Studing the link between photosynthesis and coccolites production from calcium carbonate isotopic anomalies

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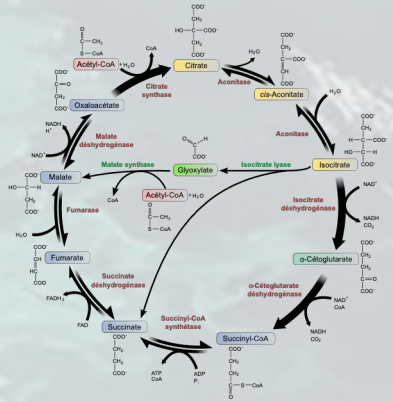
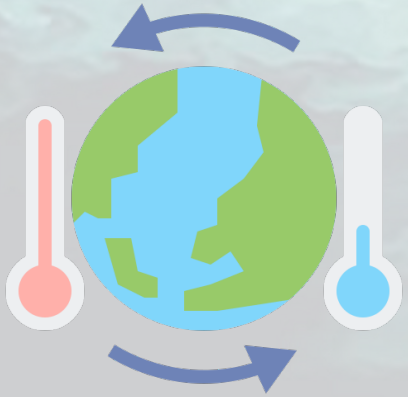
I. General approche

How dissociate biological from enviromnental control on biocarbonate istopic signature ?

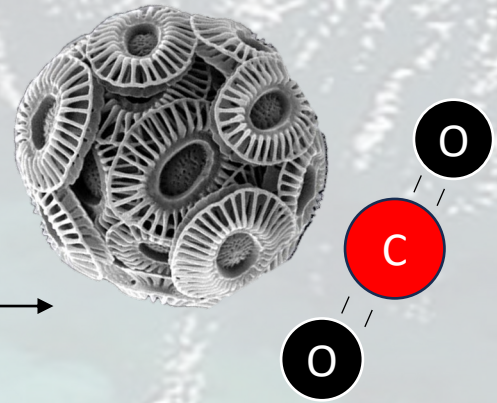


Metabolism



Climate

Paleoclimat



Bio-minerals

I. Case study: Coccolithophores

Emiliana huxleyi

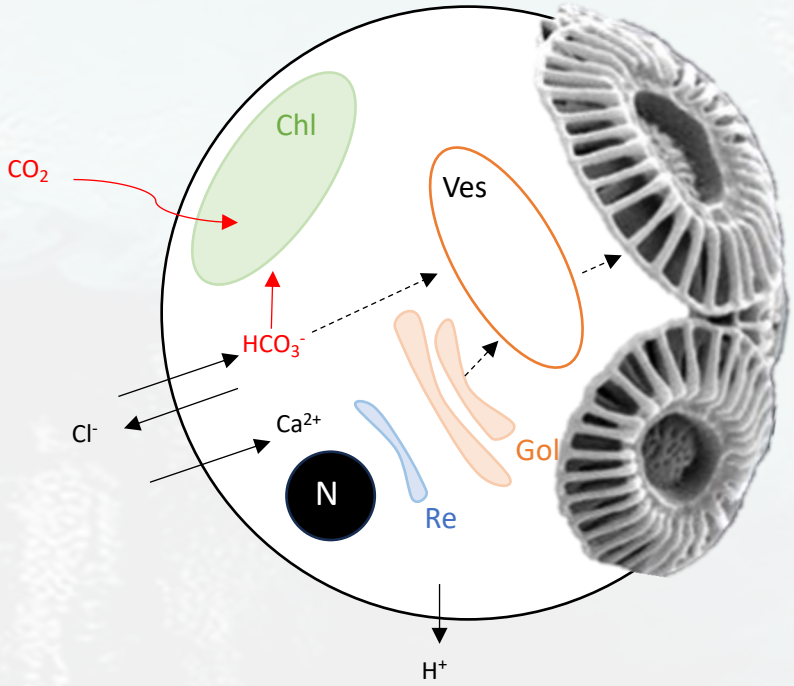
5-8 µm

- **Type**: phytoplankton (unicellular algae)
  - Primary producer
  - Photosynthetic (capture of CO_2)
- **Living environment**: Ocean sub-surface
- **Fossil record**: Trias
- Resistance to P_{CO2} elevation

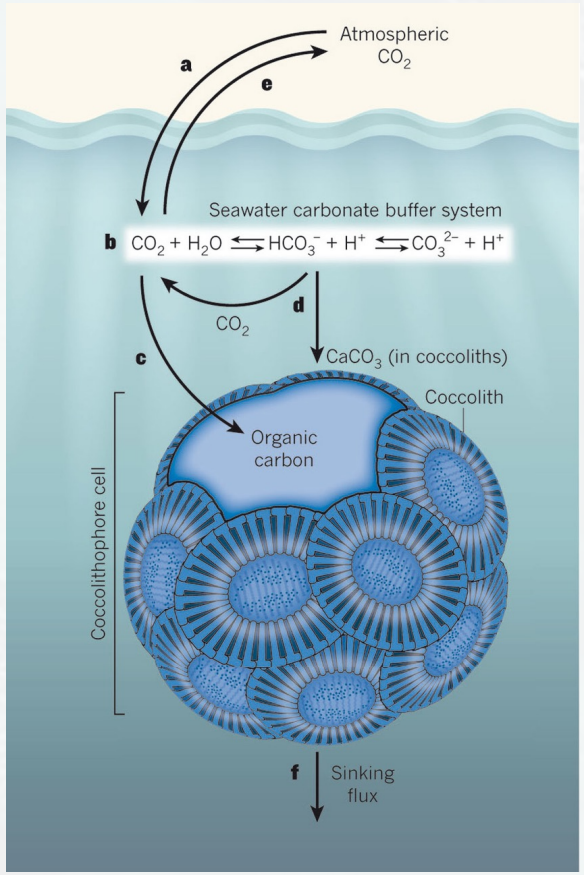
Etretat (Cretaceous)

