Fossil bivalves in the Rainbow area:

New insight into the diversity and evolution of chemosynthetic communities

F. Lartaud[1,2]*, M. de Rafelis[2], C.T.S. Little[3], G. Bayon[4], B. Ildefonse[5], J. Dyment[6] and N. Le Bris[1]

[1] LECOB, FRE CNRS 3350, Observatoire Océanologique de Banyuls, UPMC Univ Paris 06

[2] ISTeP, UMR 7193, UPMC Univ Paris 06

[3] School of Earth and Environment, Univiversity of Leeds

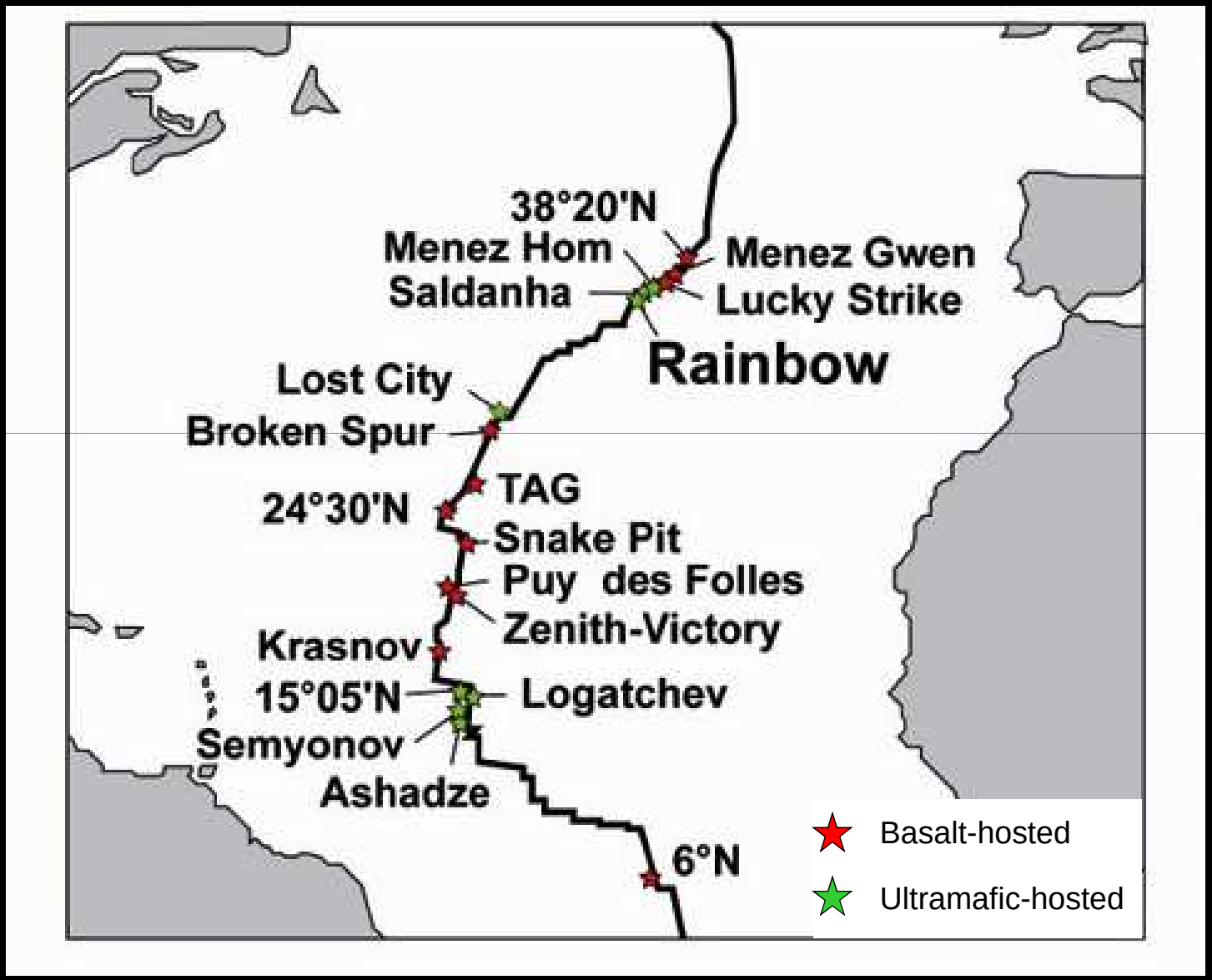
[4] Département Géosciences Marines, IFREMER

[5] Géosciences, UMR 5243, Université Montpellier 2

[6] Géosciences Marines, Institut de Physique du Globe de Paris

* franck.lartaud@obs-banyuls.fr

Large variety of hydrothermal vent systems at slow spreading ridges:



Ultramafic-hosted hydrothermal vents:

High-temperature (e.g., Rainbow, Logatchev):

Gabbroic and ultramafic-hosted
High-temperature (>300°C), metal-rich and acidic vent fluids enriched in CO_2, but also in CH_4 and H_2 (derived from serpentinization).

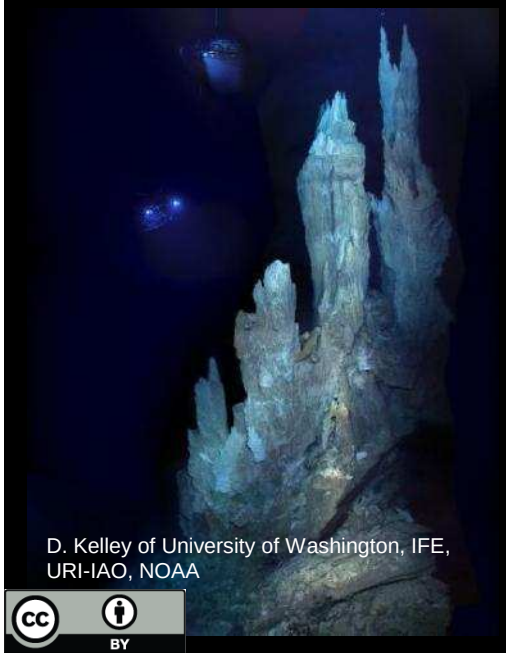
Supports high-biomass of chemosynthetic communities:
-bresiliid shrimps and *Bathymodiolus* mussels at chimney complexes
-vesicomyid clams in the sedimented diffuse flow areas (Anya's Garden at Logatchev).

Ultramafic-hosted hydrothermal vents:

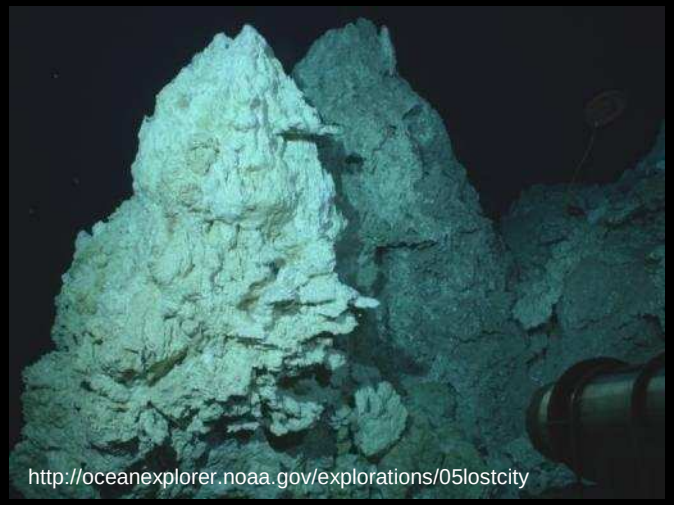
Low-temperature (only one found = Lost City):

Ultramafic-dominated
Low-temperature (<100°C), metal-poor and high-pH vent fluids enriched in CH_4 and H_2 and comparatively lower in H_2S.

