GIOVANNELLI LAB

DIPARTIMENTO DI BIOLOGIA

University of Naples "Federico II"

Marine Microbial Diversity

(microbial) Marine Ecosystems 3

SHALLOW WATER HYDROTHERMAL VENTS

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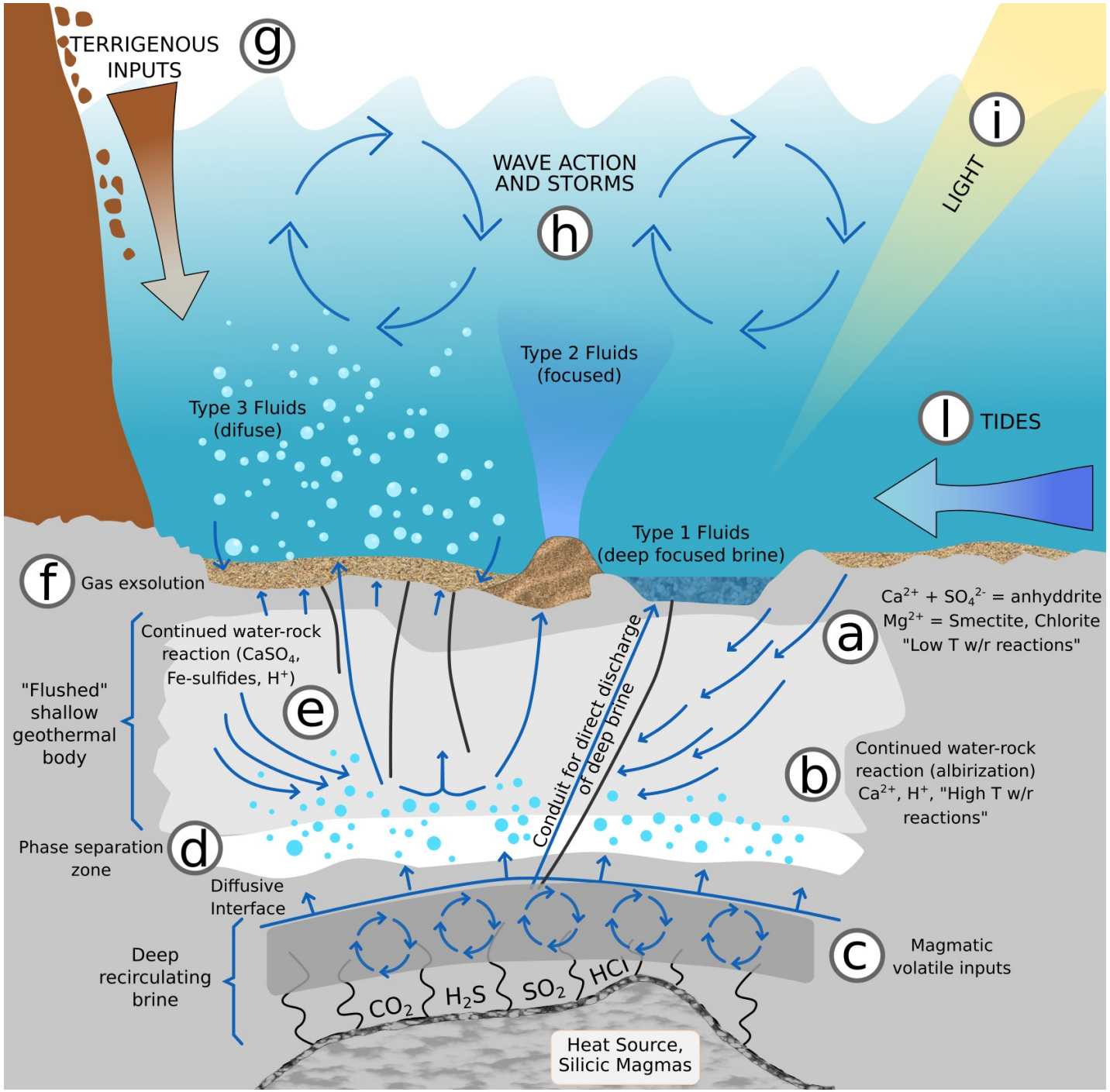
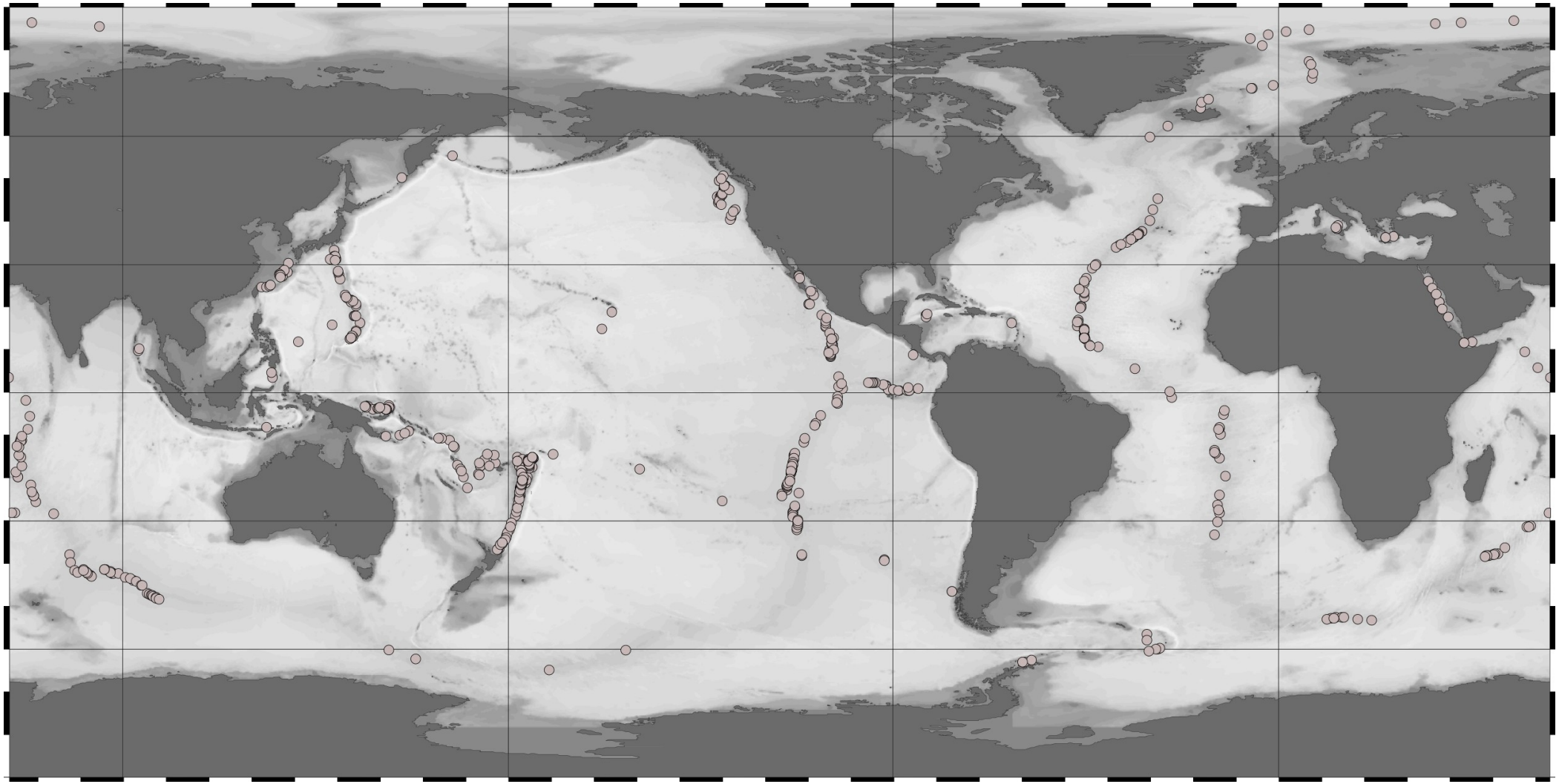
Kueishan island, Taiwan – vent plume

credit: http://www.earth-of-fire.com / Chen Minming



Price and Giovannelli, 2017

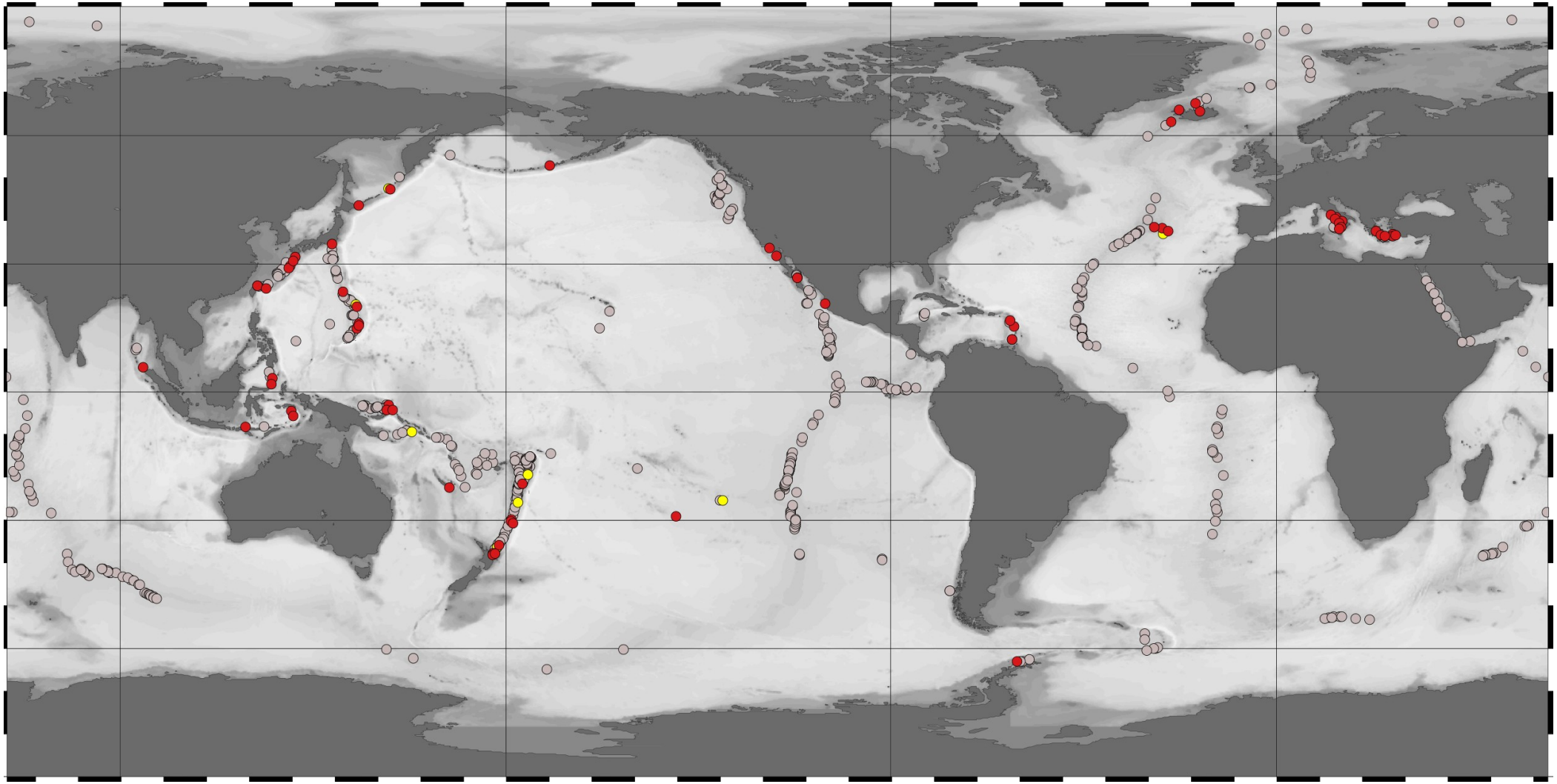
606 deep-sea hydrothermal vent sites
(InterRidge database)



Deep-Sea Vents

Price and Giovannelli, 2017

77 shallow-water hydrothermal vent sites
(InterRidge database)

