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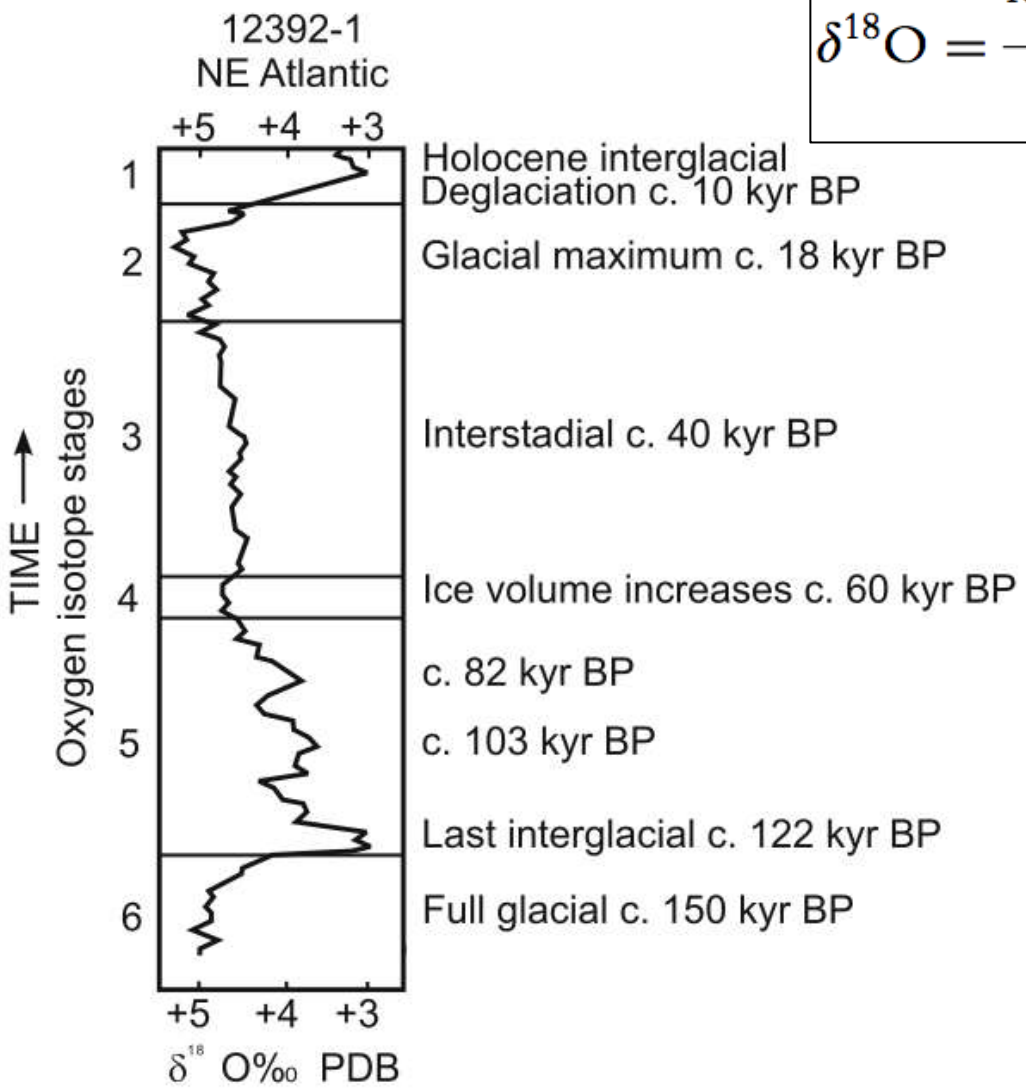