Lacks of high-biomass chemosynthetic communities:
-only 2 living specimens of *Bathymodiolus* aff. *azoricus* have been found



D. Kelley of University of Washington, IFE, URI-IAO, NOAA

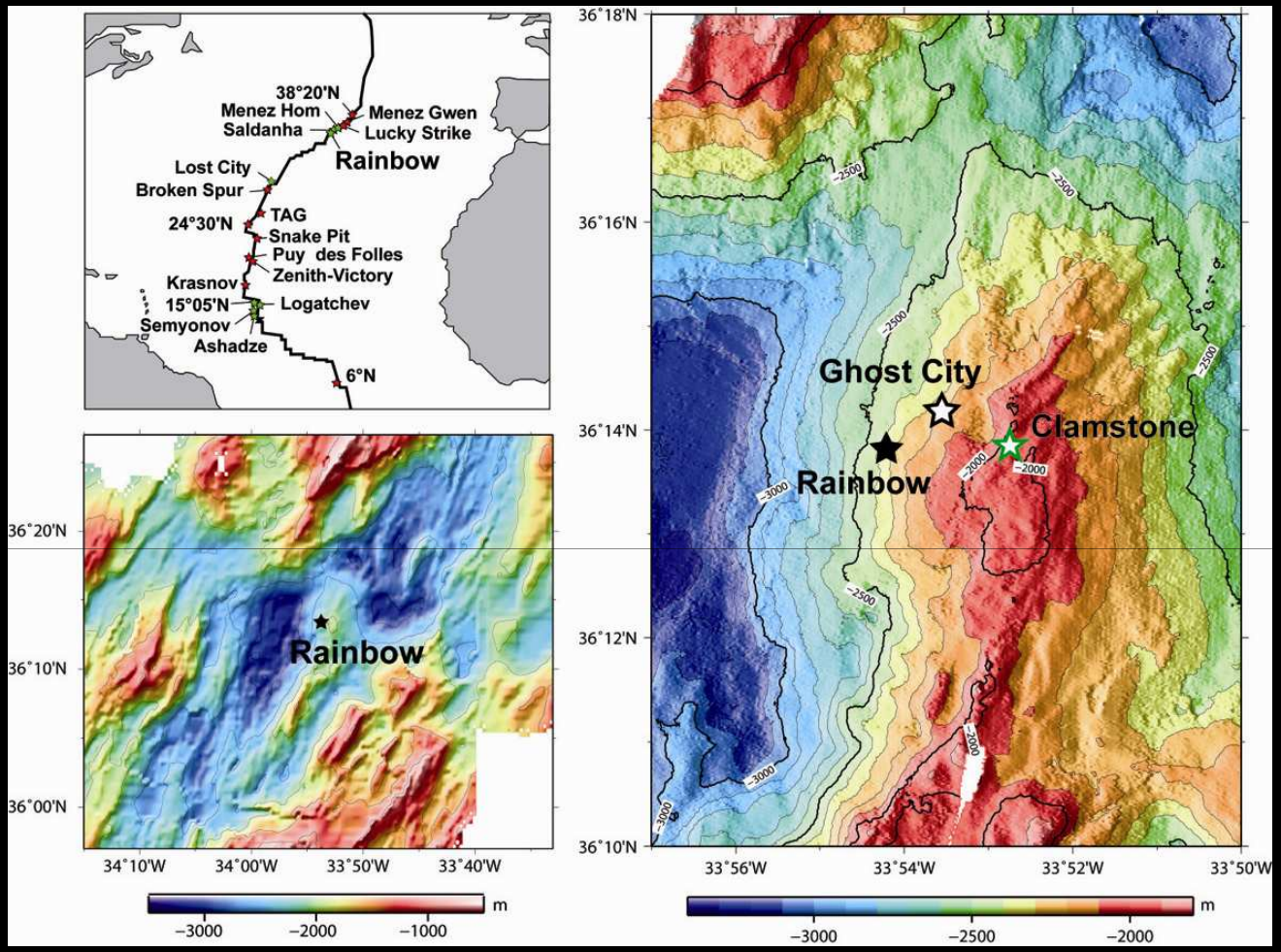


http://oceanexplorer.noaa.gov/explorations/05lostcity

D. Kelley of University of Washington, IFE, URI-IAO, UW, Lost City science party, NOAA

The MoMARDREAM 08 cruise focused on the Rainbow serpentinized seamount:

Dredges and/or ROV surveys to discover 2 fossil bivalve sites:



Clamstone

2.5 km east to Rainbow field, ~2000 m depth

Lartaud et al., 2010 (G3)

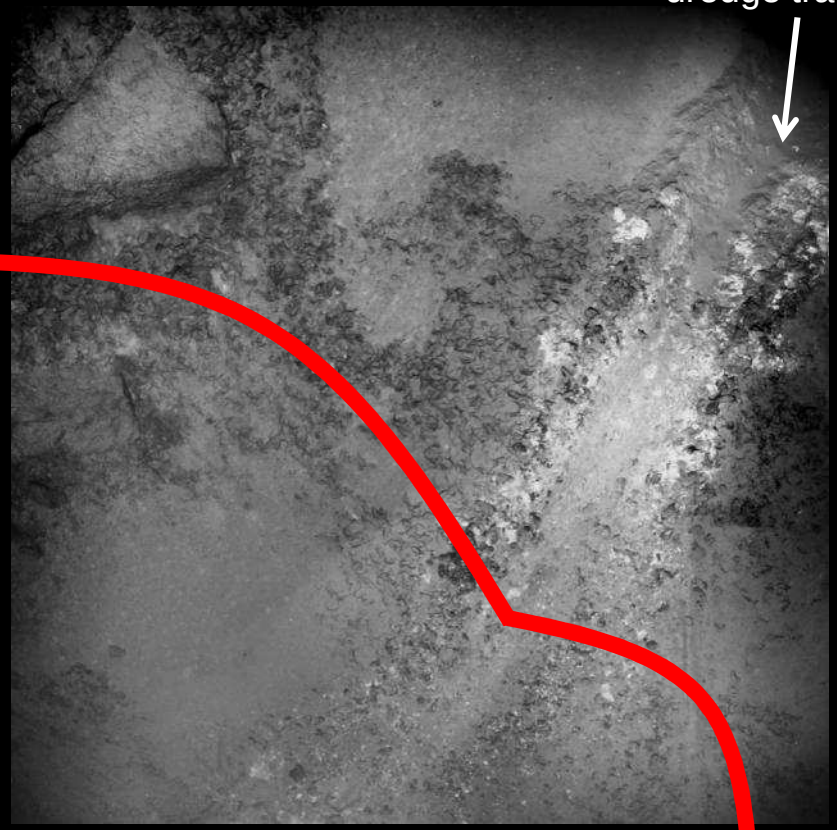
Ghost City

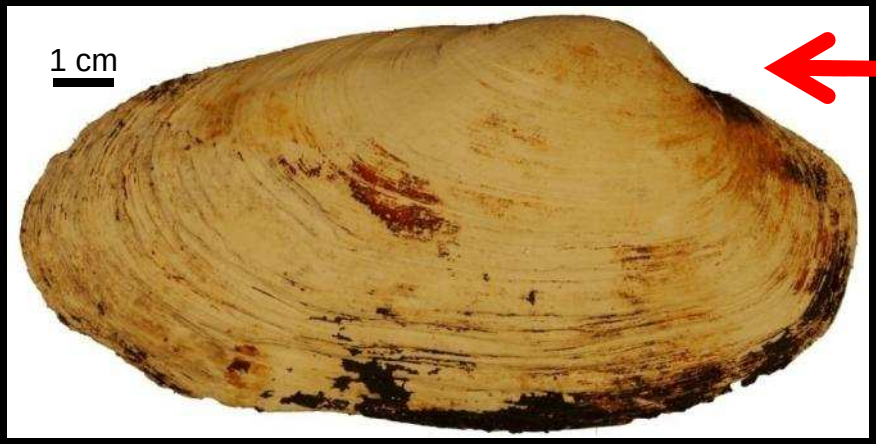
1.2 km north-east to Rainbow field, 2100 m depth

Lartaud et al., 2011 (PNAS)

CLAMSTONE

Fauna assemblage:



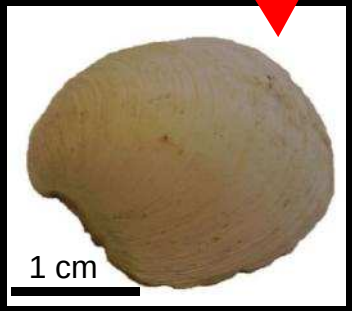


Phreagena sp.

