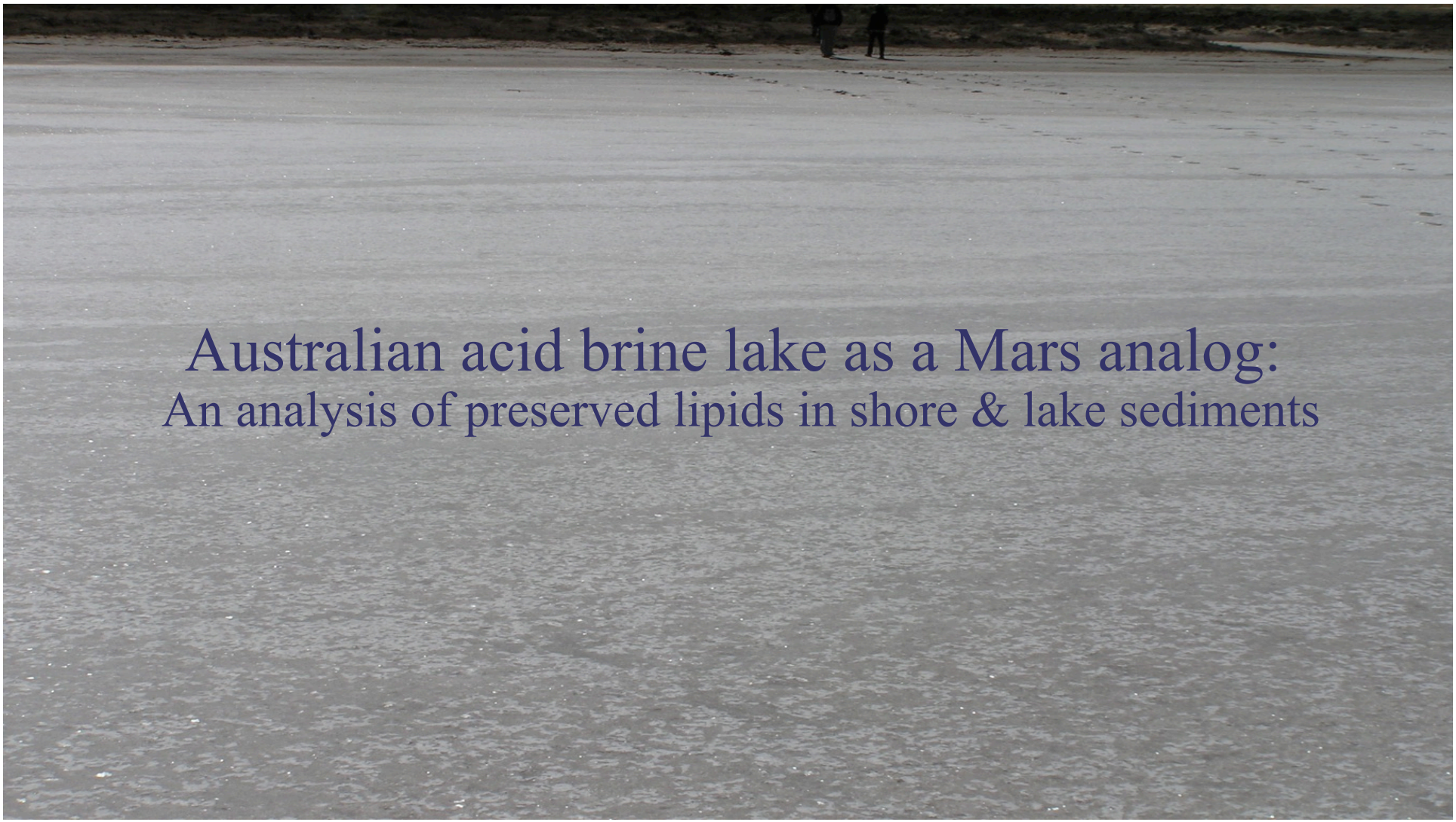
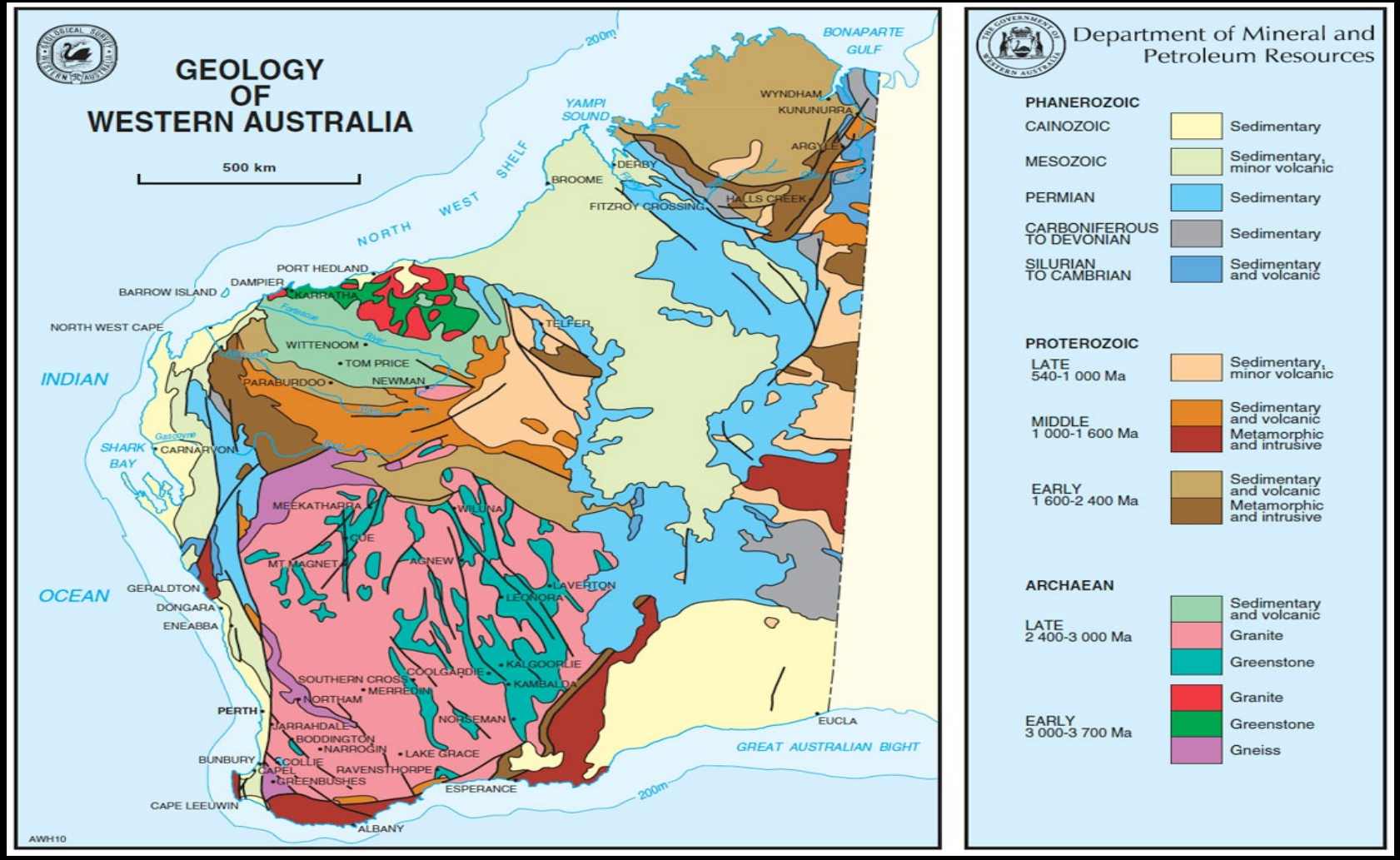
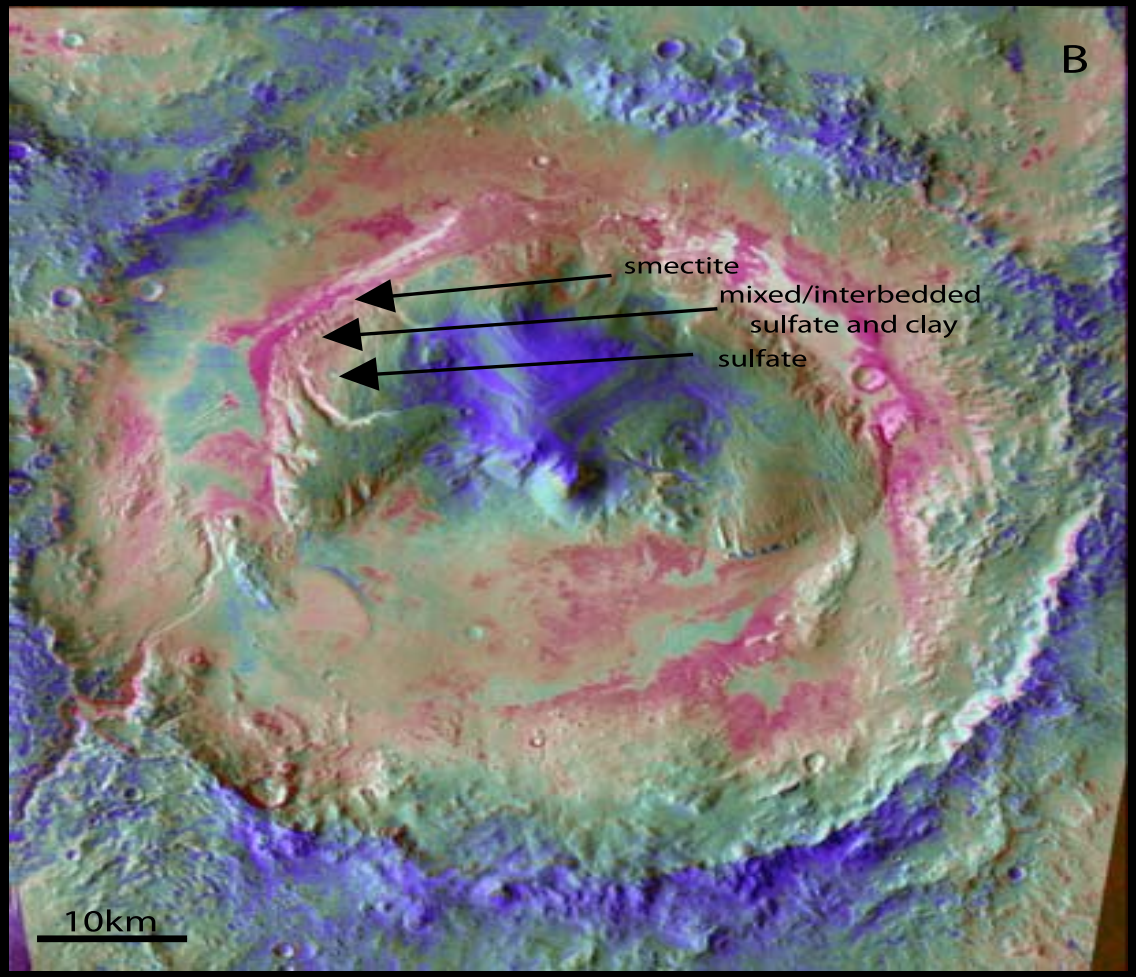
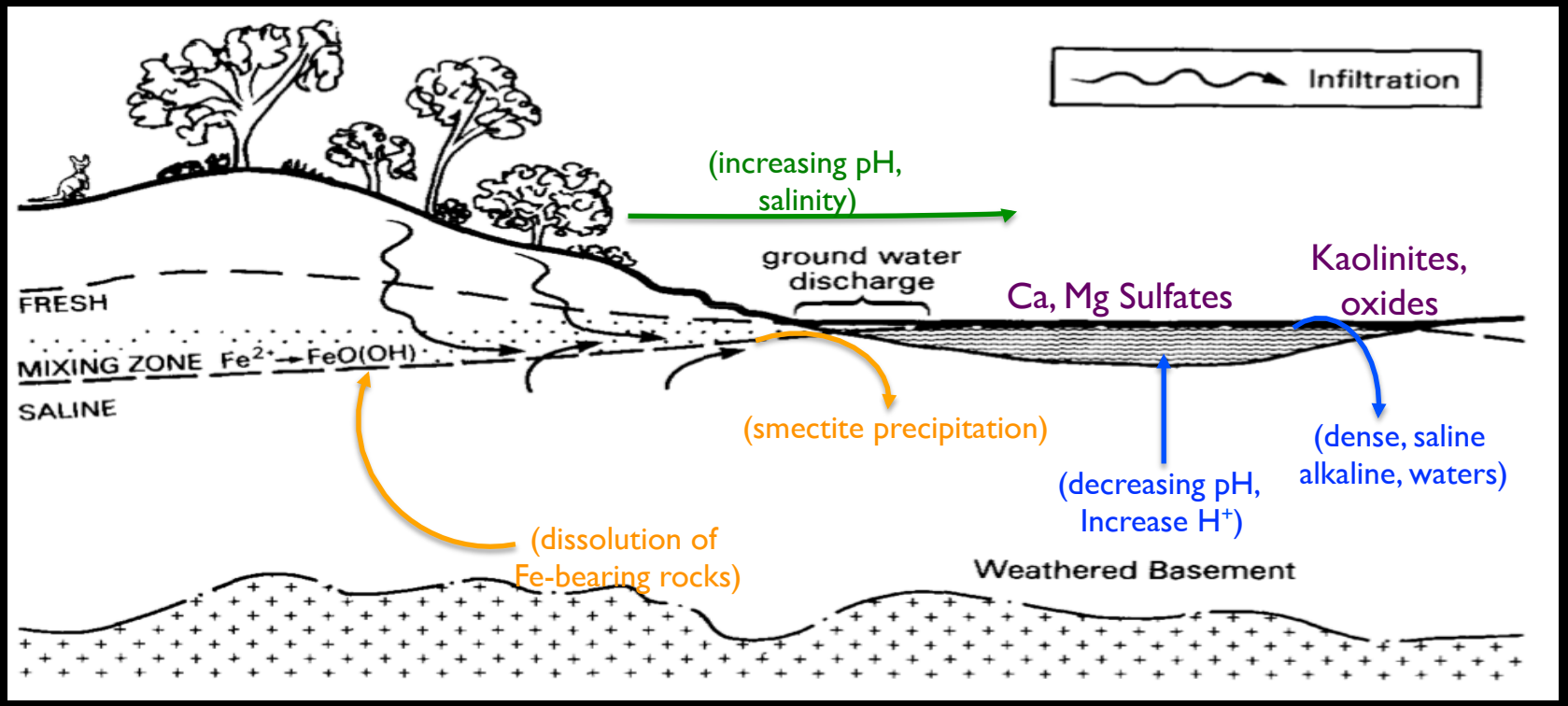


