



EXCELENCIA  
MARÍA  
DE MAEZTU

Centro de Astrobiología  
(INTA-CSIC)

Unidad de Excelencia María de Maeztu

# 4th Stable Isotopes Course in Ecology and Environmental Sciences

Estación Biológica de Doñana (Sevilla)

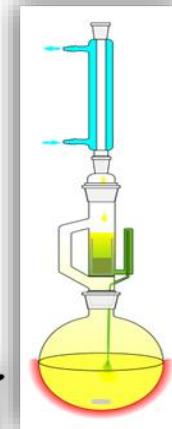
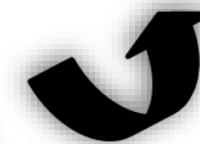
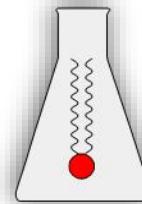
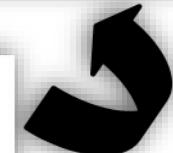
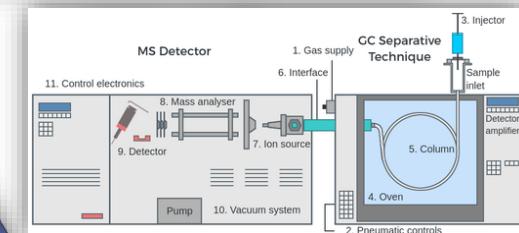
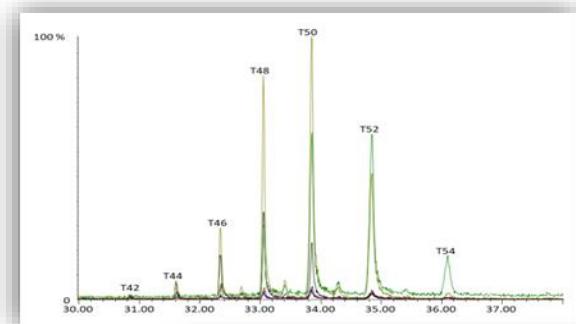
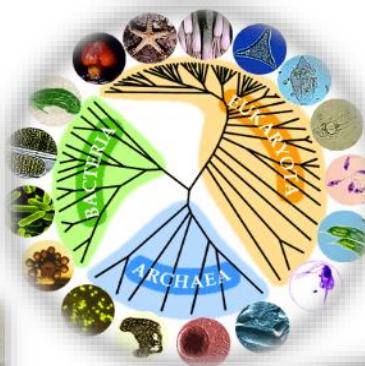
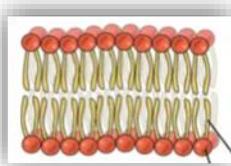
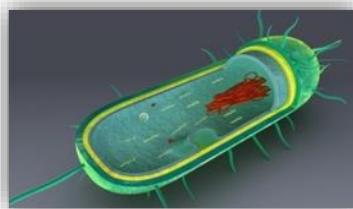
22-25 February 2022

