

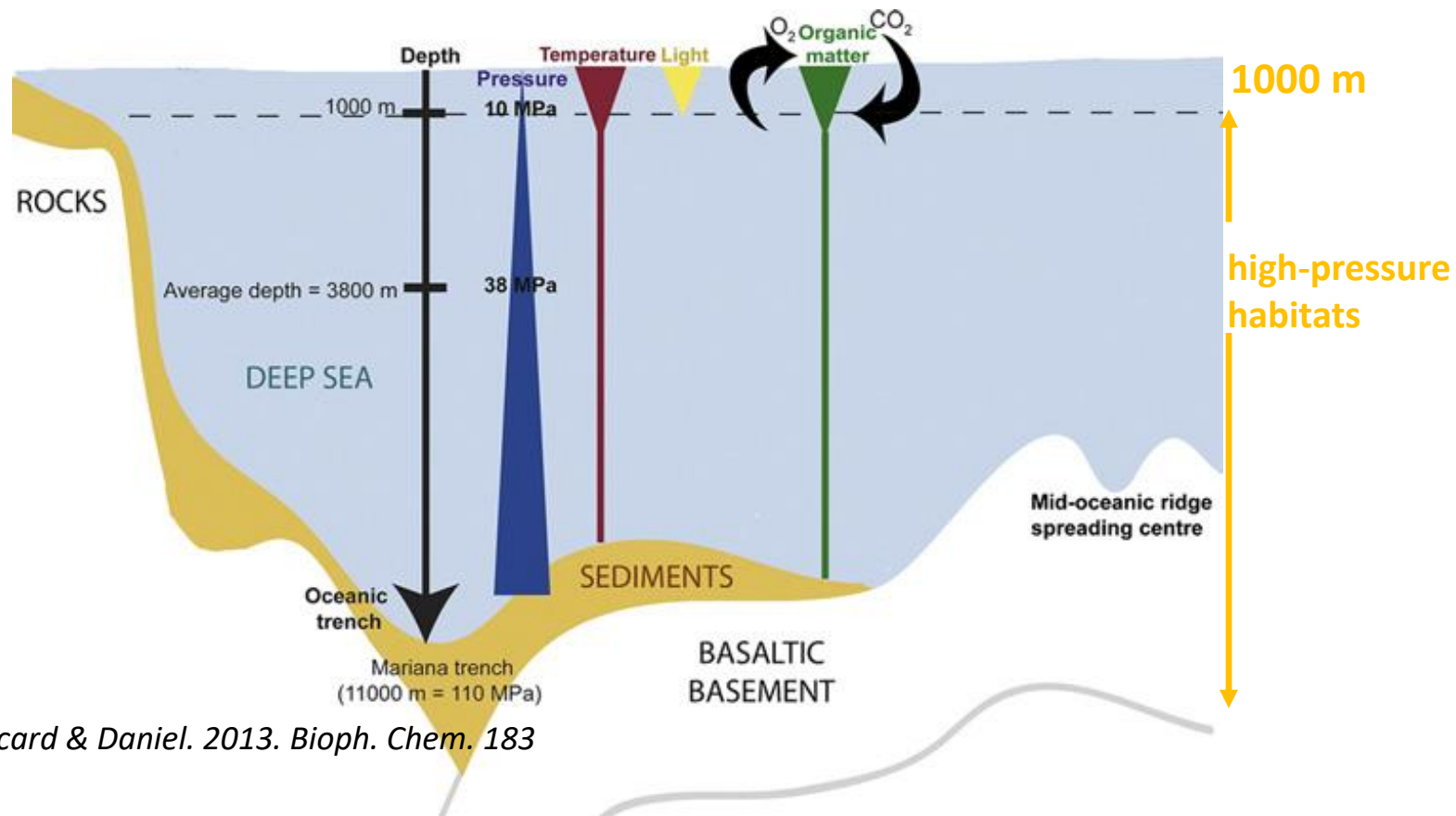
High-pressure technologies for the study of the deep marine biosphere

(with a focus on deep-sea hydrocarbon-degraders)

