3.9E-04
2.4E-04
7.2E-05
Clay
3.9E-05
G. Relative Head (mm difference from 19m value)
-200
-100
0
100
200
300
May-01
Dec-01
Jan-02
Feb-02
Mar-02
Apr-02
May-01
-10
-8
-6
-4
-2
0
2
H. δ18O (per thousand)
0.0
-1.0
-2.0
-3.0
-4.0

Tritium and Helium

$$\left[{}^{3}H\right]=\left[{}^{3}H_{0}\right]e^{-\lambda t}$$

$$\left[{}^{3}H_{0}\right]=\left[{}^{3}He_{trit}\right]+\left[{}^{3}H\right]$$

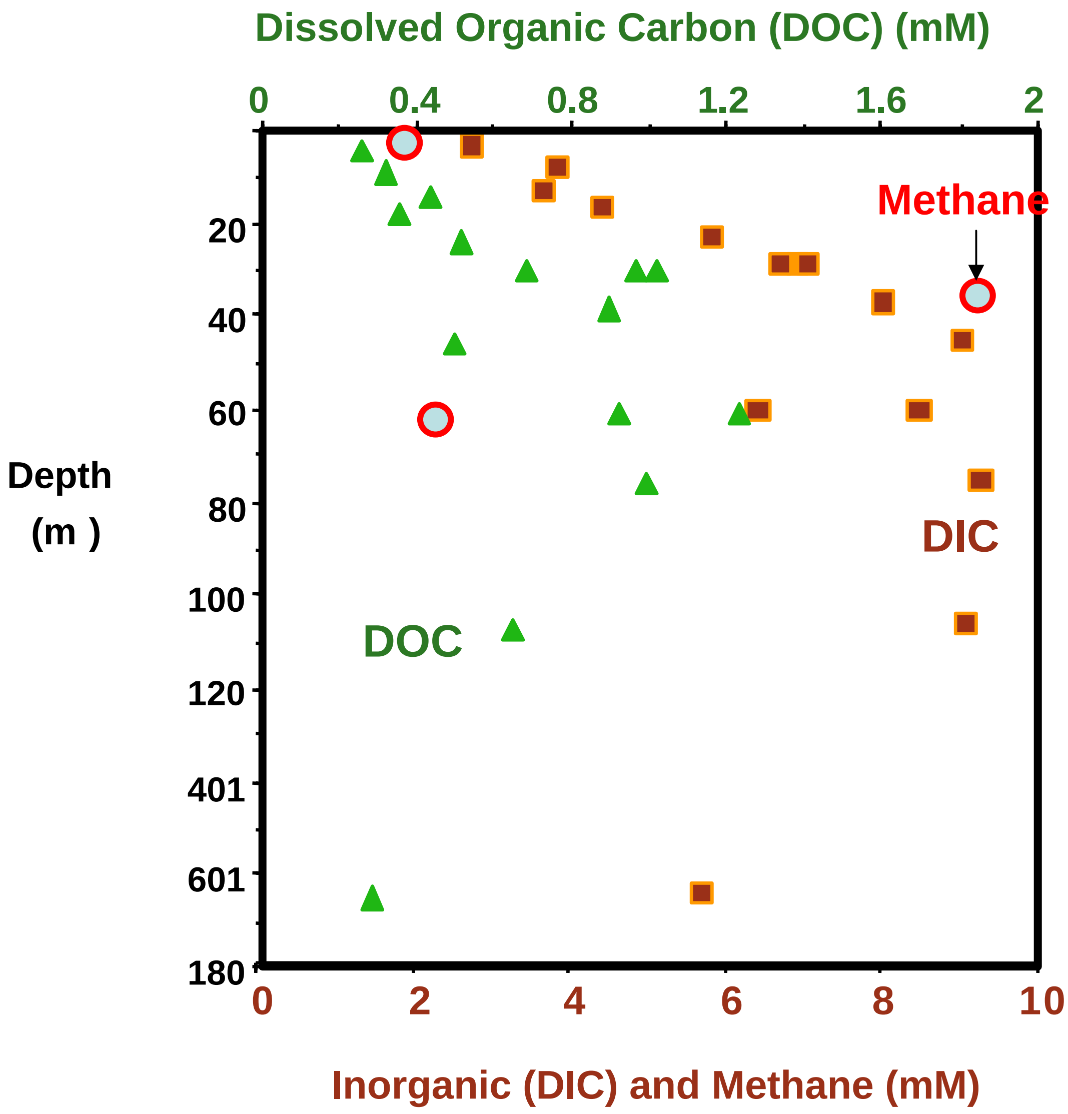
$$t_{{}^{3}H/{}^{3}He}=\frac{1}{\lambda}\ln\left(\frac{[{}^{3}He_{trit}]}{[{}^{3}H]}+1\right)$$



