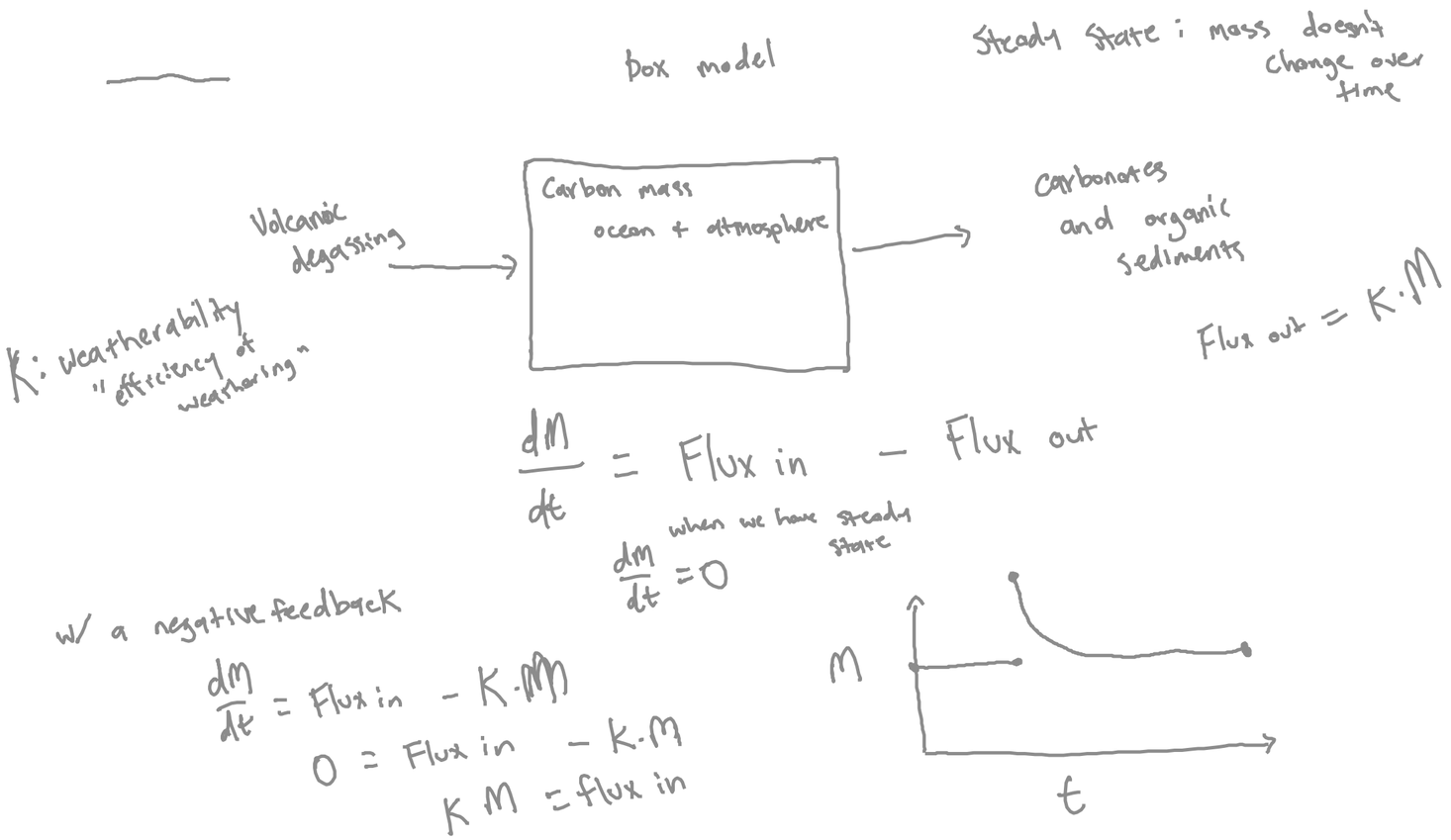
Lecture 15: Past Climate

1. Changing climate
2. Stable isotopes
3. Cenozoic climate

We acknowledge and respect the lək^{w}əŋən peoples on whose traditional territory the university stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day.