Australian acid brine lake as a Mars analog:
An analysis of preserved lipids in shore & lake sediments

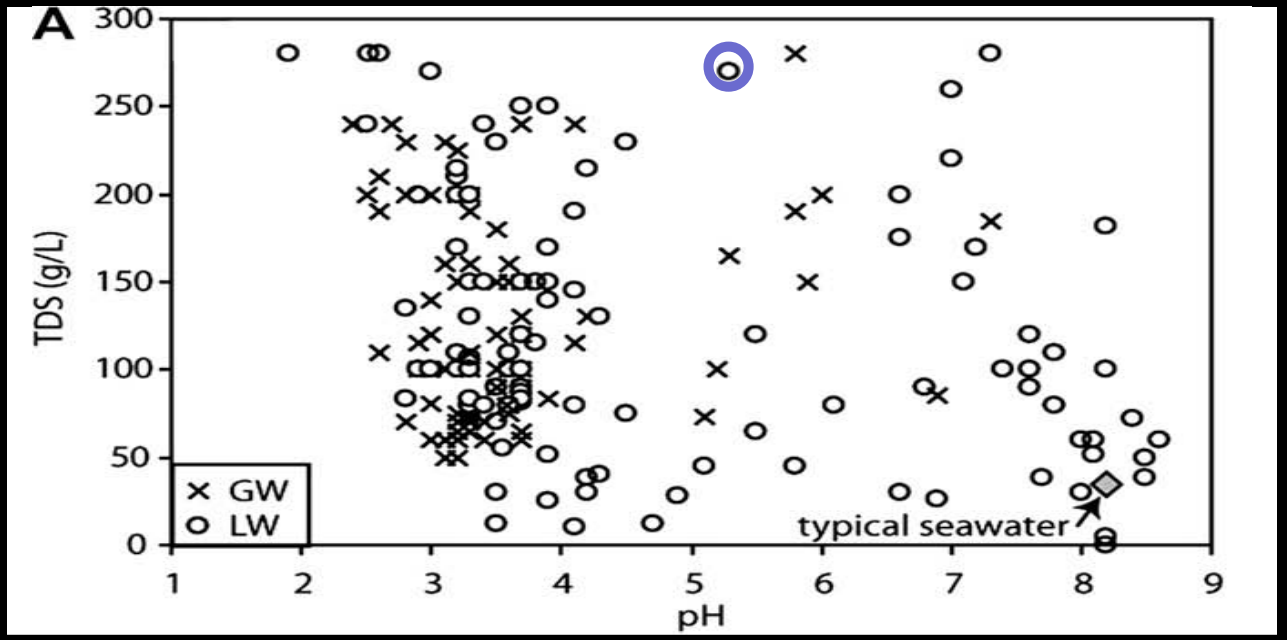

GEOLOGY
OF
WESTERN AUSTRALIA
500 km
INDIAN
OCEAN
NORTH WEST SHELF
BONAPARTE GULF
YAMPI SOUND
GREAT AUSTRALIAN BIGHT
200m
WYNDHAM
KUNUNURRA
ARGYLE
DERBY
BROOME
FITZROY CROSSING
HALLS CREEK
PORT HEDLAND
DAMPIER
BARROW ISLAND
KARRATHA
NORTH WEST CAPE
TELFER
WITTENOOM
TOM PRICE
PARABURDOO
NEWMAN
SHARK BAY
CARNARVON
MEEKATHARRA
WILUNA
CUE
MT MAGNET
AGNEW
GERALDTON
LAVERTON
LEONORA
DONGARA
ENEABBA
KALGOORLIE
COOLGARDIE
KAMBALDA
SOUTHERN CROSS
MERREDIN
NORTHAM
PERTH
NORSEMAN
EUCLA
JARRAHDALE
BODDINGTON
NARROGIN
LAKE GRACE
BUNBURY
COLLIE
CAPE
RAVENSTHORPE
GREENBUSHES
ESPERANCE
CAPE LEEUWIN
ALBANY
AWH10
Department of Mineral and Petroleum Resources
PHANEROZOIC
CAINOZOIC
Sedimentary
MESOZOIC
Sedimentary, minor volcanic
PERMIAN
Sedimentary
CARBONIFEROUS TO DEVONIAN
Sedimentary
SILURIAN TO CAMBRIAN
Sedimentary and volcanic
PROTEROZOIC
LATE 540-1 000 Ma
Sedimentary, minor volcanic
MIDDLE 1 000-1 600 Ma
Sedimentary and volcanic
Metamorphic and intrusive
EARLY 1 600-2 400 Ma
Sedimentary and volcanic
Metamorphic and intrusive
ARCHAEAN
LATE 2 400-3 000 Ma
Sedimentary and volcanic
Granite
Greenstone
EARLY 3 000-3 700 Ma
Granite
Greenstone
Gneiss