II. Case study: Coccolithophores

Major Role in atmospheric carbon removal



Intracellular production of $CaCO_3$



1. How do coccolithophores mineralize?

2. How environmental changes control their production?

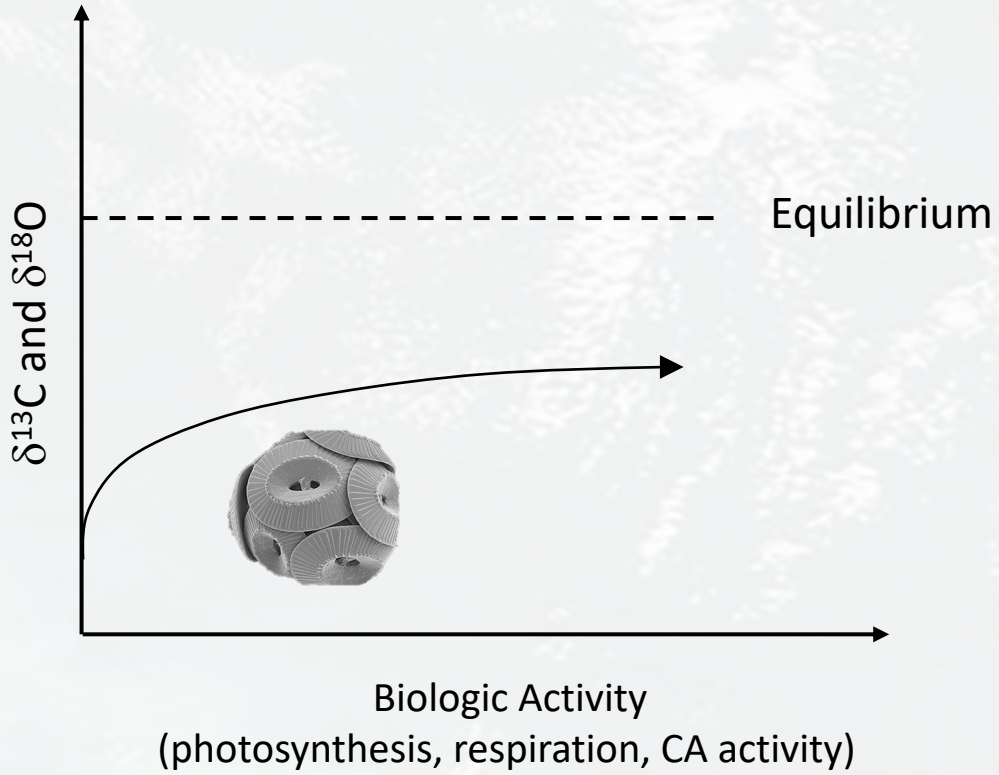
II. Tools: Stable isotopes (O and C)

Stable isotopes

$\delta^{13}C$

$\delta^{18}O$

Multifactorial control on coccolith isotopic compositions

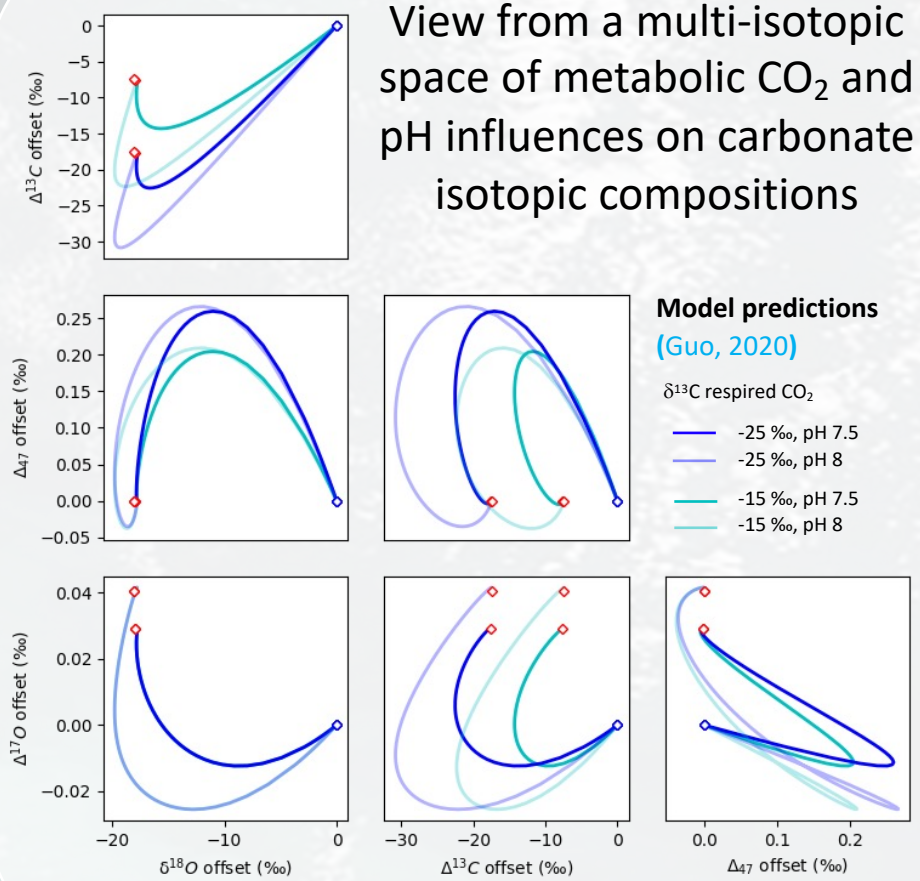


f (pH, pCO_2, T°)

II. Tools: isotopic anomalies (Δ_{47} and $\Delta^{17}O$)

Stable isotopes	Isotopic anomalies
^{16}O ^{13}C ^{16}O $\delta^{13}C$	^{18}O ^{13}C ^{16}O Δ_{47}
^{18}O ^{12}C ^{16}O $\delta^{18}O$	^{17}O ^{12}C ^{16}O $\Delta^{17}O$