First occurrence of this genus on the MAR

Shallowest and northernmost vesicomyids on the MAR

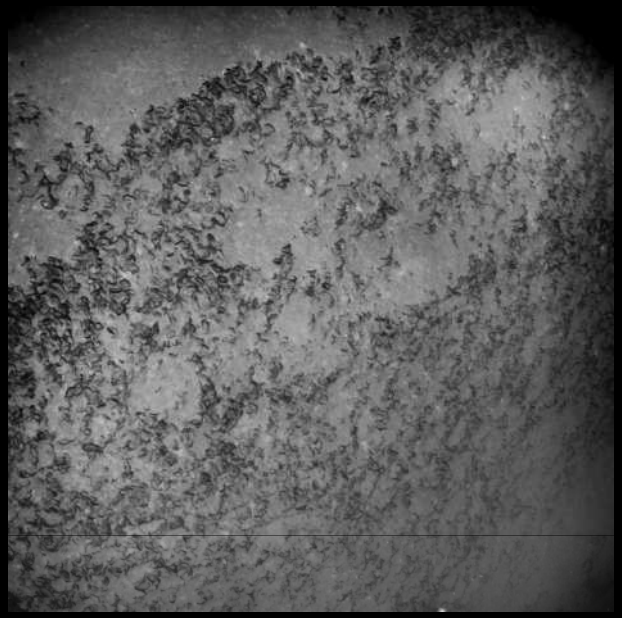
With Anya's Garden, only proof of hydrothermal thyasirids, which are more common at cold seeps (e.g., *T. vulcolutre* from the Gulf of Cadiz).



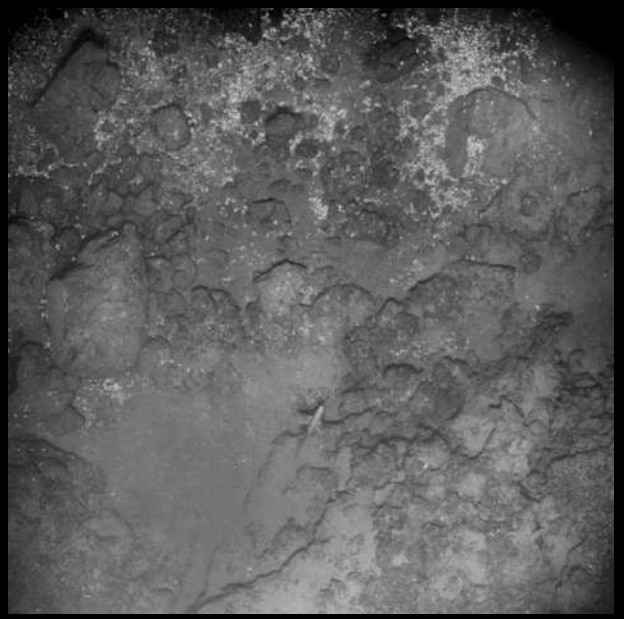
Thyasira aff. *southwardae*

Phreagena sp.: shells dissociated, partly burried in the sediment or shells formed small banks, on cracks in the underlying rocks

^{14}C dating :
~25 kyr BP

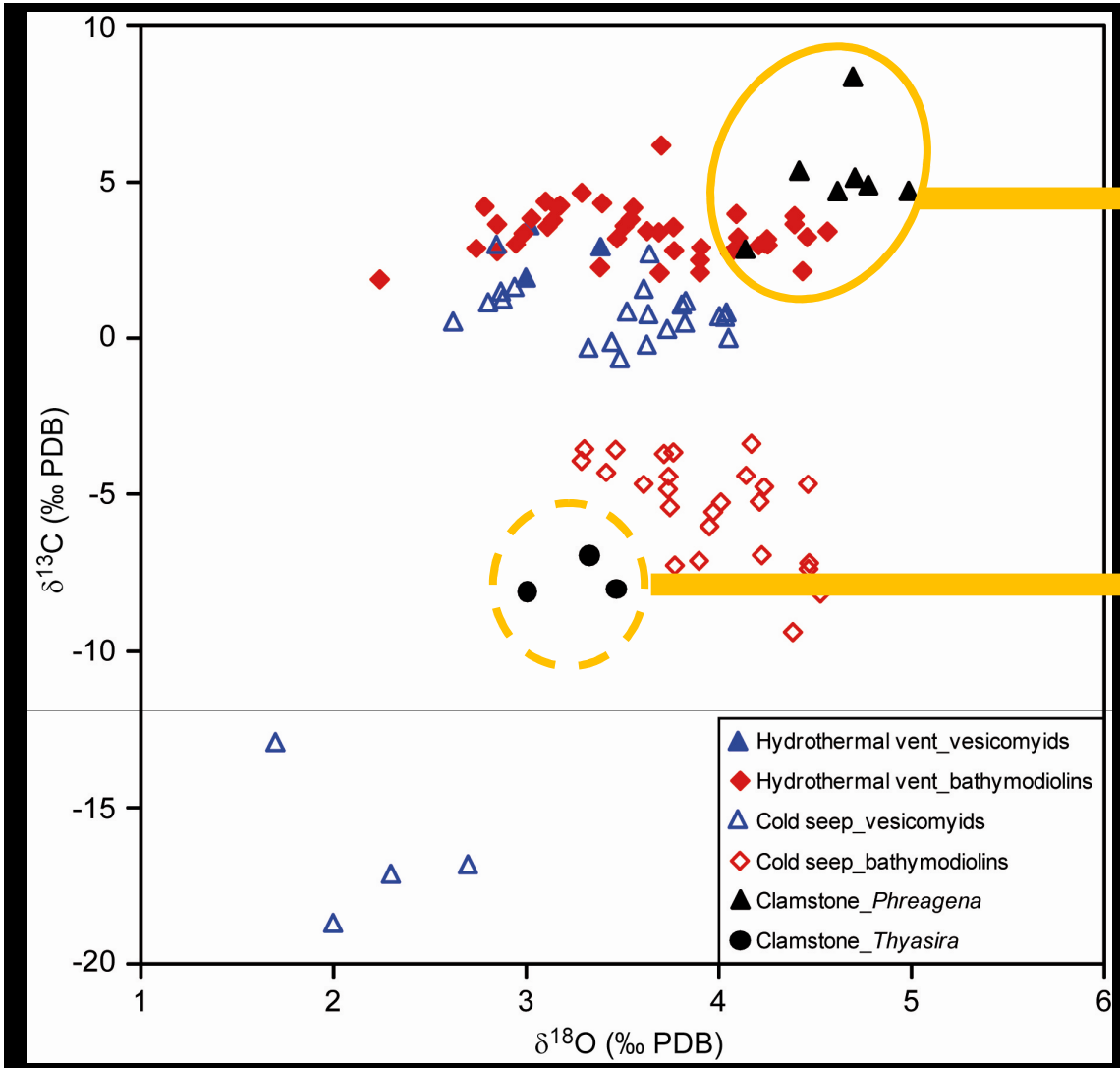


18 fields of dead vesicomyids over an area covering 300m x 100m.



Thyasira aff. *southwardae*:

3 shells in the dredge and only one additional patch identified during the ROV survey



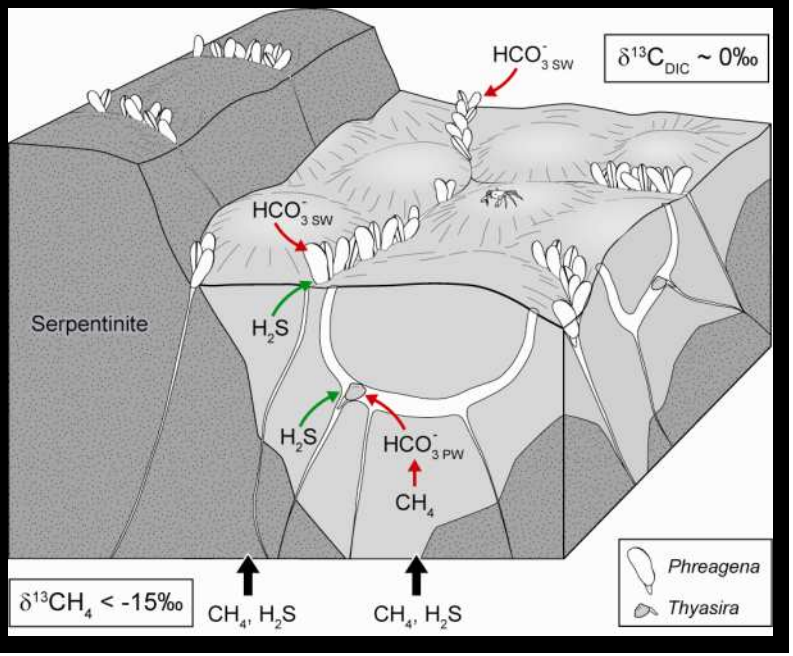
Shell isotopic signatures:

Phreagena sp.