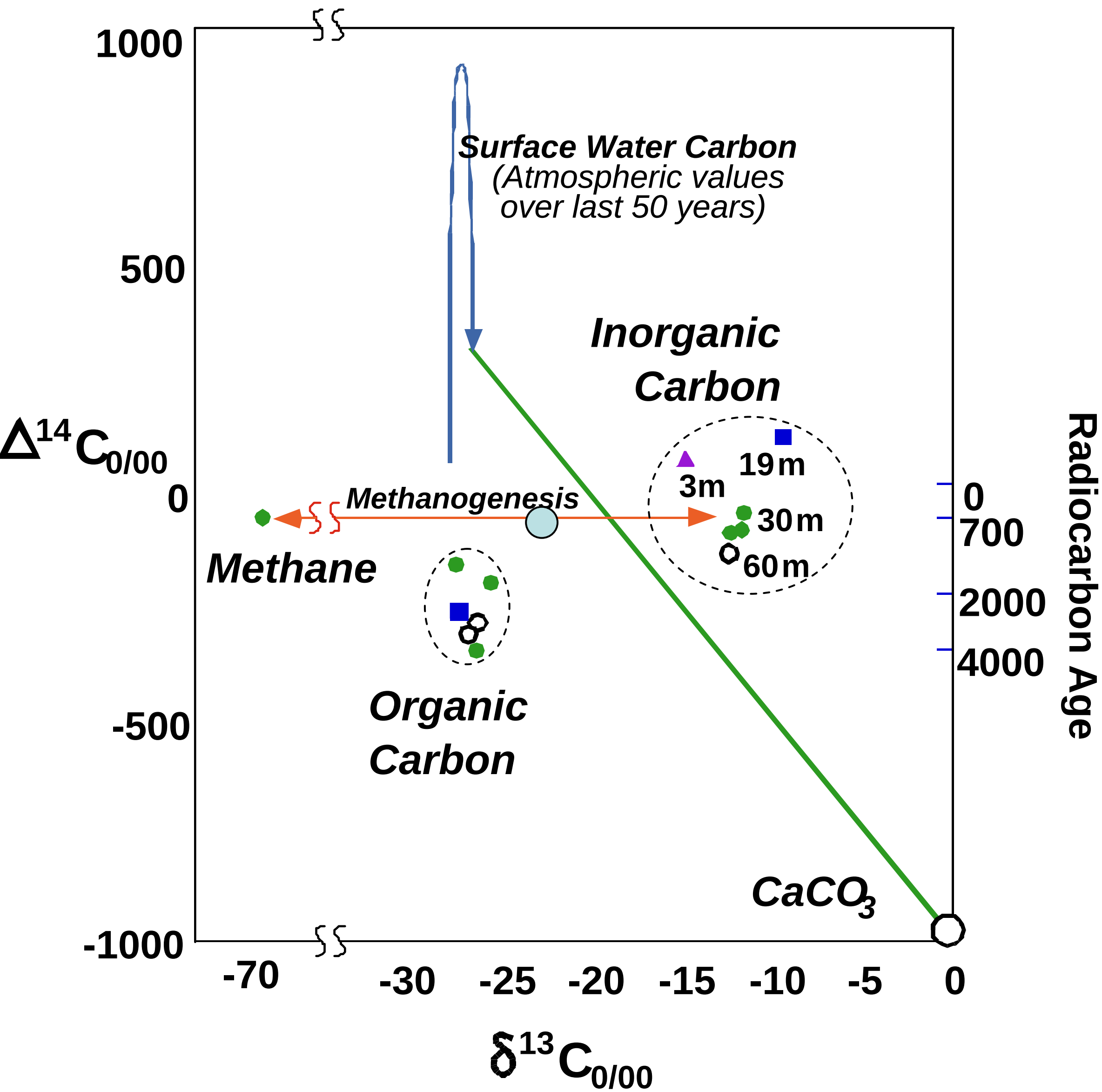
depth
Tr
0
1
2
3
4
5
As
0
20
40
60
80
100
0
100
200
300
400
500
600
As
Tr
0
1
2
3
4
As
0
20
40
60
80
100
0
100
200
300
400
500
600
As