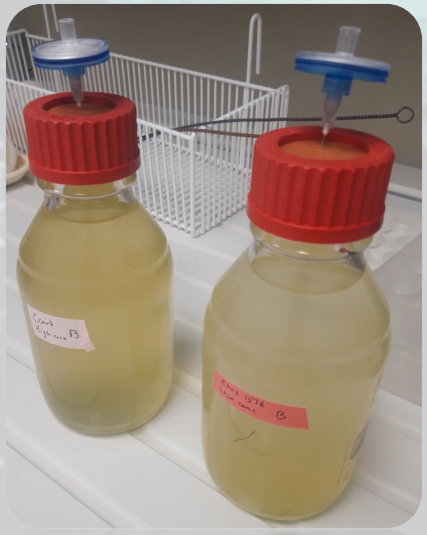
View from a multi-isotopic space of metabolic CO_2 and pH influences on carbonate isotopic compositions



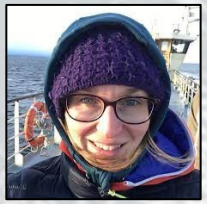
III. Strategy

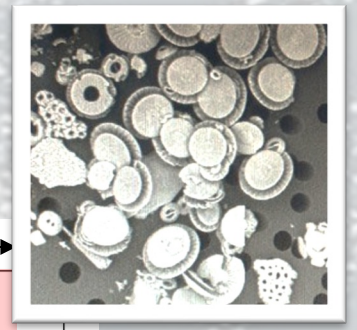
1. To establish a model (culture)

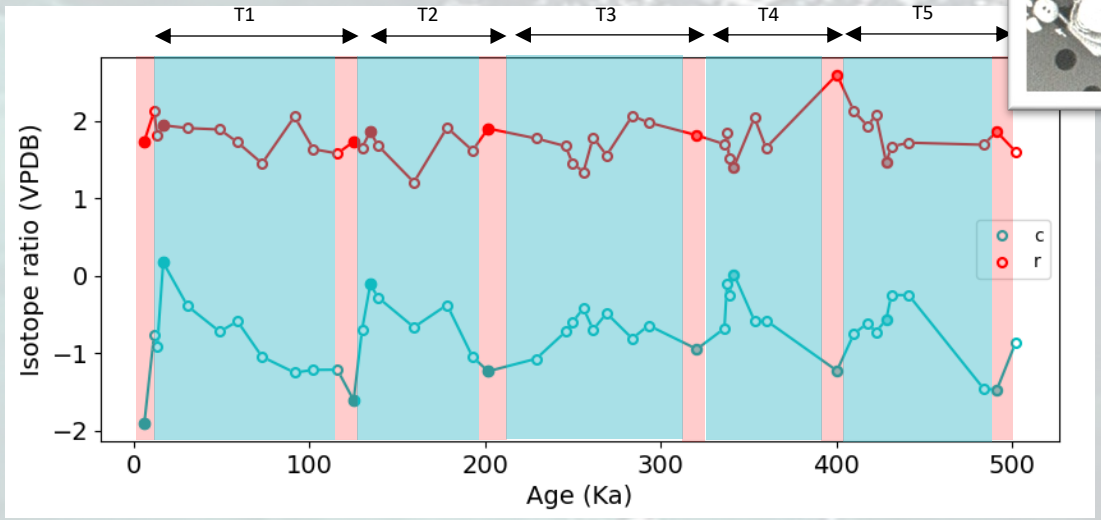
D. Chevrier



2. Applications(sedimentary record)

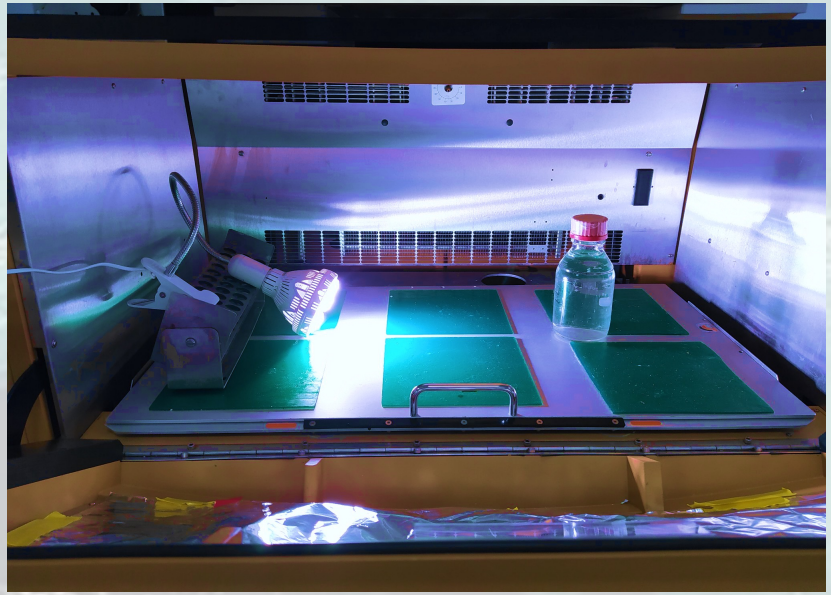






Last galcial-interglacial cycles (IODP 762)

III. Culture strategy



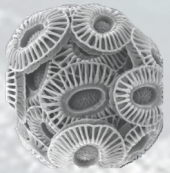
Fixed: T°, pCO_2, luminosity, salinity

Variabie: species, cell size, cell constration

2 µm

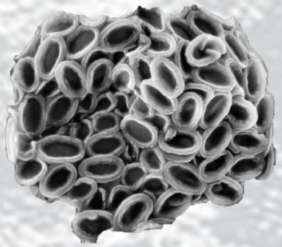
E.huxleyi (RCC 1516)