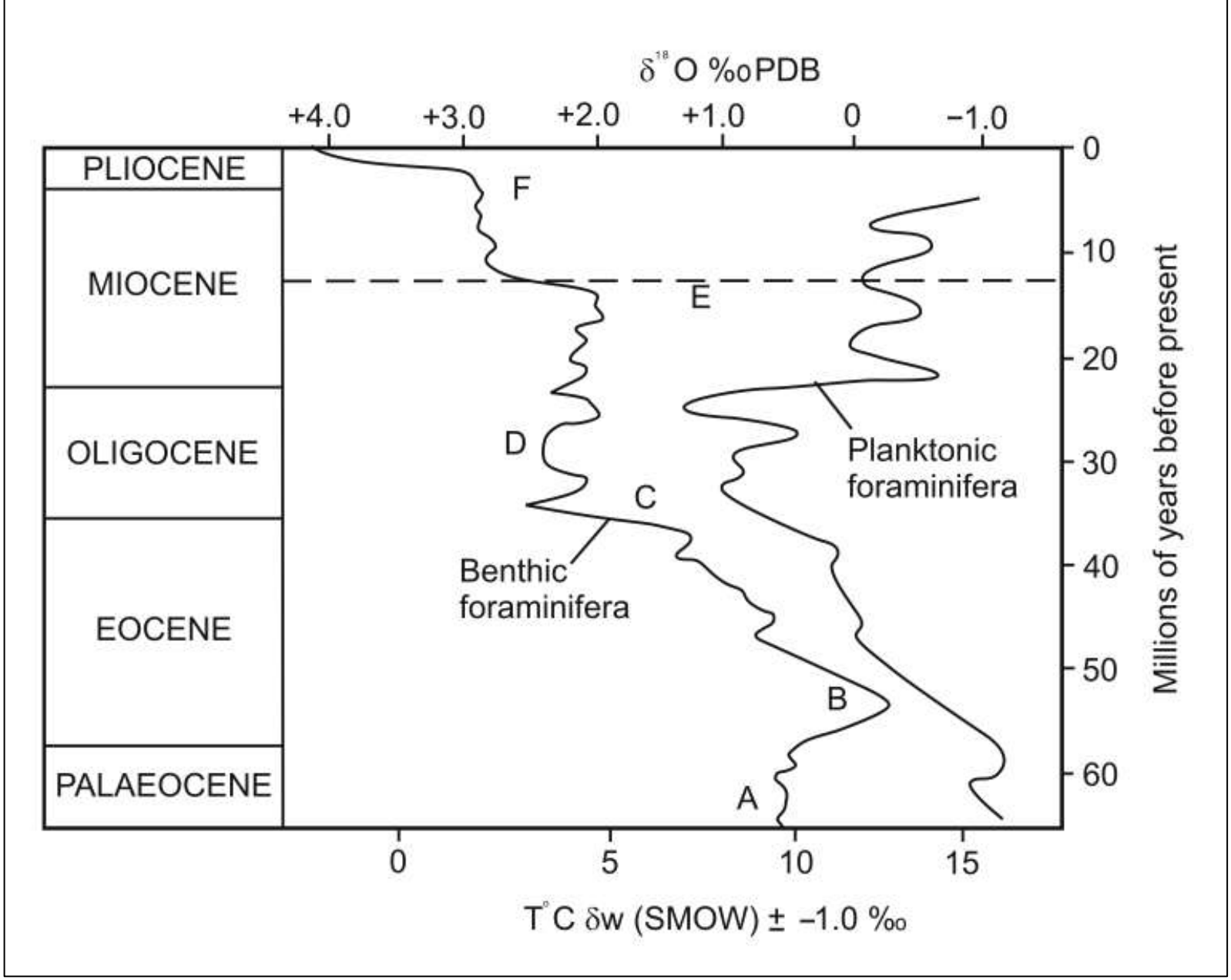
# Microfossils, stable isotopes and ocean-atmosphere history