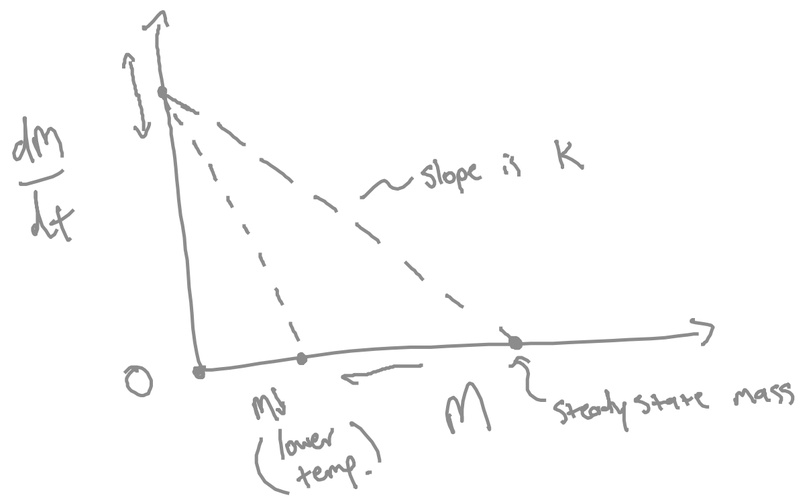
The long term carbon cycle (a model)



How does climate change?

- change steady state M

$$\frac{dM}{dt} = F_{in} - KM \qquad (y = b - mx)$$

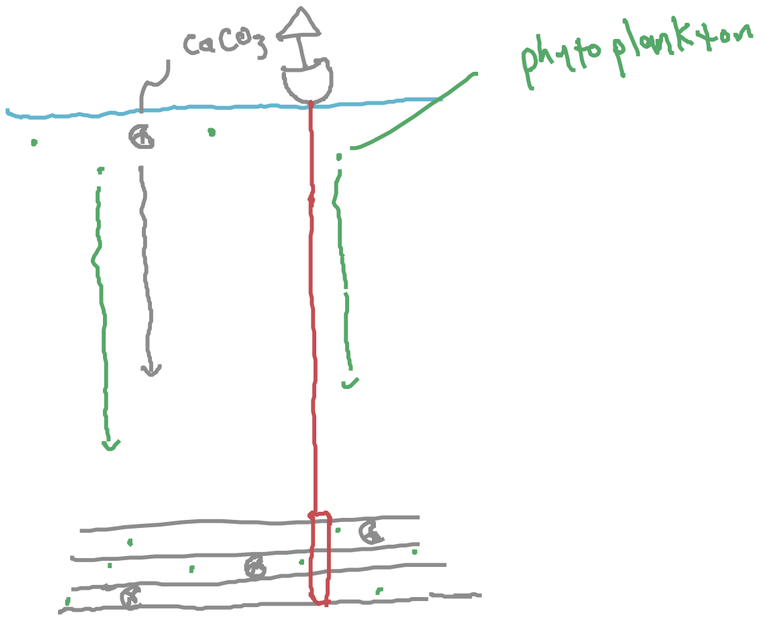


How do we measure past climate change?

Sediment hold records of the past surface conditions

- we look at "proxies"
  - ↳ paleo sea level elevations
  - ↳ organic molecules
  - ↳ Stable isotopic composition of ~~Sediments~~

- Direct measurements
  - ice cores have trapped gas bubbles that hold old atmosphere