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The piezosphere

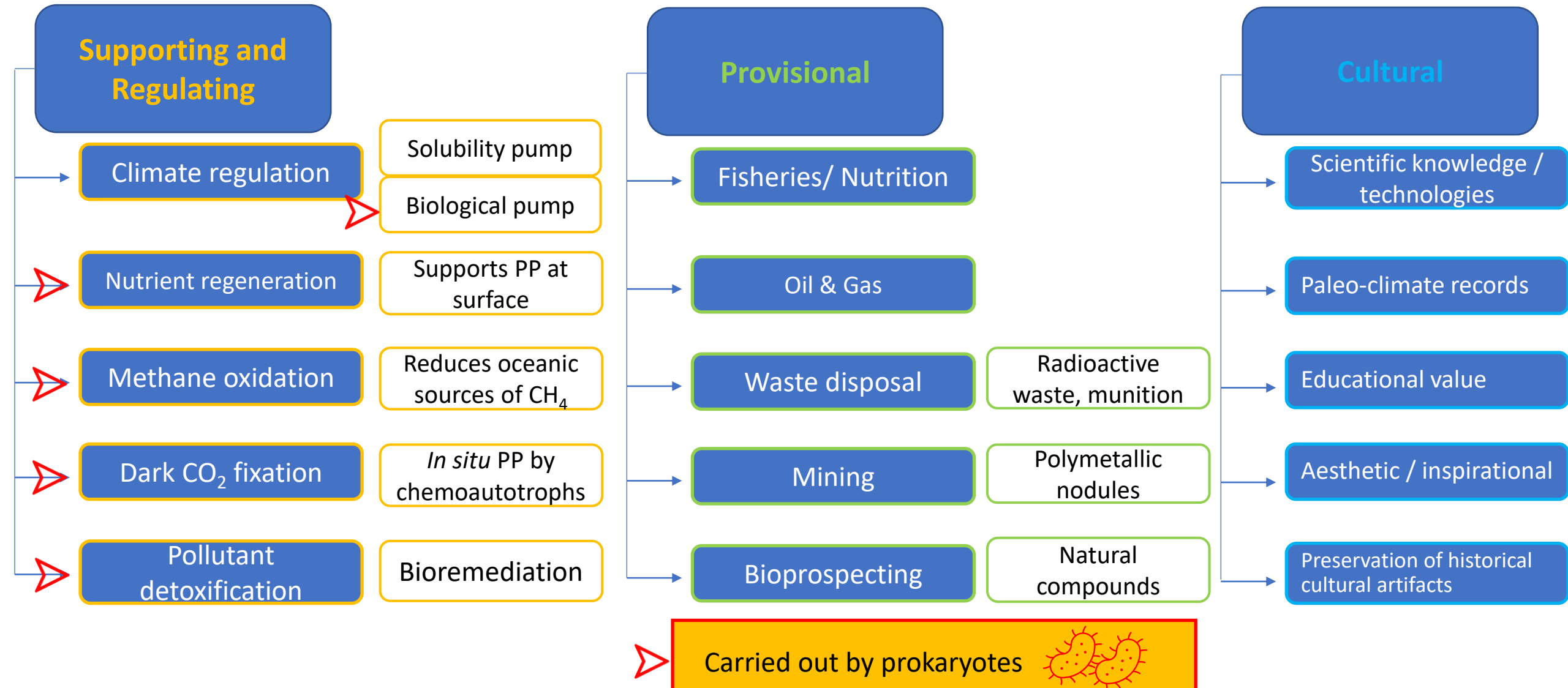


Deep-sea >1000 m depth

- ✓ Largest biotope on Earth
- ✓ 75% of total ocean volume
- ✓ 62% of global biosphere
- ✓ Least known habitat on the globe