Laura Sánchez García  
Ramón y Cajal researcher  
Dept. Molecular Evolution

# Forensic Geochemistry in extreme environments with astrobiological interest

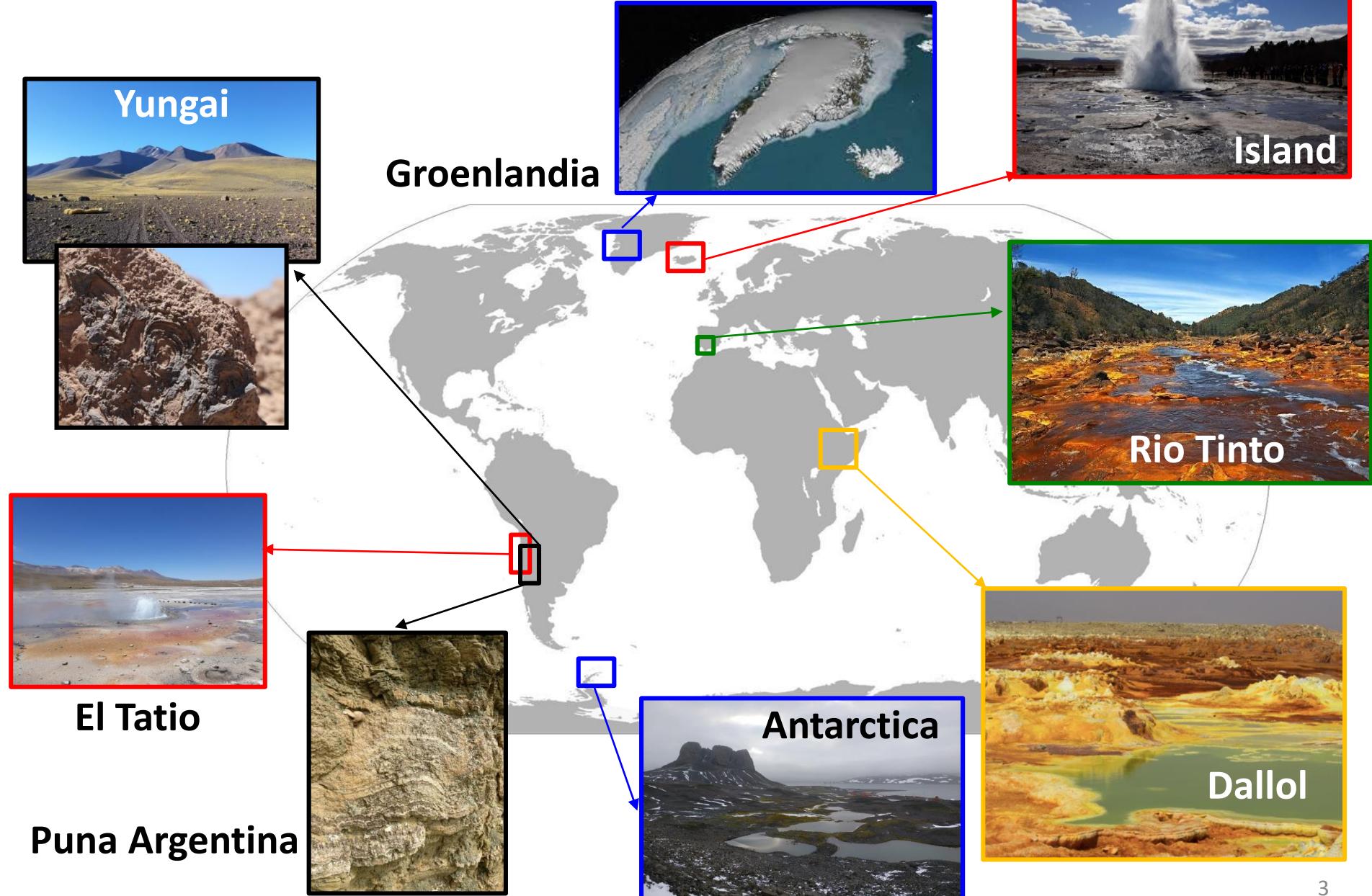


Search for  
life



**Lipids: cell-membrane derived biomolecules**

# Use of Terrestrial Analogs



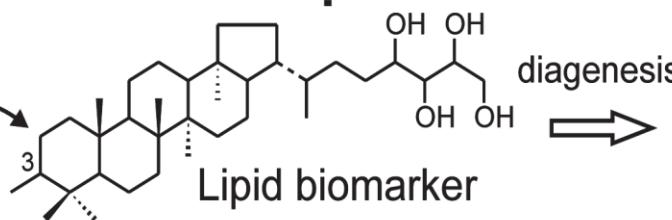
# Combining molecular and isotopic analysis

Autotroph.-Heterotr.  
Prokarya-Eukarya  
Terrestrial-Aquatic  
Marine-Freshwater