Carbon Isotopes

Dissolved Carbon

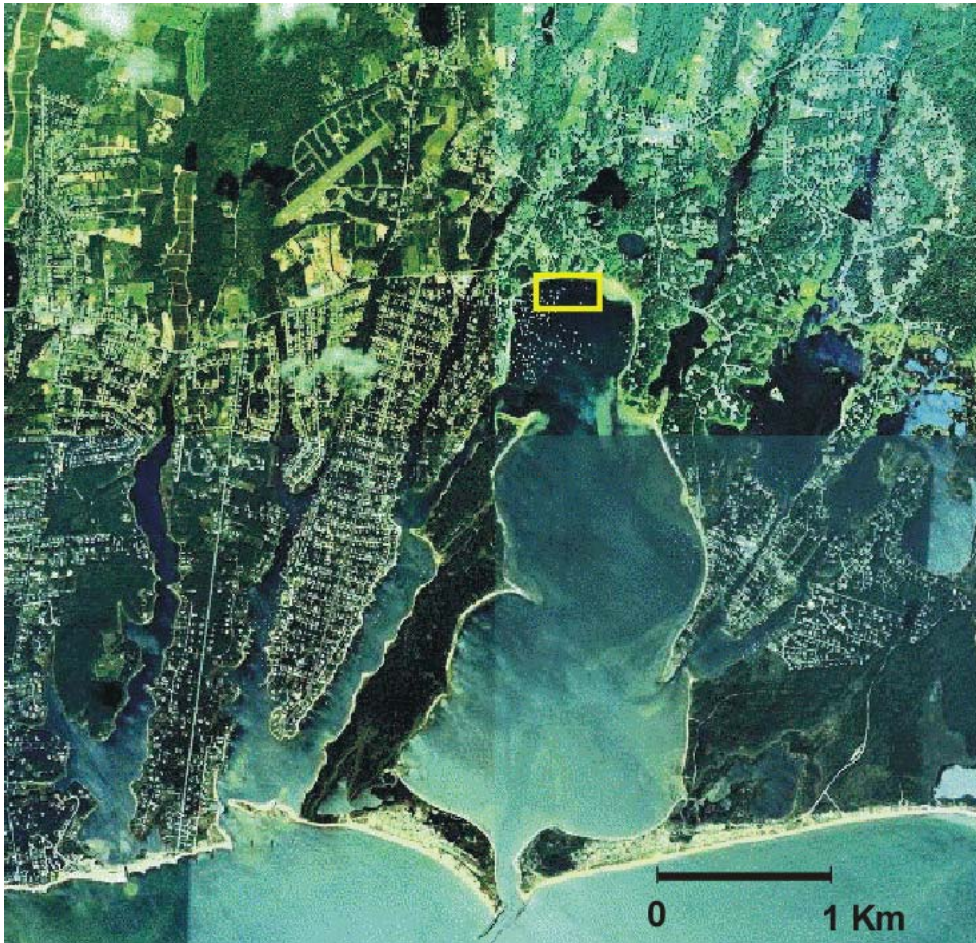


Carbon Isotopes



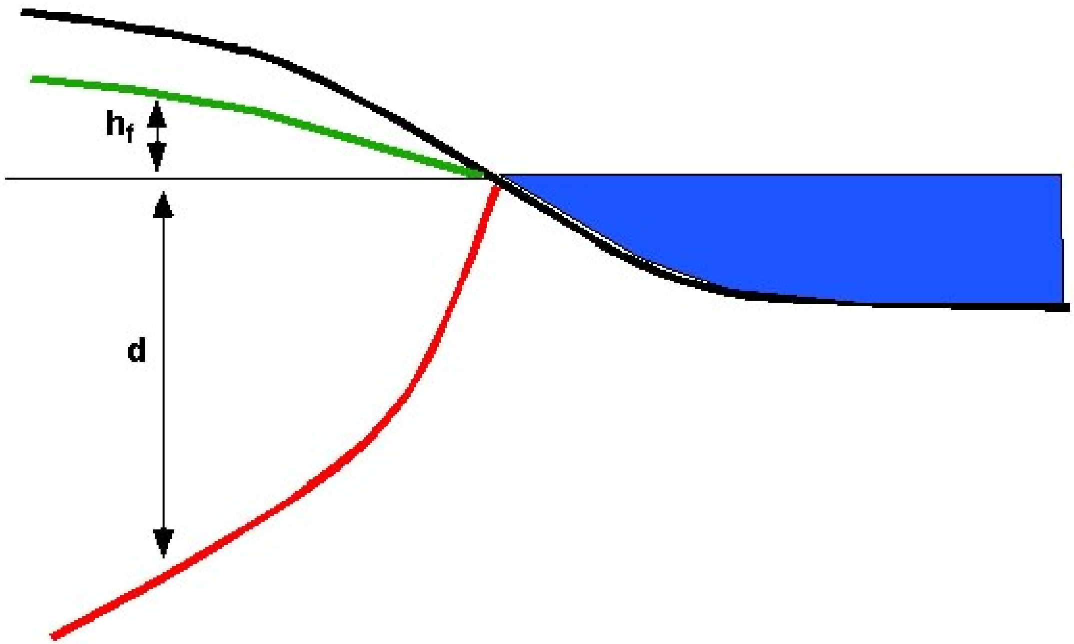
- **Inflow of young carbon**
- **Young carbon drives biochemistry**
- **Mixture of young and old carbon is not the result of pore water mixing, but mobilization of old organic carbon**