= consistent with shells from hydrothermal vents

Thyasira aff. *southwardae*

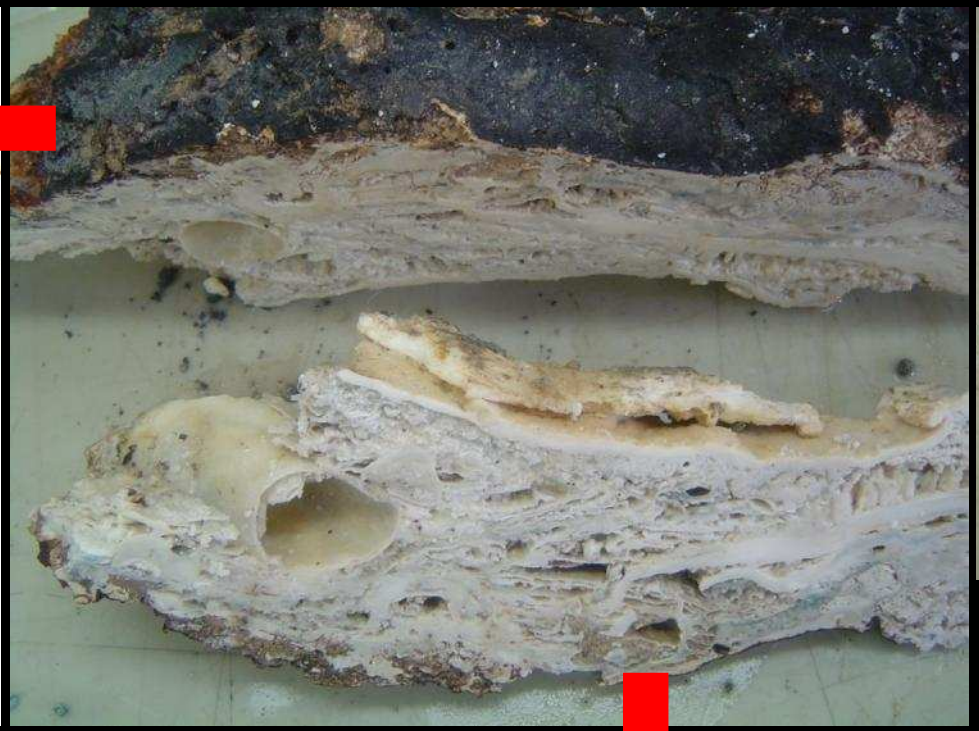
= suggest ^{13}C-depleted sediment pore water DIC



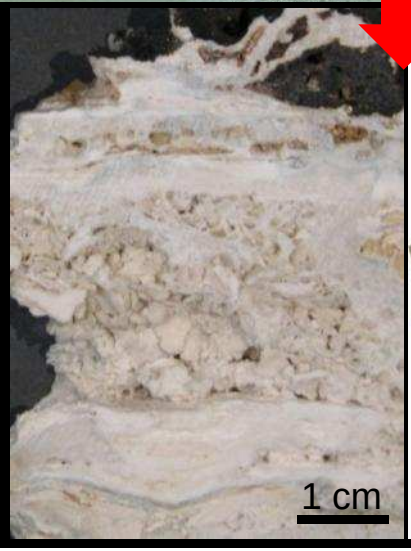
Resulting from methane oxidation

GHOST CITY

Several pieces of carbonates were dredged with serpentinized peridotites,and some troctolites and gabbros:



Ferric oxyhydroxide black crust with solitary corals on the top

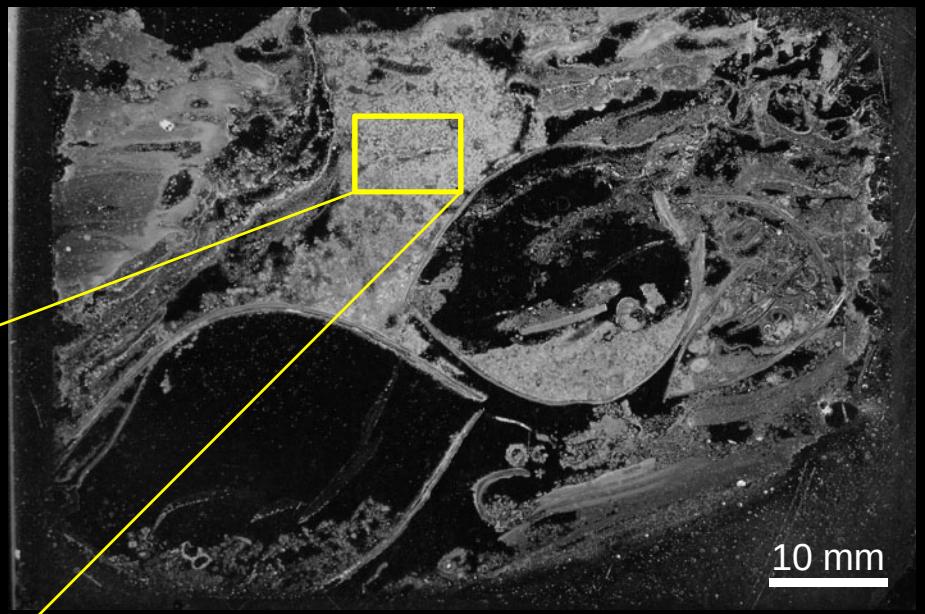


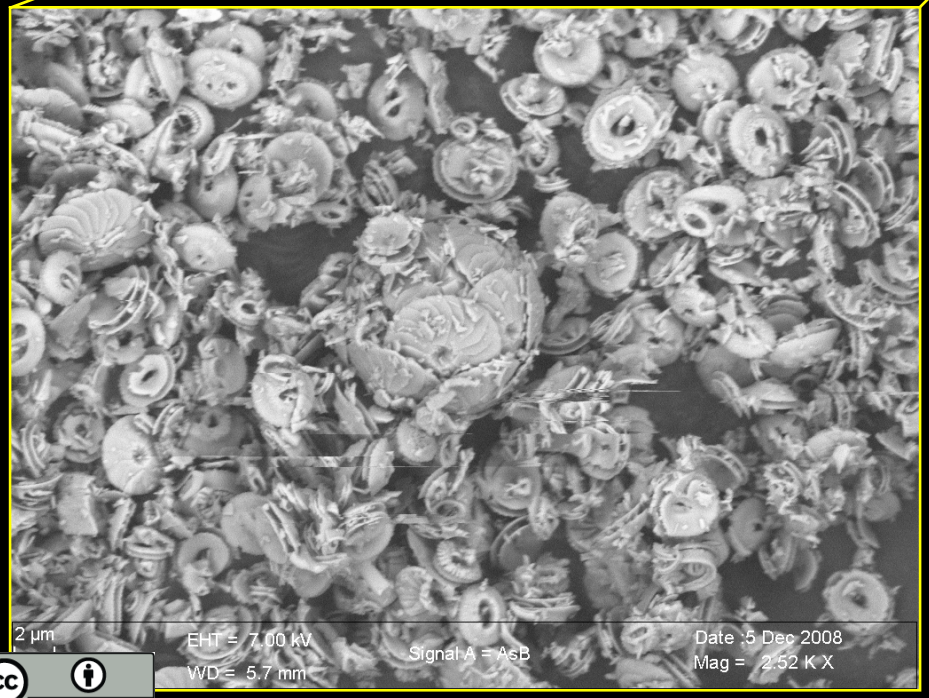
Carbonates white to ivory in colour, encrust mussel shells