$$\delta^{18}O = \frac{{}^{18}O/{}^{16}O_{sample} - {}^{18}O/{}^{16}O_{standard}}{{}^{18}O/{}^{16}O_{standard}} \times 1000$$

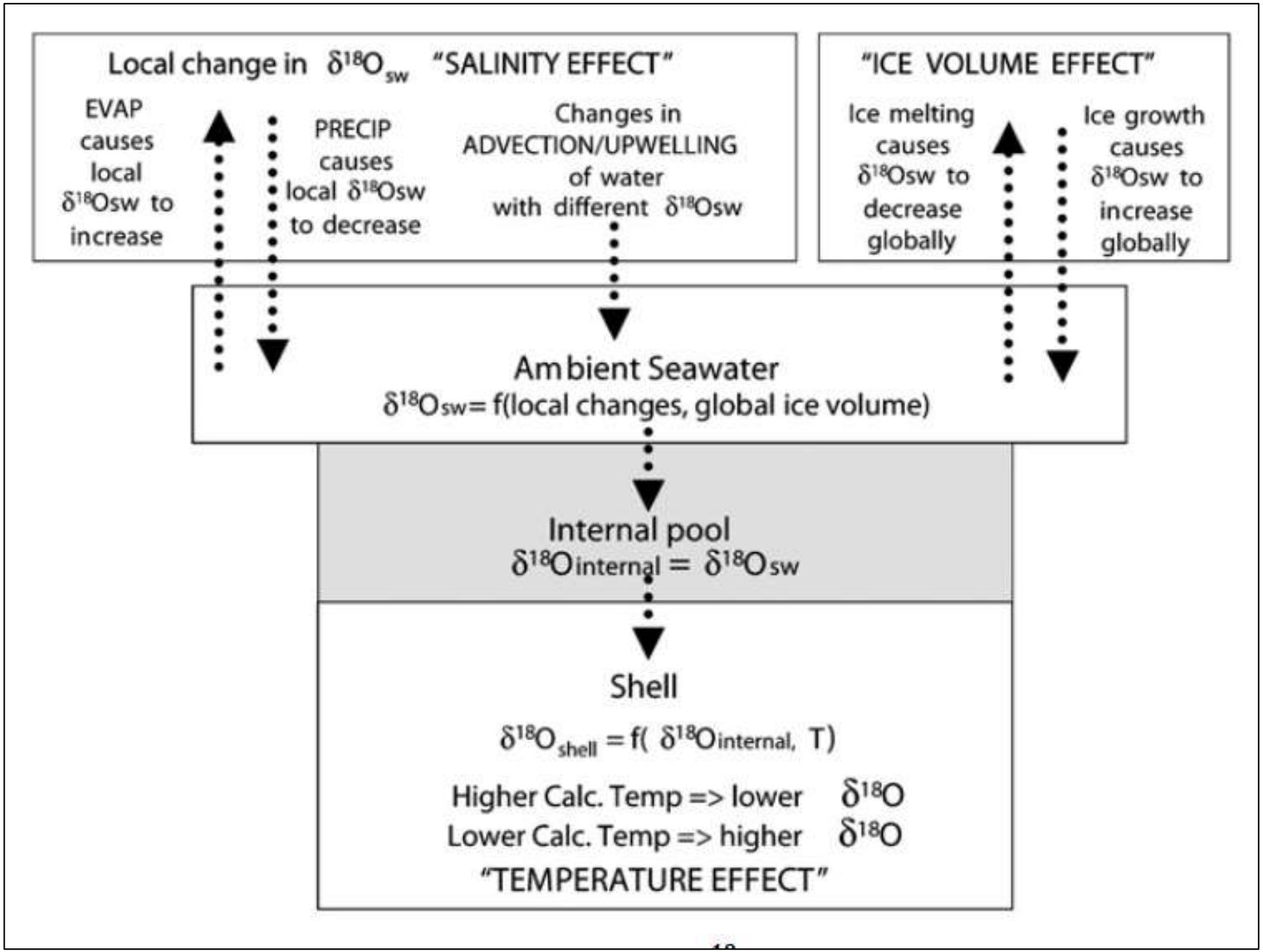



Changes in oxygen isotope ratios of epibenthic foraminiferid calcite tests through the last 150,000 years, showing fluctuations related to changing ice volume.




Changes in oxygen isotope ratios of both benthic and planktonic foraminiferid calcite tests through the Tertiary, showing fluctuations related to changing water temperature and/or ice volume. Temperature estimates depend on assumed values for δw in each period.

Factors affecting the oxygen isotope:



# Paleosalinity

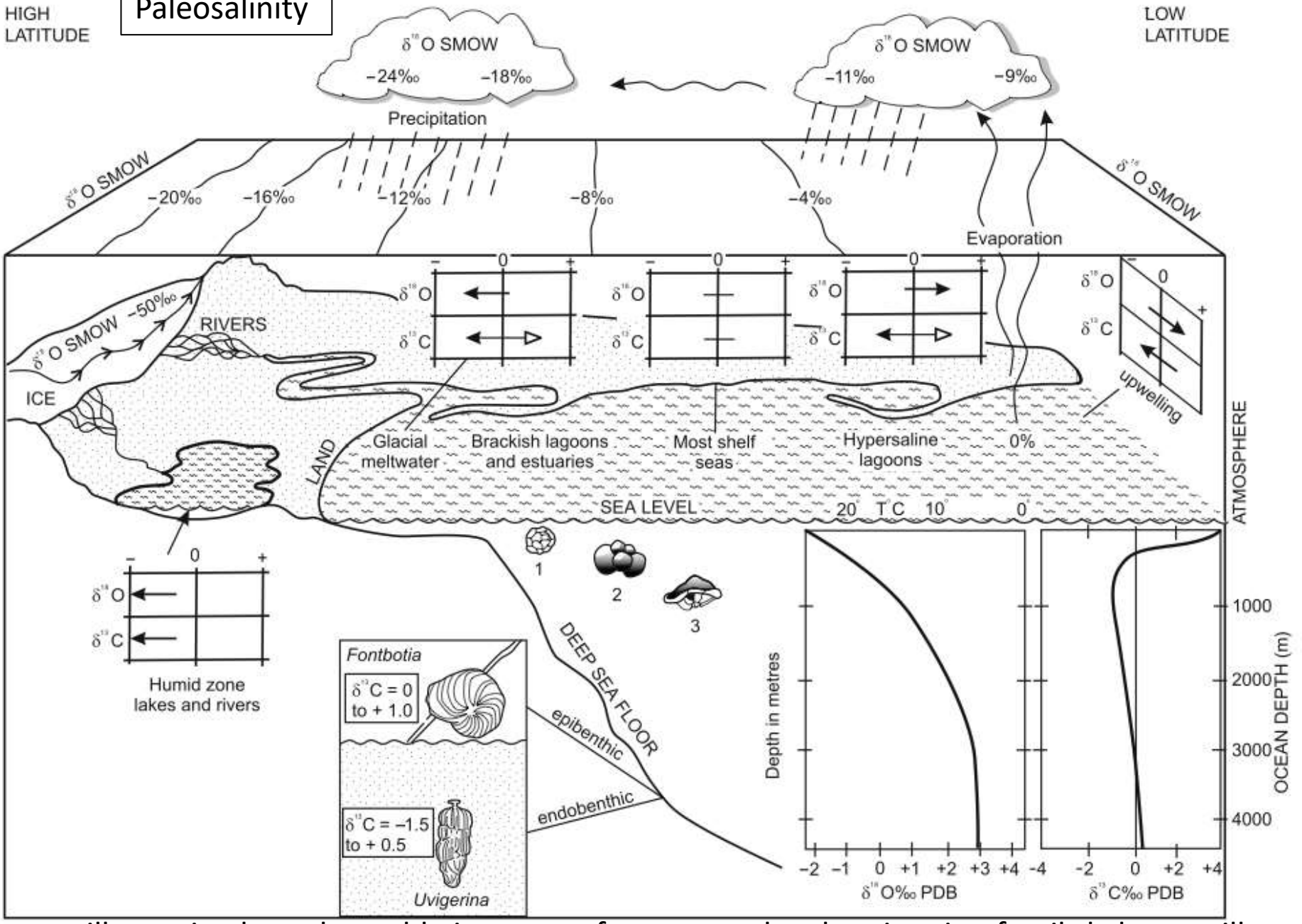


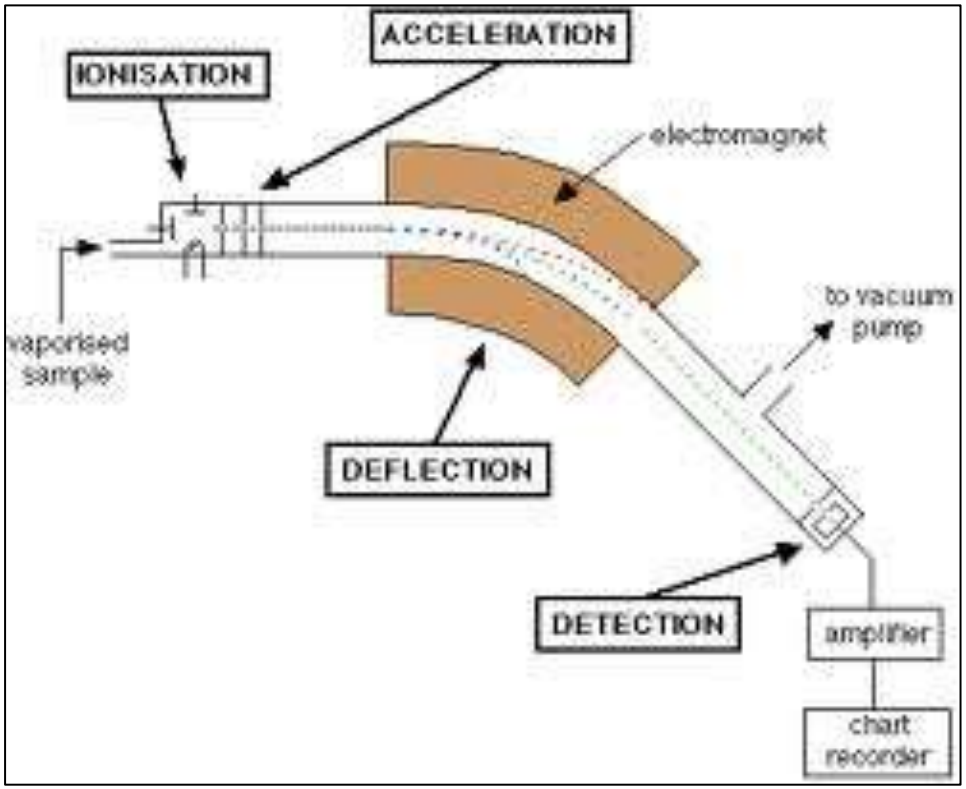

Diagram illustrating how the stable isotopes of oxygen and carbon in microfossil skeleton will tend to vary with depth and salinity.

