Stable Water Isotopes
The fundamental control on the isotopic composition of precipitation is temperature. With increasing temperature, precipitation becomes enriched in the heavier isotopes, $^{18}\text{O}$ and $^2\text{H}$, in a linear relationship. Temperature affects fractionation at a rate of approximately 0.5% for every $\text{C}^\circ$ 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 $^{16}\text{O}$ enriched water as compared to sea water.
Tritium and Helium
\[
\begin{align*}
\begin{bmatrix}
^3H
\end{bmatrix} &= \begin{bmatrix}
^3H_0
\end{bmatrix} e^{-\lambda t} \\
\begin{bmatrix}
^3H_0
\end{bmatrix} &= \begin{bmatrix}
^3He_{\text{trit}}
\end{bmatrix} + \begin{bmatrix}
^3H
\end{bmatrix} \\
t_{^3H/^3He} &= \frac{1}{\lambda} \ln \left( \frac{\begin{bmatrix}
^3He_{\text{trit}}
\end{bmatrix}}{\begin{bmatrix}
^3H
\end{bmatrix}} + 1 \right)
\end{align*}
\]
depth
Carbon Isotopes
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

\[ \rho_f g (h_f + d) = \rho_s g d \]

\( \rho_f = 1.000 \text{ (kg/m}^3\text{)} \)
\( \rho_s = 1.025 \text{ (kg/m}^3\text{)} \)

Solve for \( d \):

\[ d = \frac{h_f \rho_f}{\rho_s - \rho_f} \]
\[ d = 40h_f \]
Saline Circulation Mechanisms

Diagram showing saline circulation mechanisms with labels for fresh discharge and saline circulation.
\[ q = -K \frac{dh}{dz} = - \frac{k \rho g}{\mu} \frac{dh}{dz} \]

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