Baldridge *et al.* Geophysical Research Letters, 2009



McArthur *et al.*, Geochimica et Cosmochimica Acta, 1991



Bowen & Benison, Applied Geochemistry, 2009

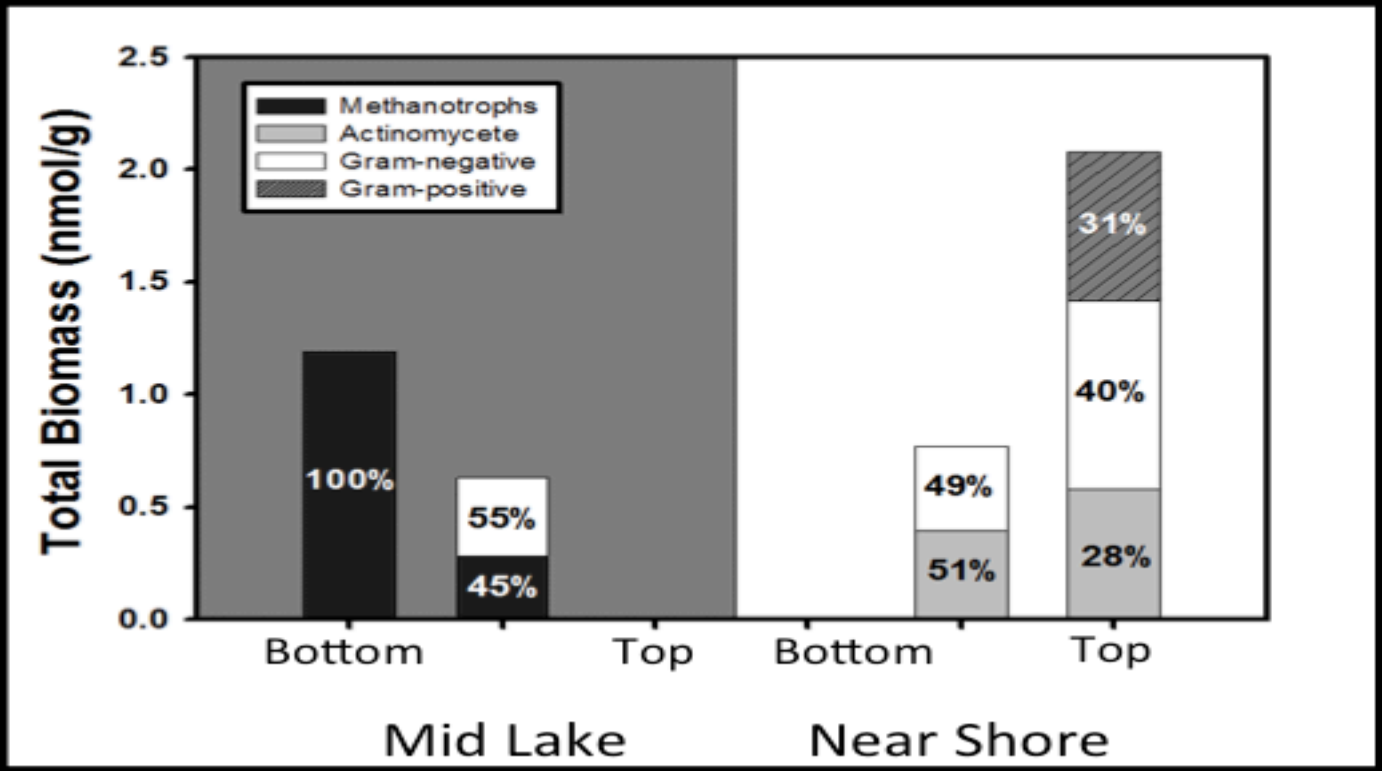
Lake Gilmore

Mid-lake core & near-shore "lunette" core

Lipid Analysis

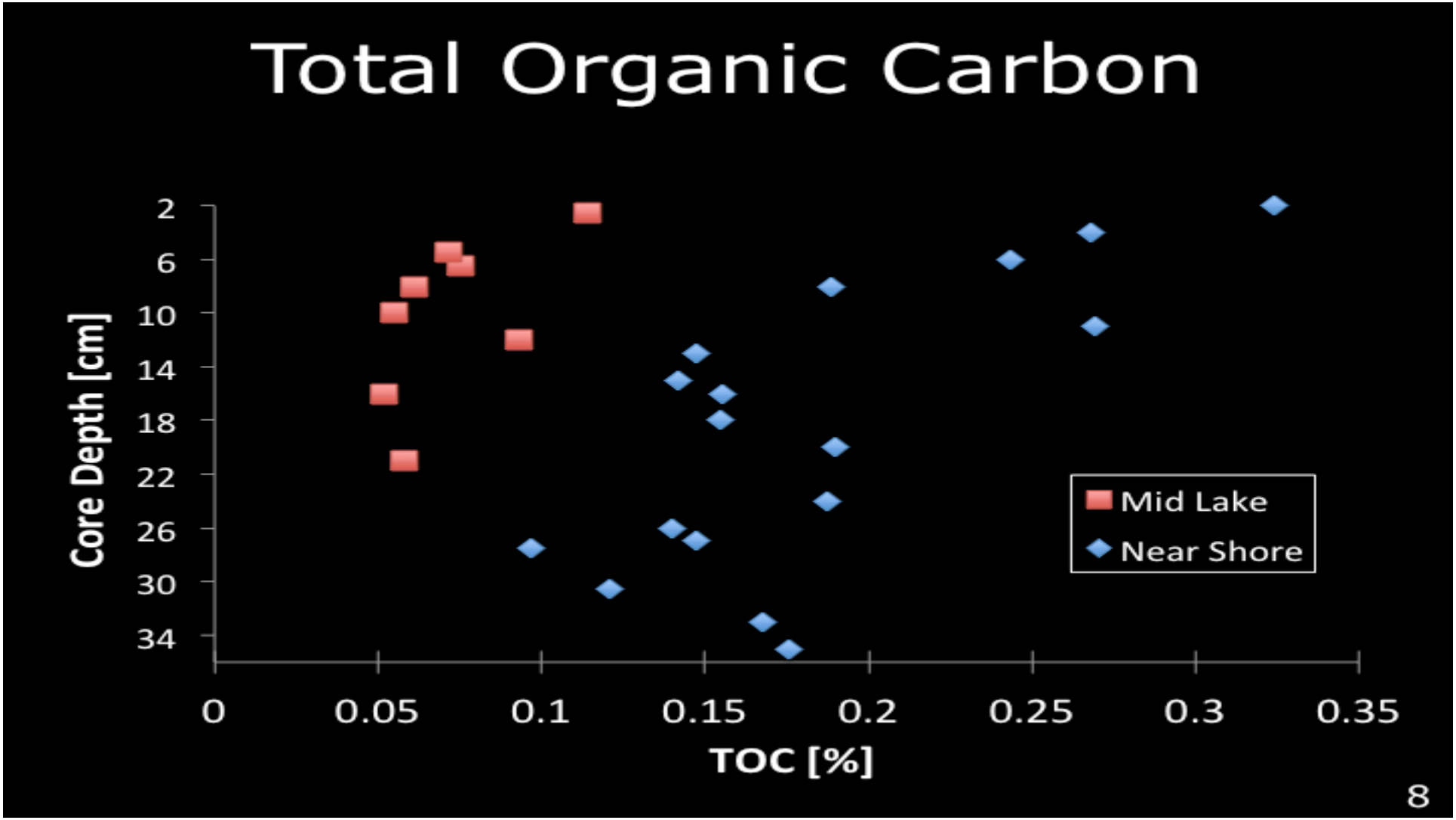
Methanotrophs in a Mars analog?