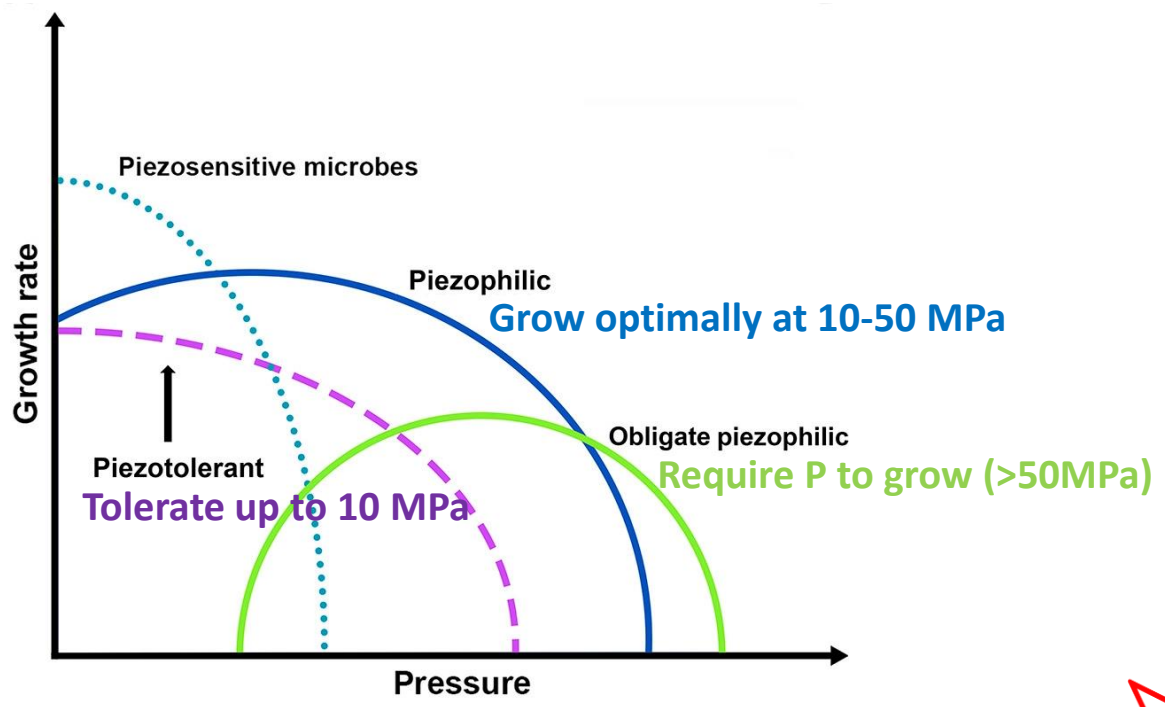
Ecosystem services
that keep the Earth
habitable

Deep-sea ecosystem services

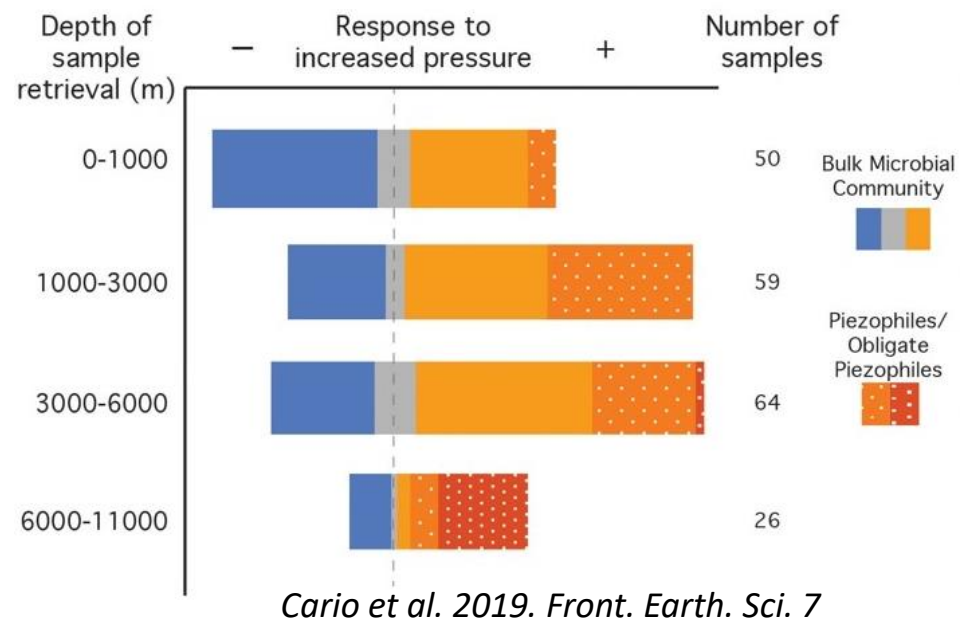


Piezophiles

Microorganisms are classified by their physiological response to pressure:



Fang et al. 2010. Trends Microbiol. 18

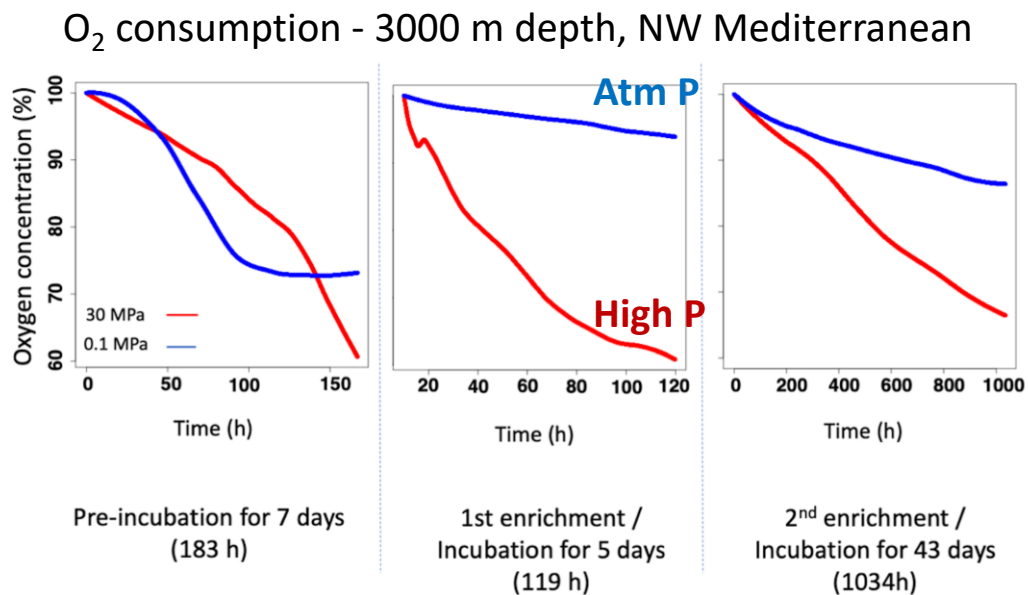


Cario et al. 2019. Front. Earth. Sci. 7

➤ The negative effect of decompression increases with depth of retrieval

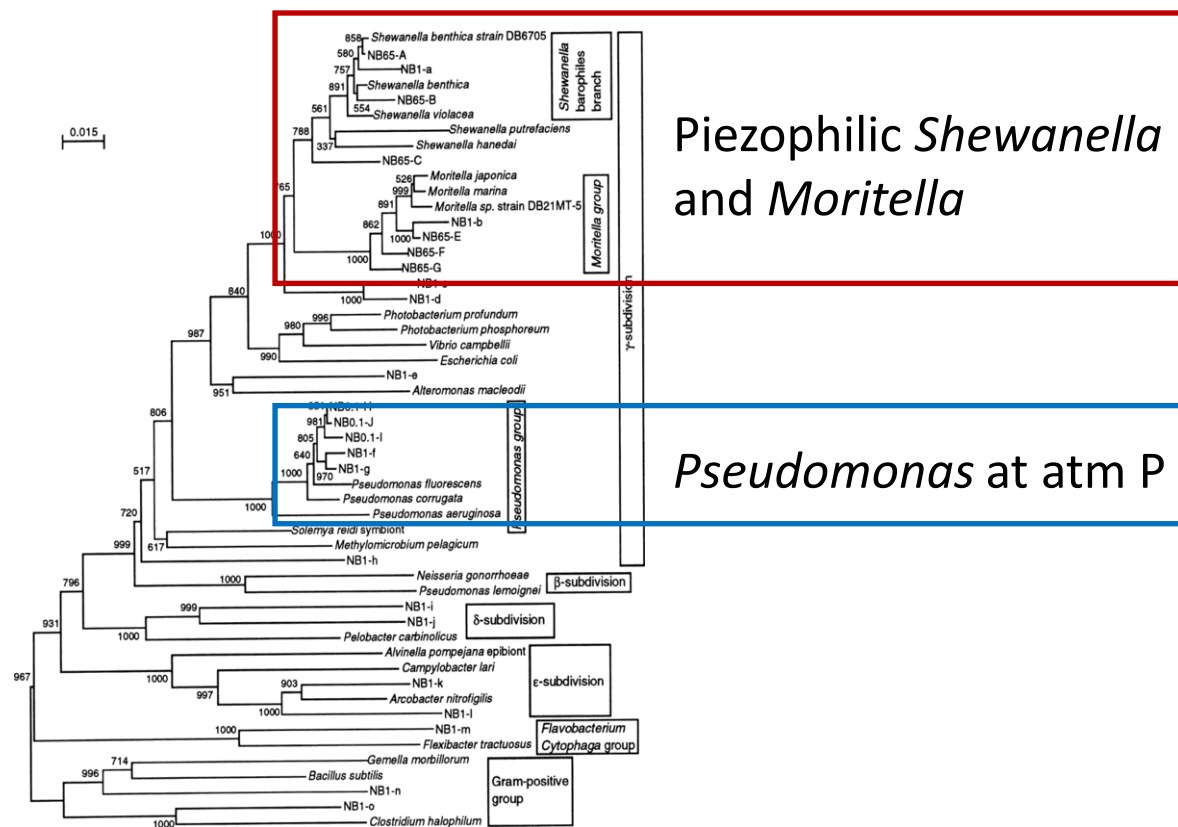
Decompression effects

Incubation of deep-sea samples at atmospheric pressure commonly underestimates *in situ* activity



Garel et al. 2019. Front. Microbiol. 10

Shifts in community composition
Japan Trench, 6000 m



Keeping *in situ* P is essential for the study of the deep biosphere

High-Pressure Sampler



1. 1L stainless-steel tube
(dimensions: 500 mm x
Φ60.3 mm x 4 mm)

2. Screwed stainless steel cap
and seals tight with a rubber