(1) The carbonate matrix lacks of sulfide minerals

(2) Consists of varying proportions of:

- infilling pelagic calcitic and aragonitic fossils



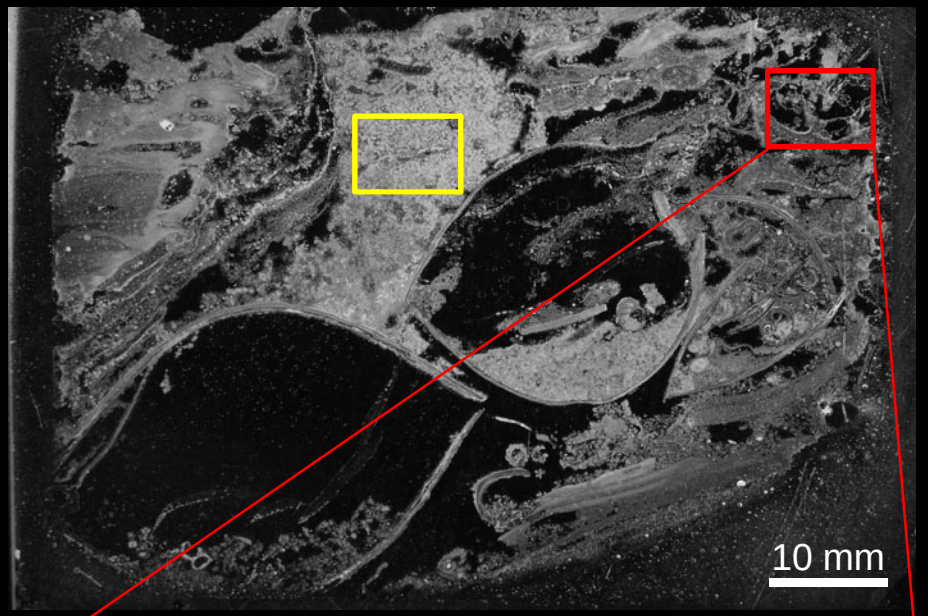


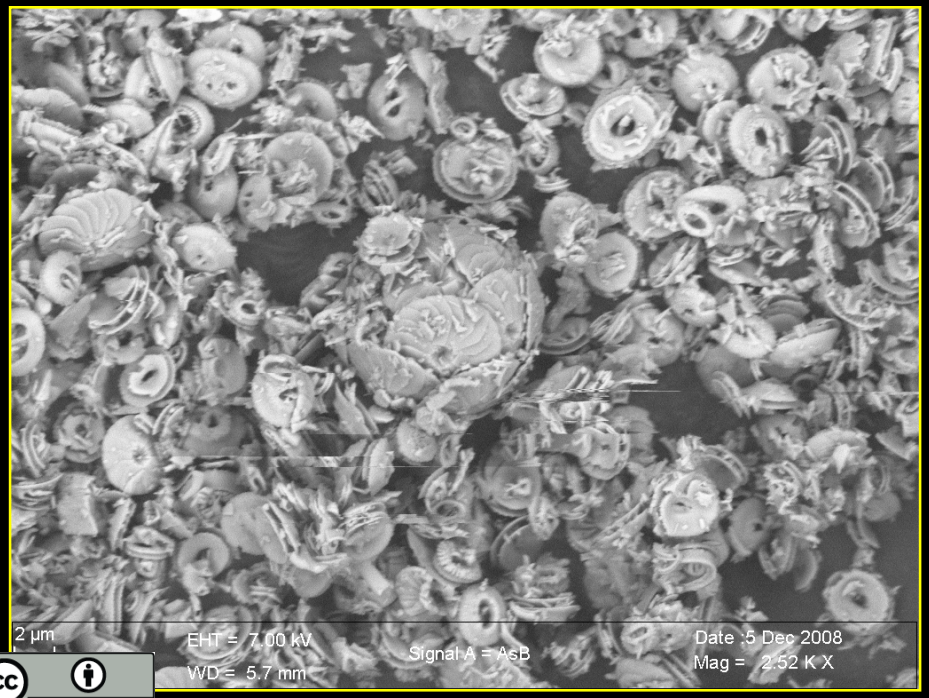
(1) The carbonate matrix lacks of sulfide minerals

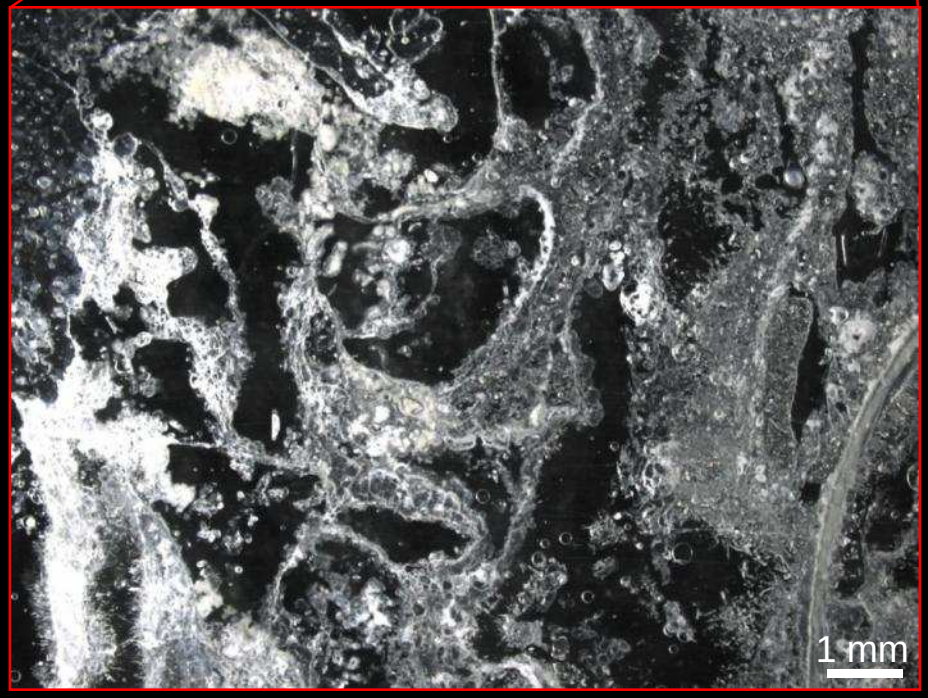
(2) Consists of varying proportions of:

- infilling pelagic calcitic and aragonitic fossils

- authigenic carbonate cements which display layered texture with significant porosity







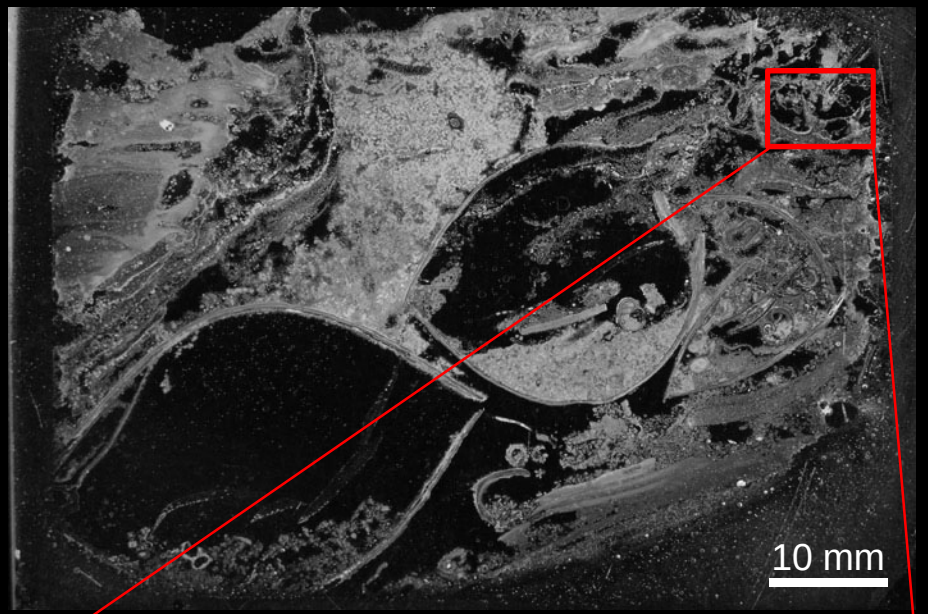
(1) The carbonate matrix lacks of sulfide minerals