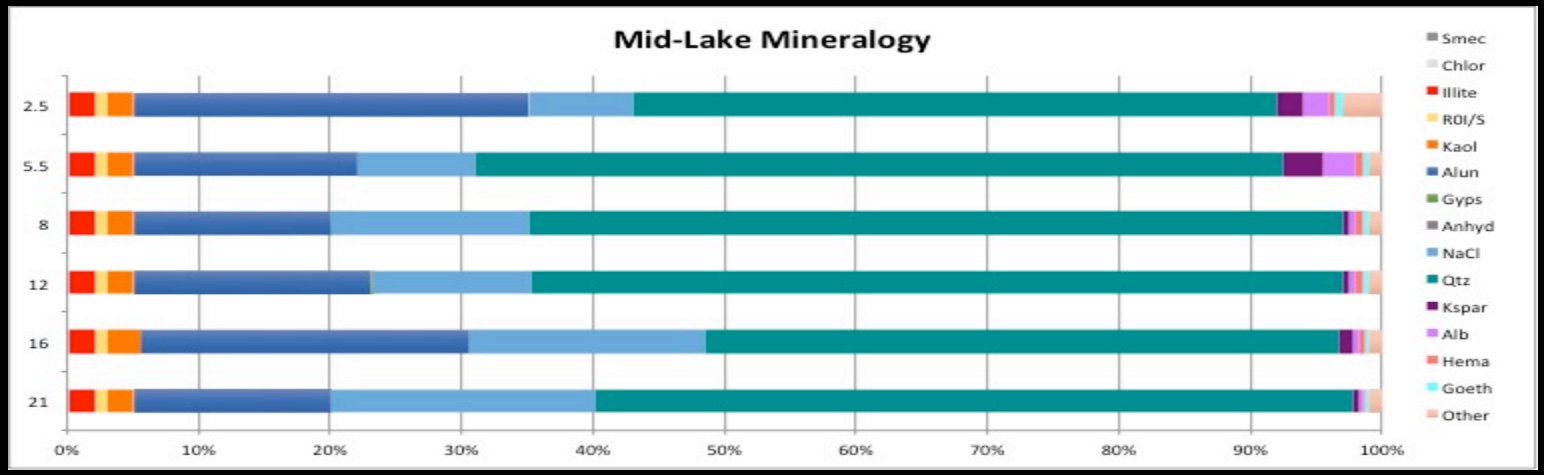
Mid Lake

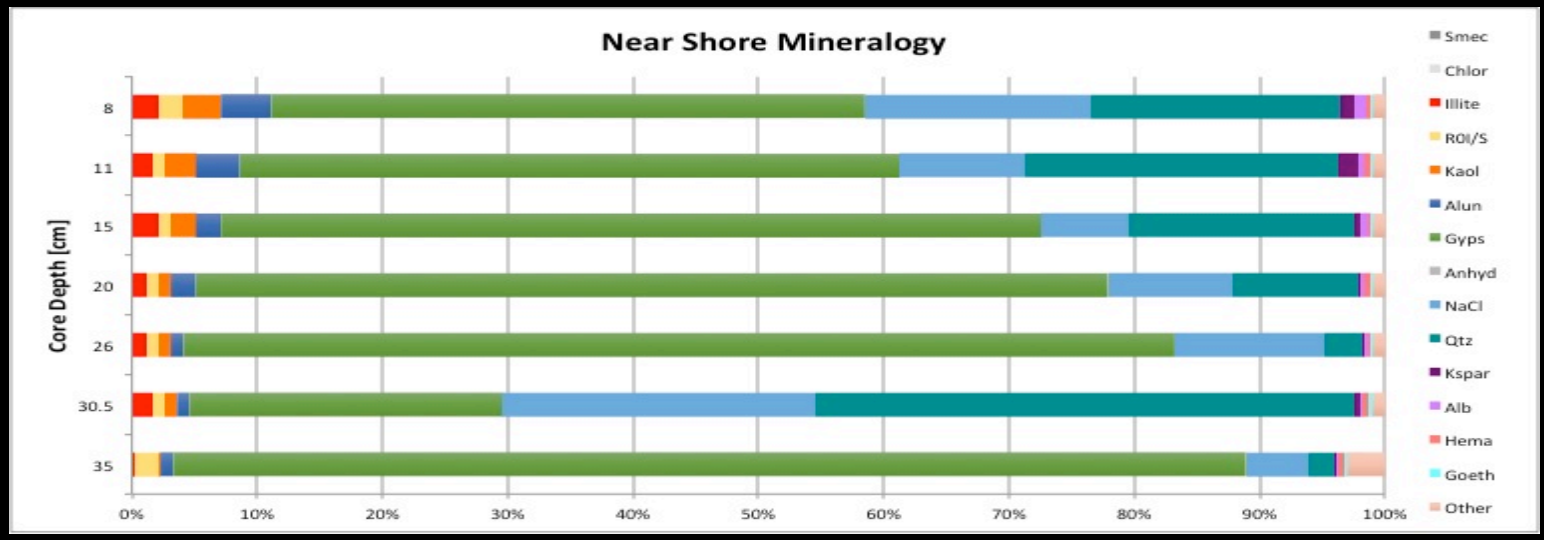


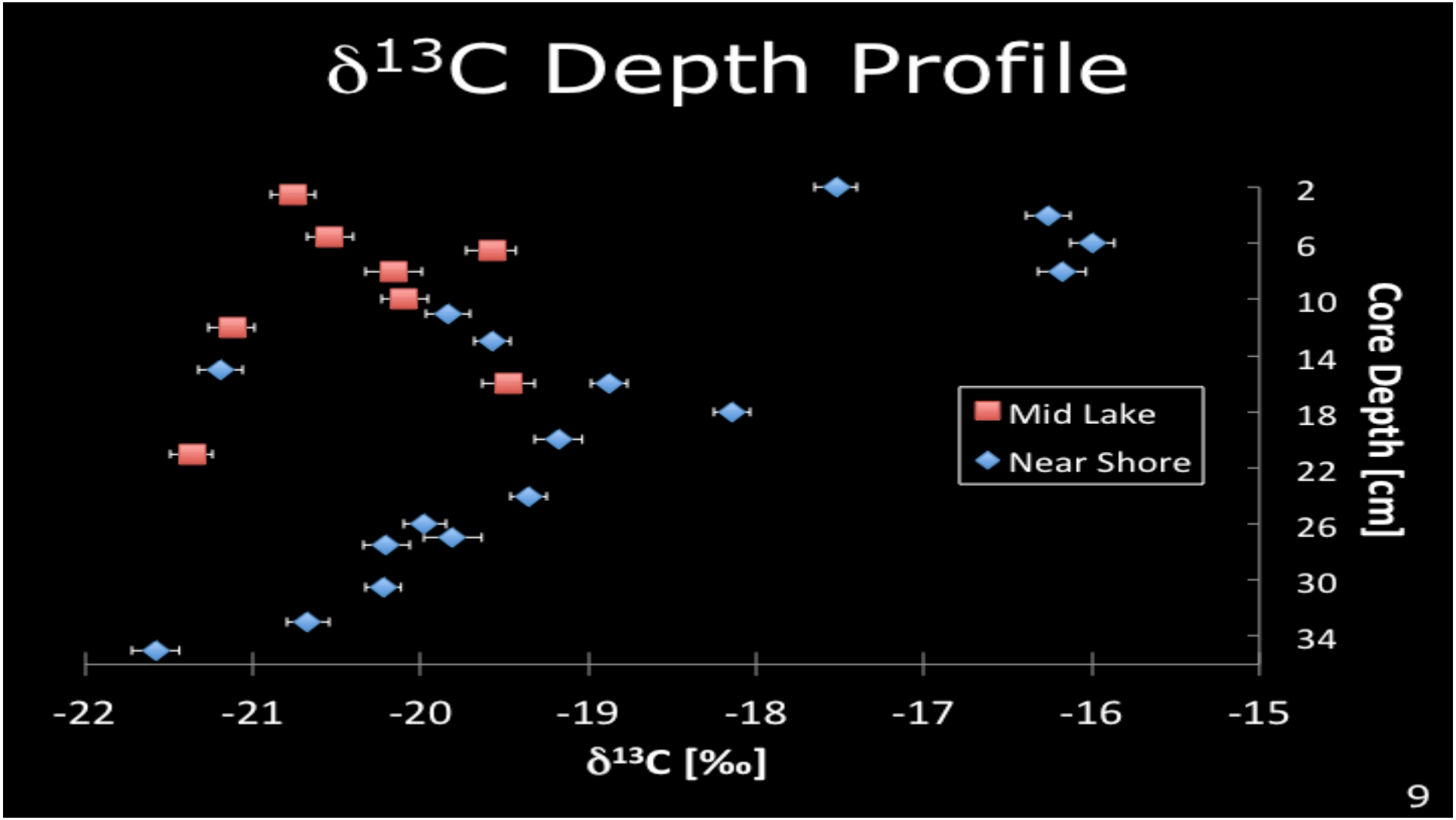
Near Shore

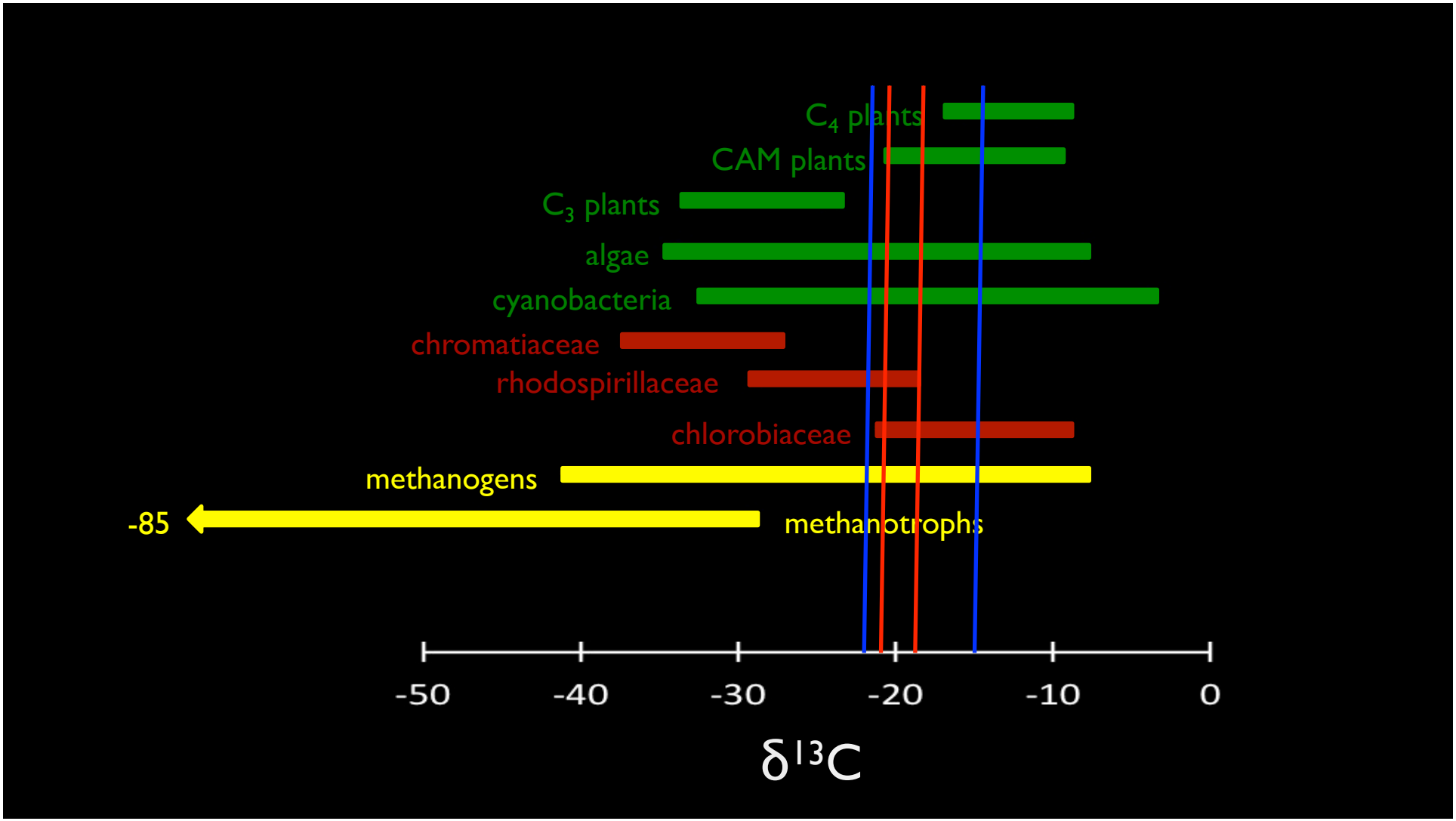
Nguyen, A. ; Baldridge, A.; Thomson, B.; AGU 2014


Total Organic Carbon
Core Depth [cm]
2
6
10
14
18
22
26
30
34
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
TOC [%]
Mid Lake
Near Shore
8

