Extreme Life on Earth (And maybe in Space!)

Life can be found in almost every environment on Earth

Mountain Goats

Atacama Desert

Some Weather Stations in the Atacama have NEVER recorded rain.

Antarctica

•Lowest temperature ever recorded **-128.6º F** at Vostok Station
•Also a desert: only 6.5 inches of precipitation a year—most of which never even melts

Pelagic SeaBirds

•Live most of their lives at sea hunting small fish and squid
•Only come to land to breed
•Some types migrate across the Atlantic to Africa

How do we define “extreme?”

- We could not live in most of these places without technology
- Places where we can’t survive are actually perfect for the organisms that evolved to live there
- “Extreme” is a human-centric term

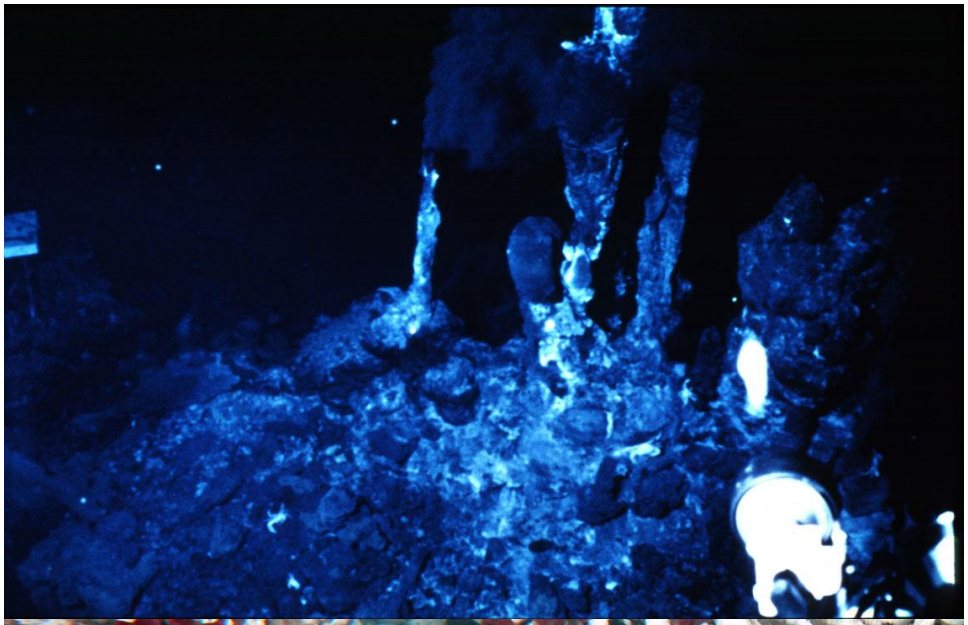
The MOST extreme life is microbial—called extremophiles

- Boiling and acidic hot springs
- Full of numerous types of Bacteria and Archaea called **Hyperthermophiles**
- ←Yellowstone National Park