3–4 µm

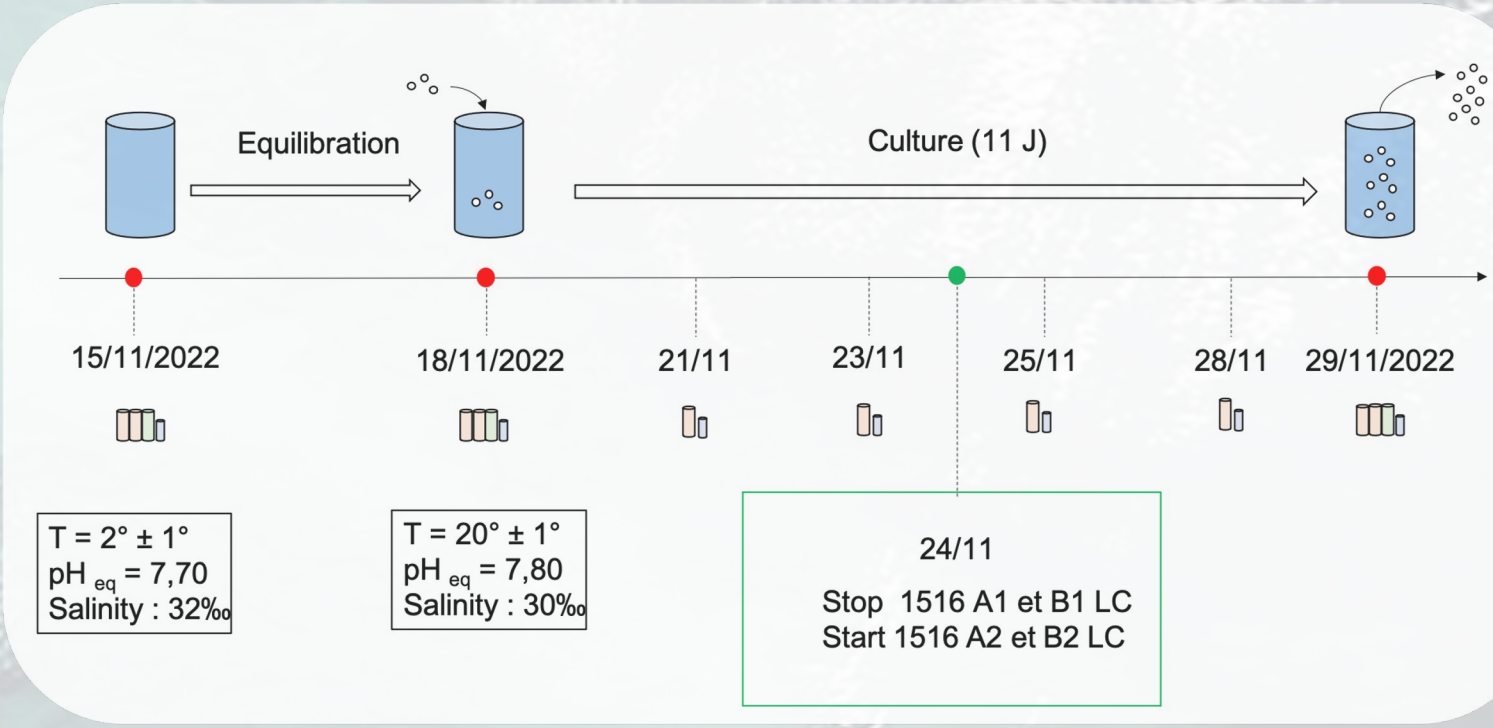


E.huxleyi (RCC 1212)