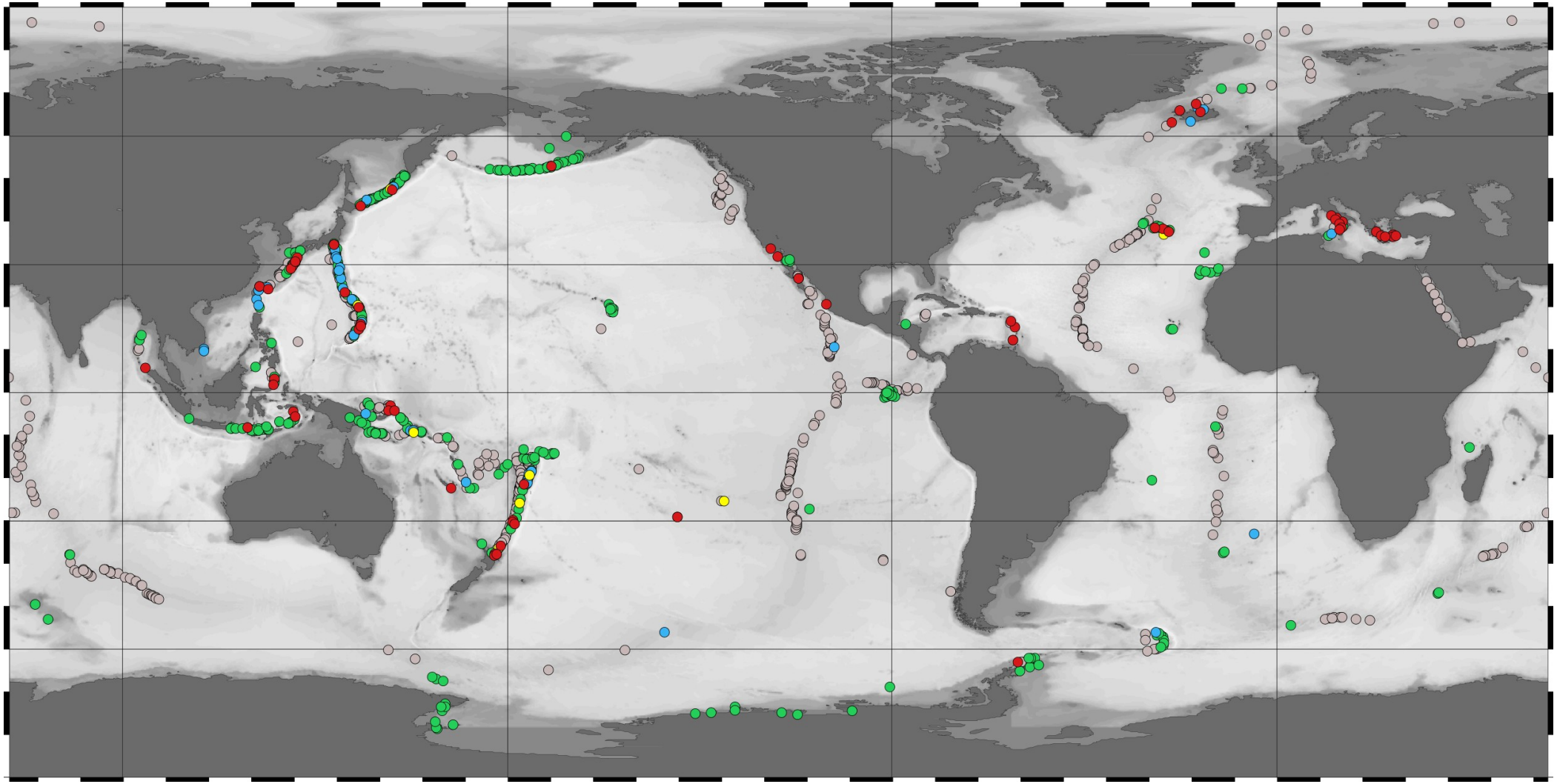


Deep-Sea Vents

Shallow-Water Vents

Price and Giovannelli, 2017

487 Putative shallow vent sites
(estimated)



Deep-Sea Vents Shallow-Water Vents Putative Shallow Vents

Price and Giovannelli, 2017

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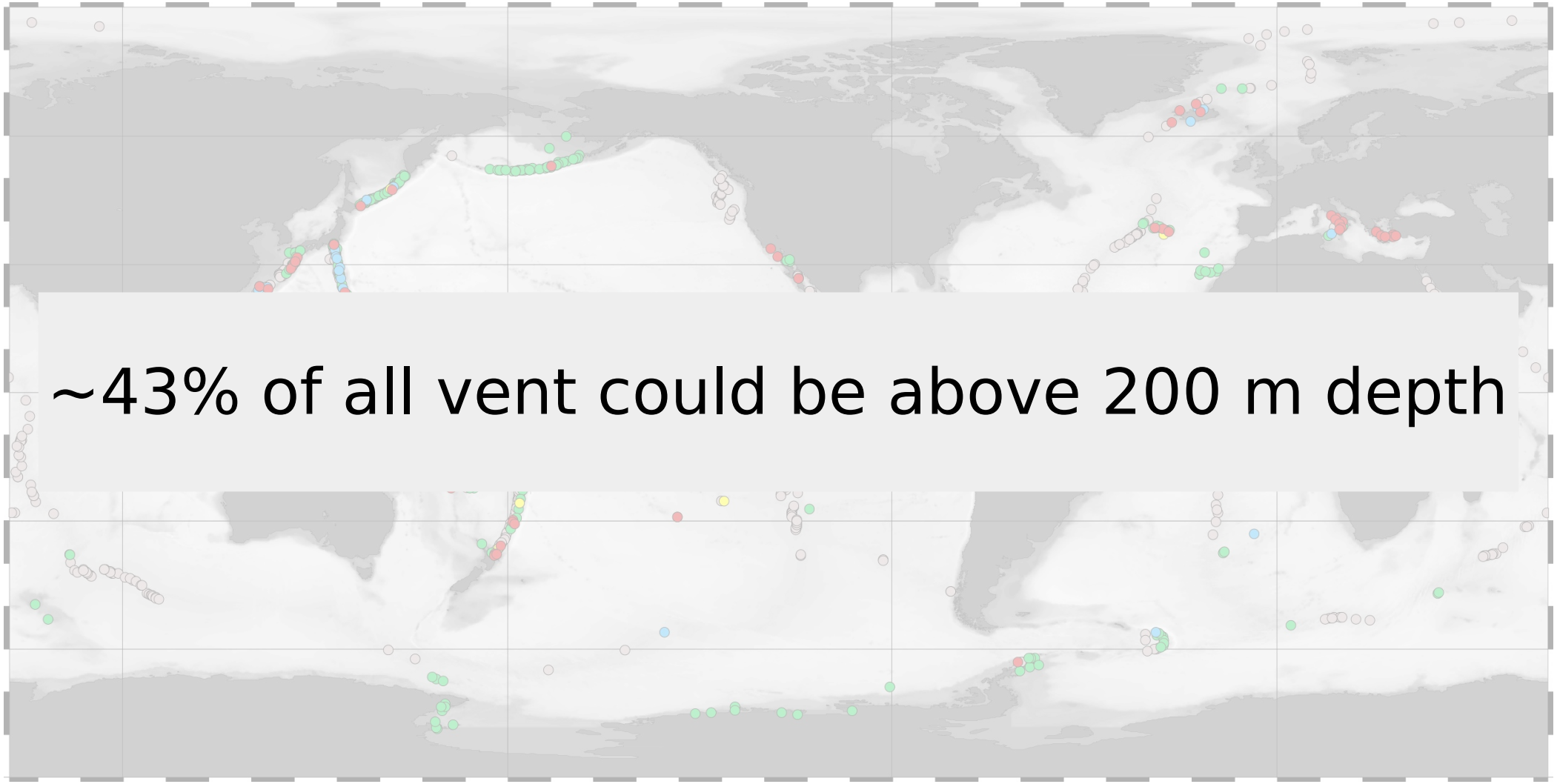


Deep-Sea Vents Shallow-Water Vents Putative Shallow Vents

Price and Giovannelli, 2017

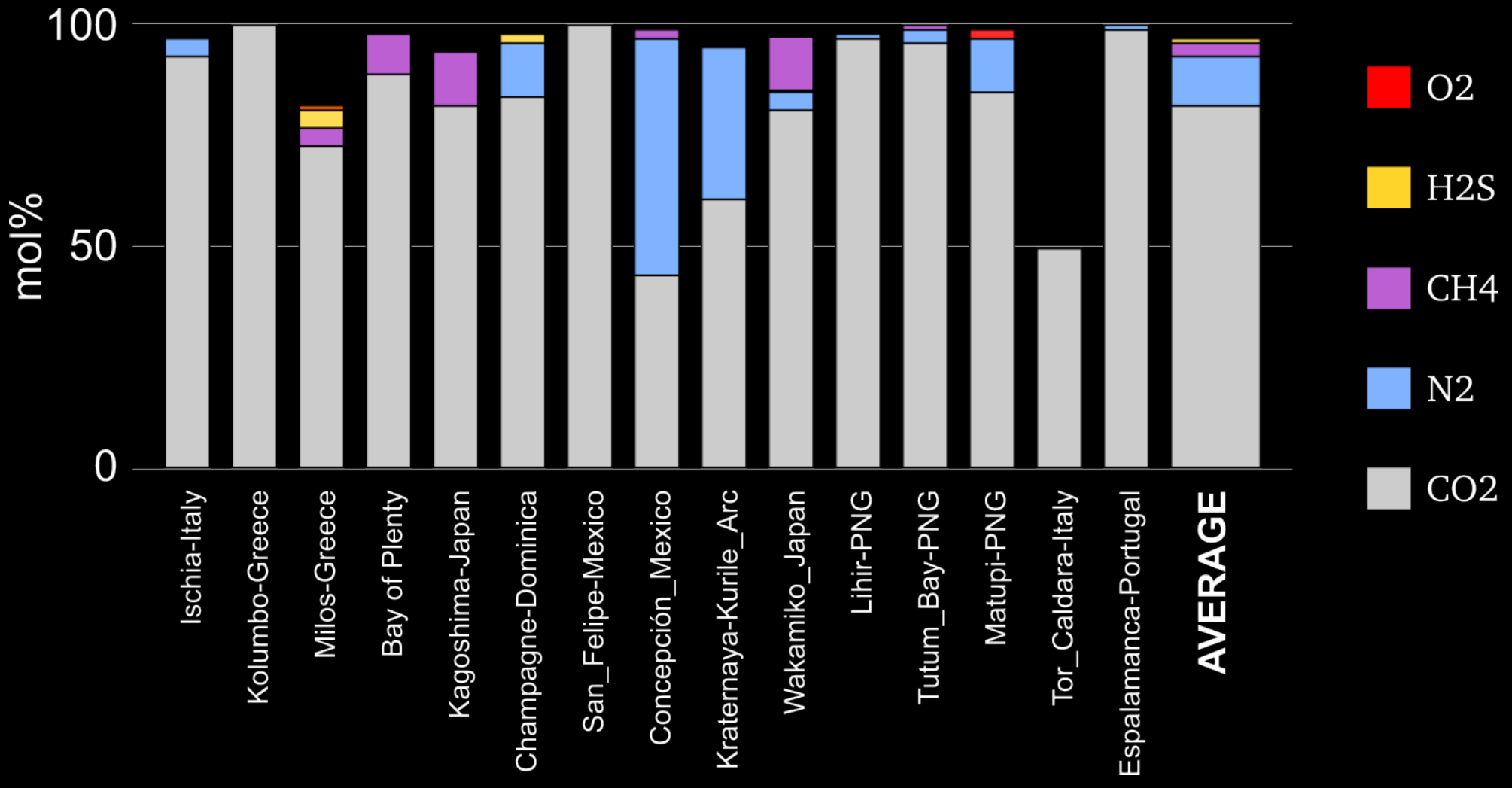
Can we better constrain the total number of shallow-water hydrothermal vents?

credits: CNR-ISMAR

credits: Jorge Fontes

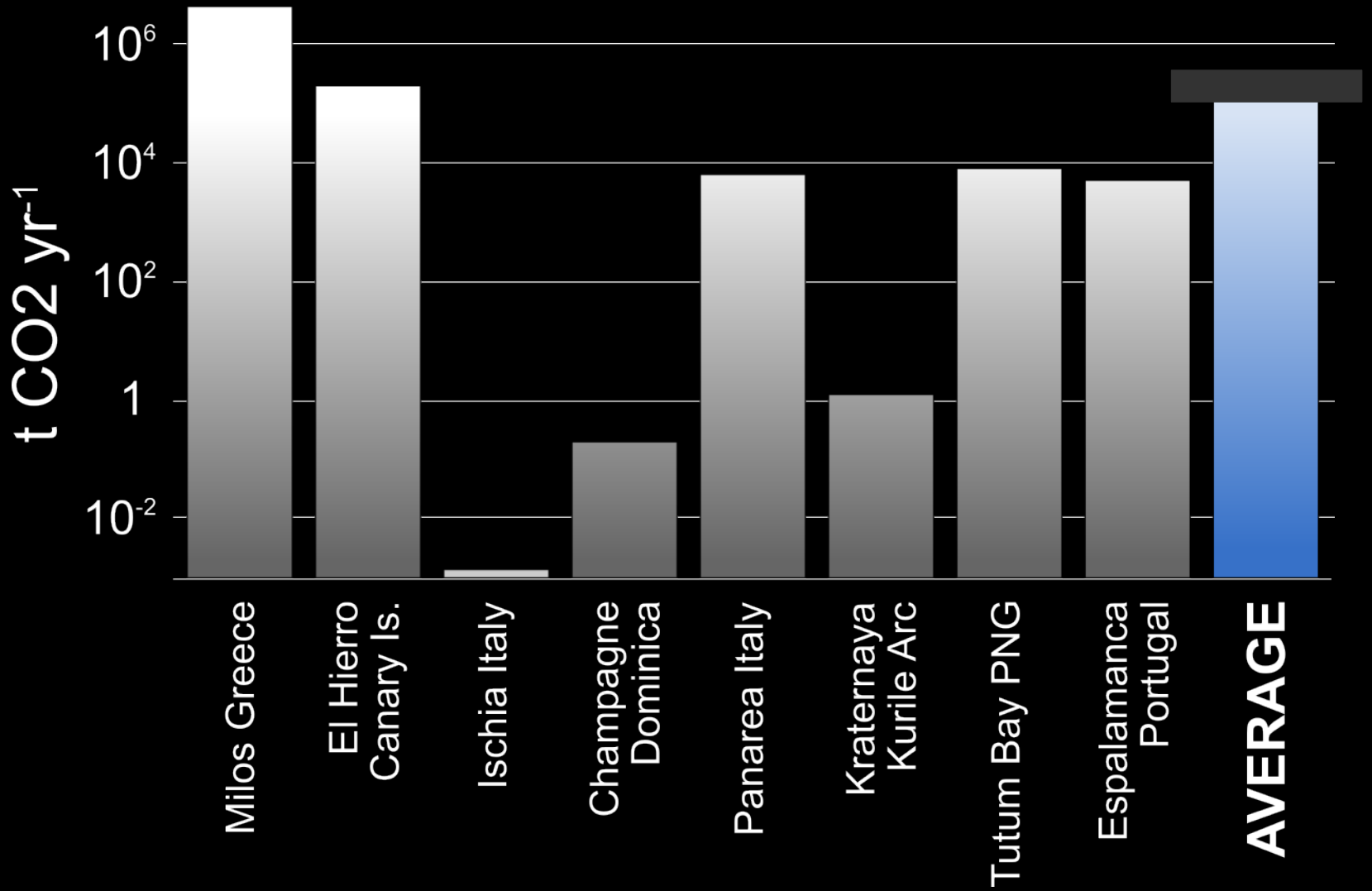
credits: Vetriani (Rutgers U)