Cryptoendoliths

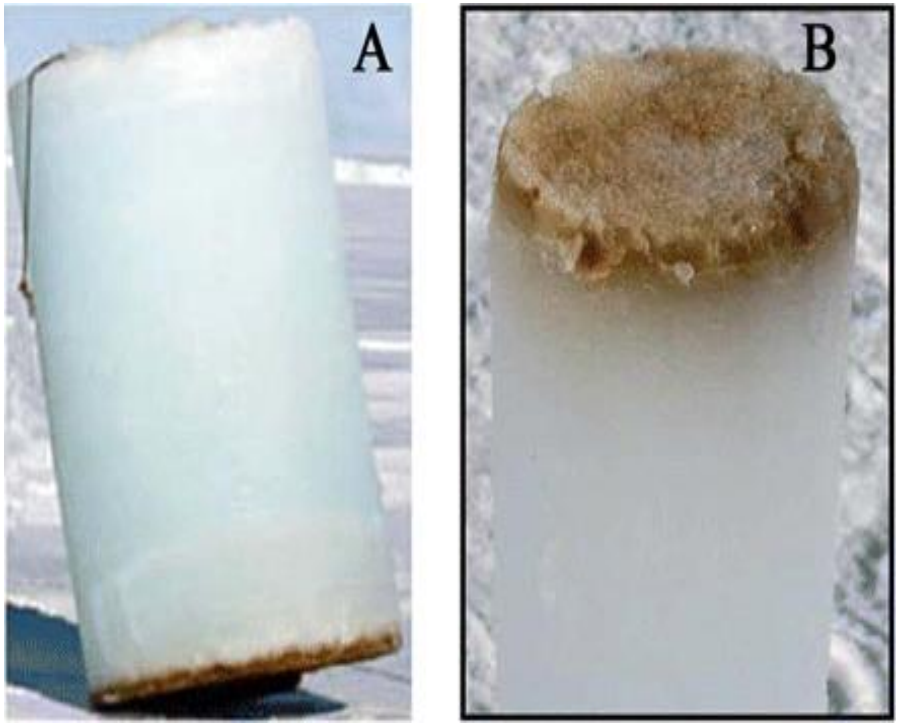
- Either allow rocks to precipitate above them or actively precipitate the rock for protection
- High UV exposure
- Dry Desert Conditions

Deep Sea hydrothermal vent creatures



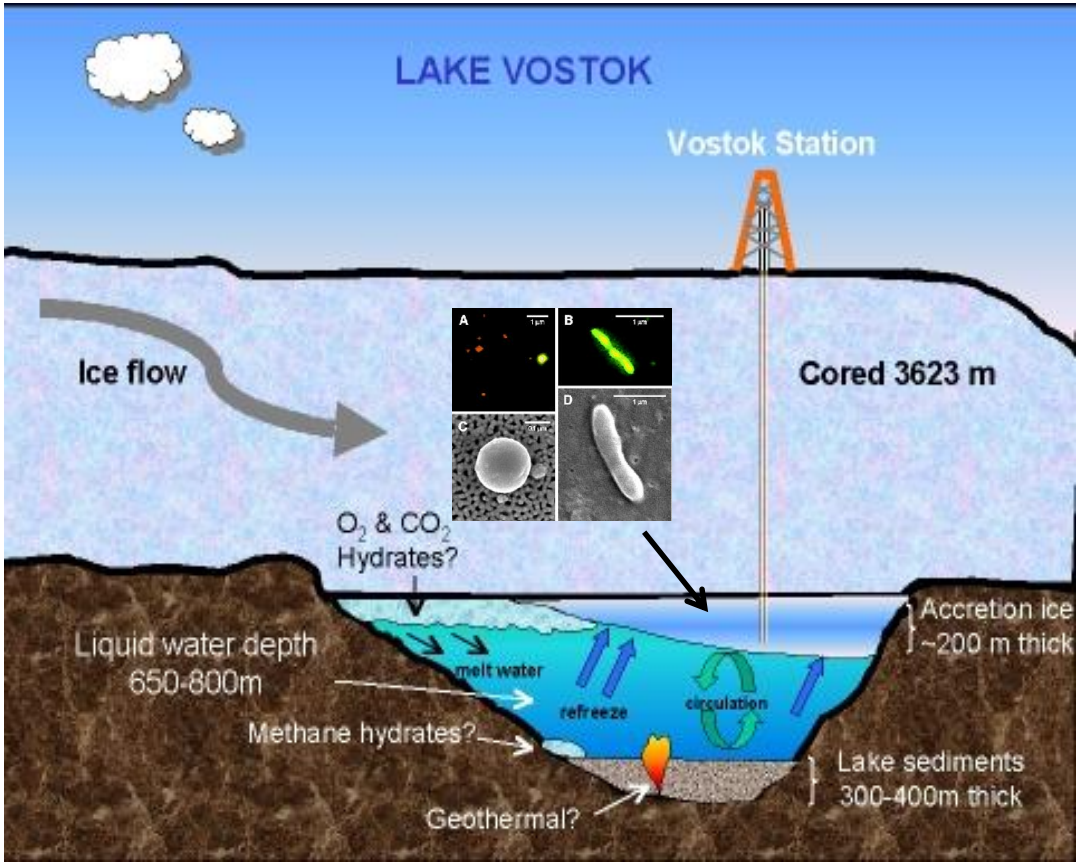
- Average Depths ~2 km, but the deepest Black Smokers are at 5 km
- No sunlight, high pressures (>210 atm)
- Freezing ocean water and superheated vent water
- ←Tube worms' guts are lined with bacteria that live on the hydrogen sulfide emitted from the vents