At Waquoit Bay

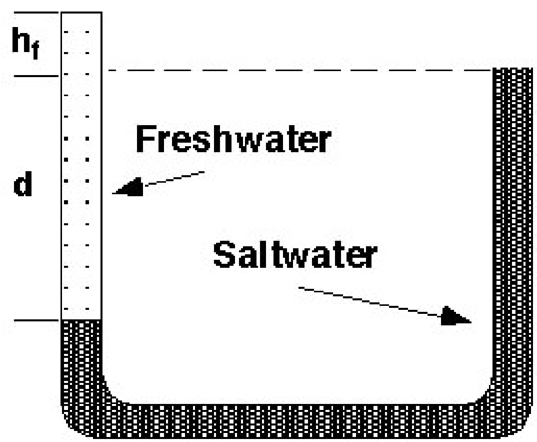


Waquoit Bay, MA

Saltwater Freshwater Interface



At steady-state pressures at interface must equal



$$\rho_f g(h_f + d) = \rho_s g d$$

$$\rho_f = 1.000 (kg/m\hat{}3)$$

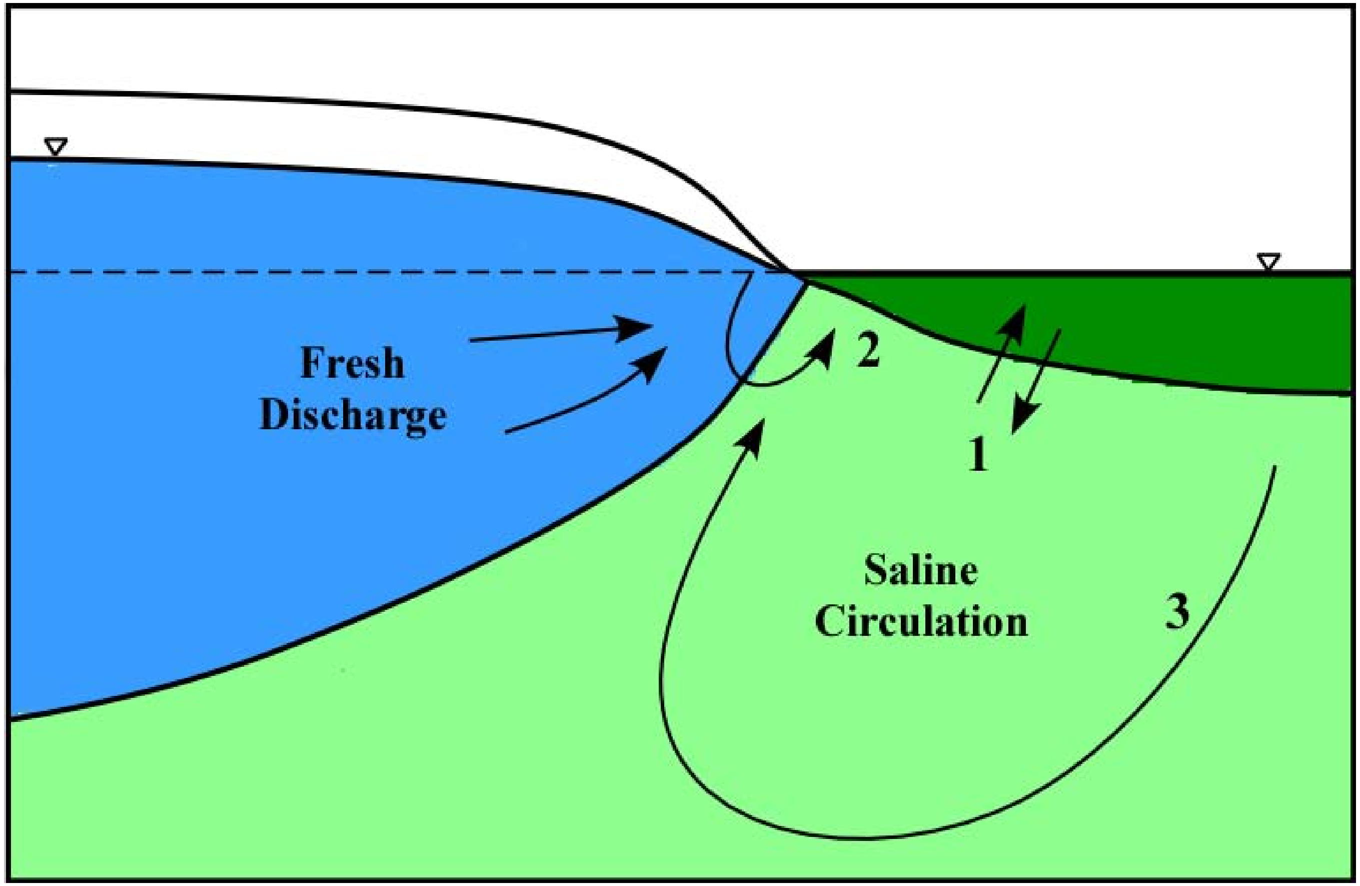
$$\rho_s = 1.025 (kg/m\hat{}3)$$

Solve for d:

$$d = h_f \rho_f / (\rho_s - \rho_f)$$

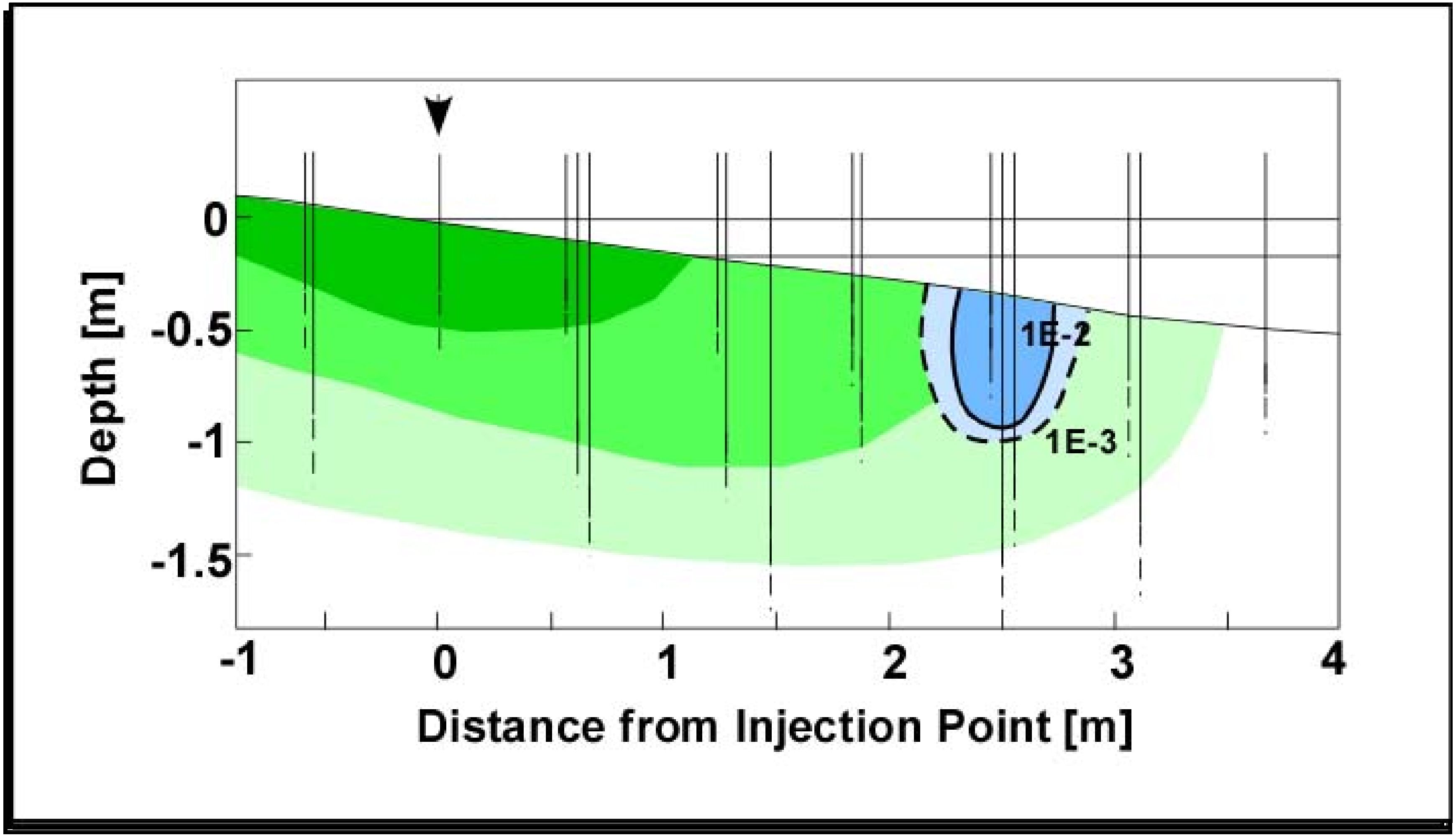
$$d = 40 h_f$$

Saline Circulation Mechanisms



$$q = -K\frac{dh}{dz} = -\frac{k\rho g}{\mu}\frac{dh}{dz}$$

$$q = -\frac{k}{\mu}\left(\frac{dP}{dz} - \rho g\right)$$


1E-2
1E-3
0
-0.5
-1
-1.5
Depth [m]
-1
0
1
2
3
4
Distance from Injection Point [m]