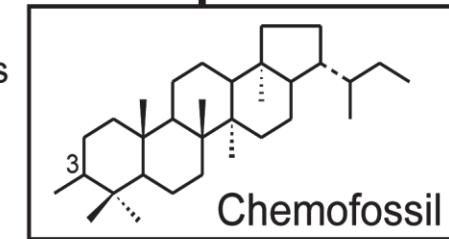
Terrestrial-Aquatic Envir.  
RedOx conditions  
Preservation

Prokaryote  
(e.g. methanotrophic bacterium)

source organism,  
metabolism, substrate



diagenesis



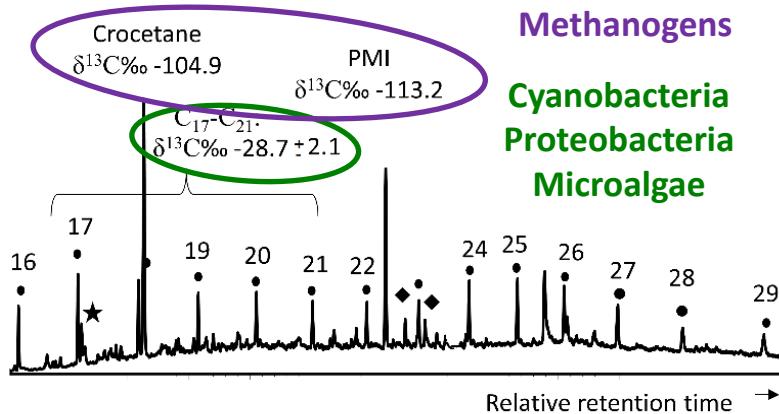
Identification of structure or subunits

Compound specific stable isotope signature

Calvin cycle  
red-acetyl-CoA  
rTCA pathway  
3HP bicycle

Archaeoglobales  
Methanogens  
Cyanobacteria  
Proteobacteria  
Microalgae

- *n*-alkane
- ★ pristane  $\delta^{13}\text{C}\% -32.4$
- ◆ unsat  $\text{C}_{25} \delta^{13}\text{C}\% -106.8$



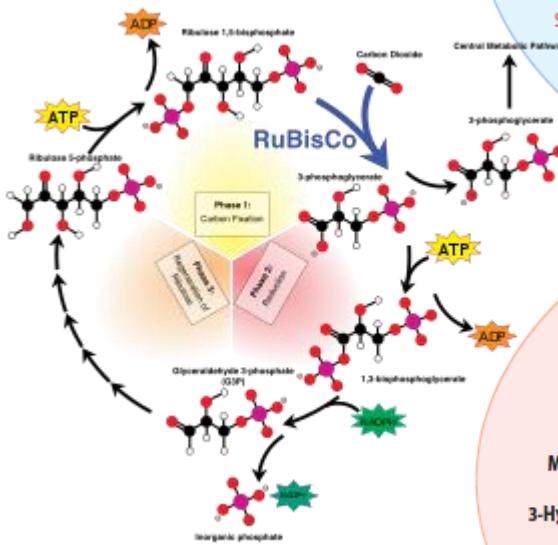
# $\delta^{13}\text{C}$ : Metabolic tracer