Gas composition



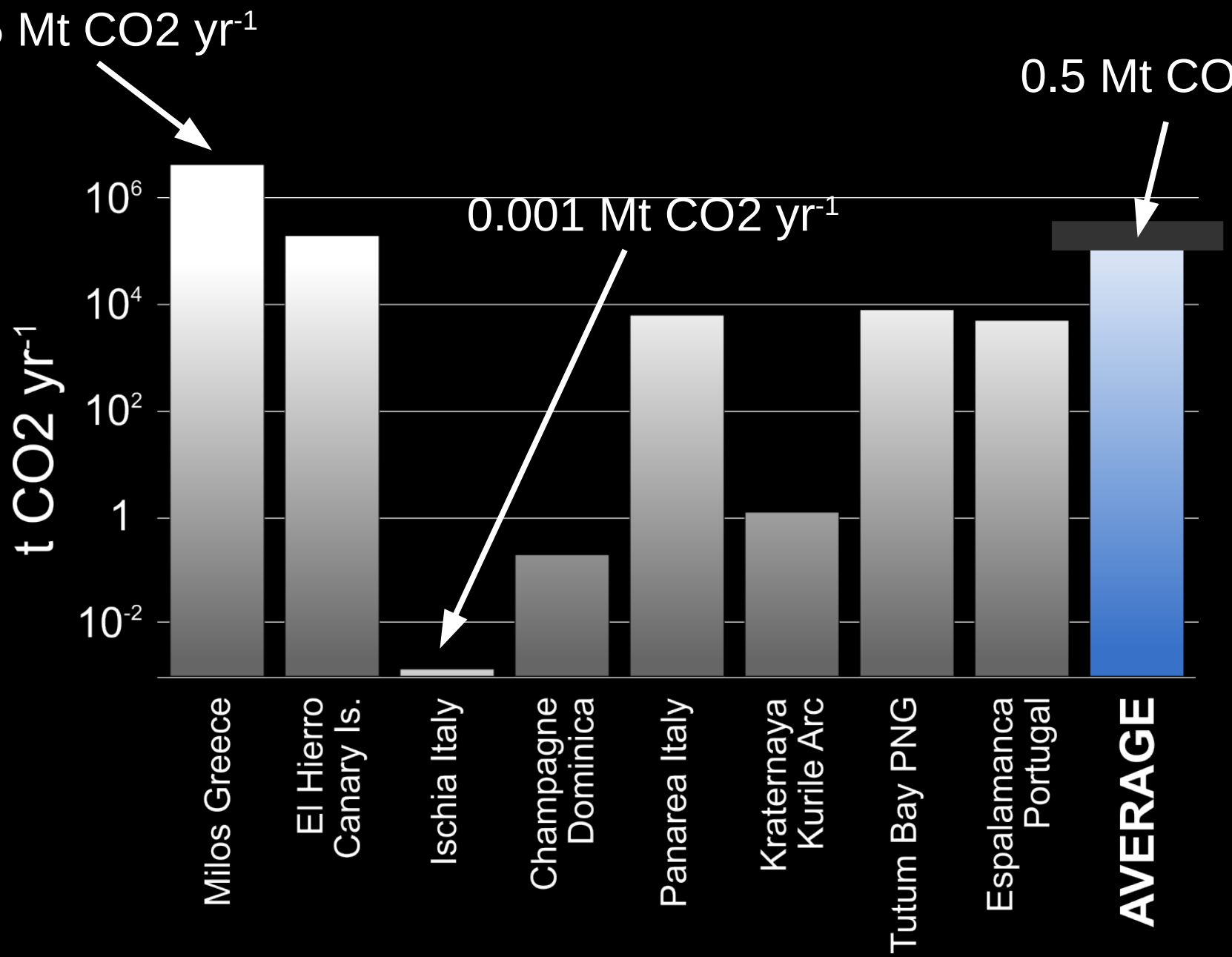
Giovannelli & de Moor

CO2 flux



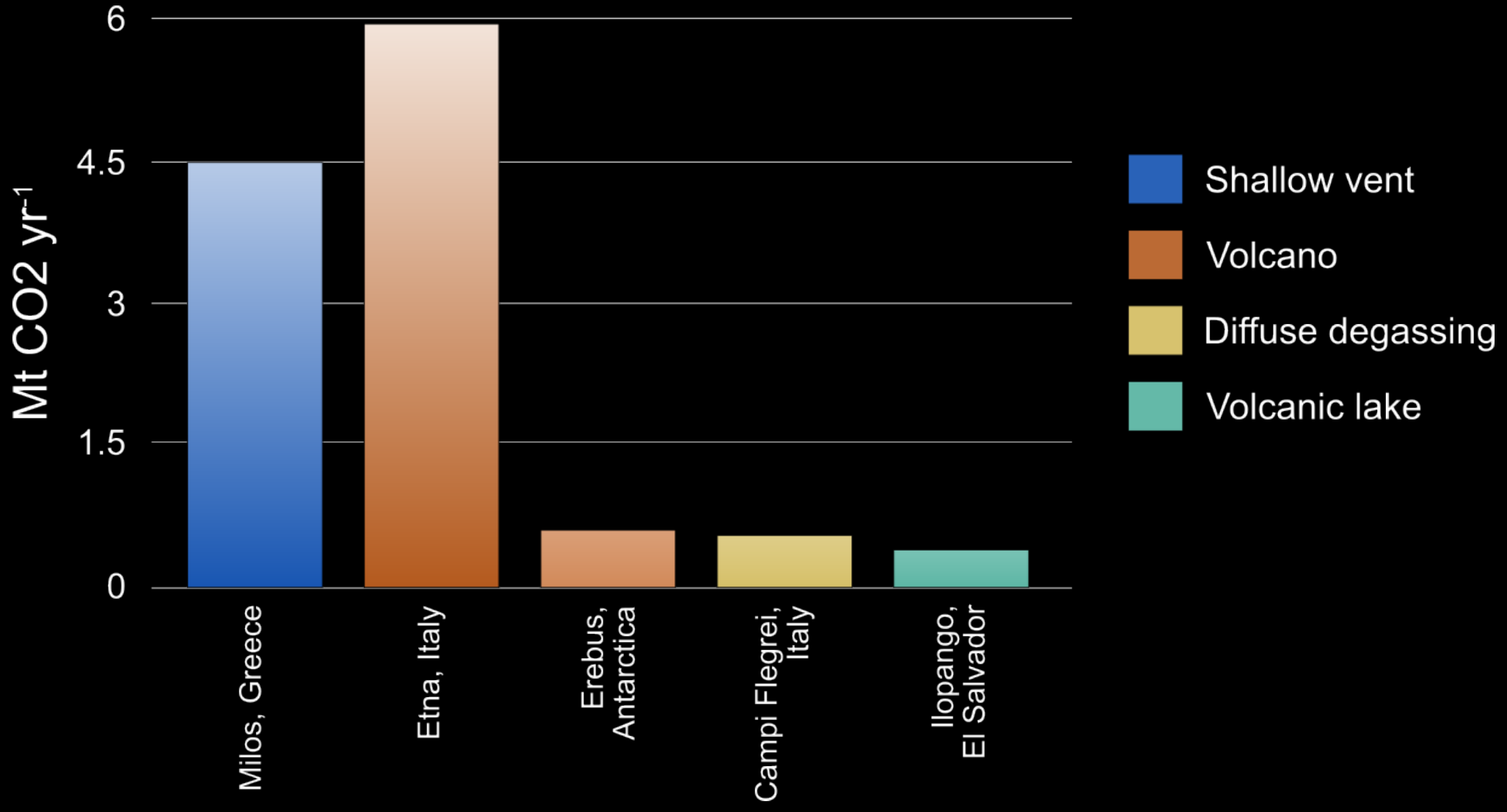
Giovannelli & de Moor

CO2 flux



Giovannelli & de Moor

CO2 Flux comparison



Giovannelli & de Moor

Global Shallow Vent CO_2 Flux Estimates

- Sum of the CO_2 flux present in the literature is ~5 Mt CO_2 yr^{-1}
- The average flux is ~0.5 Mt CO_2 yr^{-1}

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Estimate			Flux
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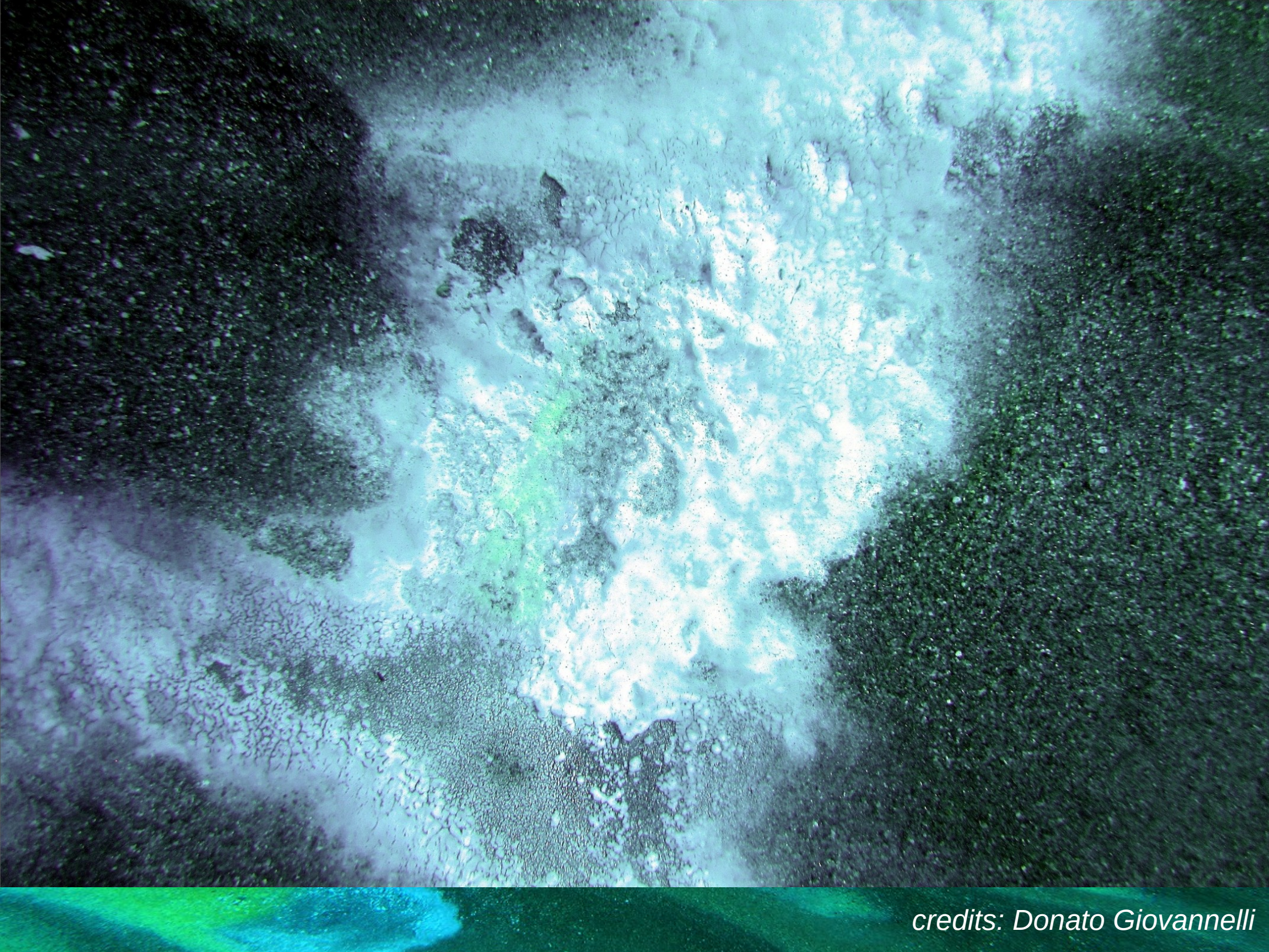
Even excluding Milos, global estimate are between 3 and 17 Mt CO2 yr-1

Can we constrain the global contribution of shallow-water venting to global CO2 degassing?

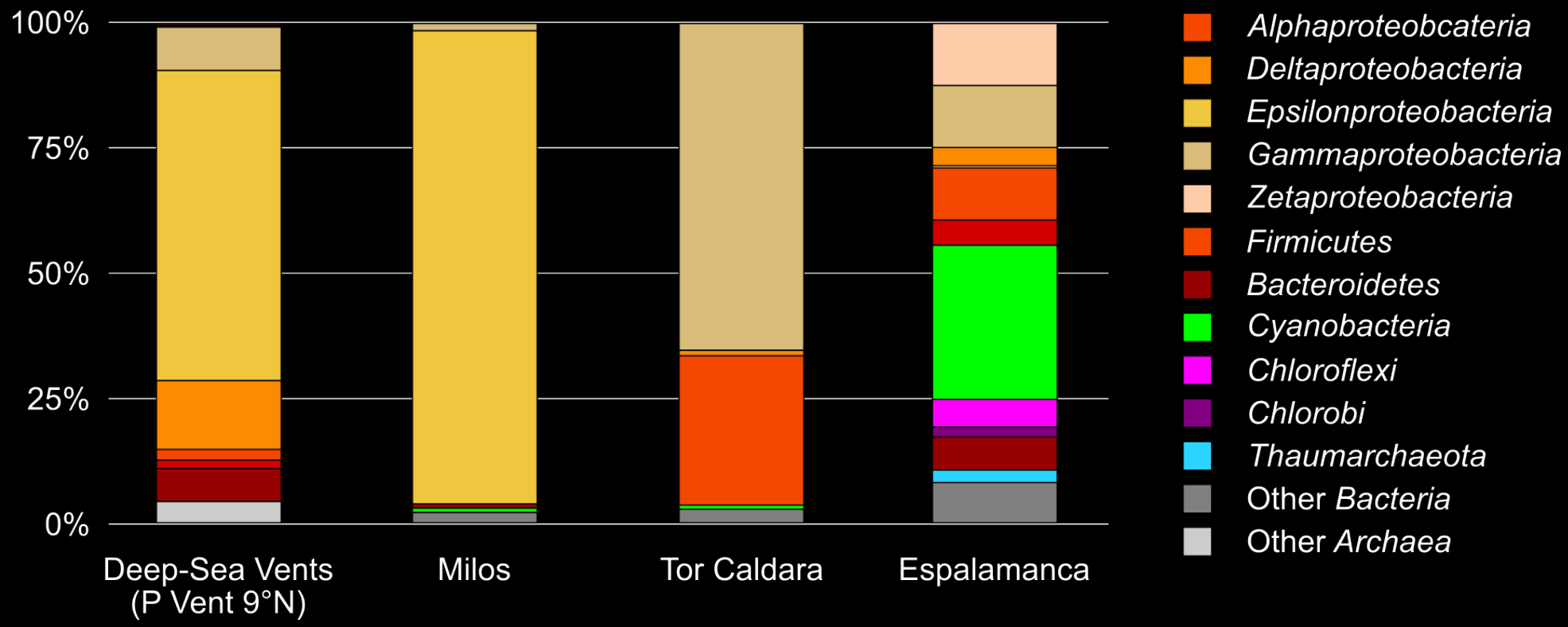


credits: Donato Giovannelli

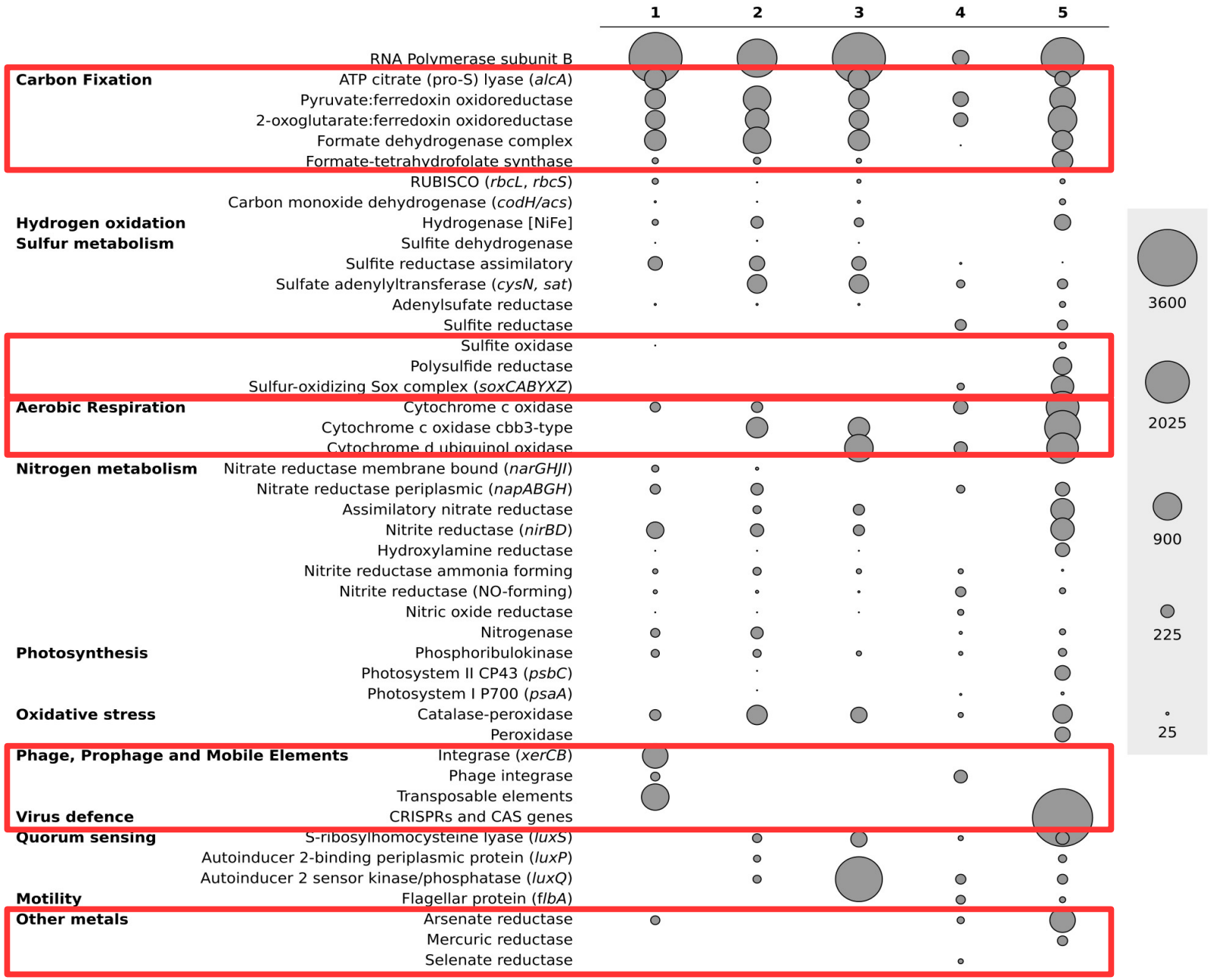
credit: Vetriani (Rutgers U)