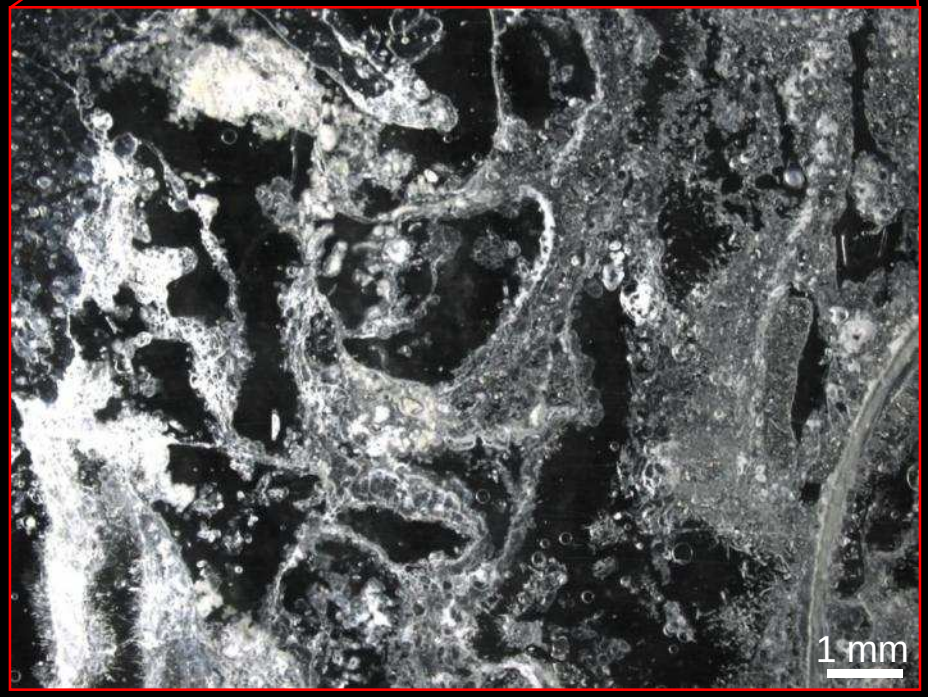
(2) Consists of varying proportions of:

- infilling pelagic calcitic and aragonitic fossils

- authigenic carbonate cement which display layered texture with significant porosity…

… close similar to the anastomosing aragonite structures of Lost City carbonate chimneys





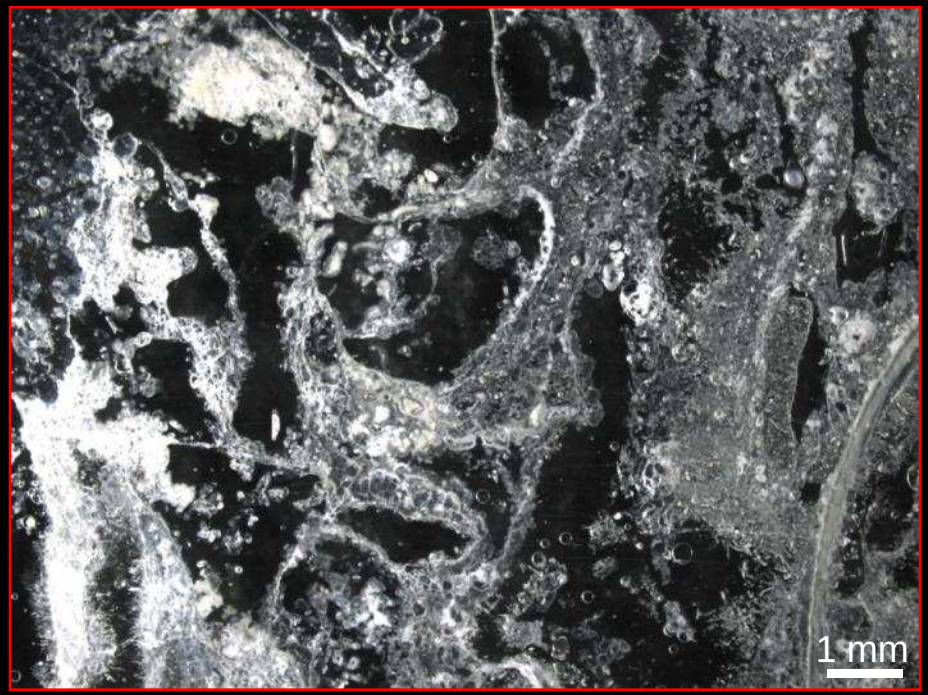
Ludwig et al., 2006 (GCA)

The authigenic carbonates consist of:

-radial aggregates of acicular aragonite crystals

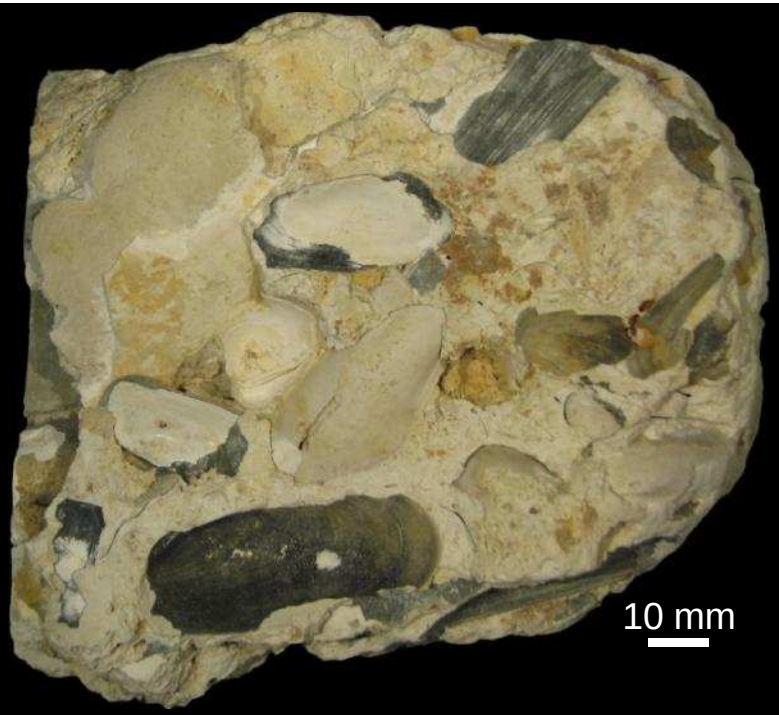
(U/Th dating = 110 kyr BP)

-sparser rosettes of glendonite crystals, a pseudomorph after ikaïte, attributed to alkaline fluid circulation

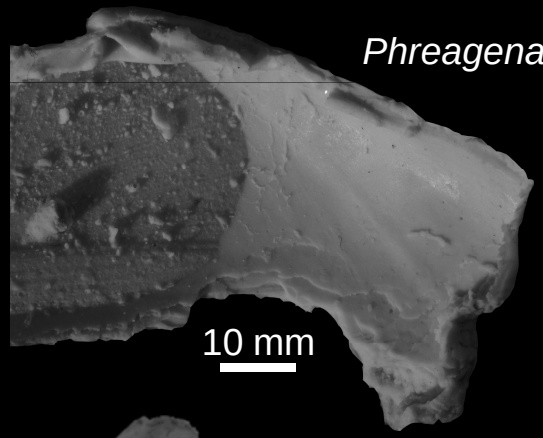


Fauna assemblage:

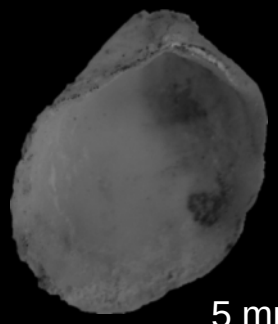
Dominated by *Bathymodiolus* aff. *azoricus* (4 shells / 10 cm^3)



Two bivalves species from sedimented vent site (Clamstone)



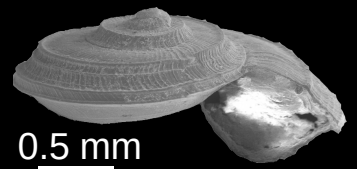
Phreagena sp.