O-ring

3. Both the screwed cap
and the closed end of the
tube have integrated ¼"
NPT male needle valves,
sealed tight with liquid
Teflon

4. Unidirectional check valve is attached to the bottom-
end needle valve to allow flow of seawater inside the
sampler. The check valve was set to open when ΔP was
0.2 MPa using a high-pressure syringe pump.



High-Pressure Experimentation

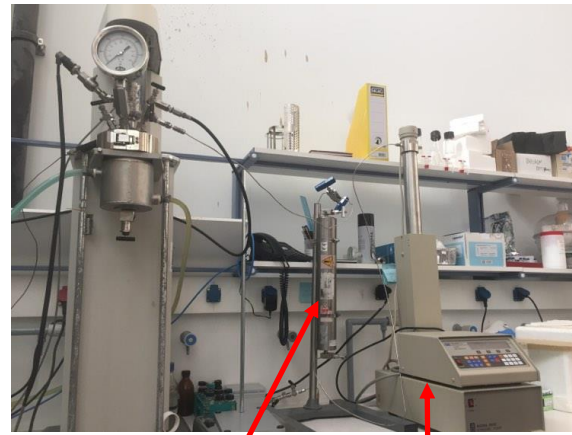
Step 1 HP Sampler

- Pressurized on deck
- Re-opens when inside-outside $\Delta P > 0.2$ MPa (20 m)



Step 2 HP Piston pump

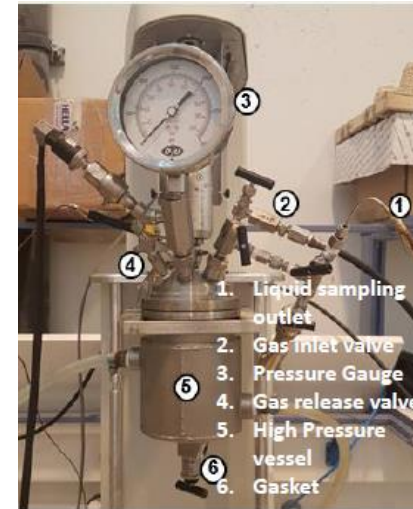
- Transfer of known volume of seawater to incubation vessels without depressurization