# Paleotemperature

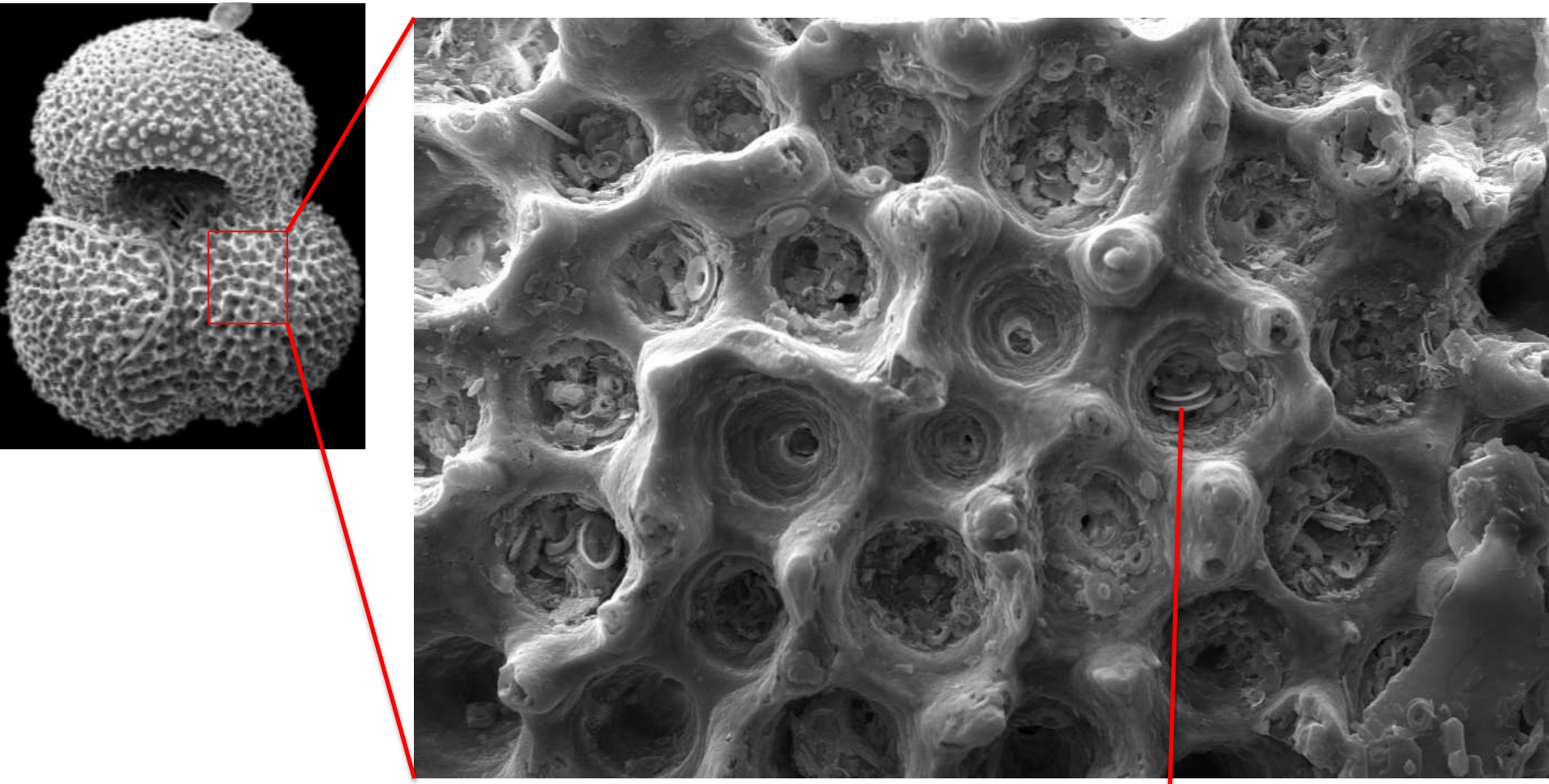
Calcite: $t(°C)=16.9-4.4(\delta c-\delta w)+0.10(\delta c-\delta w)^2$
(after Grossman & Ku 1986)

Aragonite: $t(°C)=21.8-4.69(\delta Ar-\delta w)$

where δc and δAr are the mean $\delta^{18}O$ of $CO_2$ produced from calcite or aragonite respectively, by the reaction of phosphoric acid at 25°C, and δw is the $\delta^{18}O$ of $CO_2$ in equilibrium with water at 25°C, both versus PDB.