rTCA

$\varepsilon = -3/-10\%$

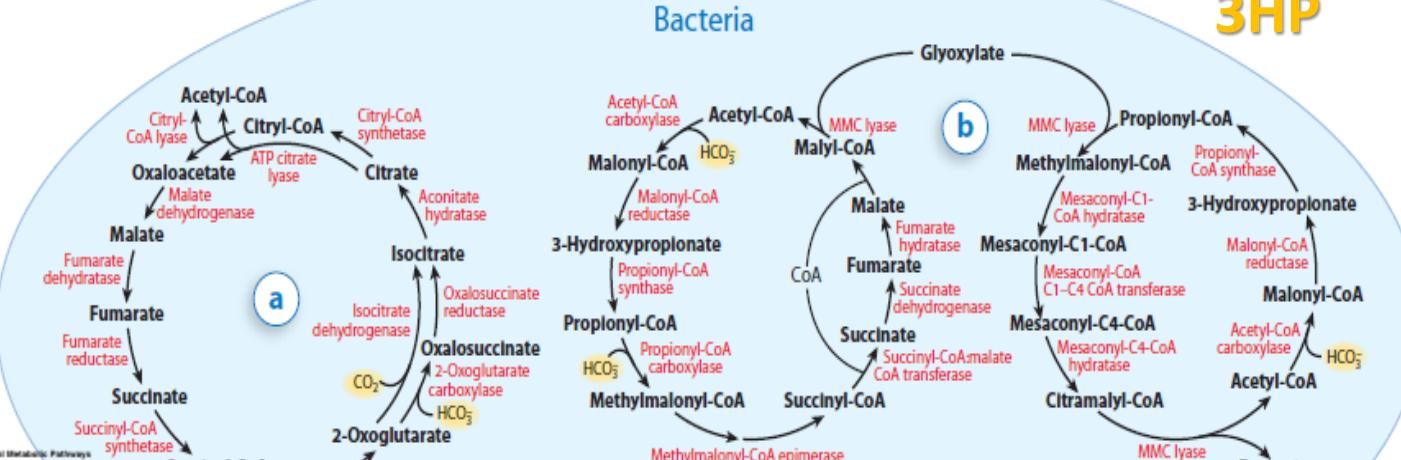
3HP

$\varepsilon = -20\%$



Calvin

3HP/4HB

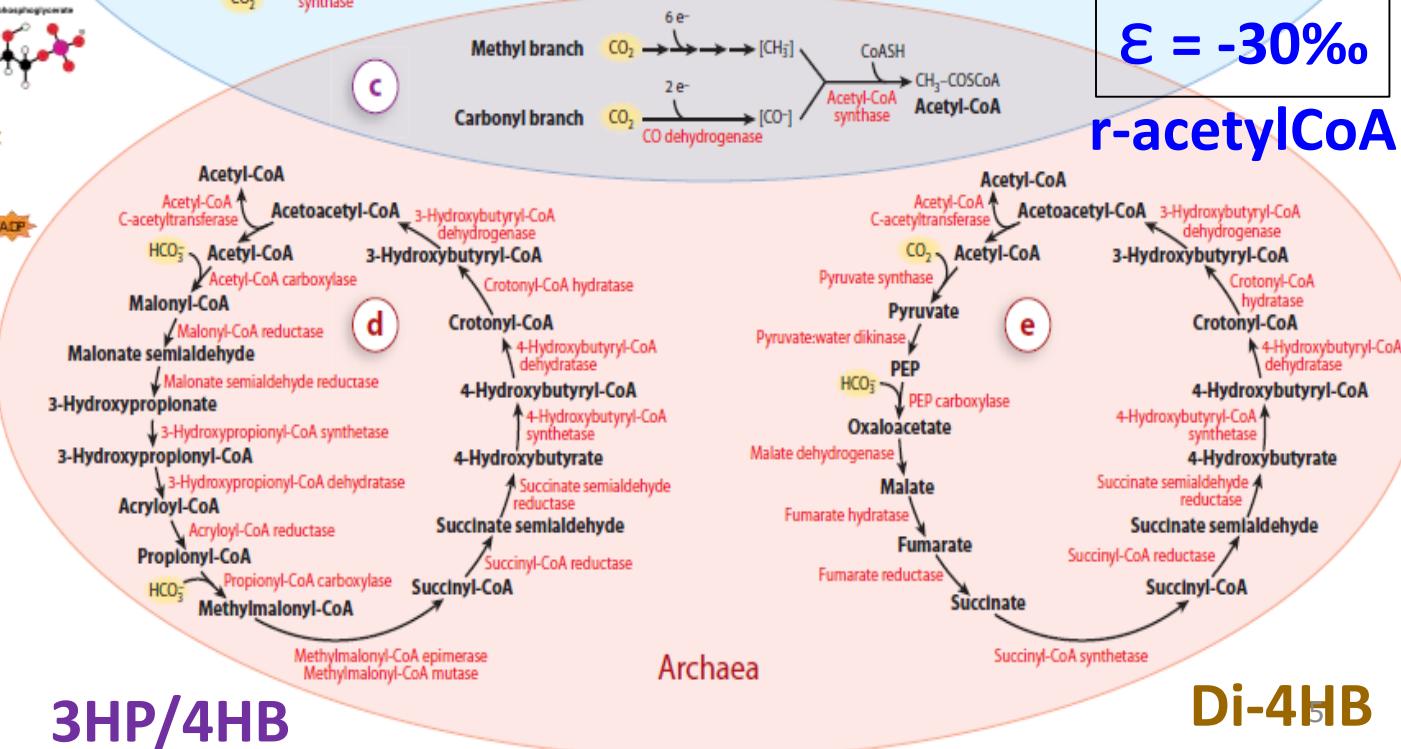


Bacteria

Di-4HB

$\varepsilon = -30\%$

r-acetylCoA



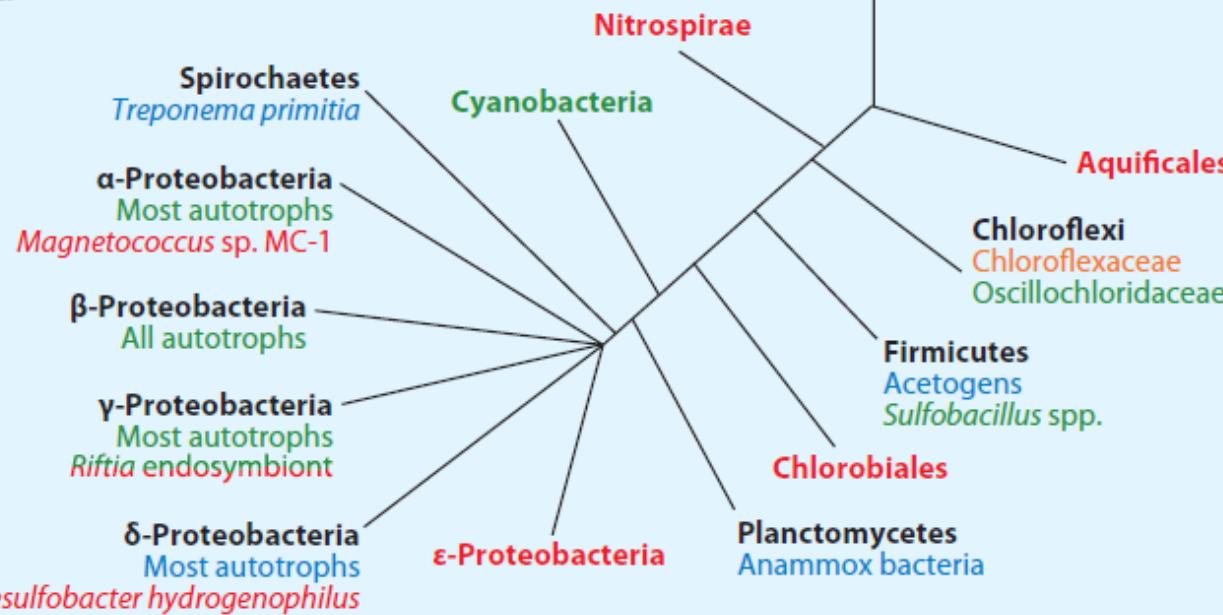