Stable isotopes: notation

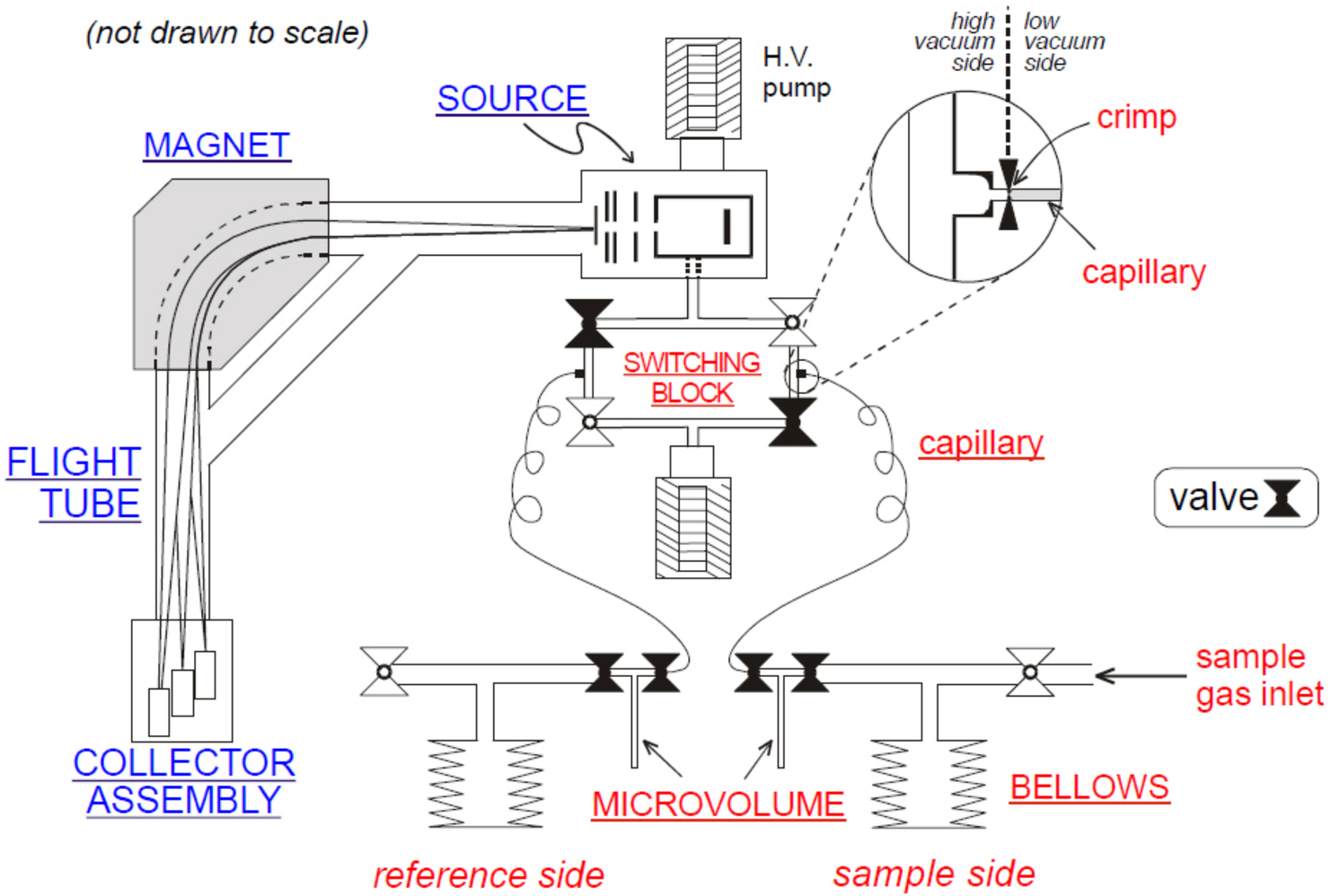
$R_C^{13} = \frac{C^{13}}{C^{12}}$ — mass number for an isotope; always the lowest mass for a given element