credits: Jorge Fontes

Community composition

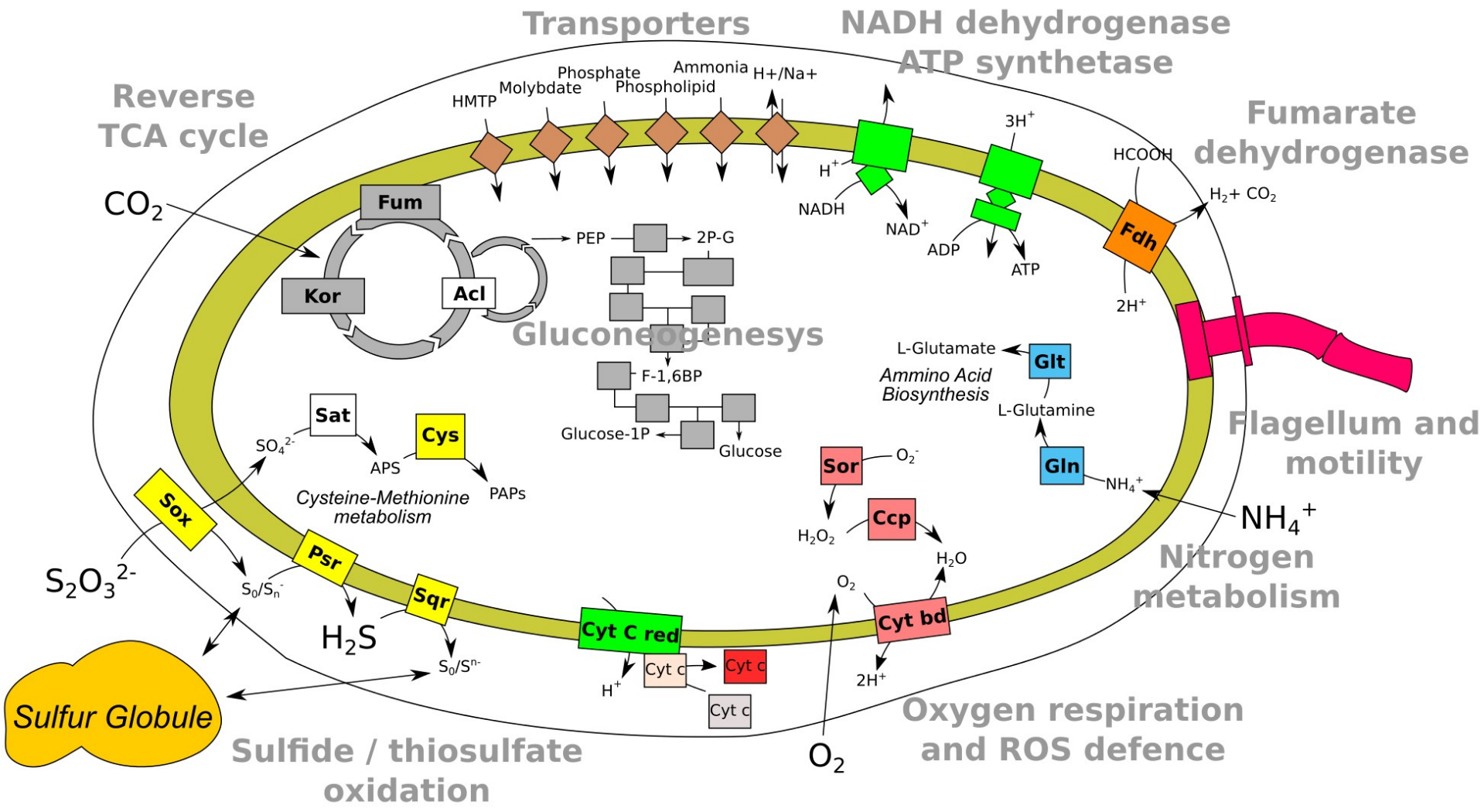


Metabolic potential



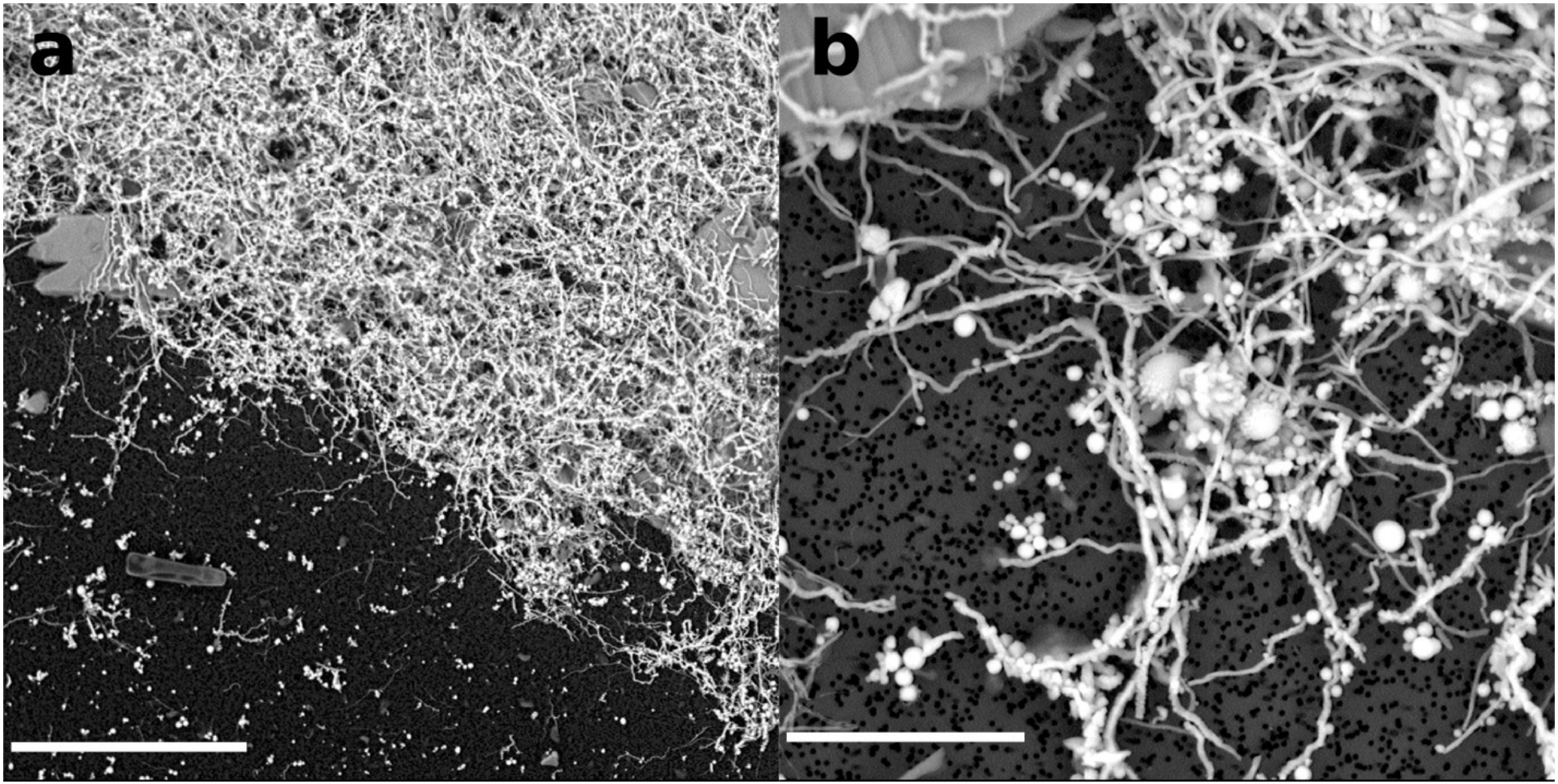
Giovannelli et al, In prep

“Candidatus Thioarachnea milensis”



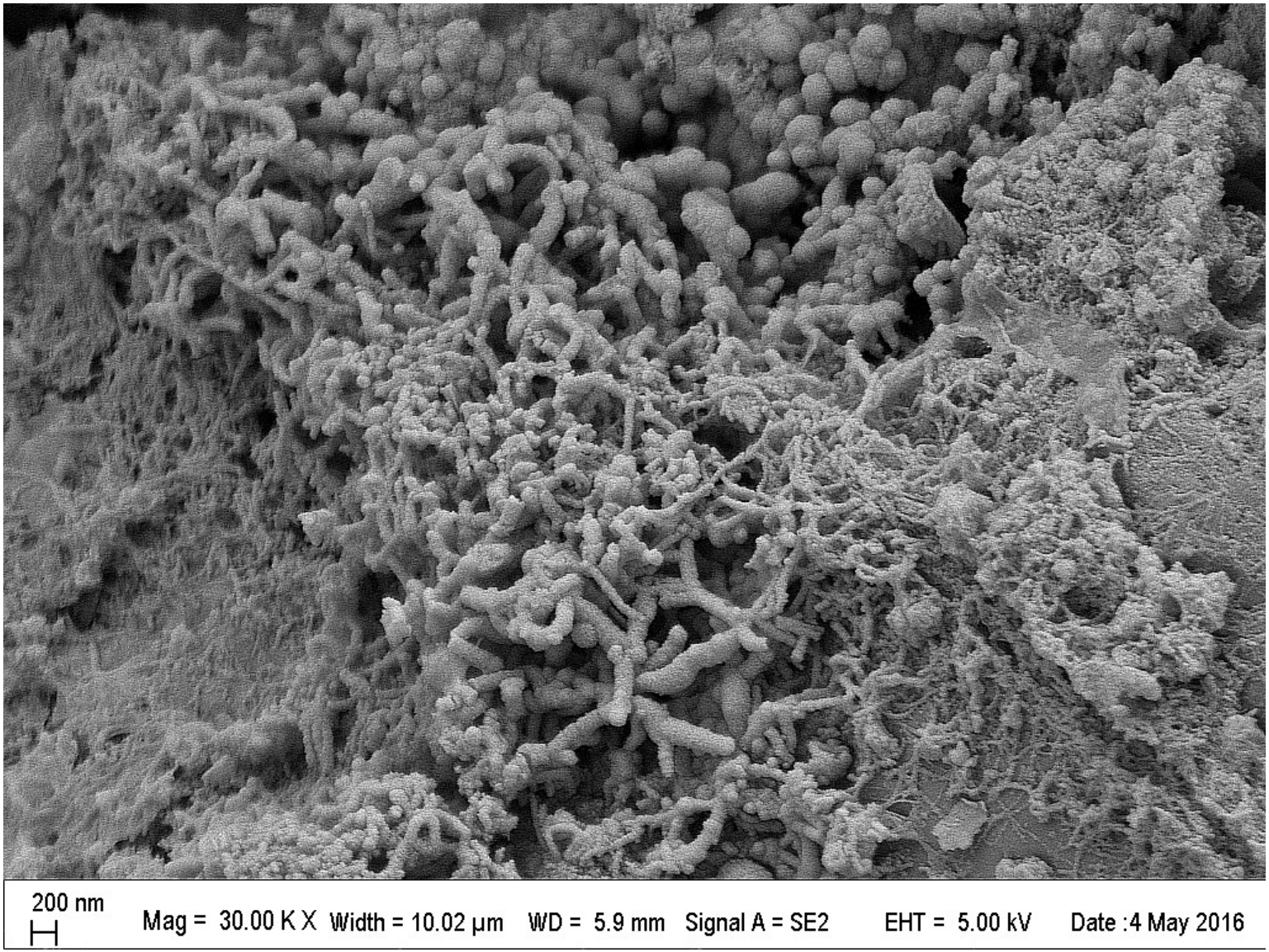
Giovannelli et al, In prep

SEM micrographs Milos white mats

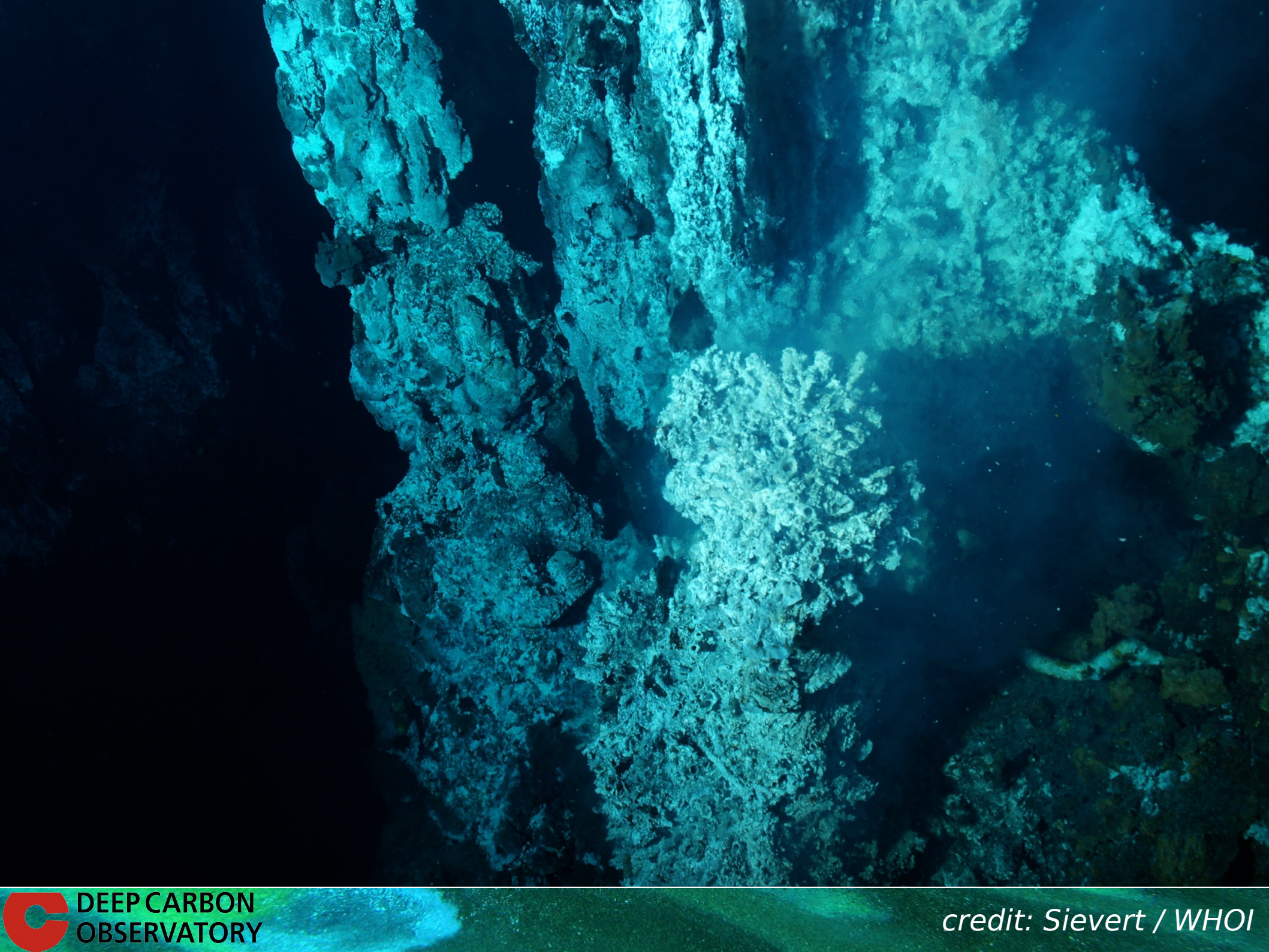


Giovannelli et al, In prep

SEM micrographs Espalamanca mats



How diverse are microbial community across the wide range of different shallow vent environments?