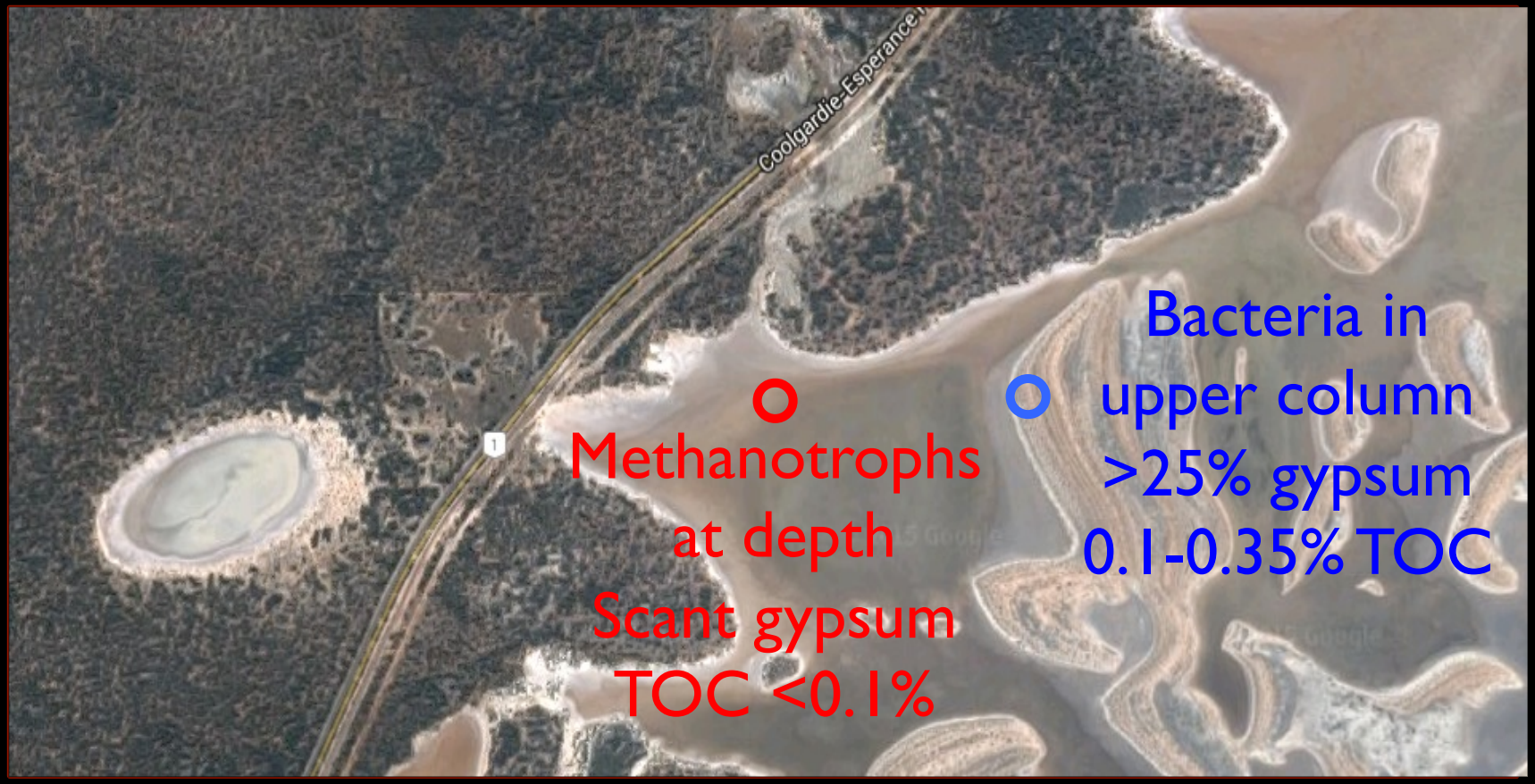

Mid-Lake Mineralogy
2.5
5.5
8
12
16
21
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Smec
Chlor
Illite
ROI/S
Kaol
Alun
Gyps
Anhyd
NaCl
Qtz
Kspar
Alb
Hema
Goeth
Other


Near Shore Mineralogy
Core Depth [cm]
8
11
15
20
26
30.5
35
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Smec
Chlor
Illite
ROI/S
Kaol
Alun
Gyps
Anhyd
NaCl
Qtz
Kspar
Alb
Hema
Goeth
Other

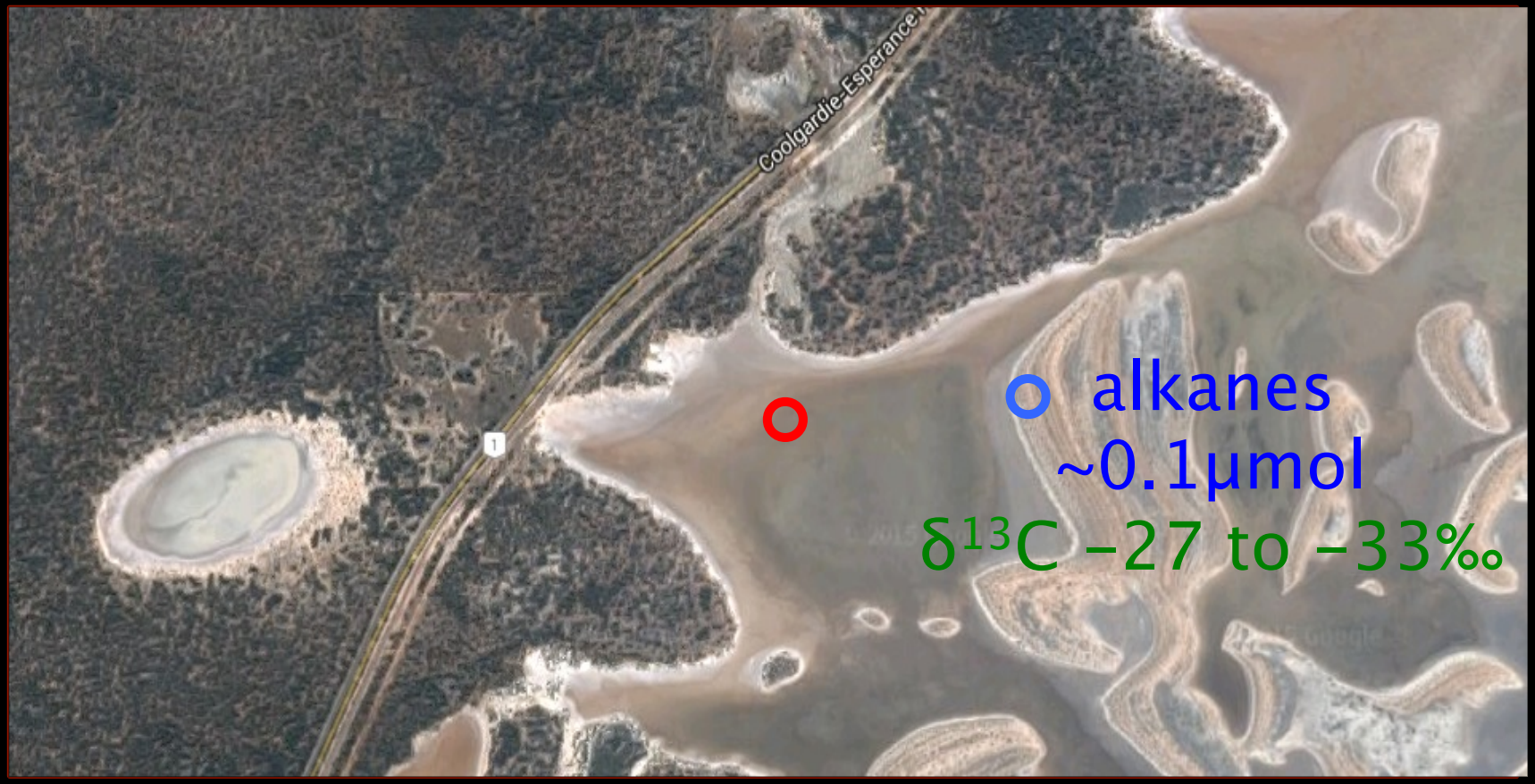

δ13C Depth Profile
Mid Lake
Near Shore
Core Depth [cm]
2
6
10
14
18
22
26
30
34
-22
-21
-20
-19
-18
-17
-16
-15
δ13C [‰]
9

