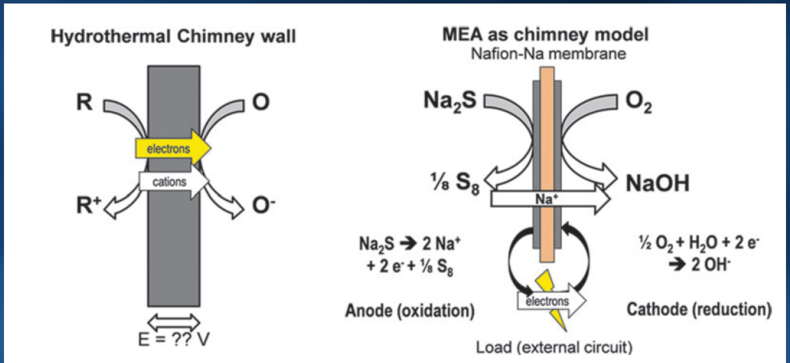
Geoelectrodes and Fuel Cells for Simulating Hydrothermal Vent Environments

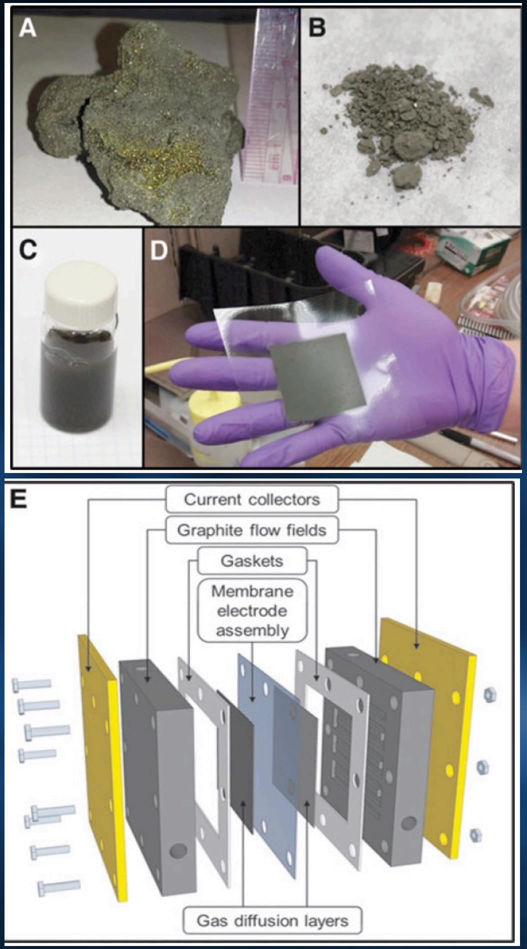
SEAFLOOR HYDROTHERMAL VENTS produce redox gradients, allowing Life's metabolism to thrive off of geochemical energy. Such vents are also likely to exist on other worlds such as Europa or Enceladus, and may provide habitable environments where life could emerge even in the absence of sunlight.

Vents are natural GEO-ELECTRO-CHEMICAL systems that behave in some ways like fuel cells. This research team used fuel cell experimental techniques to simulate the redox chemistry of a black smoker vent on Earth, in preparation for being able to simulate other types of vents and the energy they may produce for life.



Left: *Fuel cell conceptual model for a vent.*

Right: *Process for making a* ***geological sample*** *(hydrothermal minerals) into* ***electrode ink*** *that can be painted onto a fuel cell electrode assembly.(*This mineral sample was generously provided by JAMSTEC, collected at the KY14-01 Cruise.)*



These fuel cell techniques proved successful for simulating the energetics of a natural redox-active vent; including preparation of fuel cell membrane assemblies where the electrodes were painted with ink made from natural rock / mineral samples instead of traditional catalyst materials.

OBSERVATIONS AND CONCLUSIONS:

- Minerals and active surfaces can abiotically catalyze redox chemistry in vent systems, and affect the substrates that might be available to life.
- Using fuel cells as vent simulators—with informed choices of materials and operating procedures—can be an effective process for evaluating geological environments containing redox-active minerals, allowing for evaluation of energy present in a variety of astrobiologically relevant systems.

Barge LM, Krause FC, Jones J-P, Billings K, Sobron P. (2018) Geoelectrodes and Fuel Cells for Simulating Hydrothermal Vent Environments. *Astrobiology* 18, 9, DOI: 10.1089/ast.2017.1707