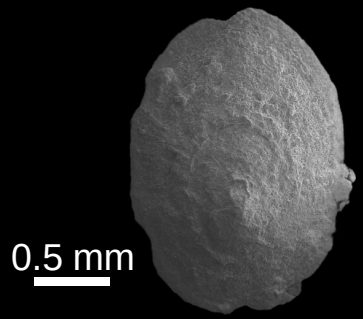


Thyasira sp.

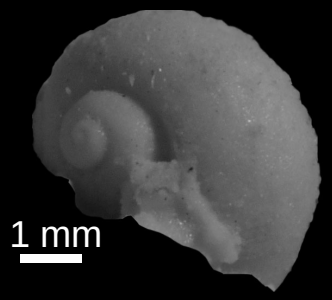
Four additional taxa from typical MAR axial high-temperature vent communities

Lurifax vitreus

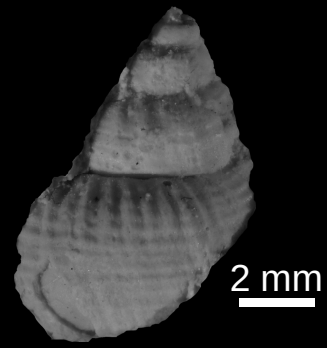




Paralepetopsis aff. *ferrugivora*



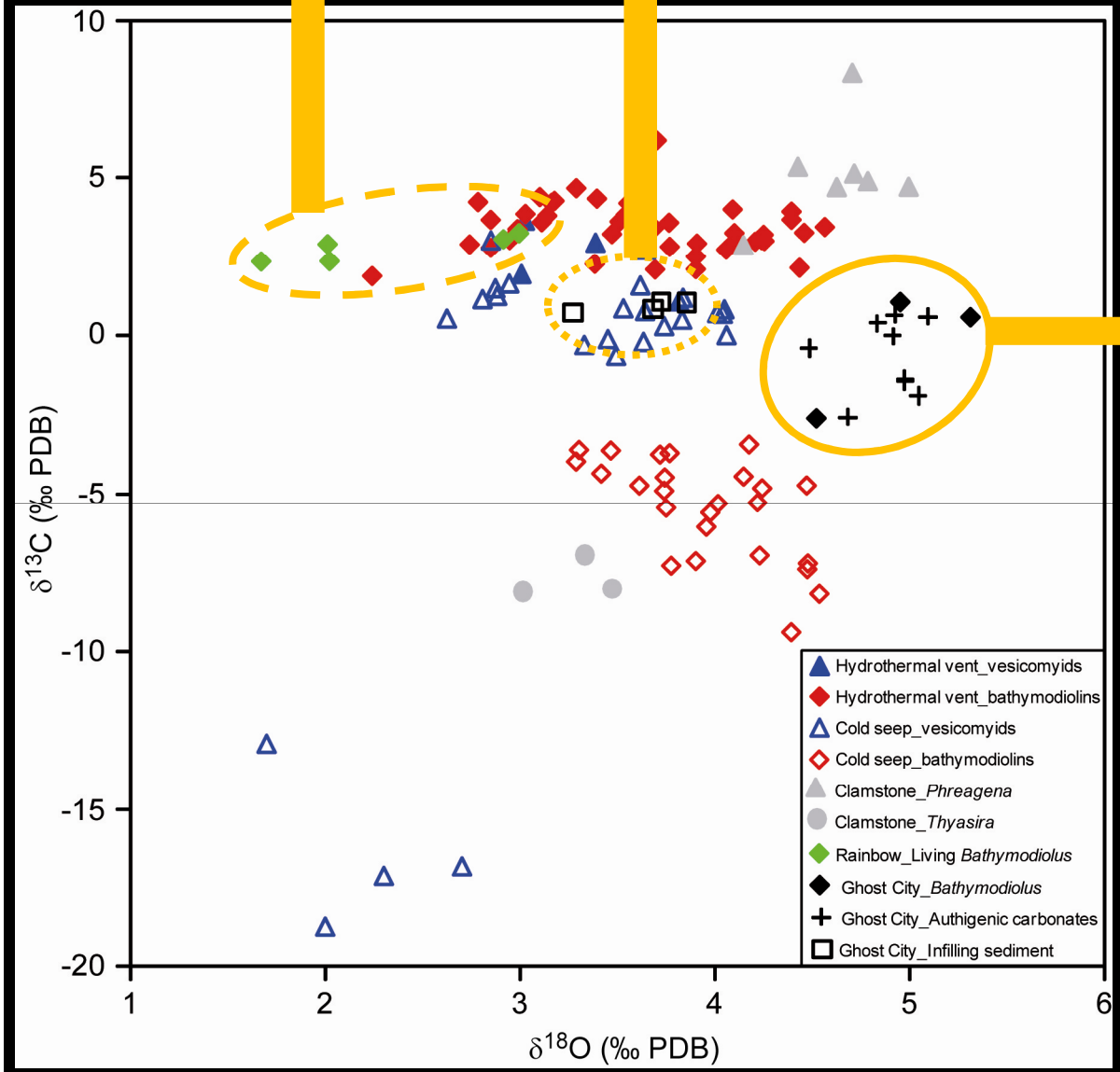
Protolira aff. *thovaldssoni*



Phymorhynchus sp.

Living *B. azoricus* from Rainbow

Infilling pelagic sediment



Shell isotopic signatures:

Bathymodiolus aff. *azoricus*

+

Authigenic carbonates

(1) *in situ* growth of the shells

(2) Isotopic signatures close to carbonates from serpentinite-hosted ecosystems (e.g., South Chamorro Seamount, Conical Seamount)

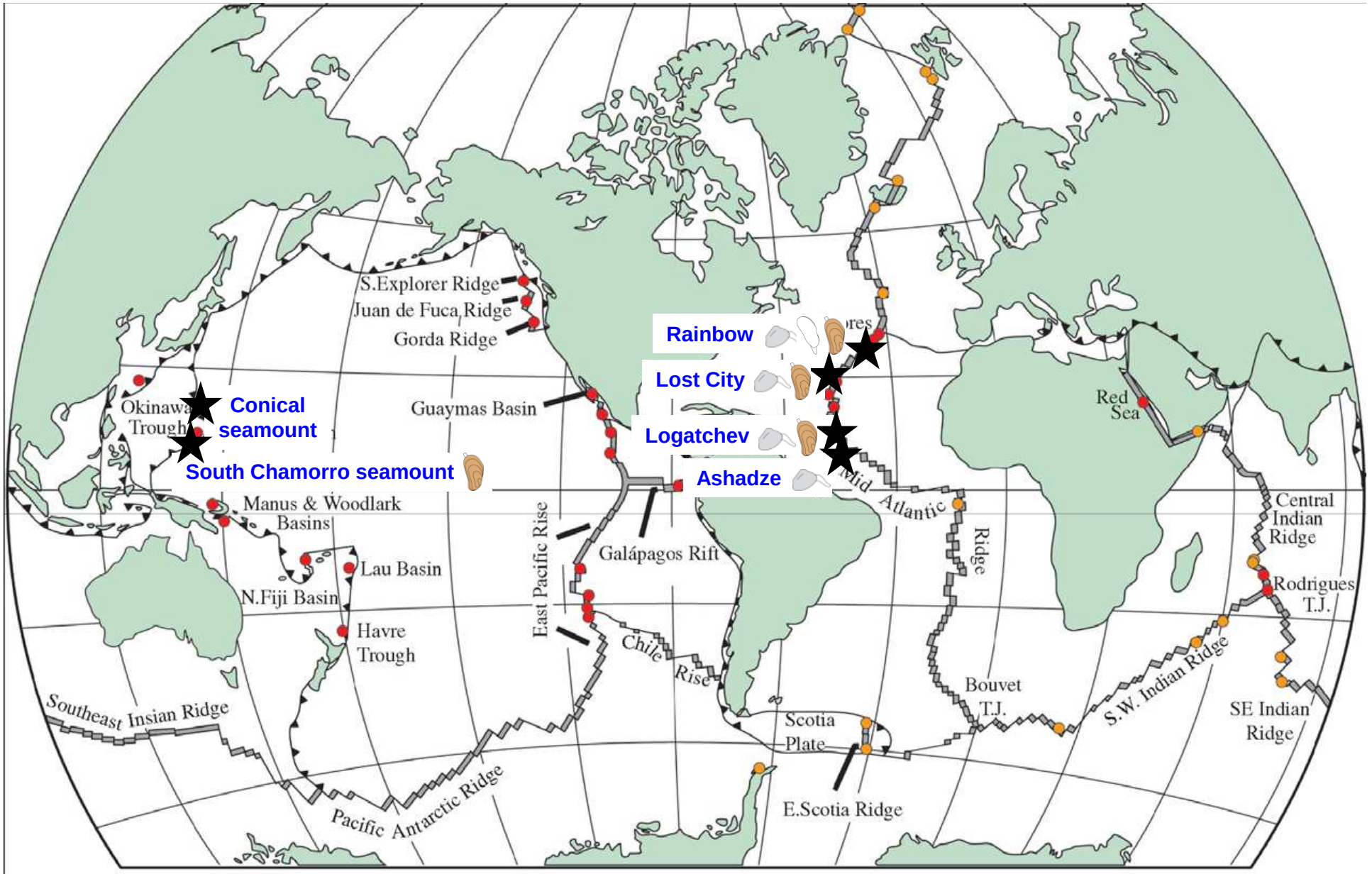
contribution of a small fraction of ^{13}C depleted methane