Chamber Pump

Step 3 HP incubation vessels

- HP Reactor & HP Bottles



- ✓ Temperature control
- ✓ Stirring at 100 rpm



- ✓ Replication

Confidential until publication

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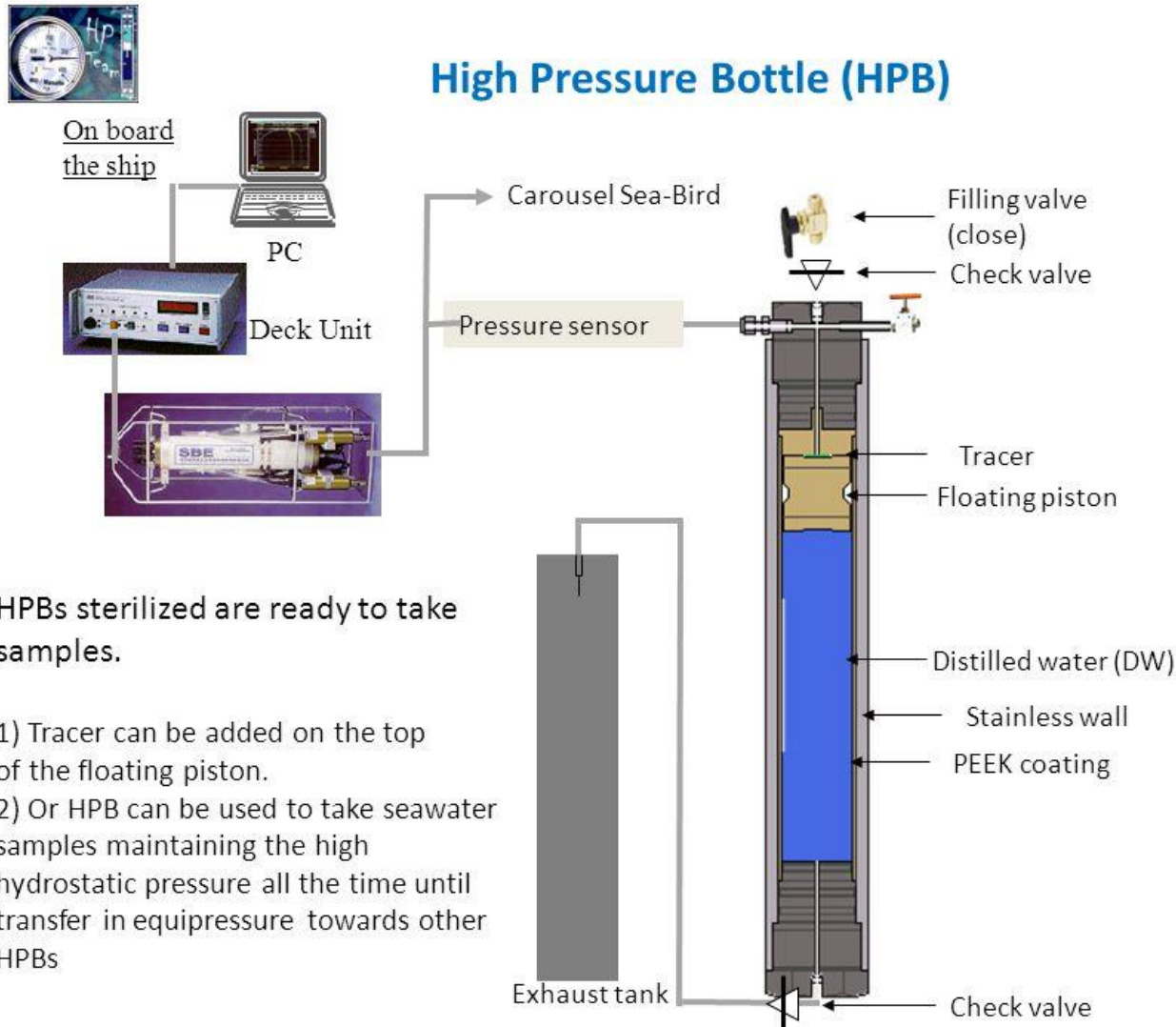
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Delving into the deep – the X-PRESS project