Archaea

# Tree scheme metabolisms

## a Archaea



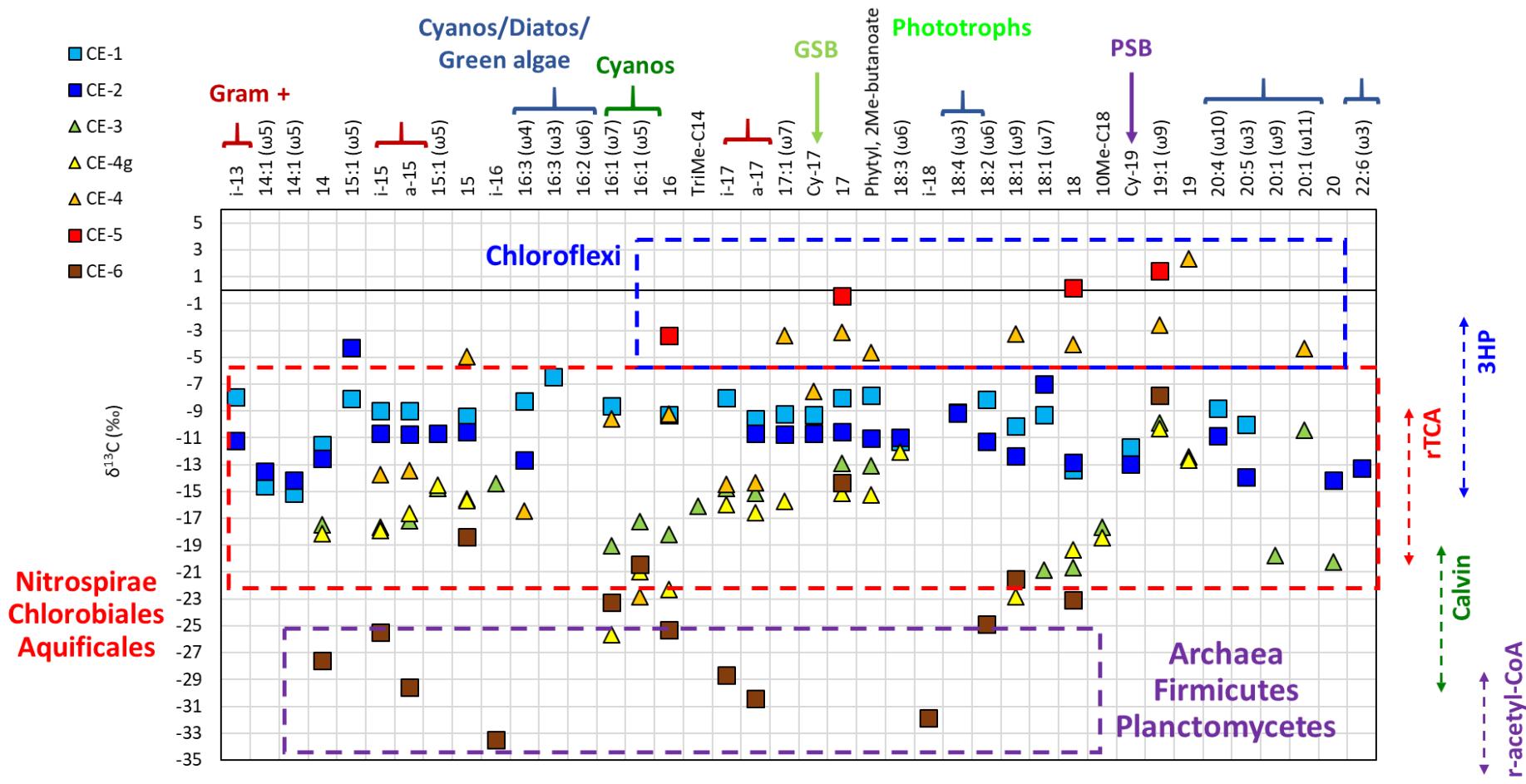
## b Bacteria



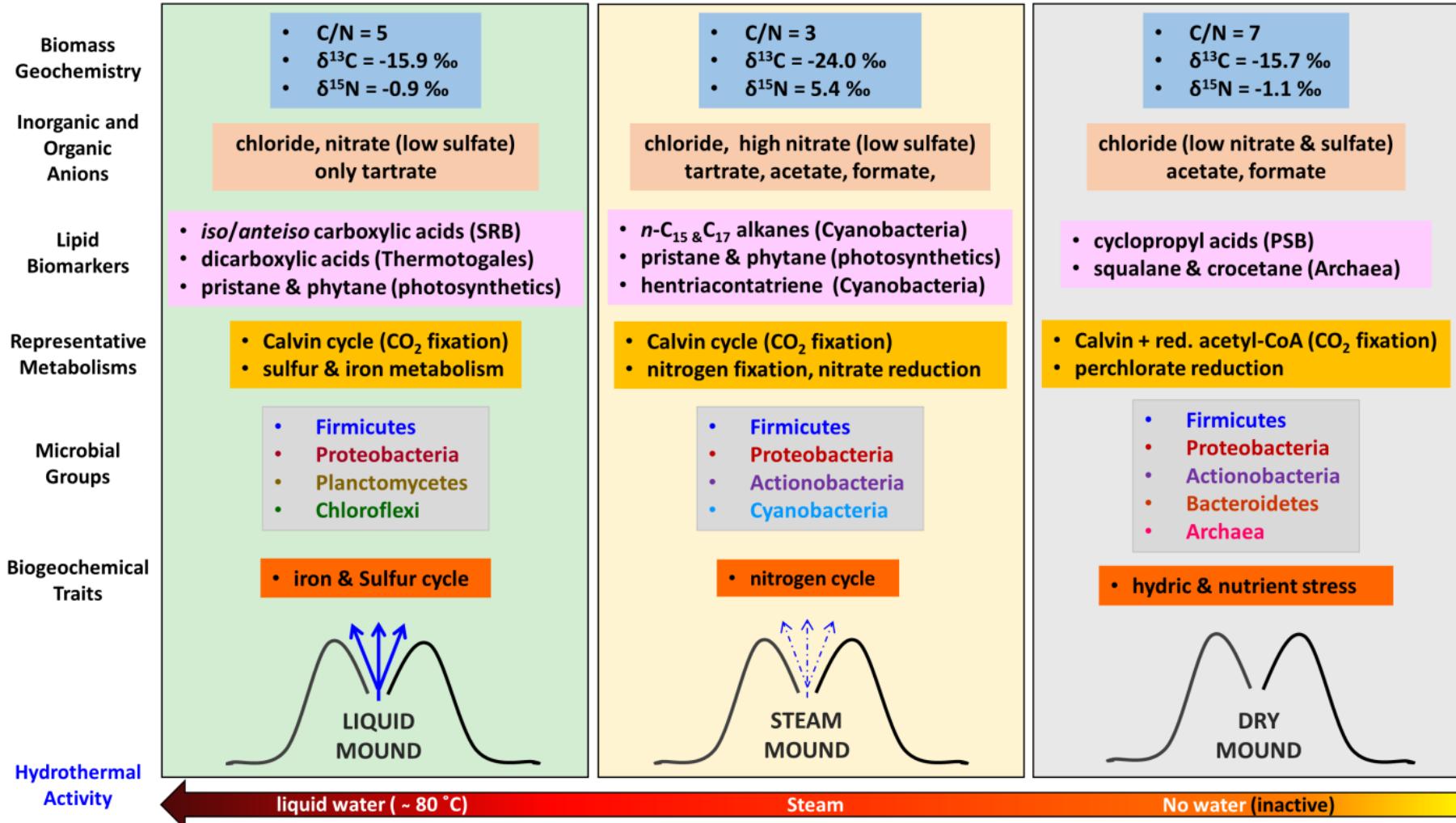
Calvin      ■ Reductive pentose phosphate cycle  
 rTCA      ■ Reductive tricarboxylic acid cycle  
 R-acetylCoA      ■ Reductive acetyl-CoA pathway

■ 3-Hydroxypropionate bicycle 3HP  
 ■ 3-Hydroxypropionate/4-hydroxybutyrate cycle 3HP/4HB  
 ■ Dicarboxylate/4-hydroxybutyrate cycle Di-4HB

- Identify biological sources from molecular analysis
- Infer carbon fixation pathways from CSIA



# Reconstruct biogeochemical functioning of paleoenvironments by combining molecular and isotopic analysis of lipids with DNA sequencing, metaproteomics, immunoassays, and bulk geochemistry.



# Applicability of lipid biomarkers