CONCLUSIONS

- Ultramafic-hosted hydrothermal circulation

  ↳ wide variety of different habitats, both on sediment cover and mineral hard substrates…

  … including at small geographical and temporal scales.


Rainbow
Lost City
Logatchev
Ashadze
Conical seamount
South Chamorro seamount
S.Explorer Ridge
Juan de Fuca Ridge
Gorda Ridge
Guaymas Basin
Okinawa Trough
Manus & Woodlark Basins
Lau Basin
N.Fiji Basin
Havre Trough
East Pacific Rise
Galápagos Rift
Chile Rise
Southeast Insian Ridge
Pacific Antarctic Ridge
Scotia Plate
E.Scotia Ridge
Bouvet T.J.
S.W. Indian Ridge
SE Indian Ridge
Central Indian Ridge
Rodrigues T.J.
Red Sea
Ridge
Serpentinite-hosted ecosystems
Bathymodiolus
Phreagena
Thyasira

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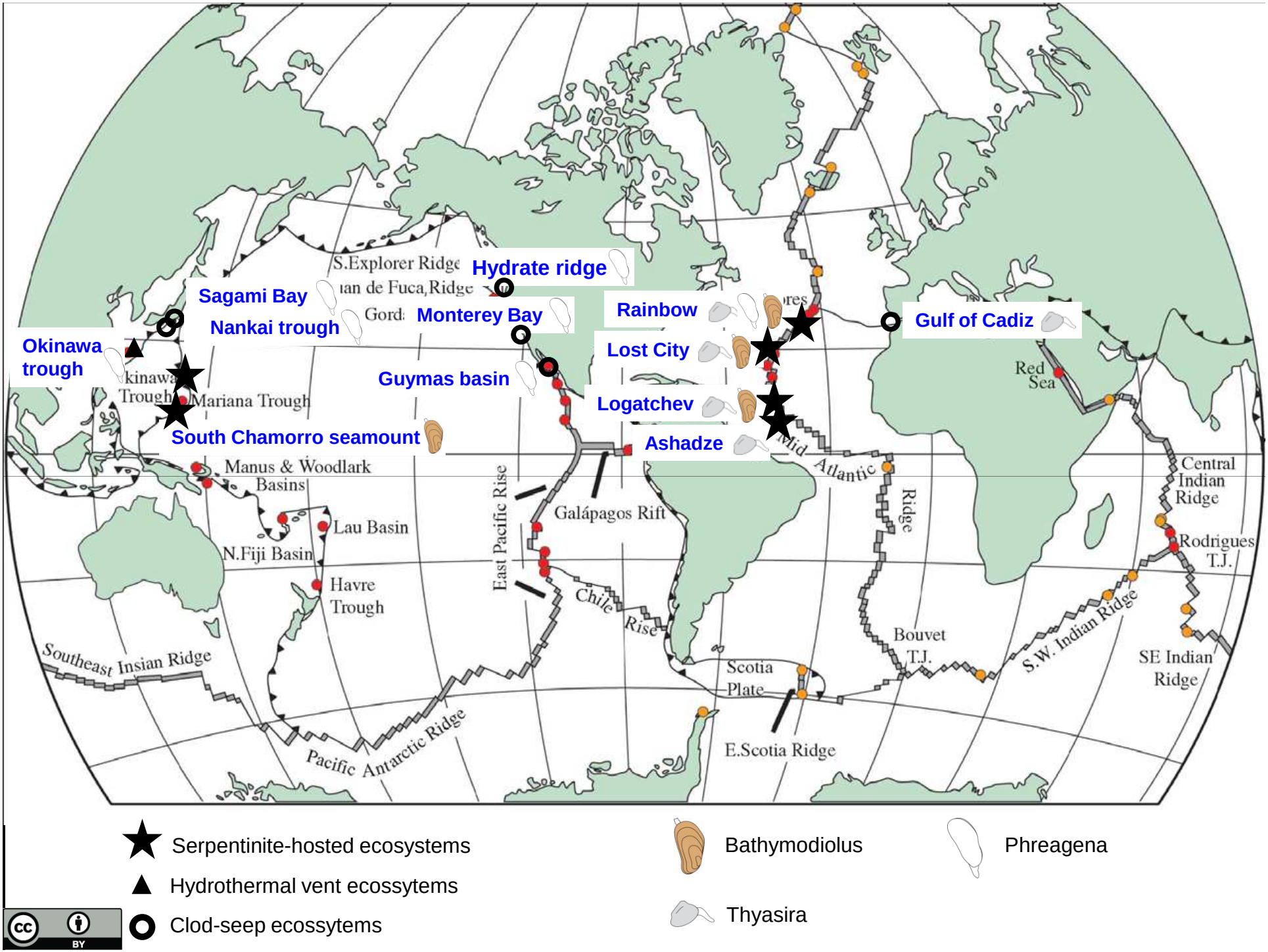
- Diverse chemosynthetic species, from both vent and seep genus, can form high-biomass assemblages (not only high-temperature ones).

- Chemosynthetic communities are more dependent to the chemical conditions in the habitat (electron donors) than the type of environment (cold seep vs. hydrothermal vents).


Hydrate ridge
Sagami Bay
Nankai trough
Monterey Bay
Rainbow
Gulf of Cadiz
Okinawa trough
Lost City
Guymas basin
Logatchev
South Chamorro seamount
Ashadze
S.Explorer Ridge
Mariana Trough
Manus & Woodlark Basins
Lau Basin
N.Fiji Basin
Havre Trough
Galápagos Rift
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Chile Rise
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- Chemosynthetic communities are more dependent to the chemical conditions in the habitat (electron donors) than the type of environment (cold seep vs. hydrothermal vents).

- Serpentinite-hosted habitat might played a major role in the ability of chemosynthetic fauna to disperse over ocean basin scales.

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ROV Victor operation group

MoMARDREAM scientific party

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REFERENCES:

Lartaud F., et al. (2010) Fossil clams from a serpentinite-hosted sedimented vent field near the active smoker complex Rainbow, MAR, 36°13'N: Insig ht into the biogeography of vent fauna. ***Geochemistry Geophysics Geosystems*** 11.

Lartaud F., et al. (2011) Fossil evidence for serpentinization fluids fuelling chemosynthetic assemblages. ***PNAS*** 108, 7698-7703.