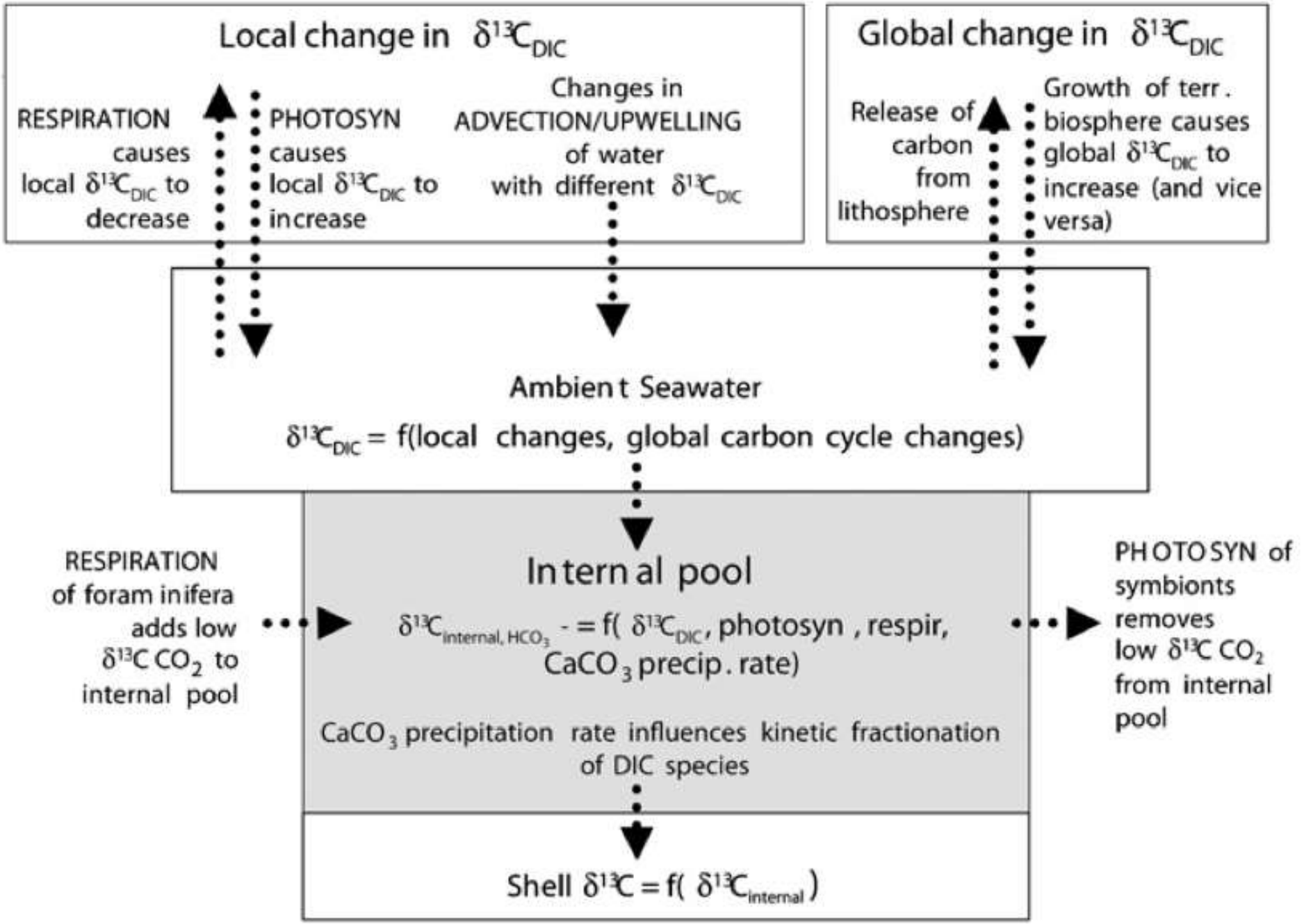

Principle of mass spectrometer

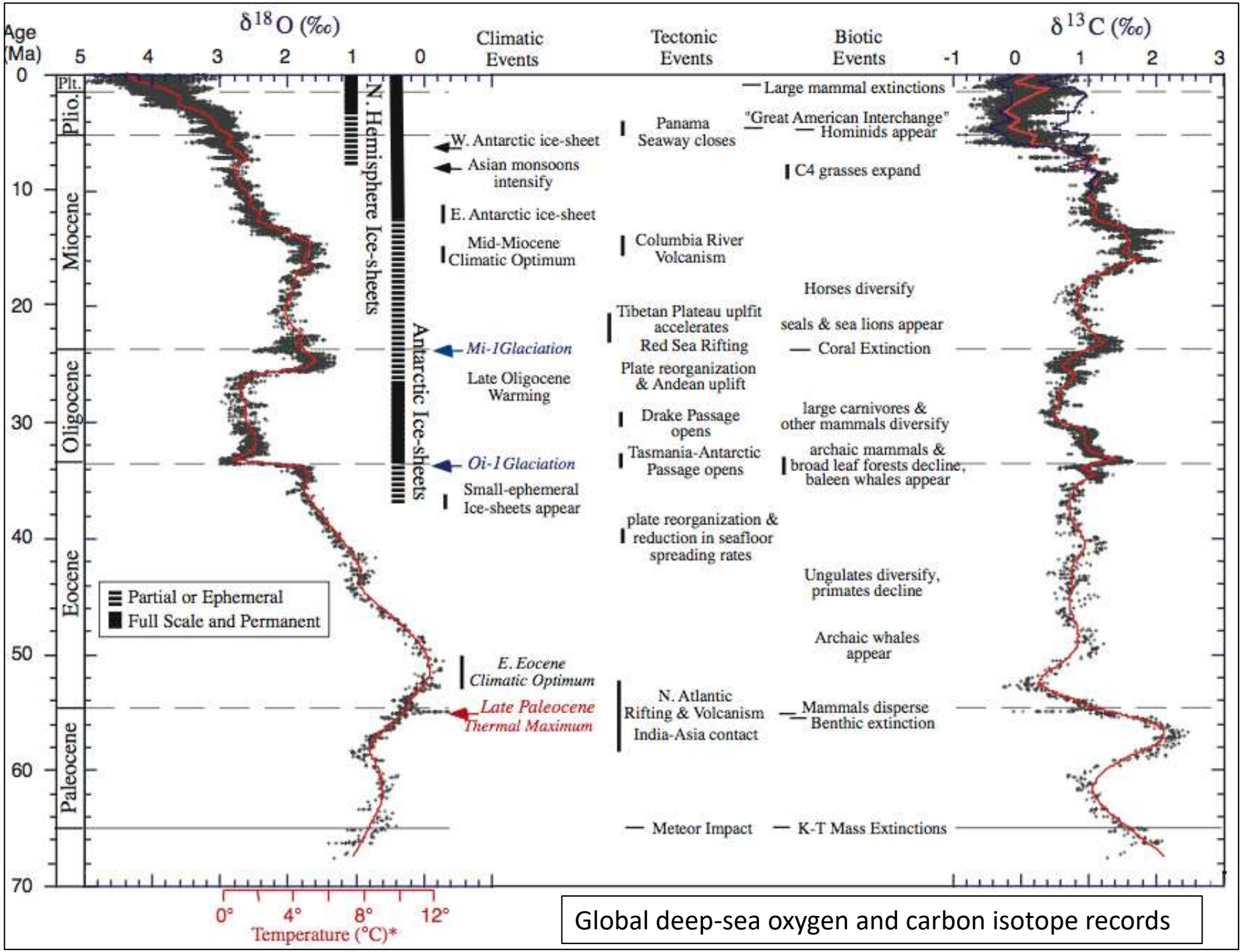