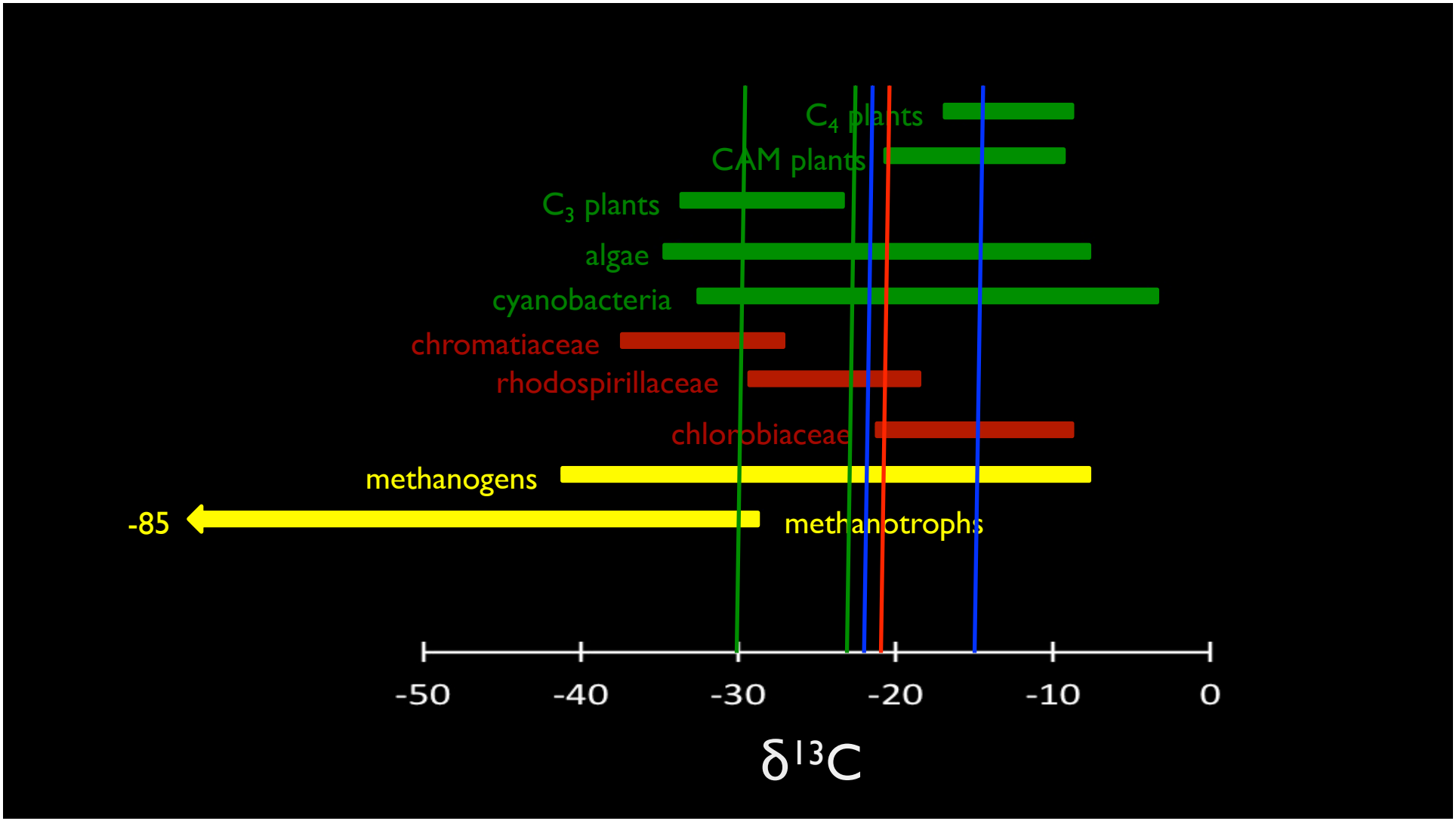

C4 plants
CAM plants
C3 plants
algae
cyanobacteria
chromatiaceae
rhodospirillaceae
chlorobiaceae
methanogens
-85
methanotrophs
-50
-40
-30
-20
-10
0
δ13C

Vegetation survey


Coolgardie-Esperance
1
Methanotrophs
at depth
Scant gypsum
TOC <0.1%
Bacteria in
upper column
>25% gypsum
0.1-0.35% TOC


Coolgardie-Esperance
1
no archaeol
no GDGTs
some fatty acids
at depth
Alkanes
nC24-nC33
Pristane/phytane
Hopanoids
Fatty acids
at surface


Coolgardie-Esperance
1
alkanes
~0.1µmol
δ13C -27 to -33‰


C4 plants
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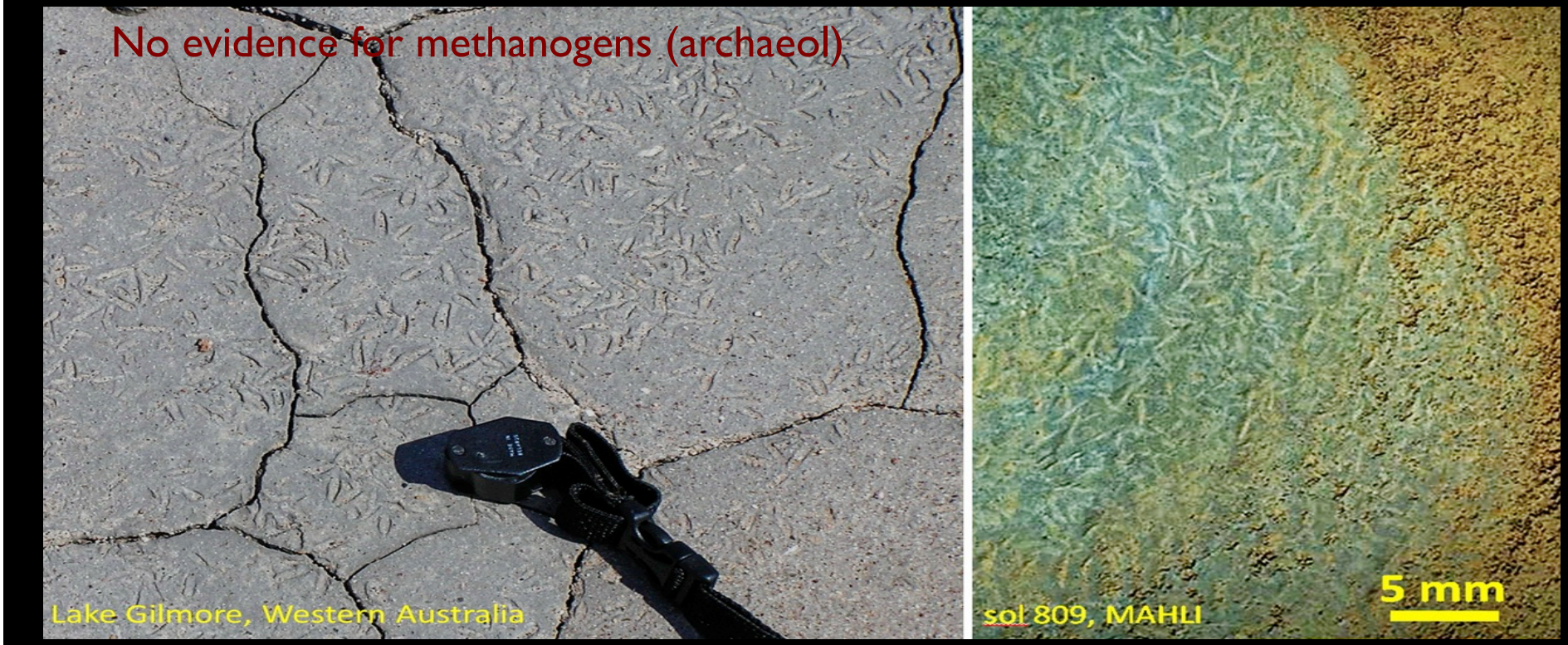
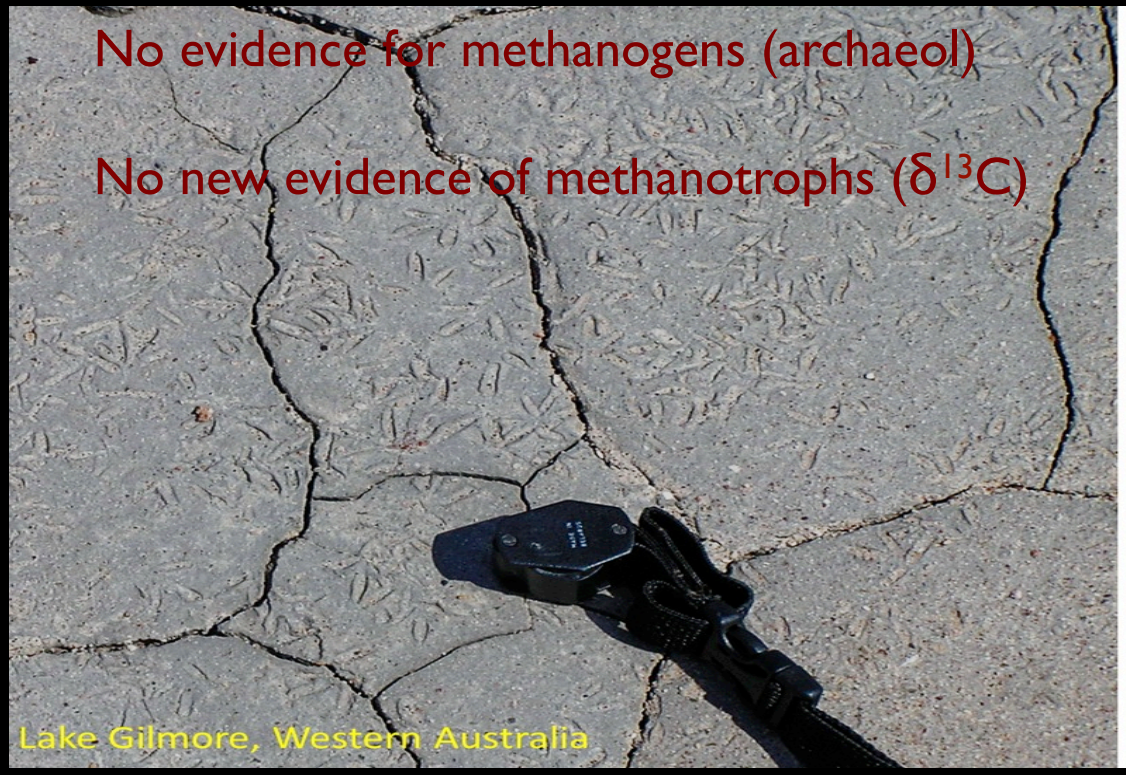
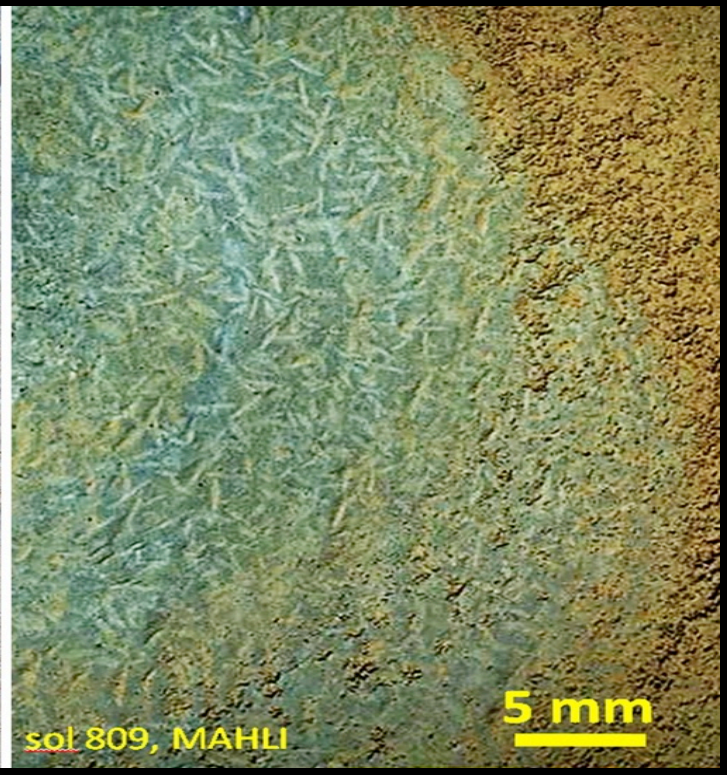
algae
cyanobacteria
chromatiaceae
rhodospirillaceae
chlorobiaceae
methanogens
-85
methanotrophs
-50
-40
-30
-20
-10
0
δ13C