oxygen comes as 16, 17, 18 ; $R_O^{17} = \frac{[O^{17}]}{[O^{16}]}$

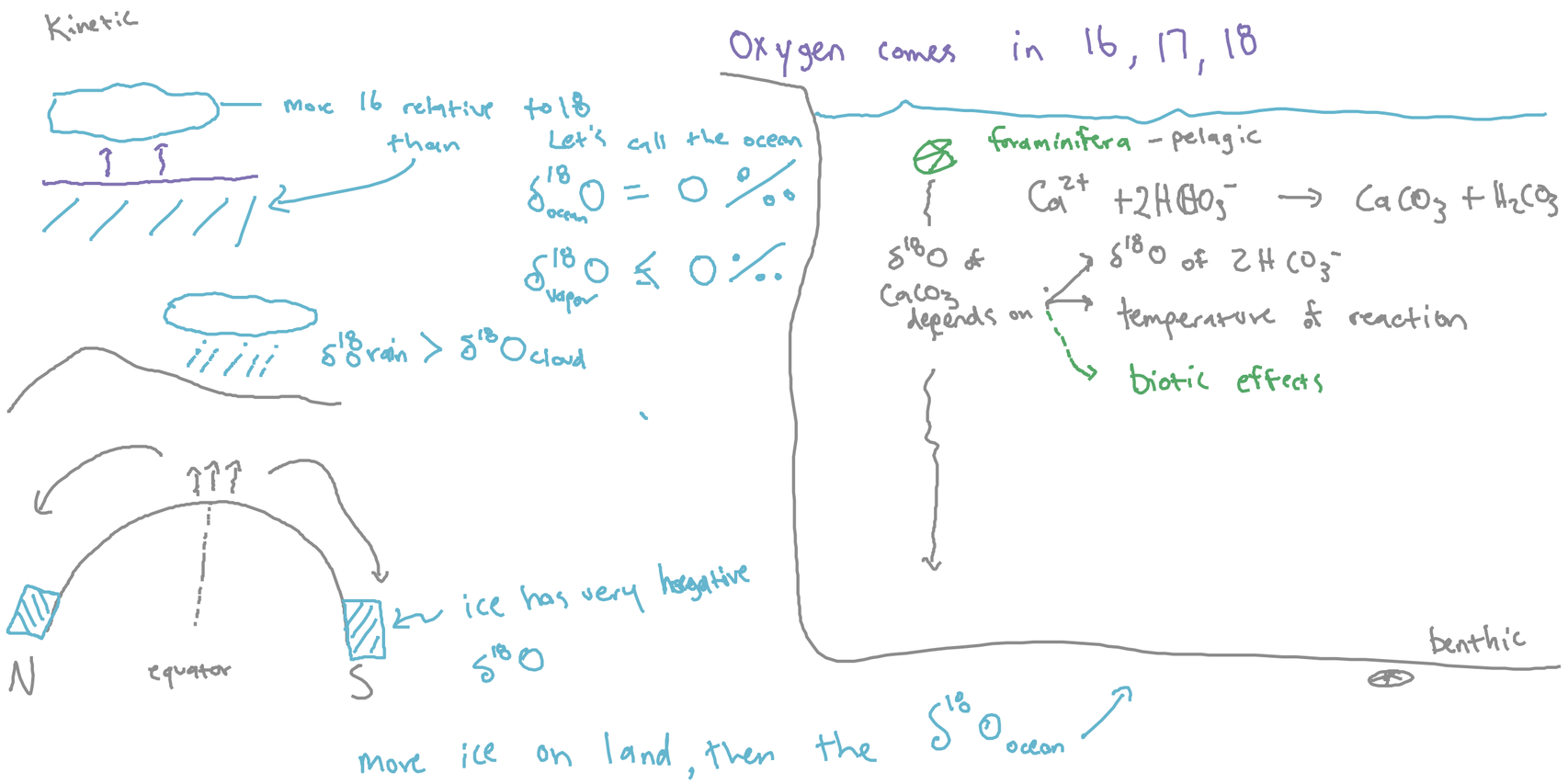
$\frac{R^{13}_{CO_2}}{R^{13}_{HCO_3^-}} = \alpha$ = fractionation factor