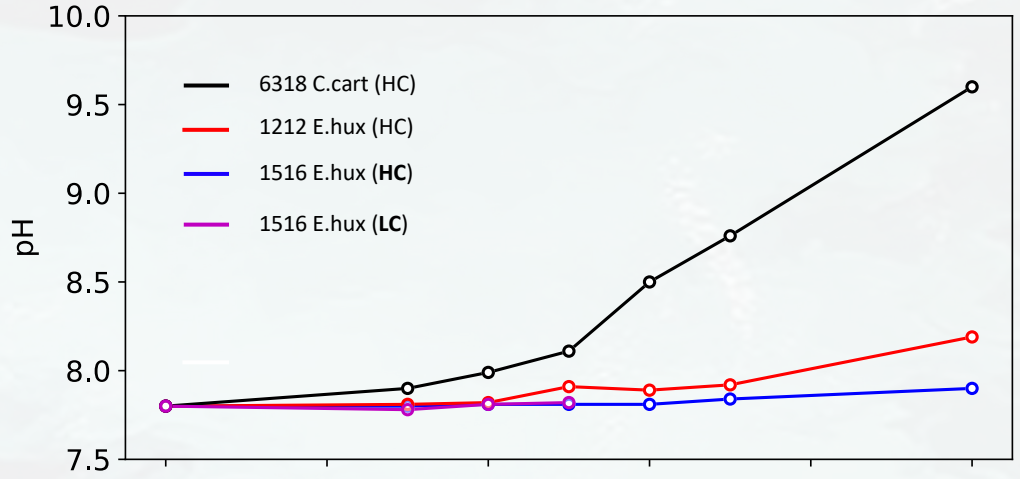
8 µm

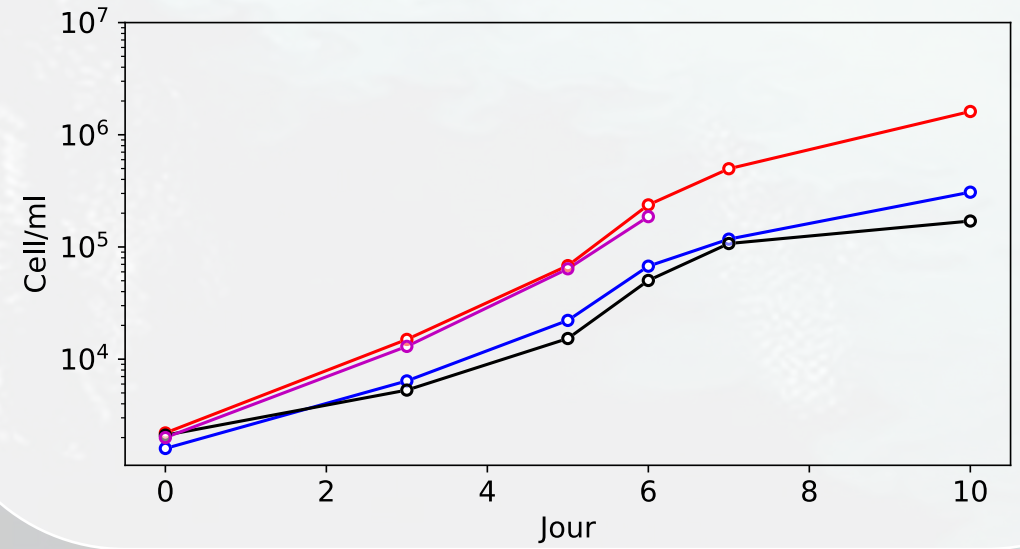


P. Carterea (RCC 6318)

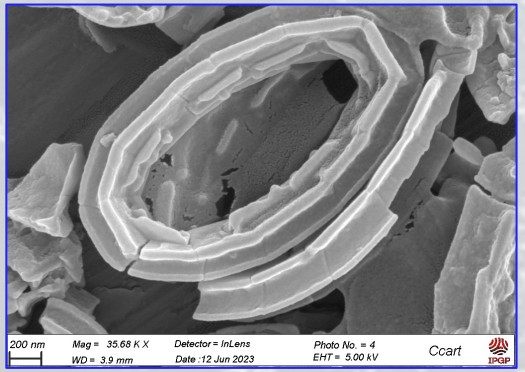


III. Monitoring (cell size, pH, cell concentrat°)

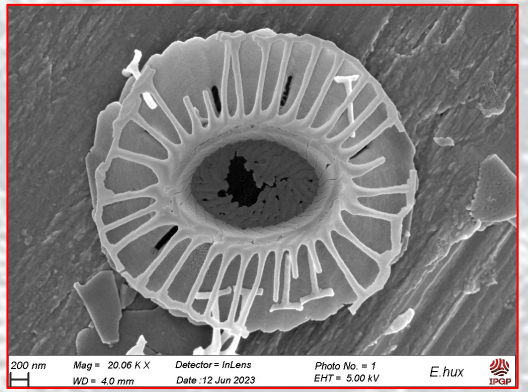




P. carterea



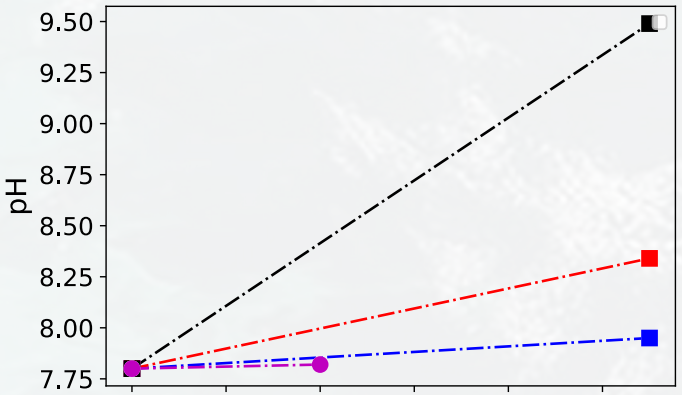
E. huxleyi

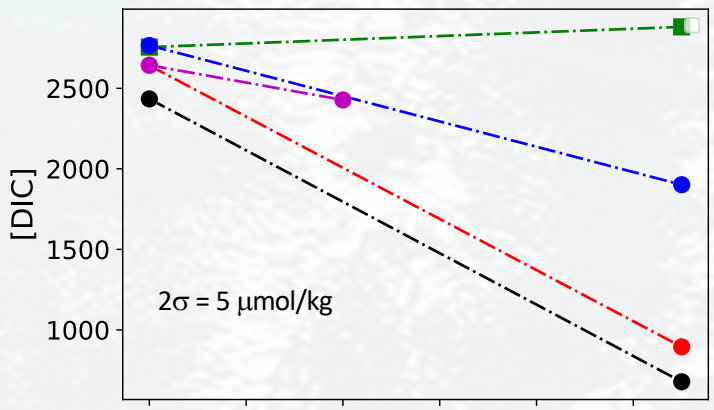


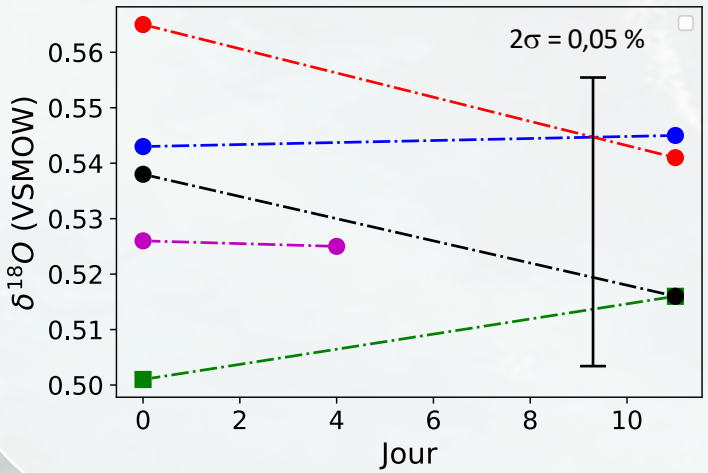
IV. Monitoring ([DIC], TA, $\delta^{18}O_w$, $\delta^{13}C_{DIC}$)

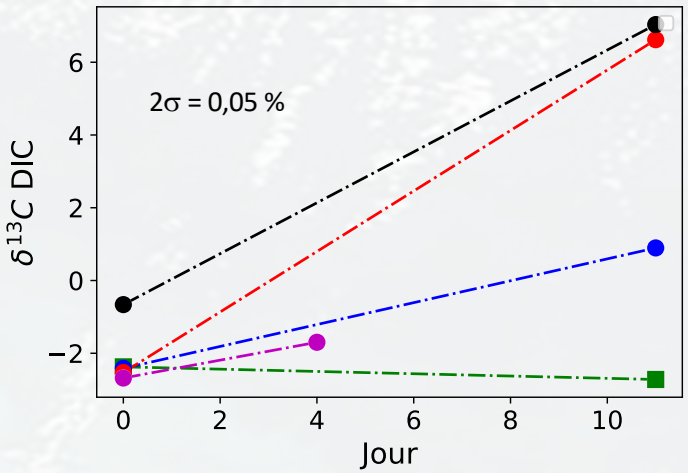
- Big cell (*P.cart*)
- Little cell (*E.hux*)
- Little cell (*E.hux*)
- Little cell (*E.hux*), low contration