No evidence for methanogens (archaeol)
Lake Gilmore, Western Australia
sol 809, MAHLI
5 mm

No evidence for methanogens (archaeol)

No new evidence of methanotrophs ($\delta^{13}C$)

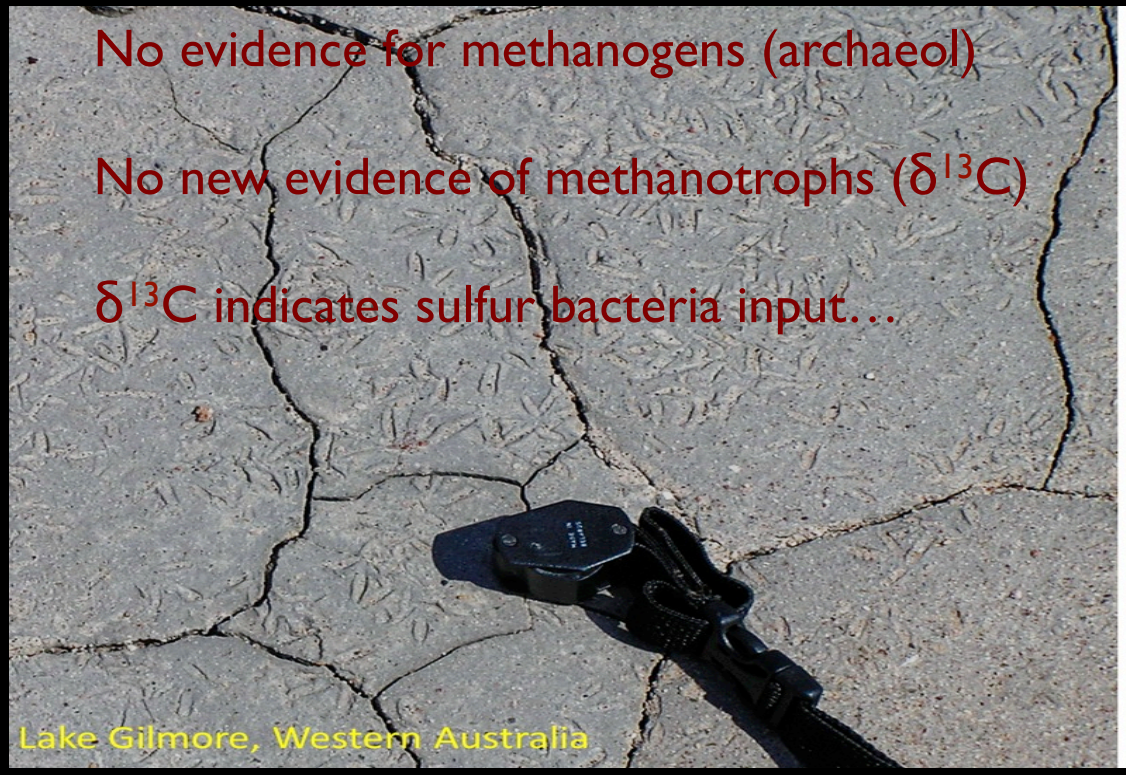


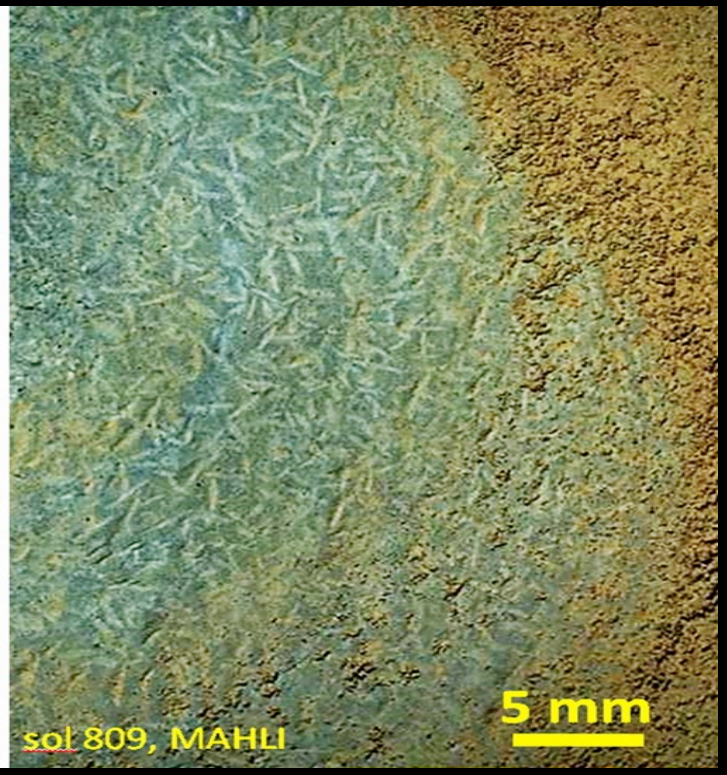


No evidence for methanogens (archaeol)

No new evidence of methanotrophs ($\delta^{13}C$)

$\delta^{13}C$ indicates sulfur bacteria input…



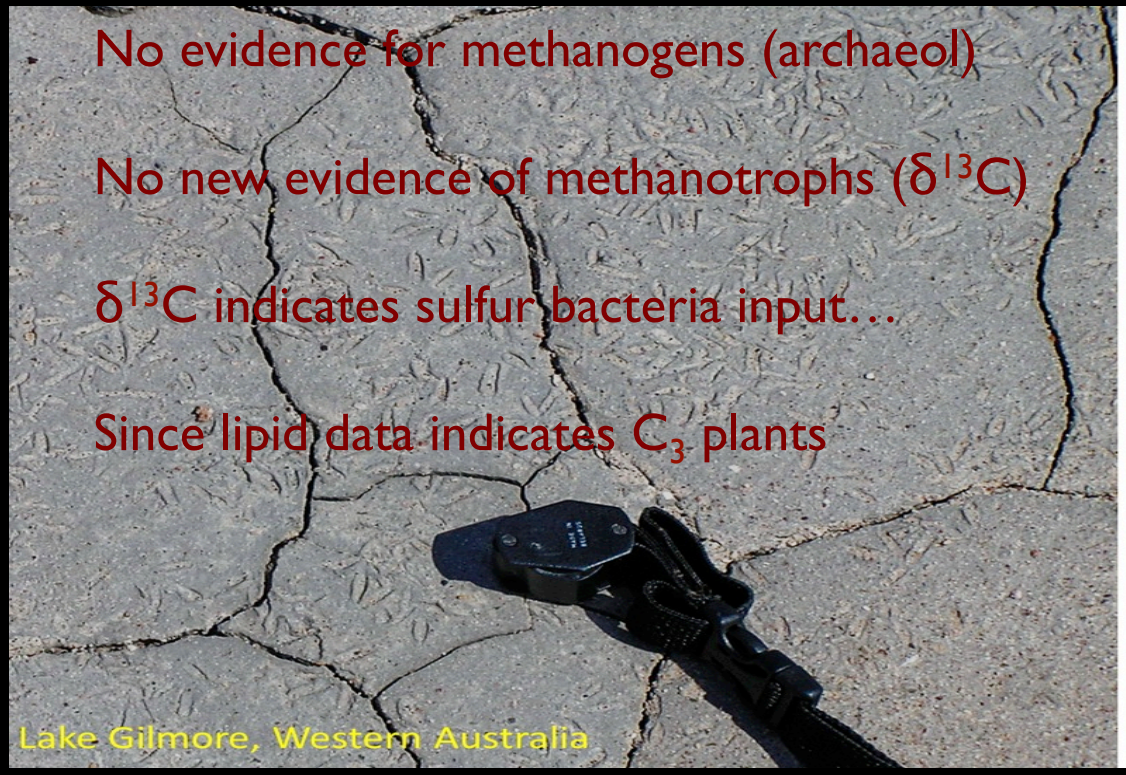


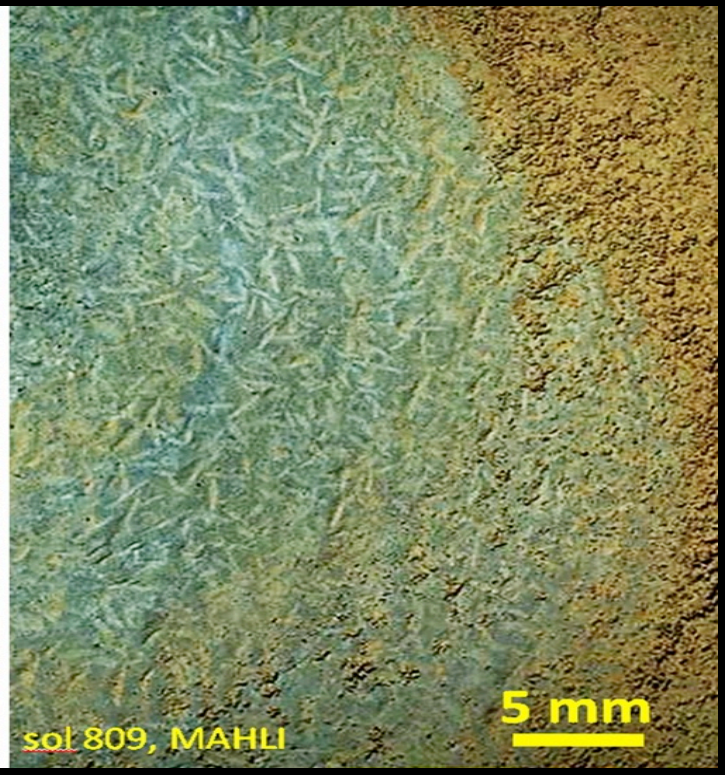
No evidence for methanogens (archaeol)