Sampling and experimentation up to 60 MPa = 6000 m depth



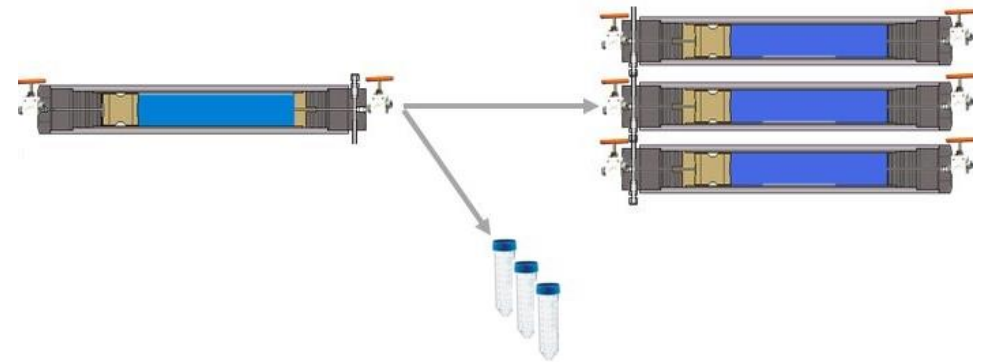
High Pressure Bottle (HPB)



HPBs sterilized are ready to take samples.

- 1) Tracer can be added on the top of the floating piston.
- 2) Or HPB can be used to take seawater samples maintaining the high hydrostatic pressure all the time until transfer in equipressure towards other HPBs

Transfer in pressure equilibrium



Delving into the deep – the X-PRESS project



High Pressure Sampler Unit (HPSU)

Filling valve (close)

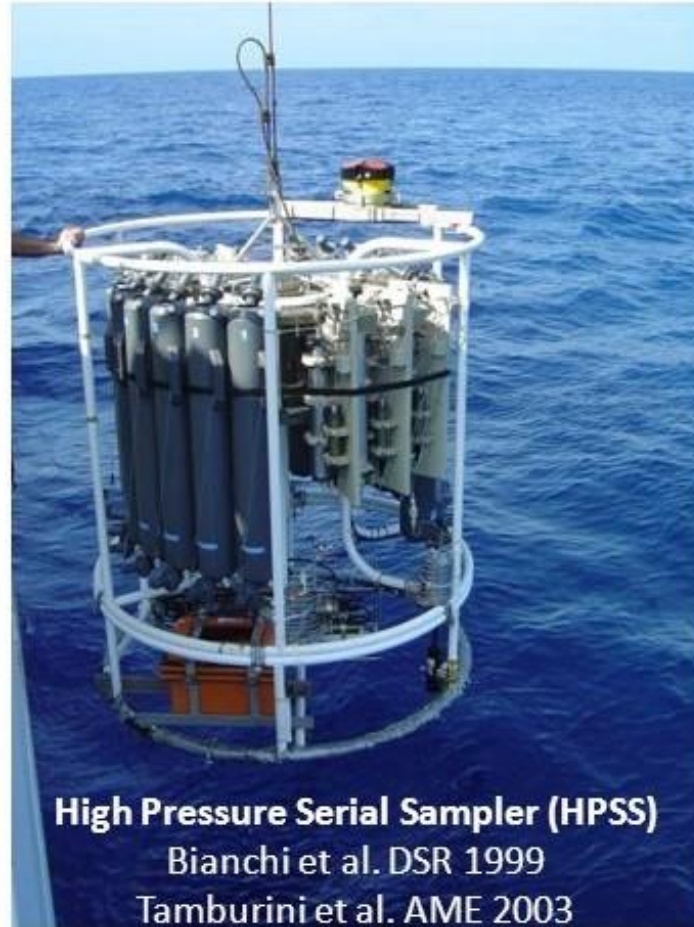
Check-valve

High-pressure bottl

Pressure sensor

Sea-Bird® carousel

Exhaust tank



High Pressure Serial Sampler (HPSS)