DEEP CARBON
OBSERVATORY
credit: Sievert / WHOI


DEEP CARBON
OBSERVATORY
credit: Giovannelli and Vetriani

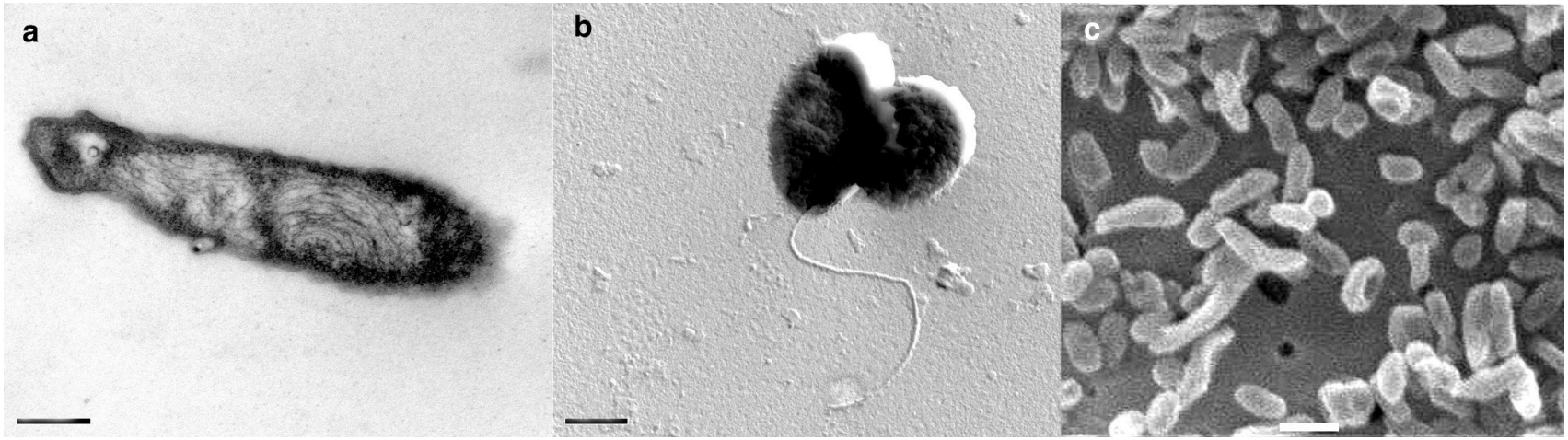
Isolate Diversity

Table 2. Characteristics of chemolithoautotrophic prokaryotes isolated as pure cultures from shallow-water hydrothermal vents.

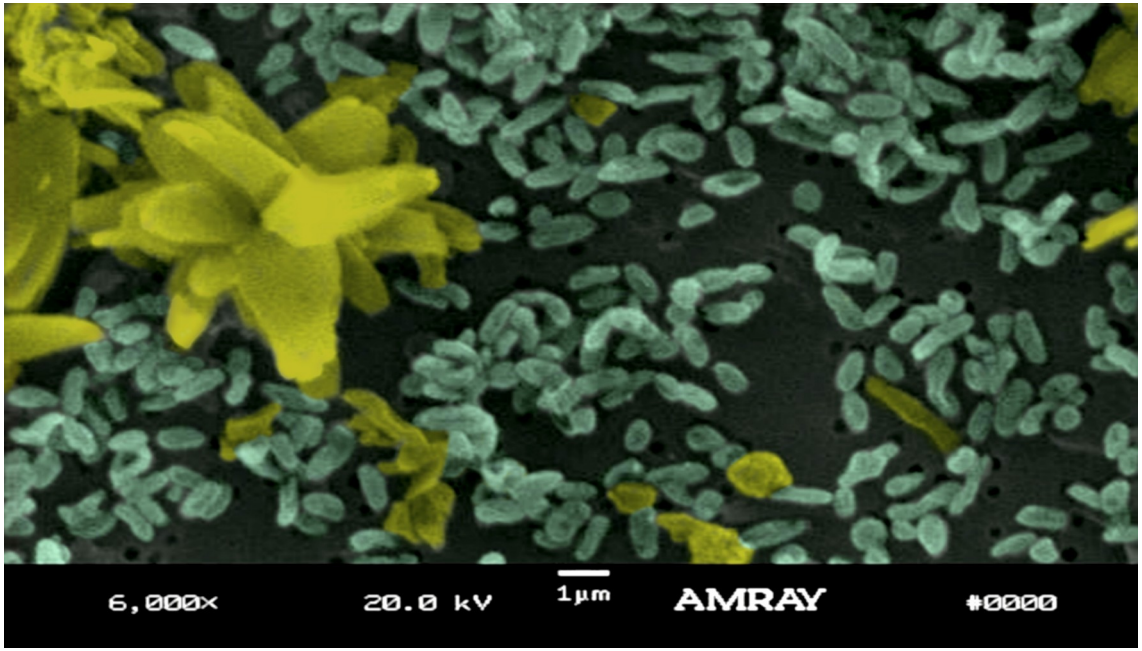
Species	Phylum	Isolation Site	Optimum Temp (°C)	Electron Donor(s)	Electron Acceptor(s)	Carbon Source	Reference
Archaea							
Acidianus infernus	*Crenarchaeota*	Campi Flegrei and Vulcano Island, Italy	90	S^0	S^0, O_2	CO_2, organic carbon	Segerer et al., 1986
Ignicoccus hospitalis	*Crenarchaeota*	Kolbeinsey Ridge, Iceland	90	H_2	S^0	CO_2	Jahn et al., 2007
Ignicoccus islandicus	*Crenarchaeota*	Kolbeinsey Ridge, Iceland	90	H_2	S^0	CO_2	Huber et al., 2000
Archaeoglobus fulgidus	*Euryarchaeota*	Vulcano island and Stufe di Nerone, Italy	83	H_2	SO_4^{2-}, SO_3^{2-}, $S_2O_3^{2-}$	CO_2, organic carbon	Stetter et al., 1987; Stetter, 1988
Ferroglobus placidus	*Euryarchaeota*	Vulcano Island, Italy	80	Fe^{2+}	NO_3^-	CO_2	Hafenbradl et al., 1996
Methanococcus aeolicus	*Euryarchaeota*	Lipari Islands, Italy	37	H_2, formate	methanogen	CO_2	Kendall et al., 2006
Methanococcus thermolithotrophicus	*Euryarchaeota*	Naples, Italy	65	H_2	methanogen	CO_2	Huber et al., 1982
Methanopyrus kandleri	*Euryarchaeota*	Kolbeinsey ridge, Iceland	98	H_2	methanogen	CO_2	Kurr et al., 1991
Methanotorris (Methanococcus) igneus	*Euryarchaeota*	Kolbeinsey ridge, Iceland	88	H_2	methanogen	CO_2	Burggraf et al., 1990
Bacteria							
Aquifex aeolicus§	*Aquificae*	Vulcano Island, Italy	95	H_2	O_2	CO_2	Huber and Stetter, 1992
Aquifex pyrophilus	*Aquificae*	Kolbeinsey ridge, Iceland	95	H_2	O_2	CO_2	Huber et al., 1992
Hydrogenivirga caldilitoris	*Aquificae*	Ibusuki, Japan	75	S^0	O_2	CO_2	Nakagawa et al., 2004
Hydrogenobacter							

Price & Giovannelli, In review

Galenea microaerophila P2D^{T} gen. nov. sp. nov.

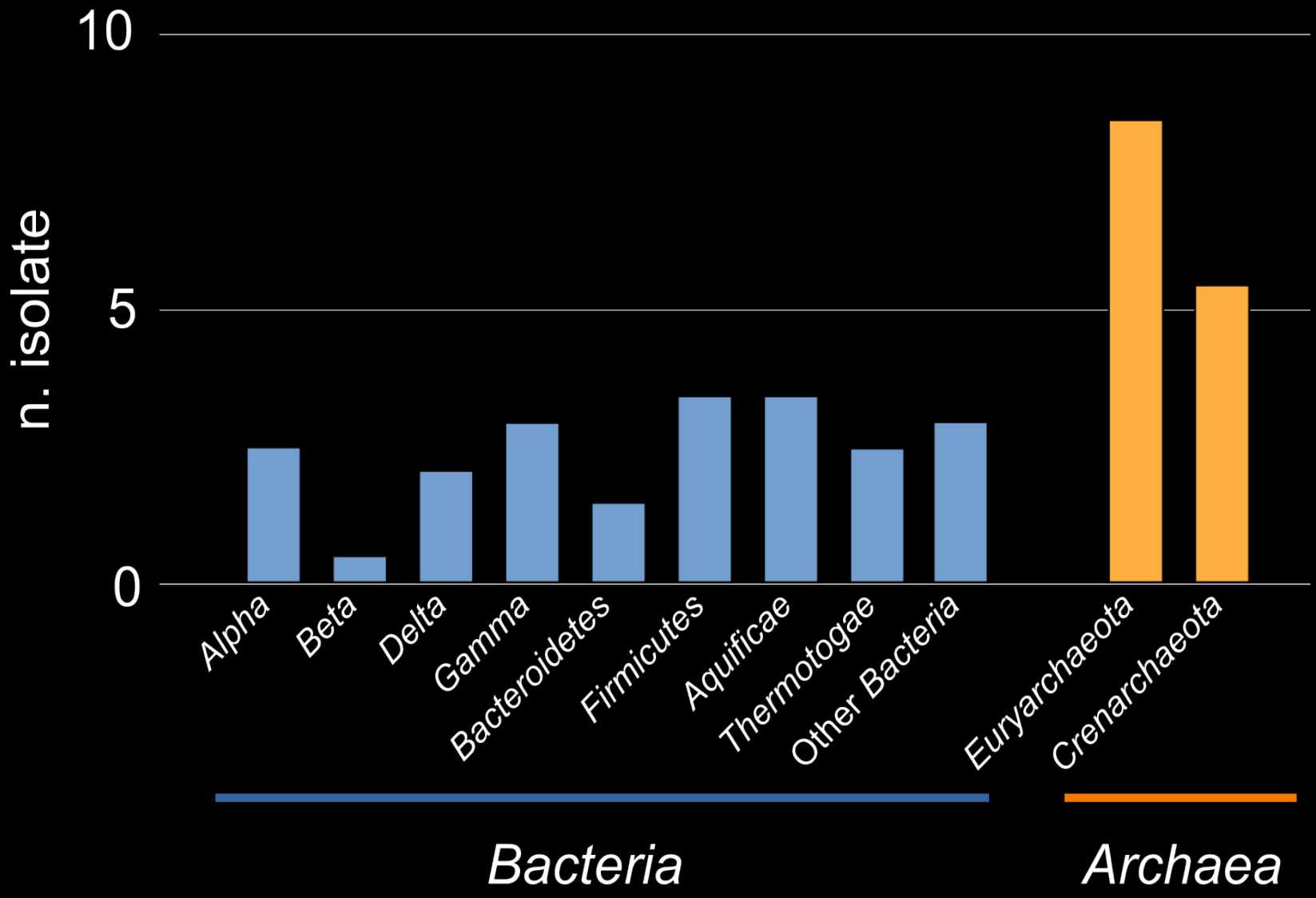


- *Gammaproteobacteria*
- Mesophilic
- Chemolithoautotroph
- Thiosulfate oxidizer
- Microaerophile