Nannoplanktons

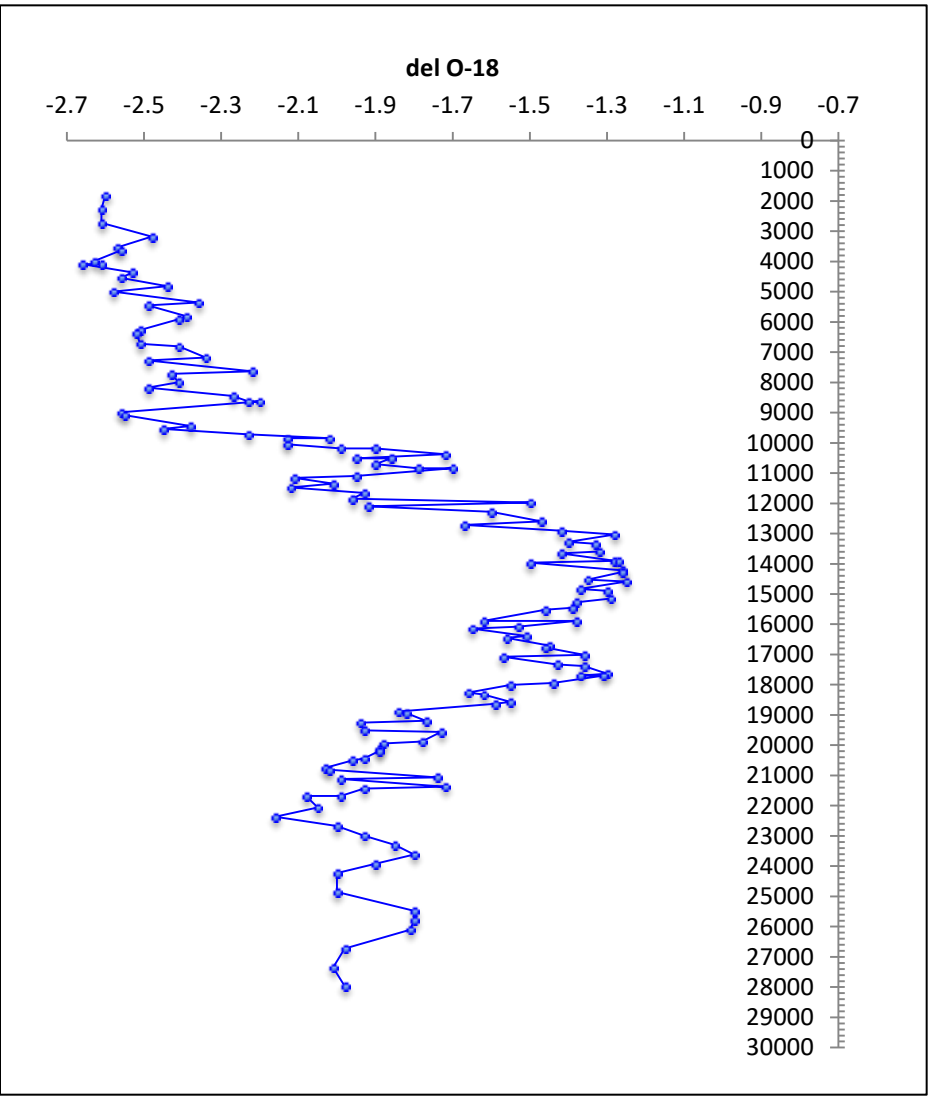
Vital effects induced by algal symbionts