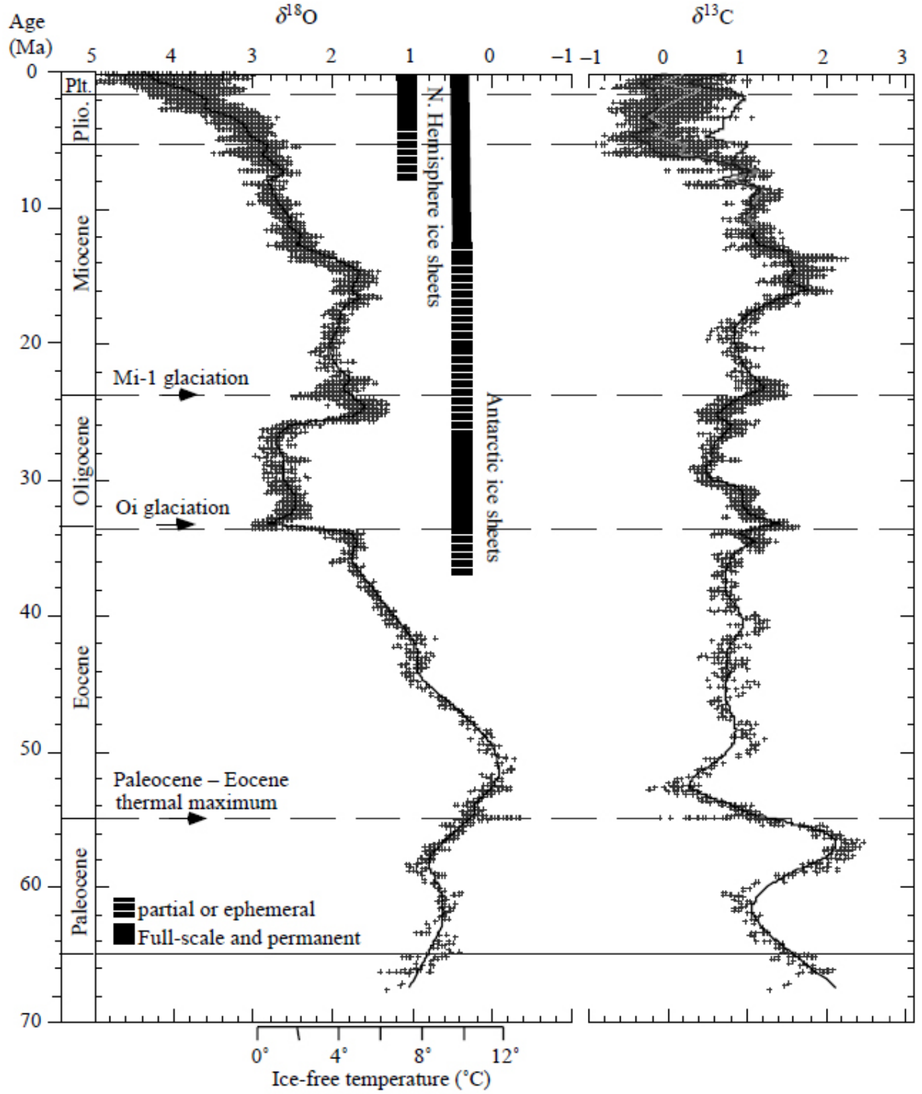
$$\delta = \left(\frac{(R^{13}_{CO_2})_{sample}}{(R^{13}_{CO_2})_{standard}} - 1 \right) \times 10^3$$

$\delta^{13}C_{PDB} = +4.1$


(not drawn to scale)
SOURCE
MAGNET
H.V.
pump
high
vacuum
side
low
vacuum
side
crimp
capillary
SWITCHING
BLOCK
capillary
valve
FLIGHT
TUBE
COLLECTOR
ASSEMBLY
sample
gas inlet
MICROVOLUME
BELLOWS
reference side
sample side

Stable isotopes: oxygen isotopes in the ocean





Compilation from Zachos *et al.*, 2001