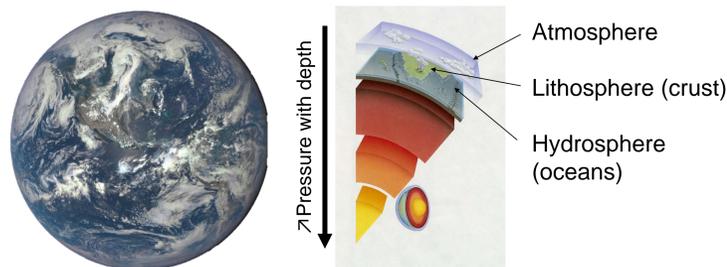


## Introduction

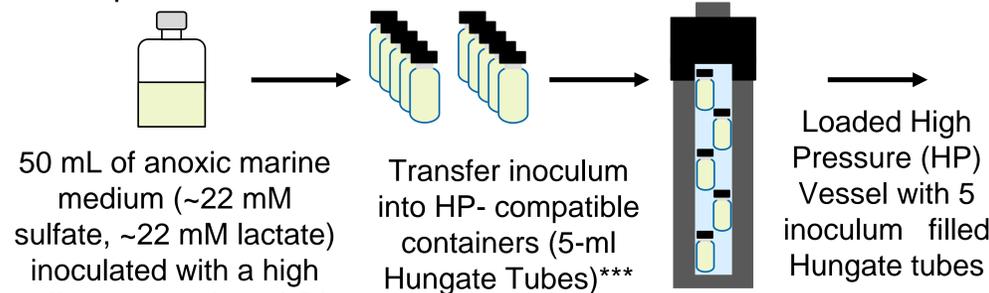
**Ocean World:** An ocean world is considered any planet or moon currently with a liquid ocean.



While the deepest part of the Ocean (Mariana Trench, 11,000 mbsl, 110 MPa) and the lithosphere host microbial life, it begs the question, **How?**

## Methods

### High-Pressure (HP) incubation Set-up: All Steps Under Anoxic Conditions



50 mL of anoxic marine medium (~22 mM sulfate, ~22 mM lactate) inoculated with a high cell concentration of *Dh* AM13; incubated from 1-2 weeks @ 35°C

\*\*\*5 tubes are put under pressure and 4-5 tubes are kept at atmospheric pressure in an incubator as control variables.



HP vessels pressurized with manual HP pump (0-80 MPa)

Microbial growth measured through optical density at 600 nm (OD<sub>600</sub>): indicates the growth stage of the bacteria

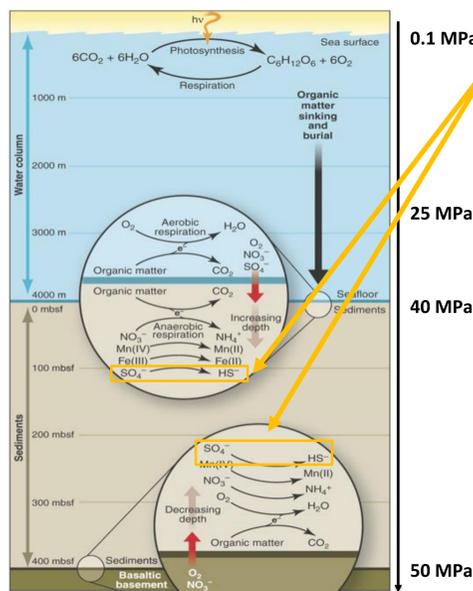
Microbial sulfate reduction monitored with sulfate concentrations in the medium: indicates the levels of the sulfate reduction cycle

Survival measured through the most probable number method (MPN): based on the principle of extinction dilution; estimates the number of viable bacteria in the cultures

## Research Question

### What Are The Pressure Limits For Microbial Activity In Aquatic Environments?

We are investigating the role of hydrostatic pressure on the S and C biogeochemical cycles in the Earth's marine environment.

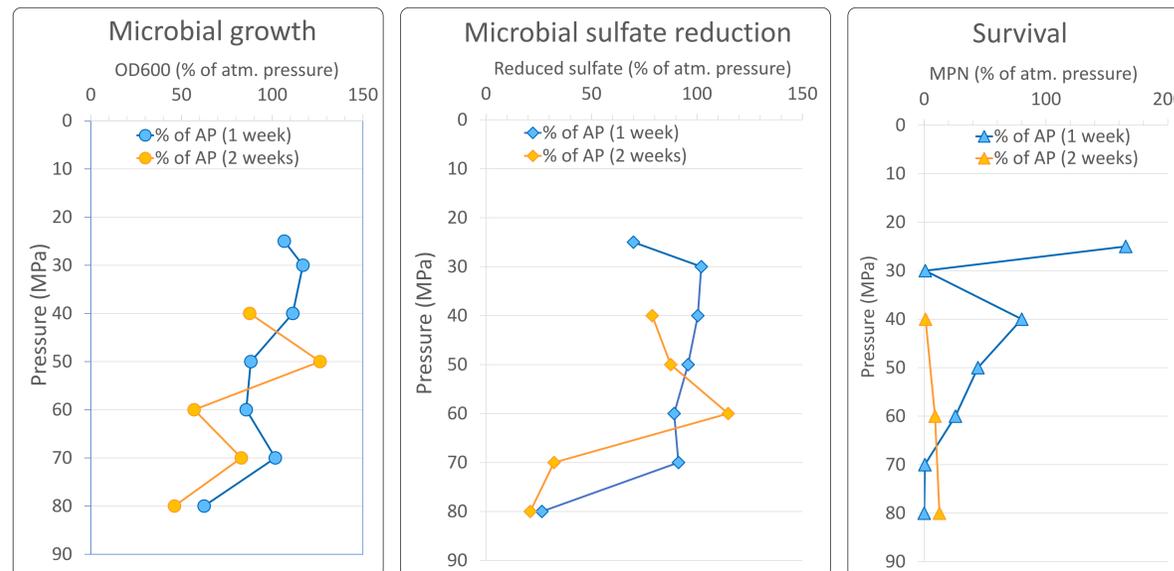


**Microbial Sulfate Reduction:** coupled to organic matter oxidation, as a model for microbial activity on Ocean Worlds

**Model sulfate-reducing bacterium:** *Desulfovibrio hydrothermalis* (*Dh*) AM13, isolated from the deep sea (Alazard *et al.* 2003)

Delong, 2004

## Results and conclusions



- At low cell density, *Dh* AM13 is active only up to 50 MPa (data not shown)
- At high cell density, *Dh* AM13 is active at least up to 80 MPa (this study)
- Resistance to pressure is higher under low energy availability
- Cell-to-cell communication (quorum sensing) promoted by high cell density might play a role in coping with pressure effects
- Pressure and/or high cell density seem to induce a change in microbial lifestyle, from planktonic to biofilm-like organization (ongoing work)

## Discussion/Future Research

### Is there any life on other ocean worlds?

Earth is the only known Ocean World with life, but there are ocean worlds in the outer solar system. These planetary bodies are believed to have larger/deep water depth. Can pressure-adapted microbes survive at these depths?

Example of Known Ocean Worlds (aka Icy Moons) and their estimate maximum pressures in oceans



## Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. IIA-1301726 (UROP scholarship to CB) and by the National Aeronautics and Space Administration under Grant No. 80NSSC19M0056 (NV NASA EPSCoR RI Seed Grant to AP)