Laser CRDS Picarro







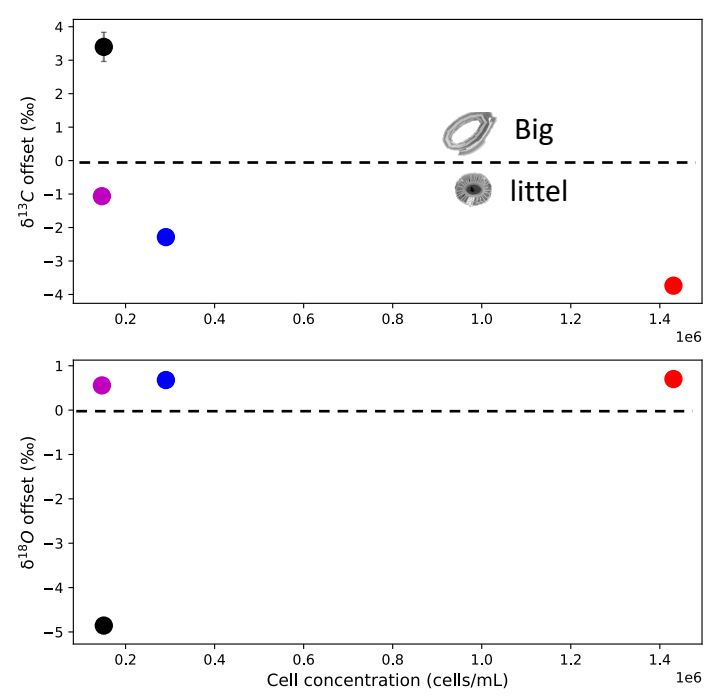


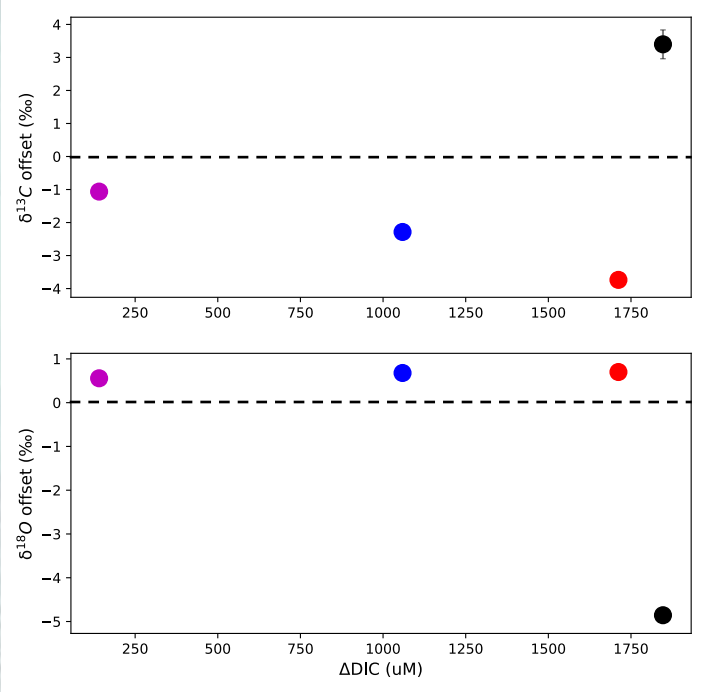
IV. Stable isotope results ($\delta^{13}C$ and $\delta^{18}O$)

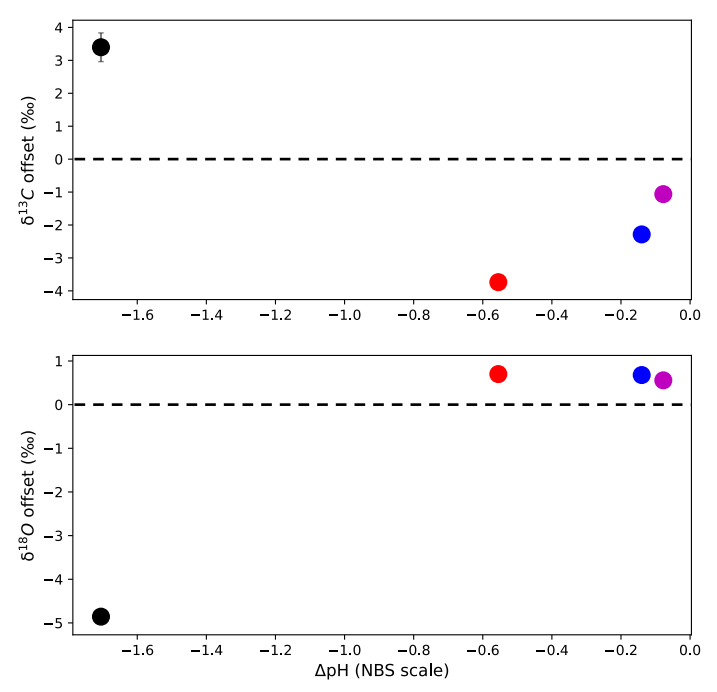
- Big cell (*P.cart*)
- Little cell (*E.hux*)
- Little cell (*E.hux*)
- Little cell (*E.hux*), low contration

[DIC]

[pH]