Bianchi et al. DSR 1999

Tamburini et al. AME 2003

→ Measurement of prokaryotic activity in deep waters at *in situ* conditions up to 6000 m depth

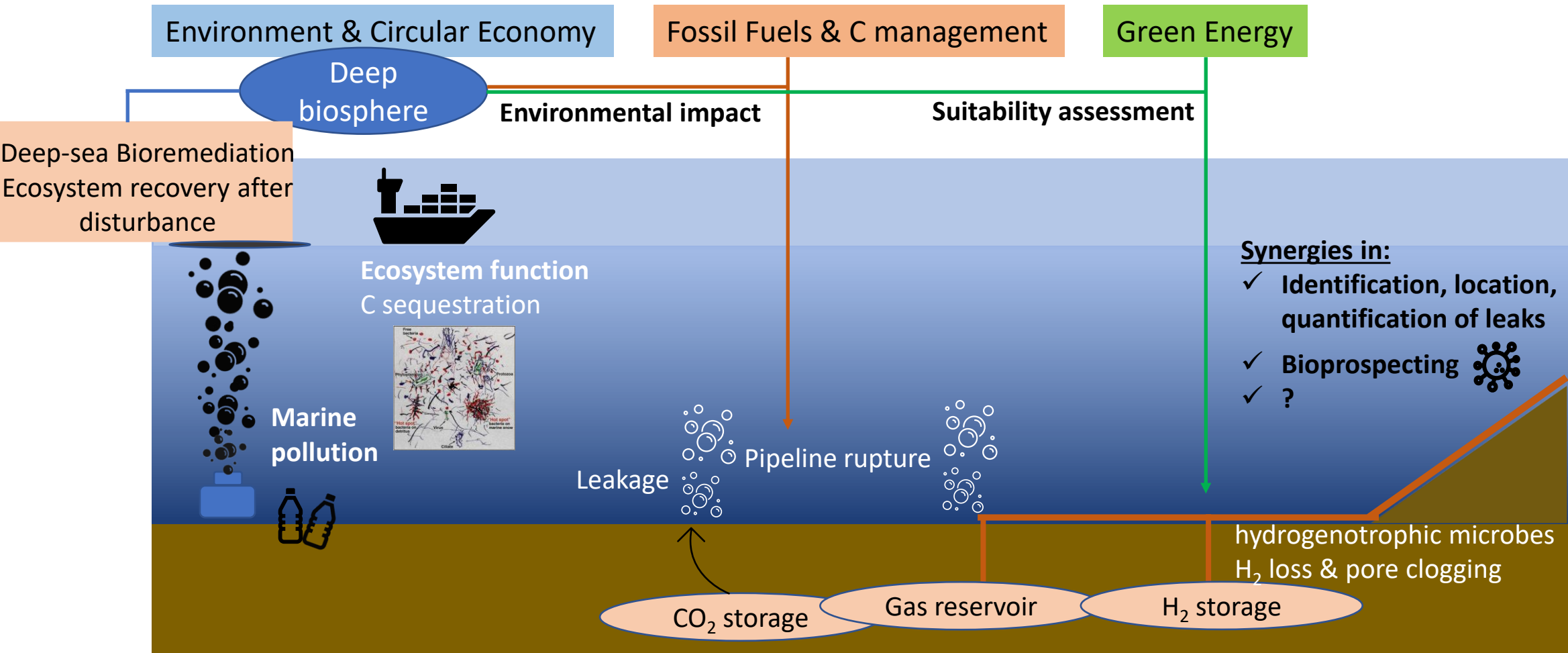
→ Enrichment and cultivation of piezophiles

→ Emulation experiments / Future scenarios

Deep biosphere – links within IG and inter-institutional synergies



Divisions



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THANK YOU FOR YOUR ATTENTION