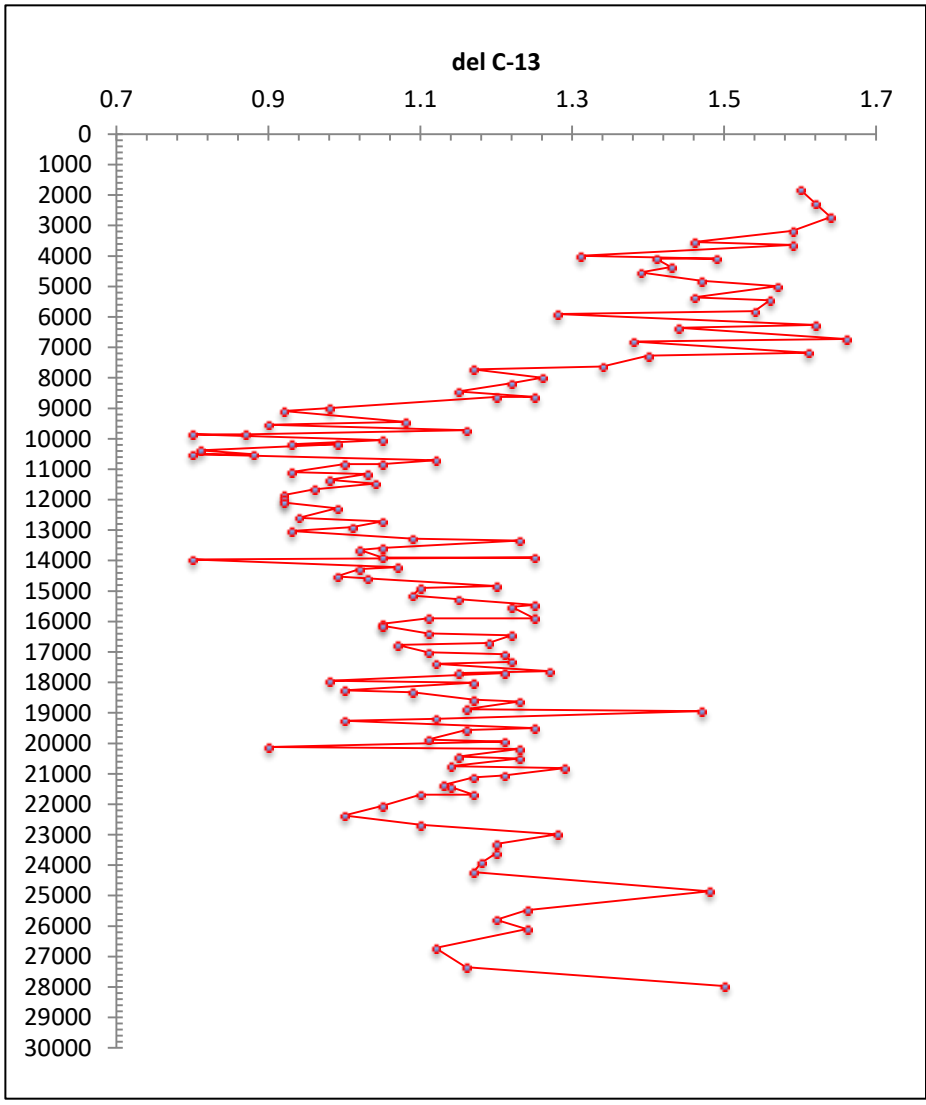
Factors affecting Carbon Isotopes






Global deep-sea oxygen and carbon isotope records




$$\delta^{13}\mathrm{C} = \frac{{}^{13}\mathrm{C}/{}^{12}\mathrm{C}_{\mathrm{sample}} - {}^{13}\mathrm{C}/{}^{12}\mathrm{C}_{\mathrm{standard}}}{{}^{13}\mathrm{C}/{}^{12}\mathrm{C}_{\mathrm{standard}}} \times 1000$$