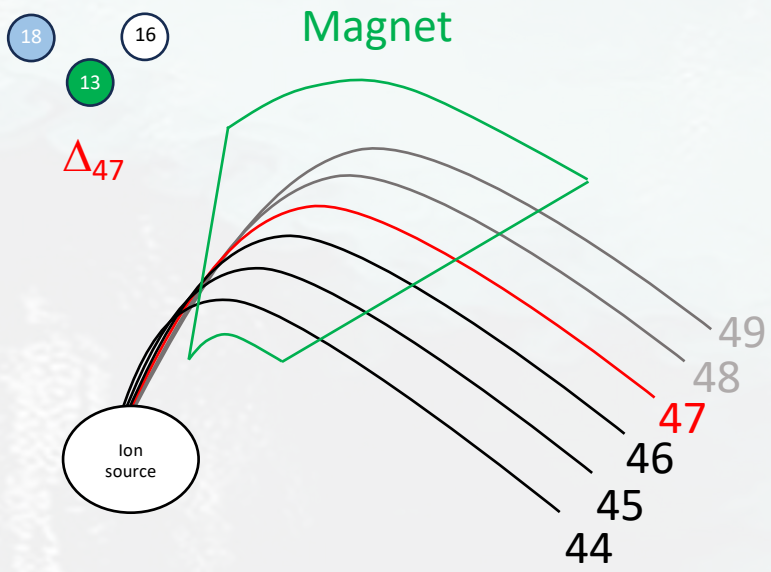


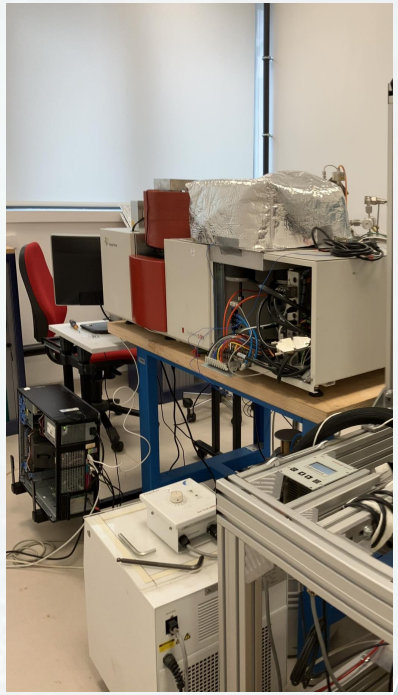


Evolution of coccoliths $\delta^{13}C$ and $\delta^{18}O$ with [cell], [DIC], [pH]

IV. Δ_{47} measurements

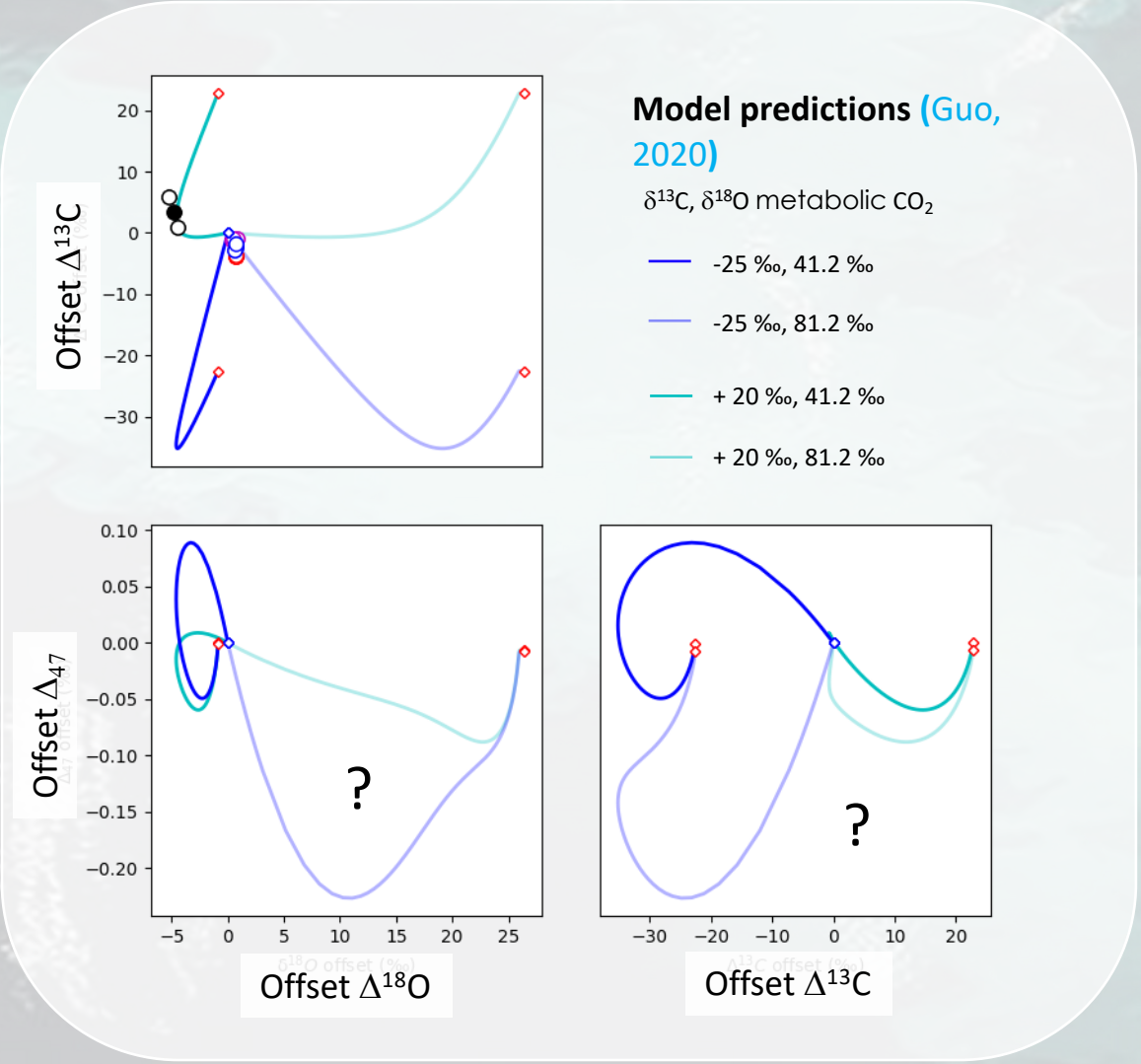
Isoprime 100 dual-inlet equipped with 6 Faraday collectors





Carbonate preparation line

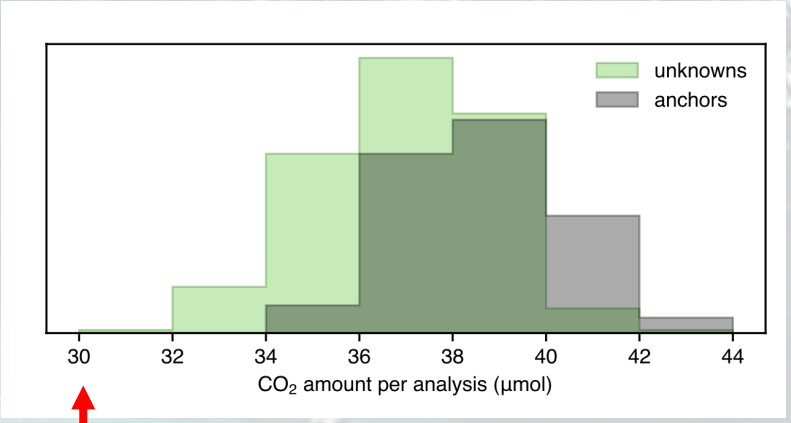
IV. Challenge for coccoliths Δ_{47} mesurments