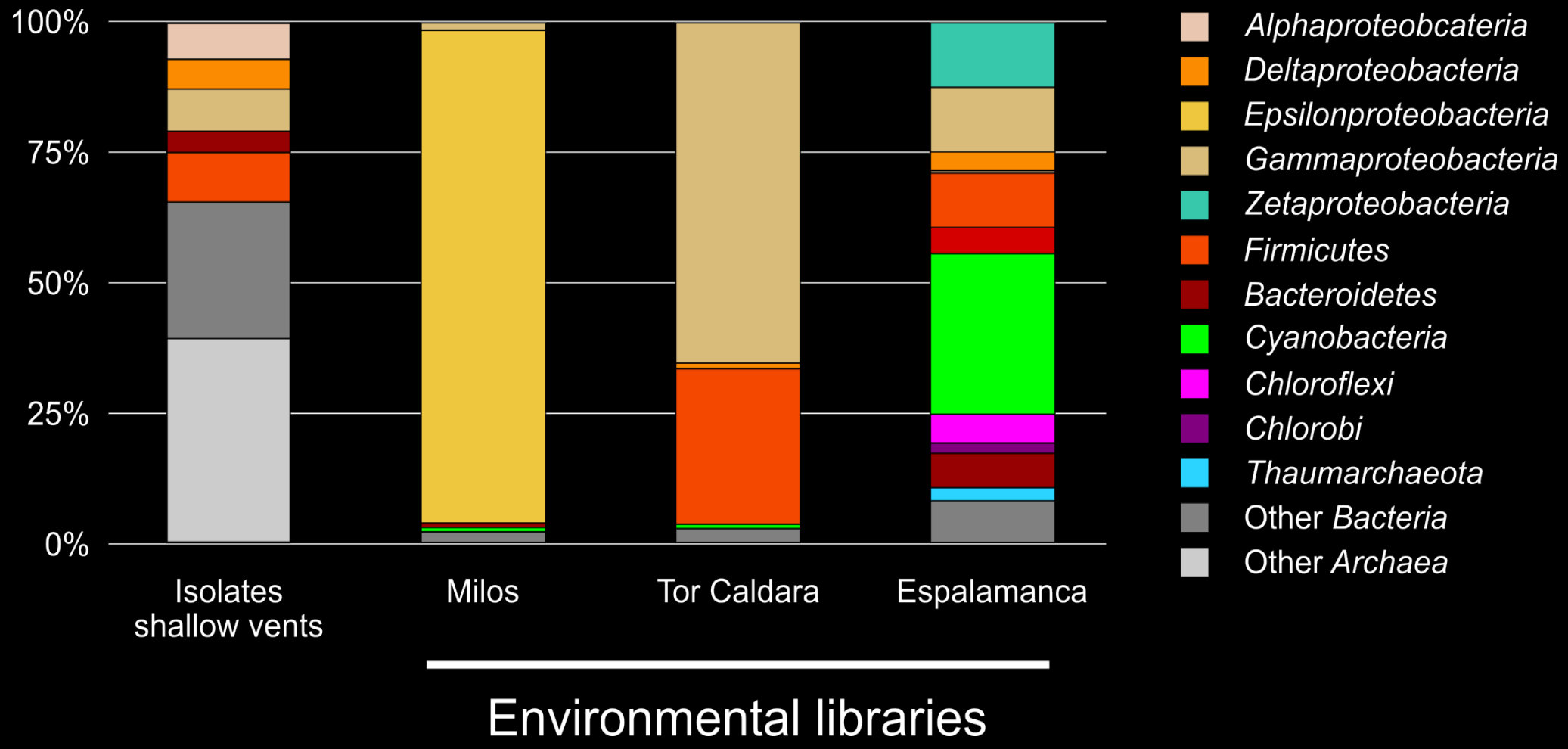
Giovannelli et al, 2012 IJSEM

Isolate Diversity



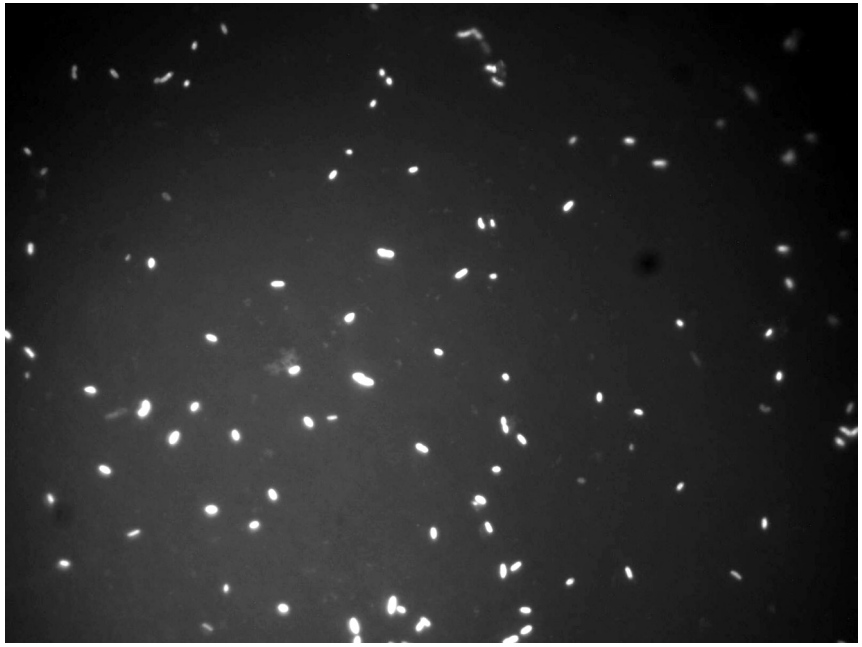
Giovannelli, Vetriani, Patwardhan, Bongiorni

Isolate Diversity

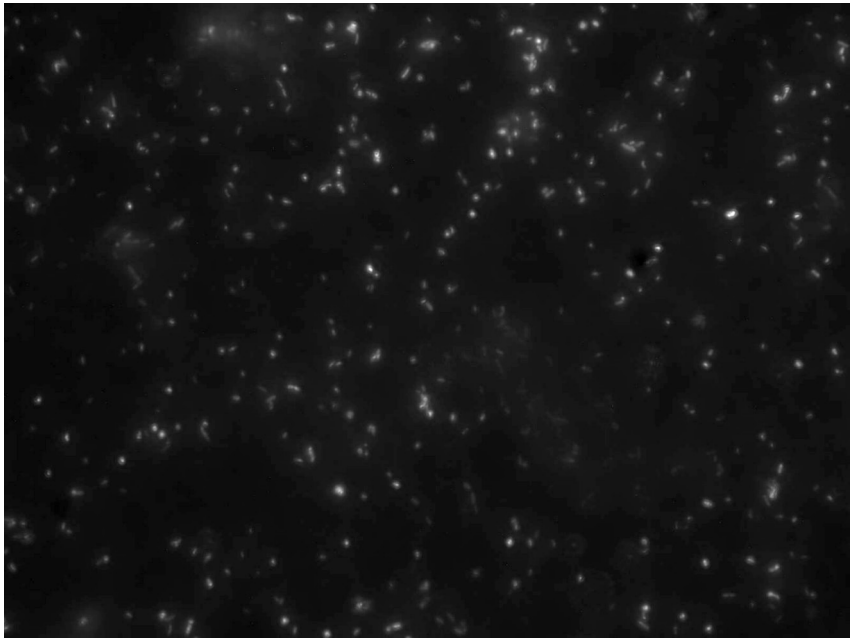


Giovannelli et al, In prep

Epsilonprotebacteria enrichments

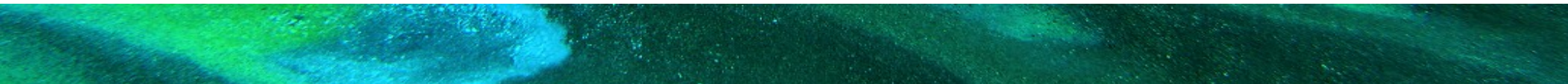


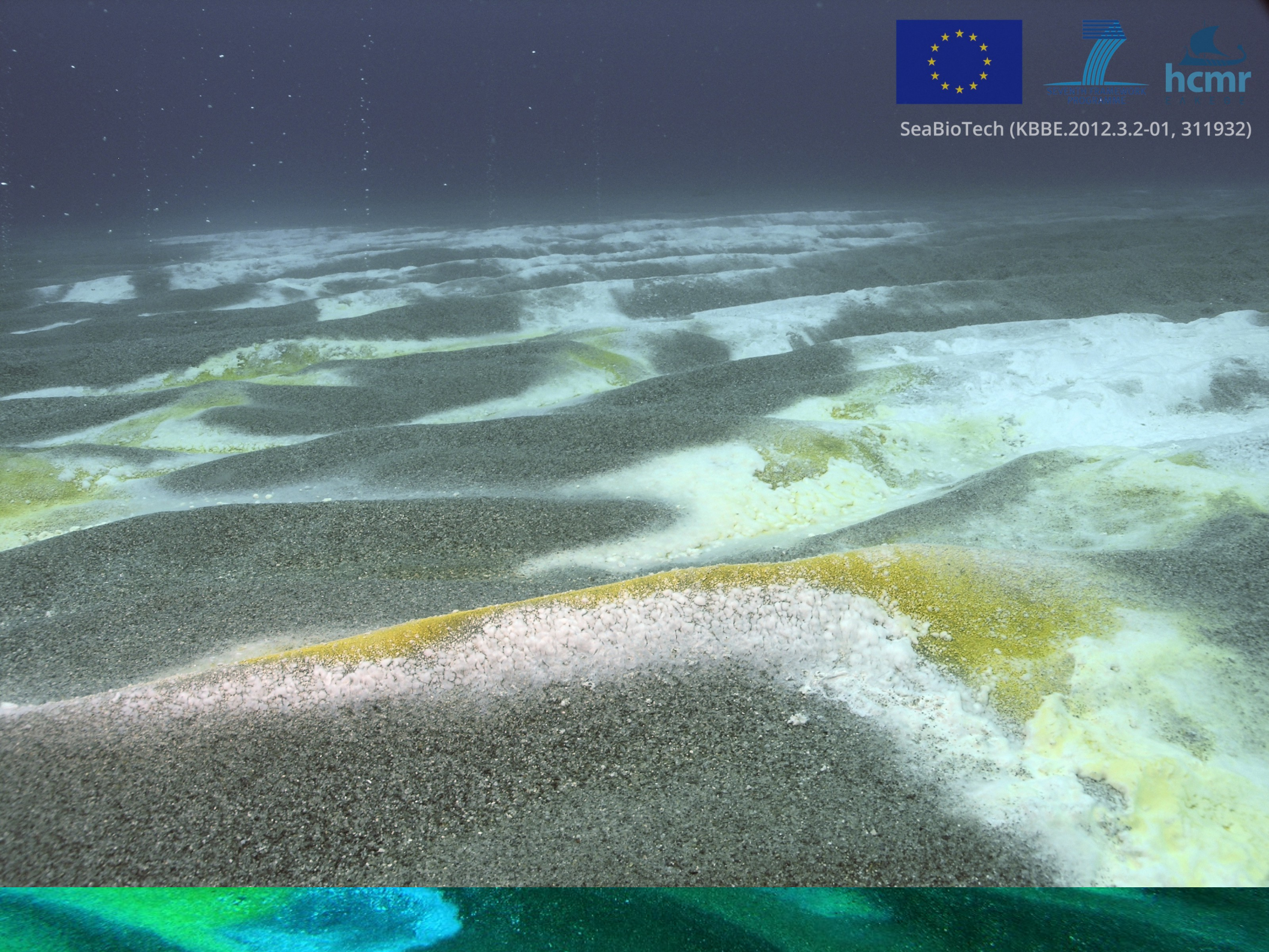
***Epsilonproteobacteria* strain MB-1A**
Milos enrichment
CO2 + thiosulfate + nitrate, 35°C
av. similarity to *Arcobacter defluvii* 95%



***Epsilonproteobacteria* strain TC-3**
Tor Caldara enrichment
CO2 + thiosulfate + nitrate, 30°C
av. similarity to *Sulfurimonas autotrophica* 93%

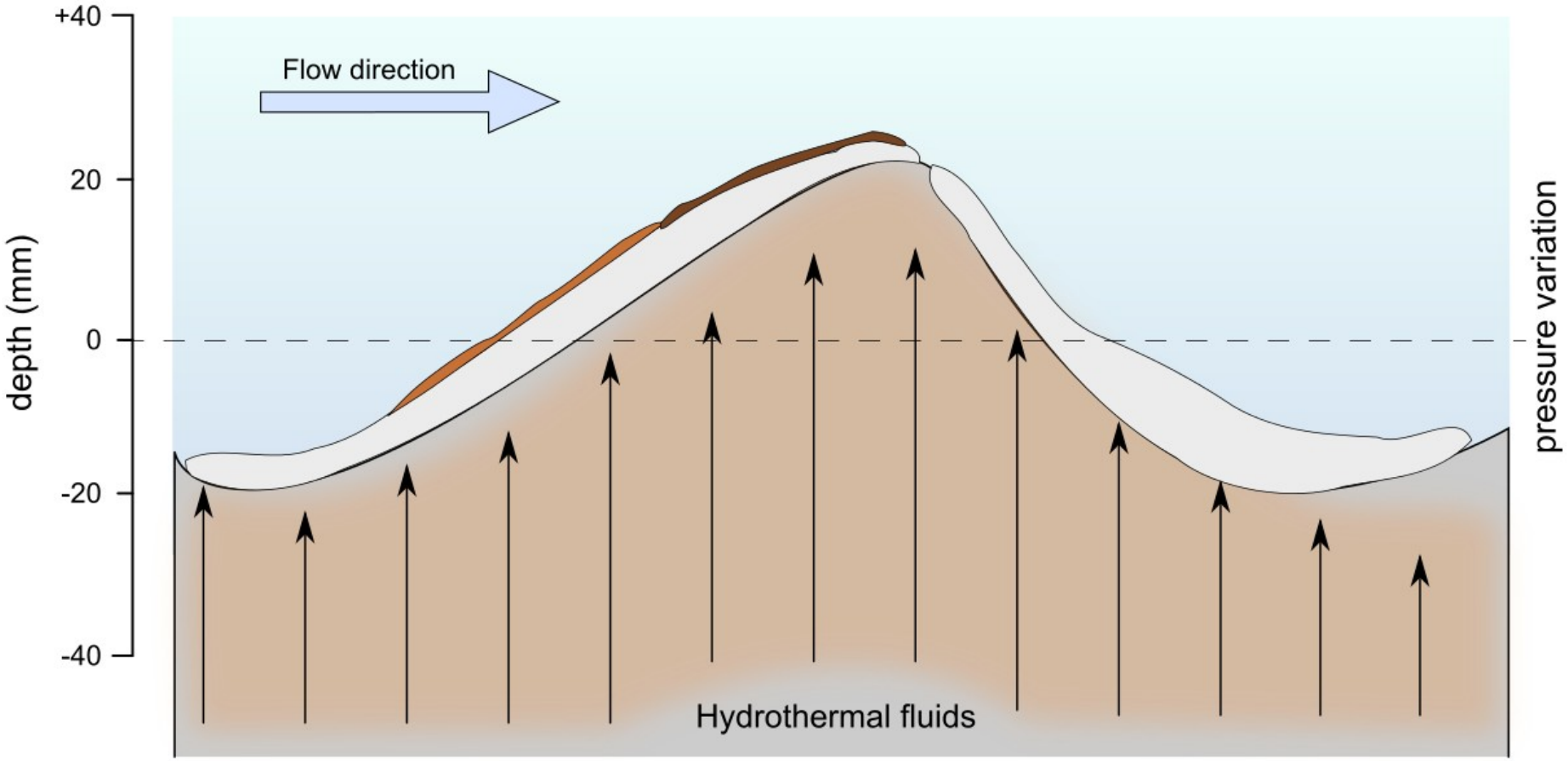
We really need ecologically relevant isolates from shallow-water vents. Can we devise new ways to coerce these microbes into the confined space of our lab to be able to peak into microbial dark matter in a new way?





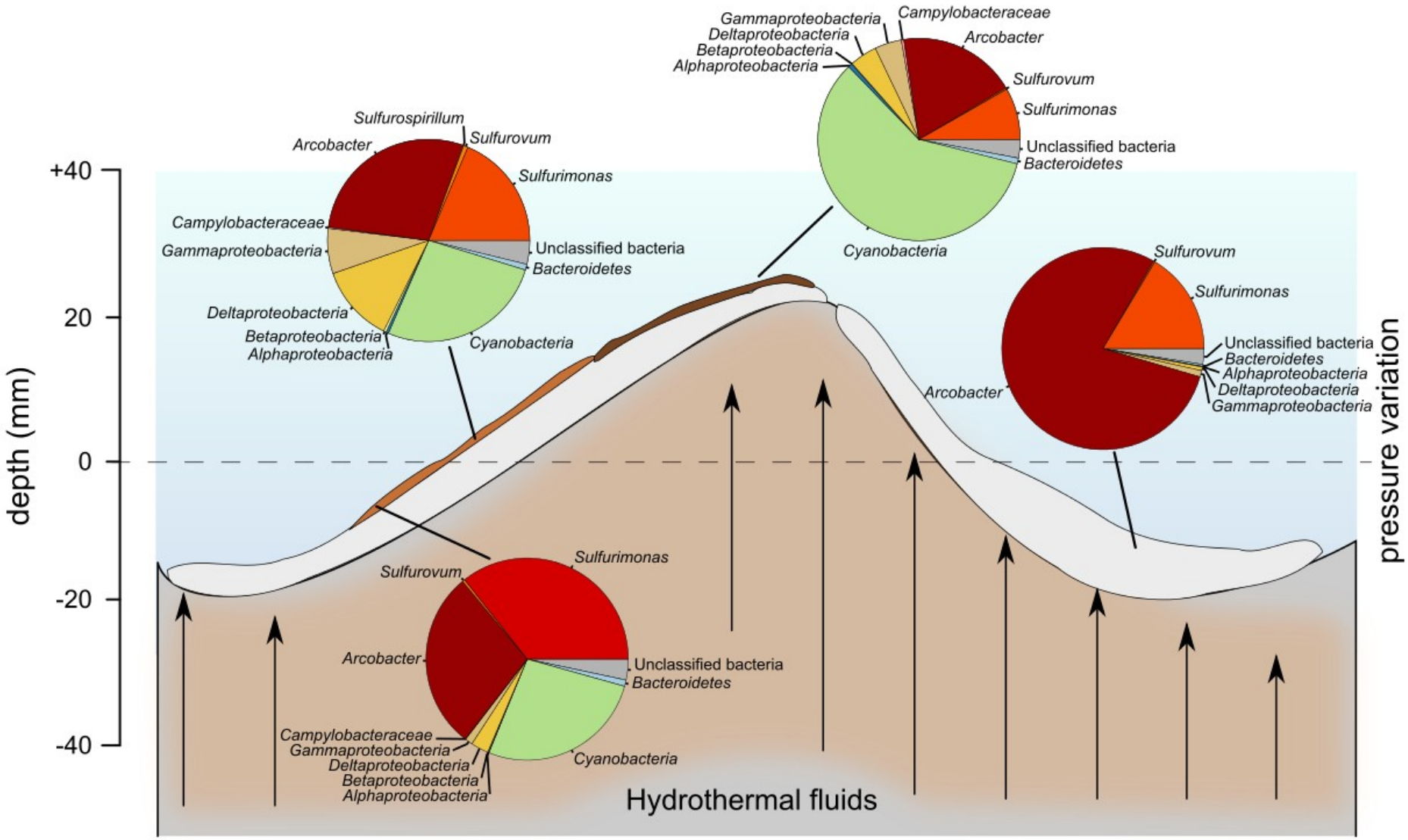
SeaBioTech (KBBE.2012.3.2-01, 311932)