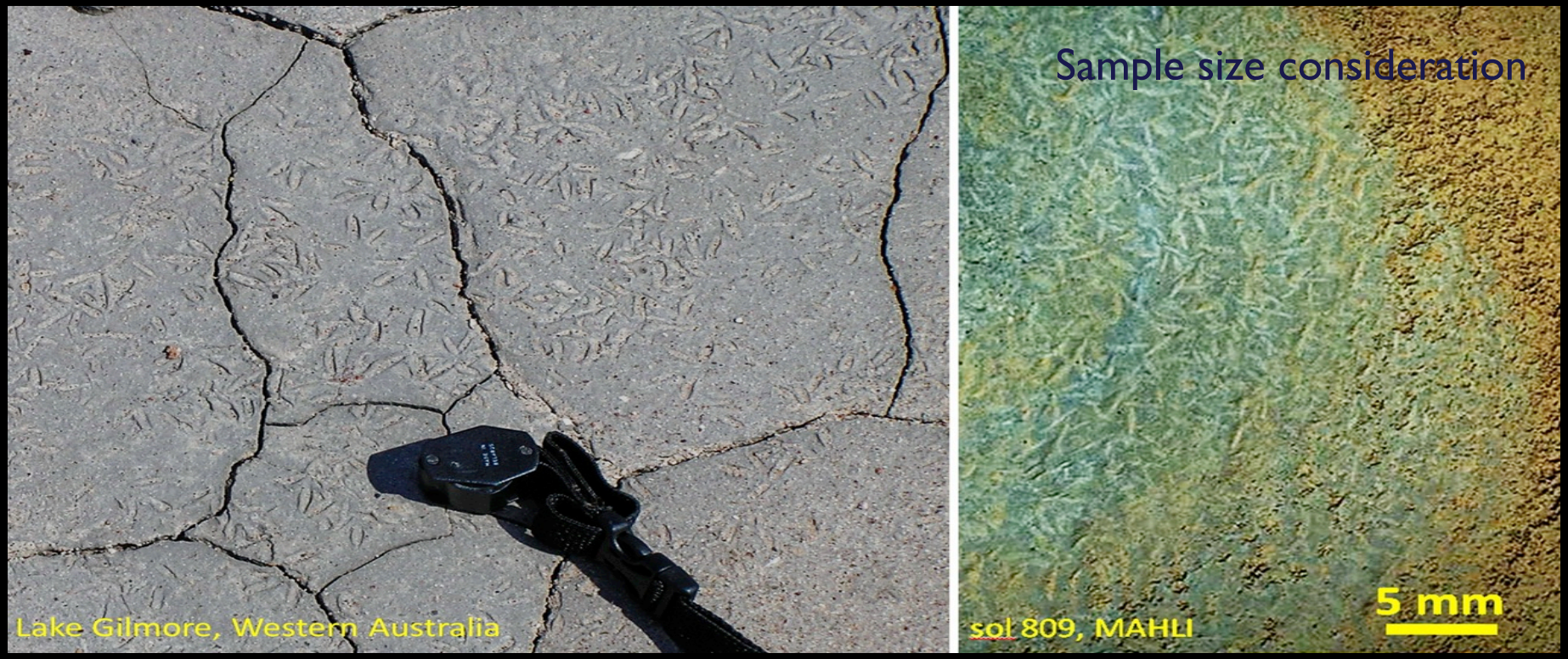
No new evidence of methanotrophs ($\delta^{13}C$)

$\delta^{13}C$ indicates sulfur bacteria input…

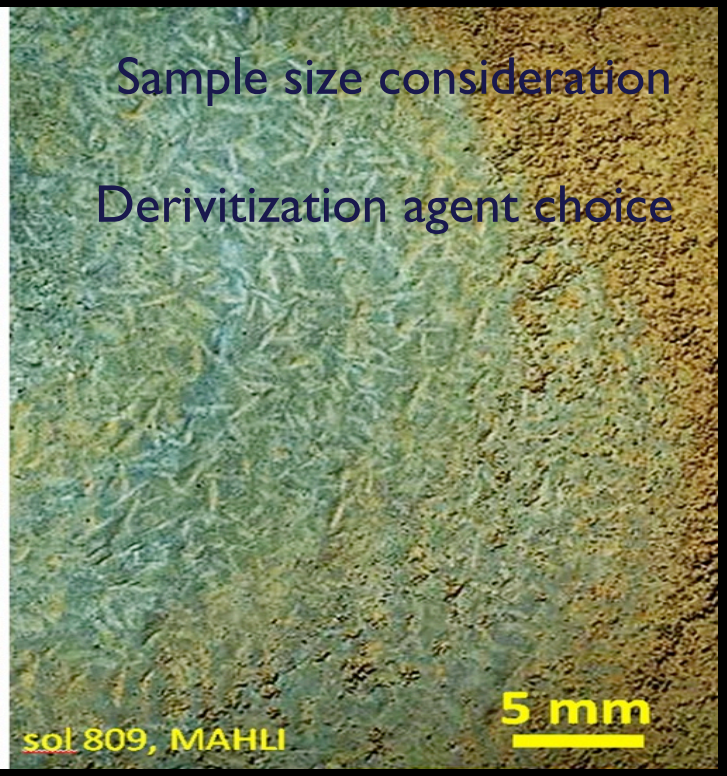
Since lipid data indicates C_3 plants



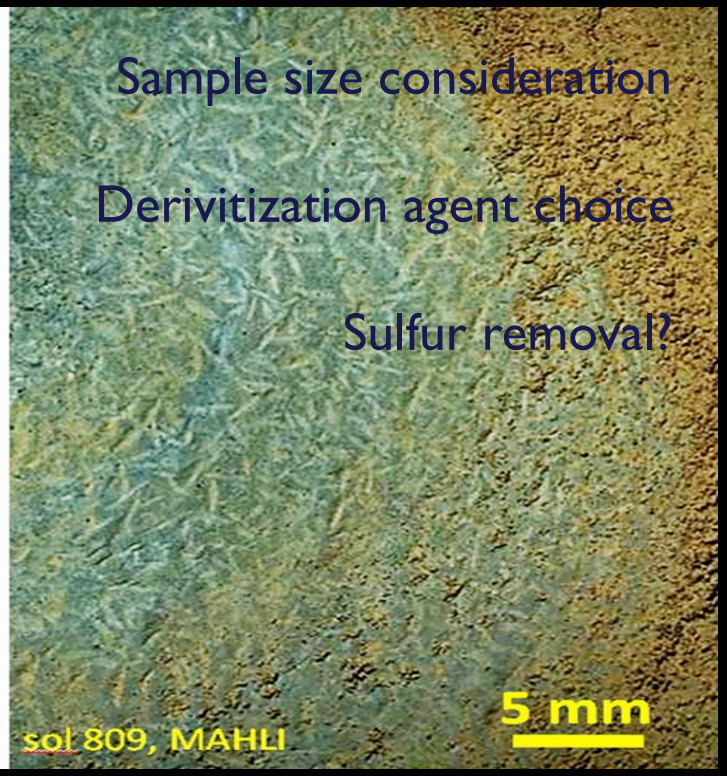



Sample size consideration
Lake Gilmore, Western Australia
sol 809, MAHLI
5 mm

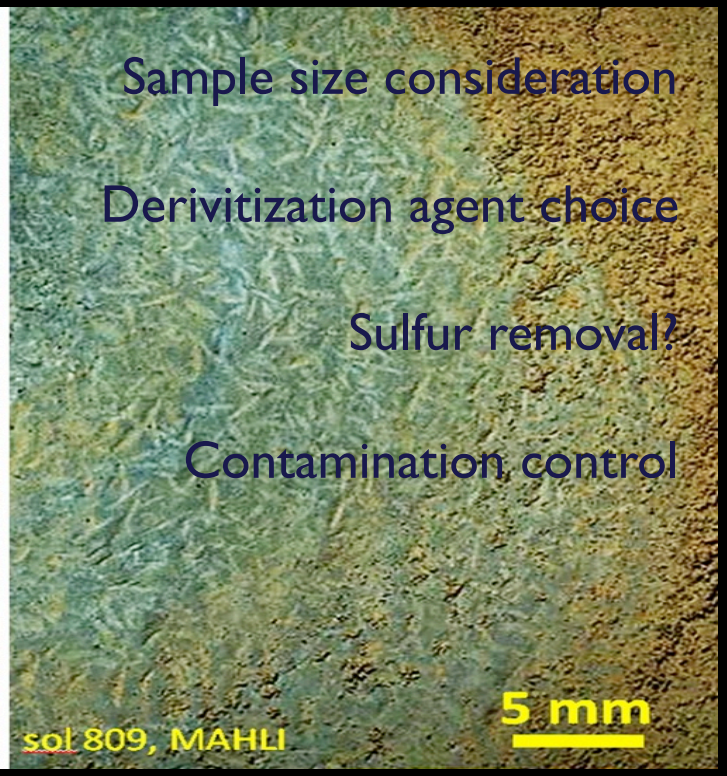

Lake Gilmore, Western Australia


Sample size consideration
Derivitization agent choice
sol 809, MAHLI
5 mm


Lake Gilmore, Western Australia


Sample size consideration
Derivitization agent choice
Sulfur removal?
sol 809, MAHLI
5 mm


Lake Gilmore, Western Australia


Sample size consideration
Derivitization agent choice
Sulfur removal?
Contamination control
sol 809, MAHLI
5 mm


Questions?
Many thanks to Beatriz Saldana and Sara Lincoln