Work in progress

Normal mass requirement: 30 mg

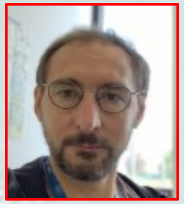
2 SD Δ_{47} = 8.1 ppm ≃ 1.9°C



Objective: 25% reduction of mass requirement for Coccoliths Δ_{47} measurements

M. Daëron

C. Rollion-Bard



S. Nomade

P. Richard

G. Reverdin

J. Chaillot

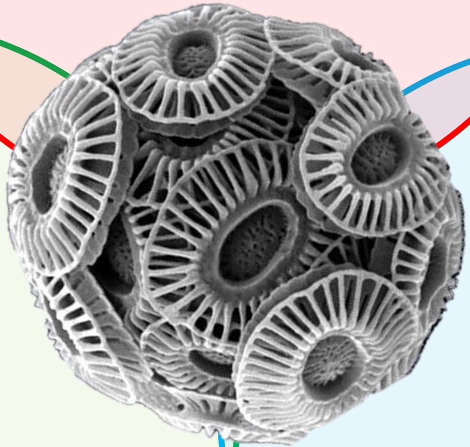
D. Chevrier

Determination of isotopic anomalies

LIPhy Laboratoire interdisciplinaire de Physique

LSCE

LOCEAN



Culture experiment

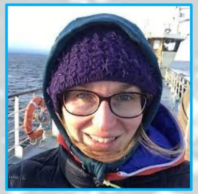
CITÉ DES ÉNERGIES by cea

Sedimentary record

UVSQ université PARIS-SACLAY

GEOPS

UCB Lyon 1



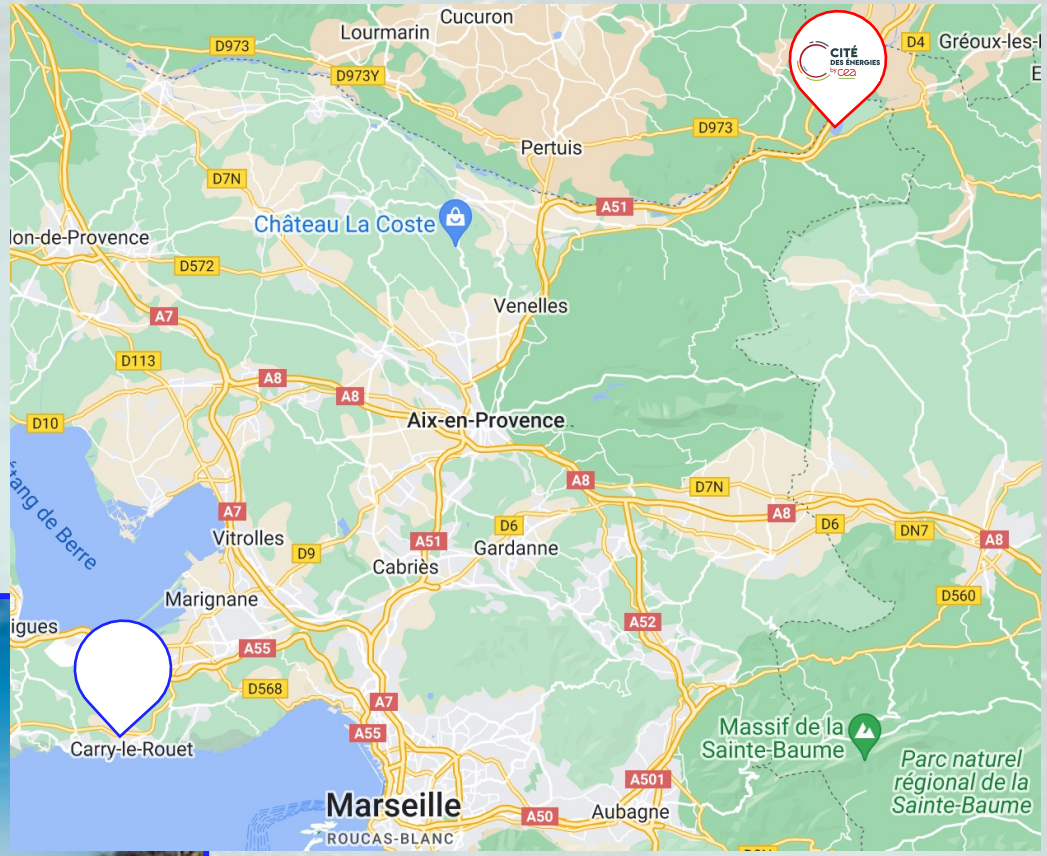
S. Duchamp

M.Tremblin

S.Le Houedec

III. Facilities for culture experiment (BIAM)

Carry le Rouet

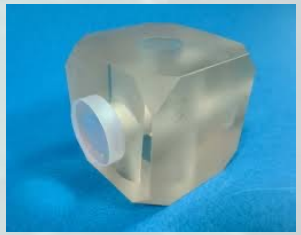


BIAM (MEM team)

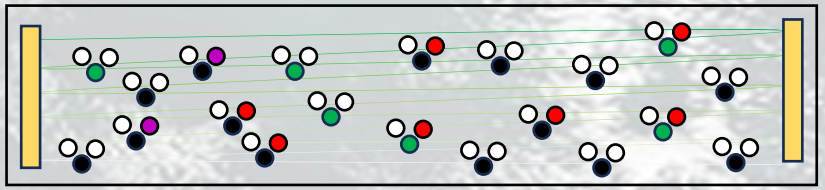
To go futher : Mesurments with VCOF CRDS

Laser Source

VCOF



CRDS



Spetre d'absotion