Small scale distribution



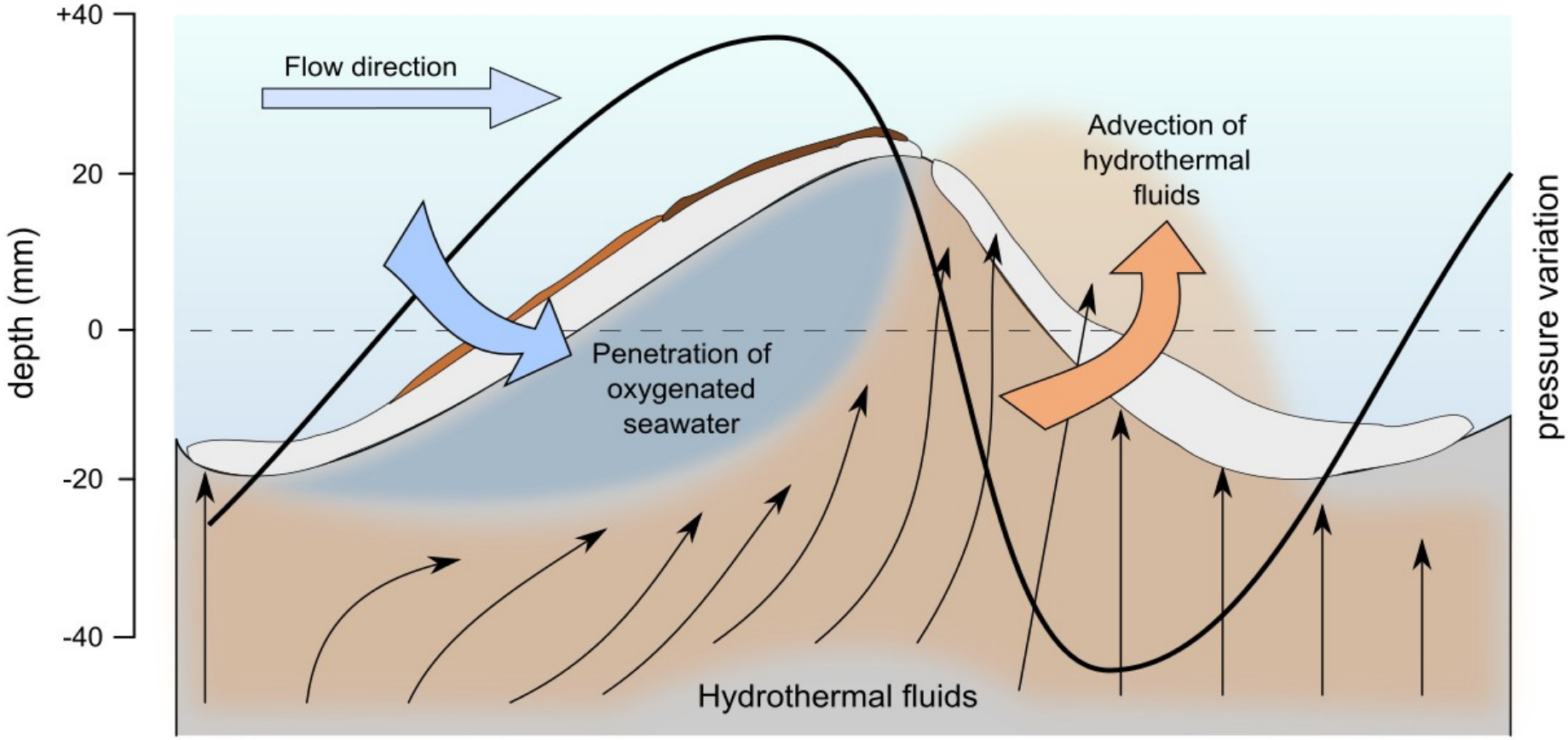
Giovannelli et al, In prep

Small scale distribution

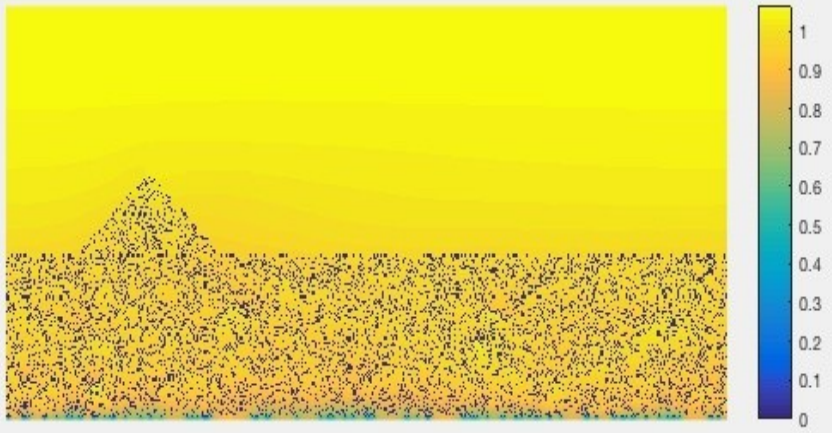


Giovannelli et al, In prep

Small scale distribution



Giovannelli et al, In prep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0.7
0.6
0.5
0.4
0.3
0.2
0.1
0


0.8
0.7
0.6
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0.4
0.3
0.2
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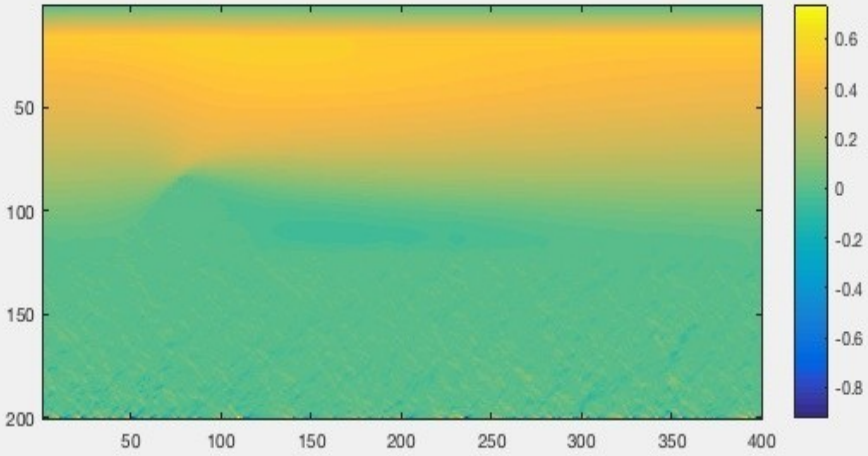
0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0.2
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100
150
200
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300
350
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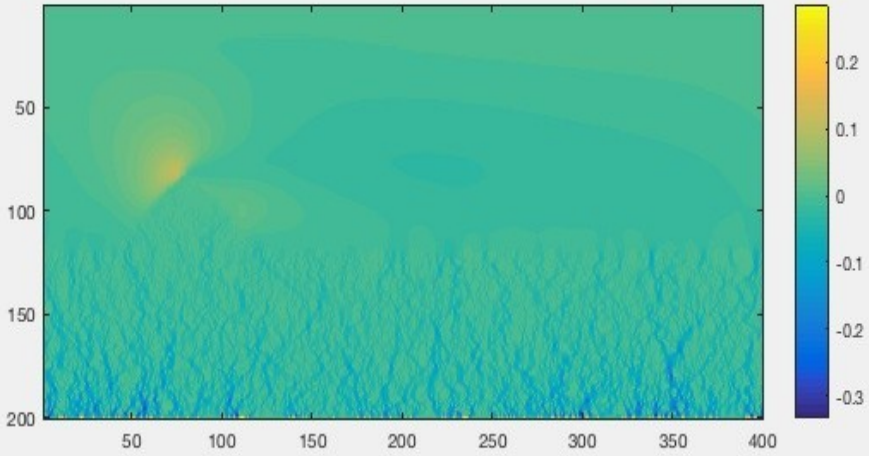
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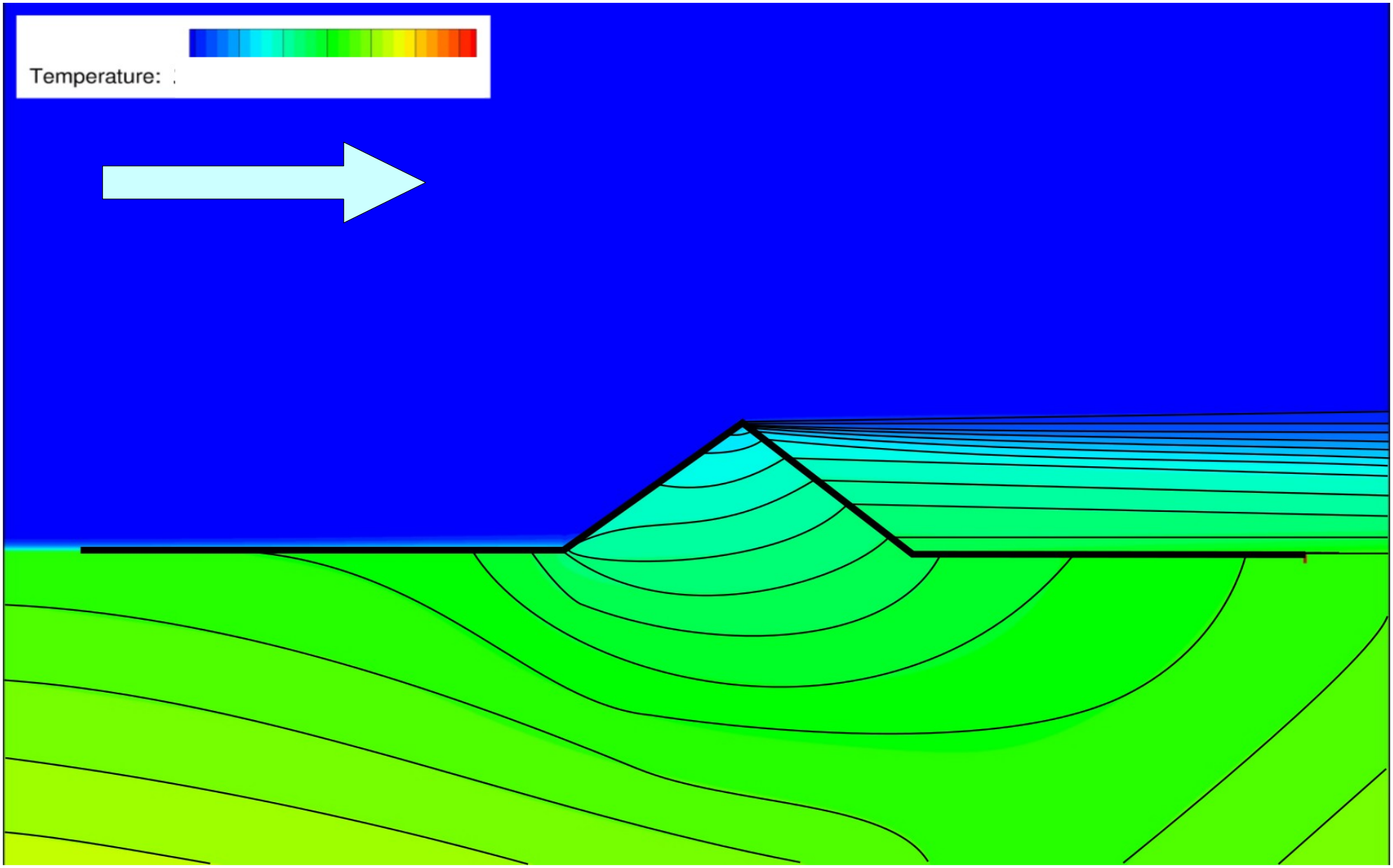
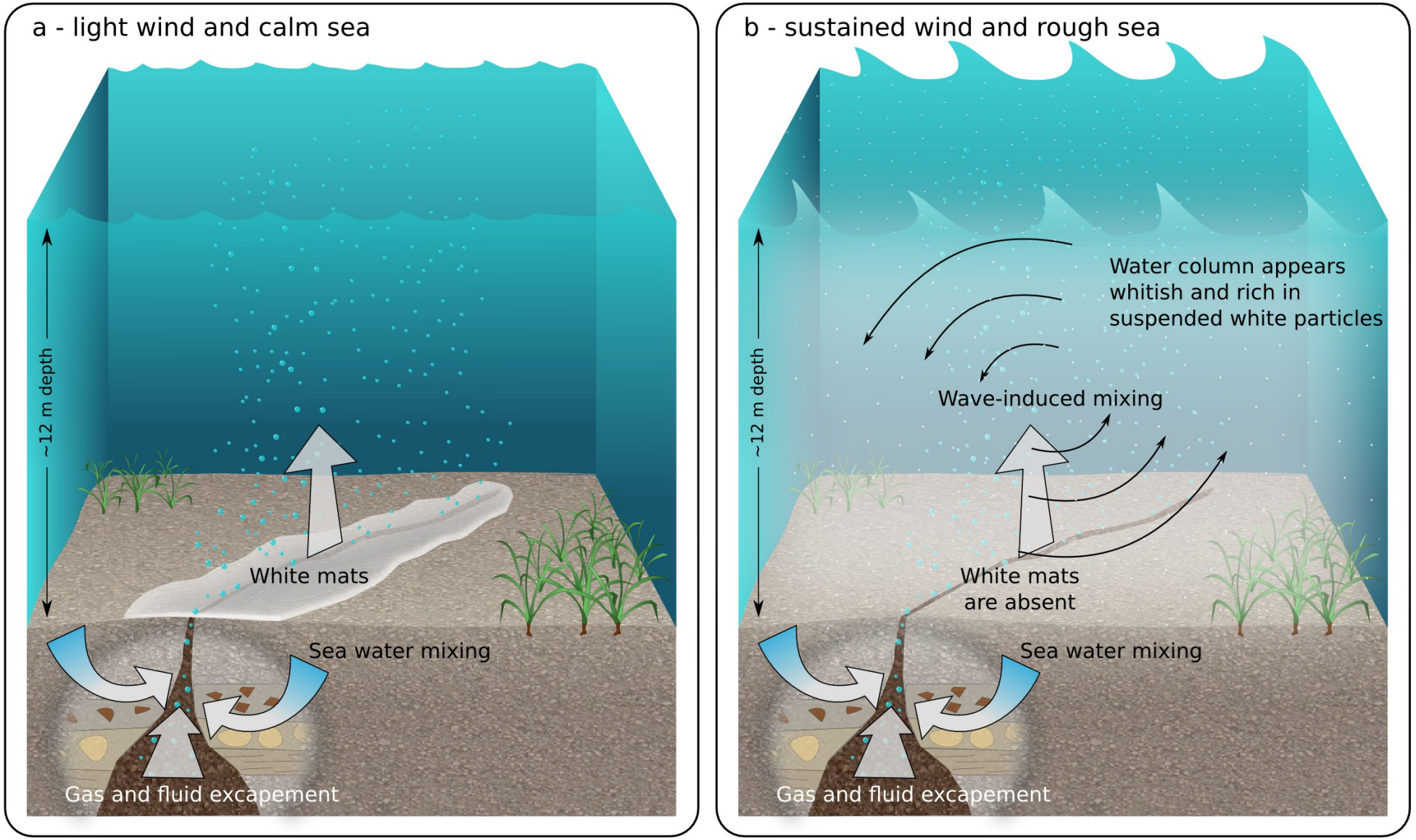


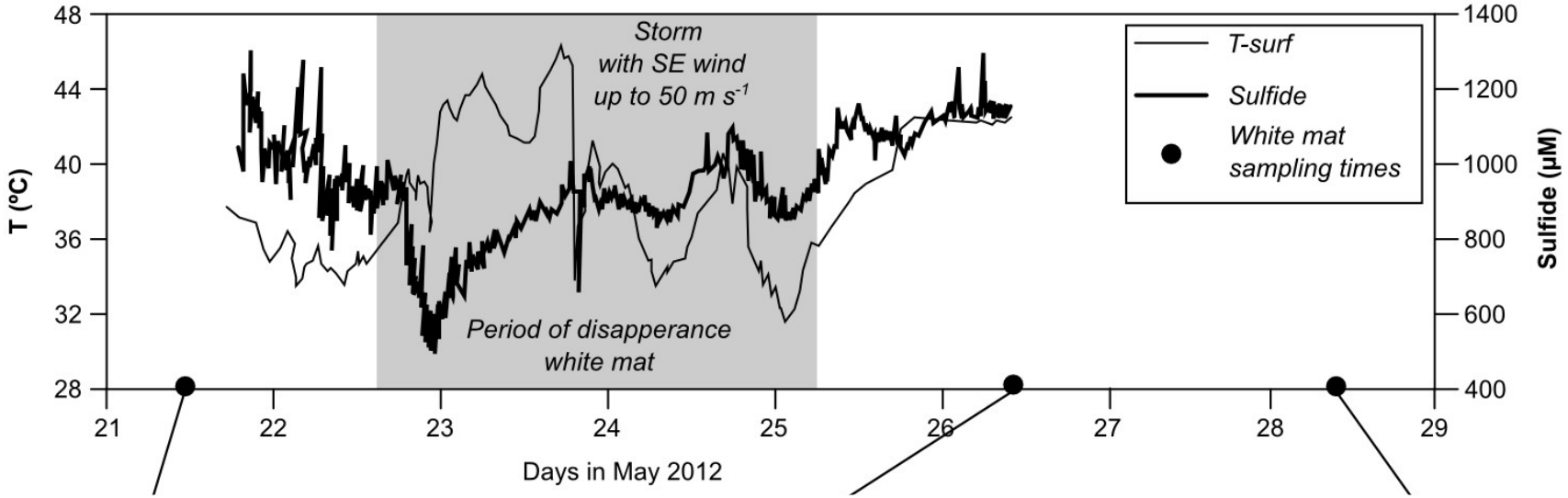
Bartlett, D'Alessandro, Yucel, Giovannelli

Milos shallow-water vents

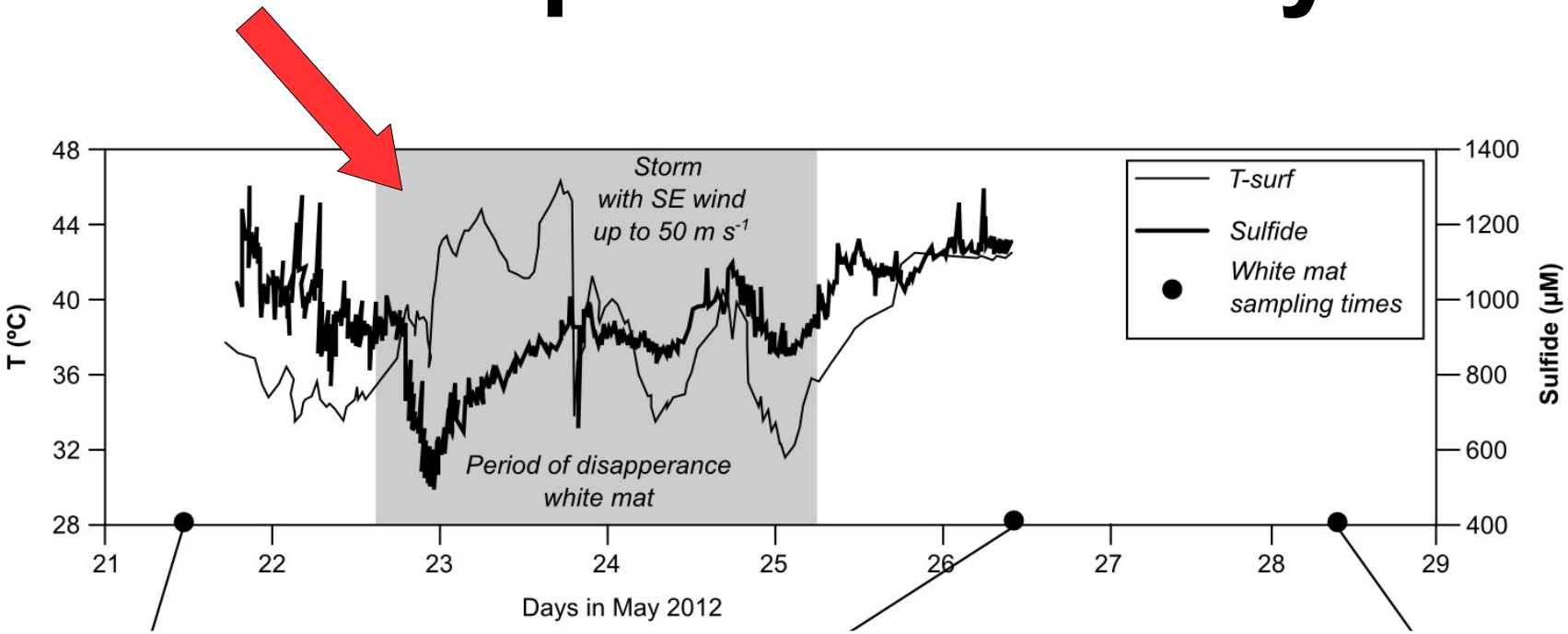


Giovannelli et al, In prep

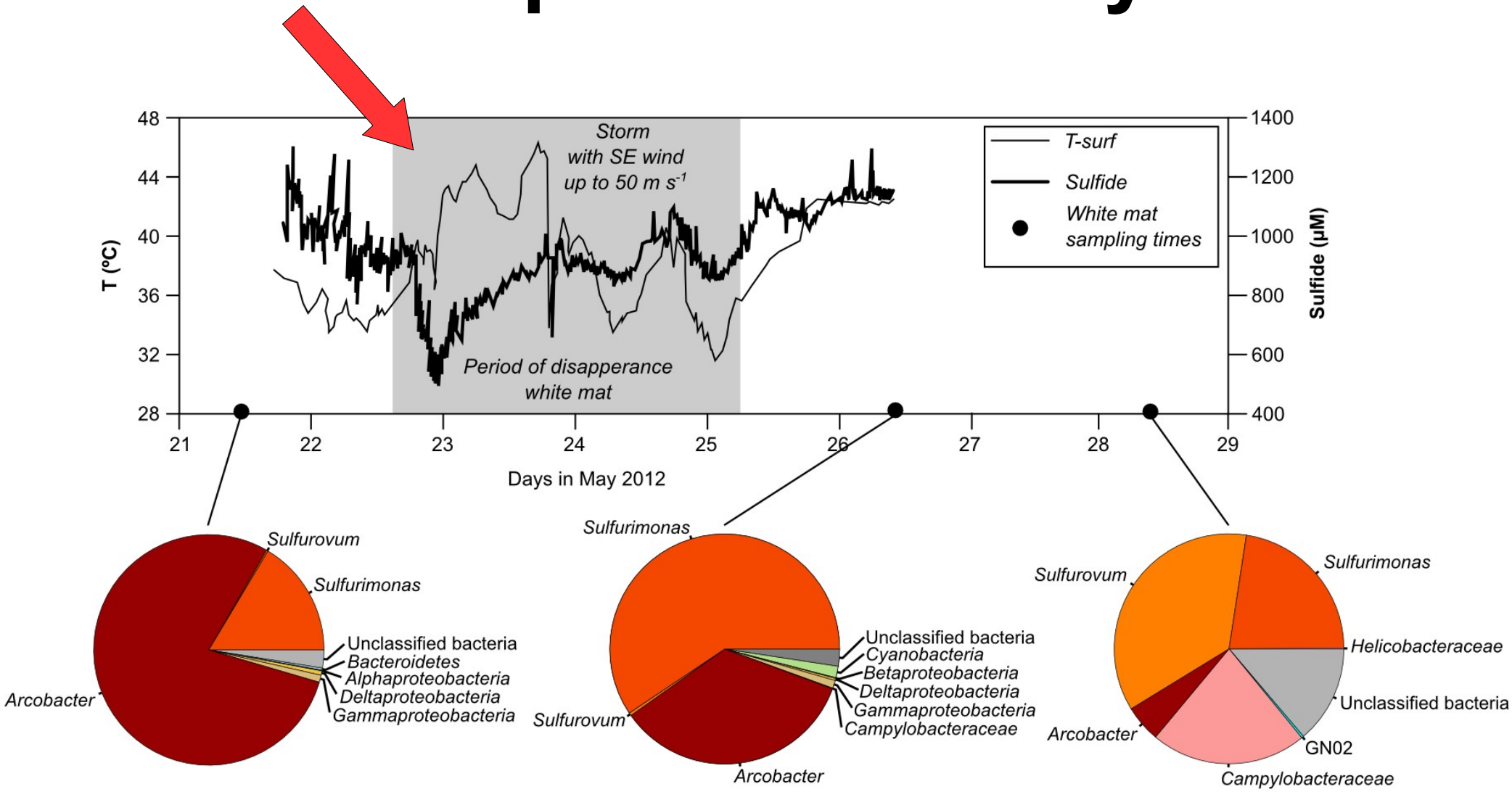
Temporal variability

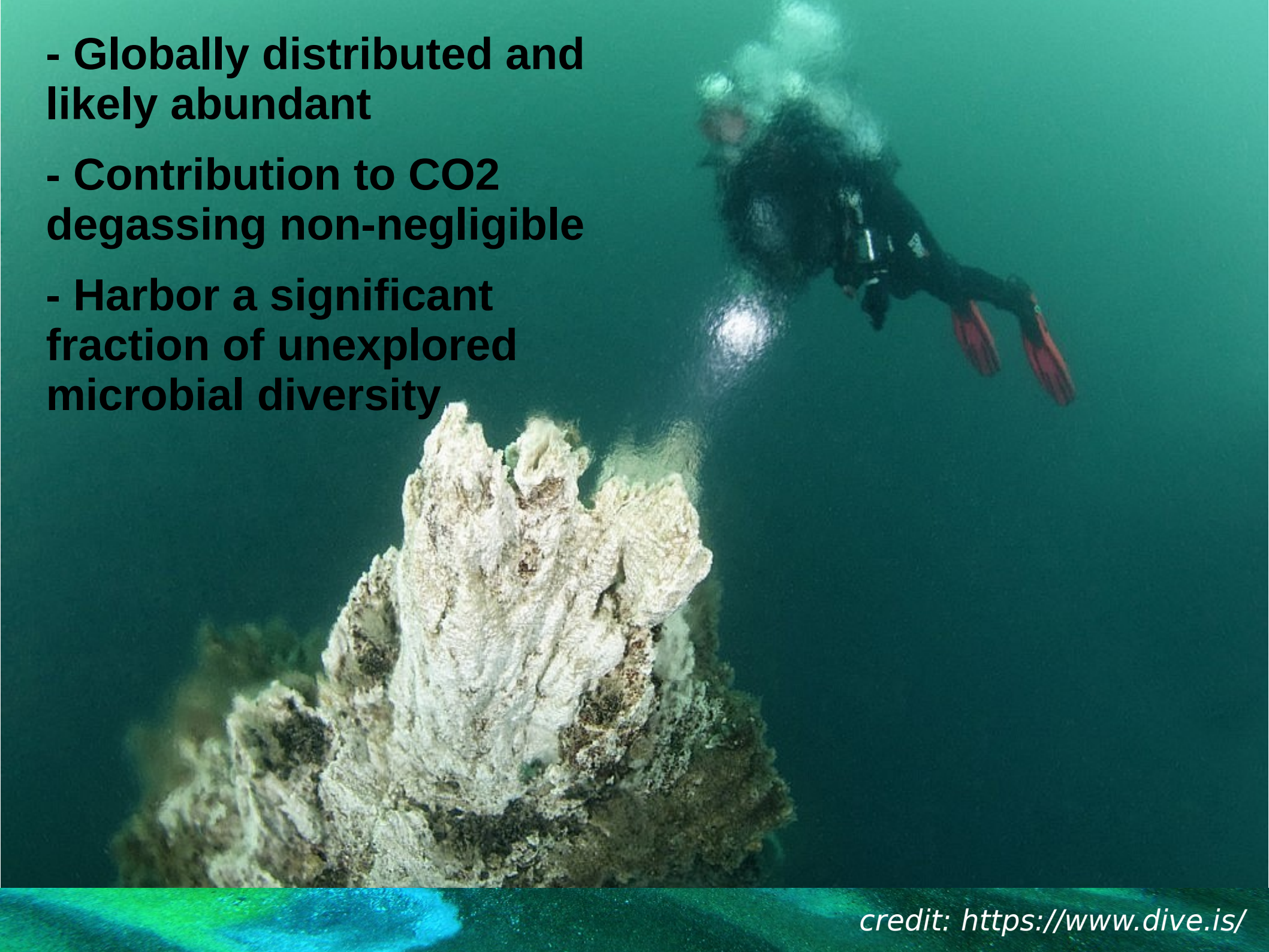


Temporal variability



Temporal variability




- Globally distributed and likely abundant
- Contribution to CO2 degassing non-negligible
- Harbor a significant fraction of unexplored microbial diversity
credit: https://www.dive.is/

Readings

Price, R. E., and Giovannelli, D. (2017). "A Review of the Geochemistry and Microbiology of Marine Shallow-Water Hydrothermal Vents," in Reference Module in Earth Systems and Environmental Sciences (Elsevier). doi:10.1016/B978-0-12-409548-9.09523-3.