Bacteria living on the bottom of Sea Ice



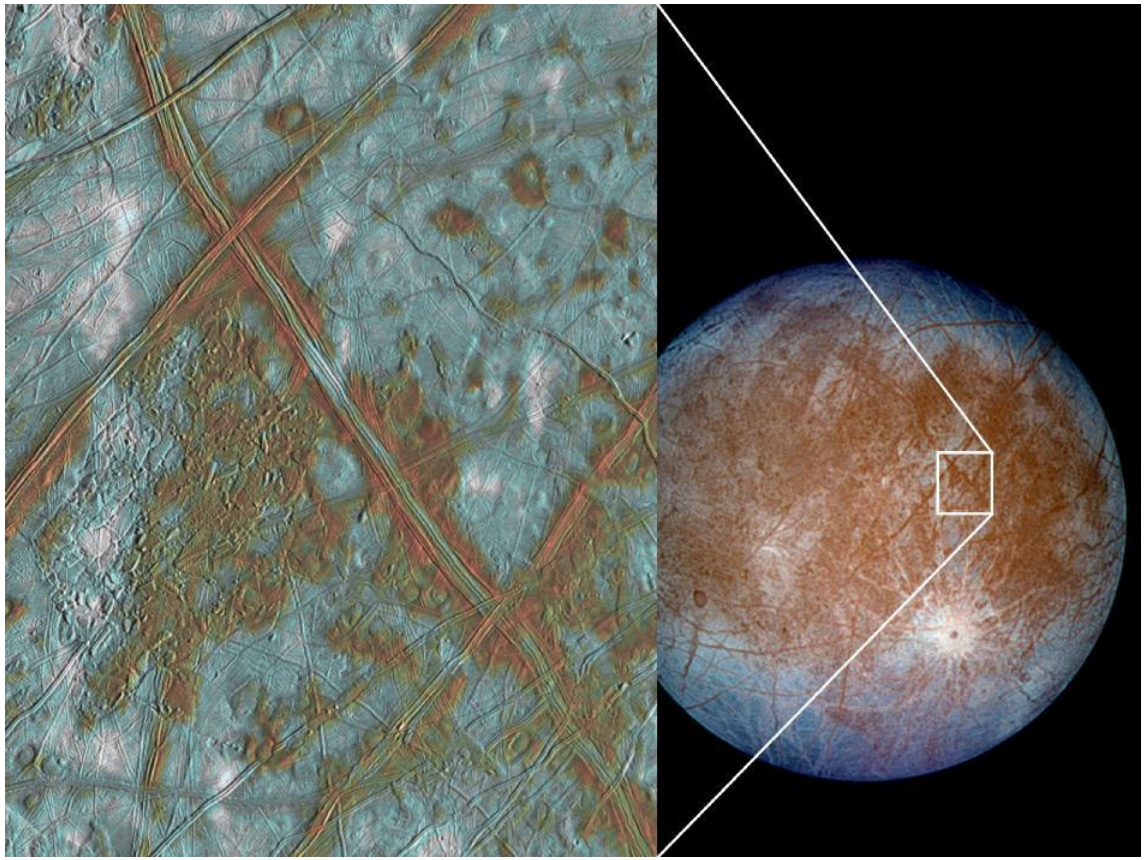
- Important to the ocean community—base of food chain
- Commonly consumed by krill

Lake Vostok—Antarctica



- Lake ~4 km below Antarctic Ice Sheet
- Bacteria found in the accreted ice (refrozen from lake) above the lake
- Scientists just broke through to the lake in February 2012

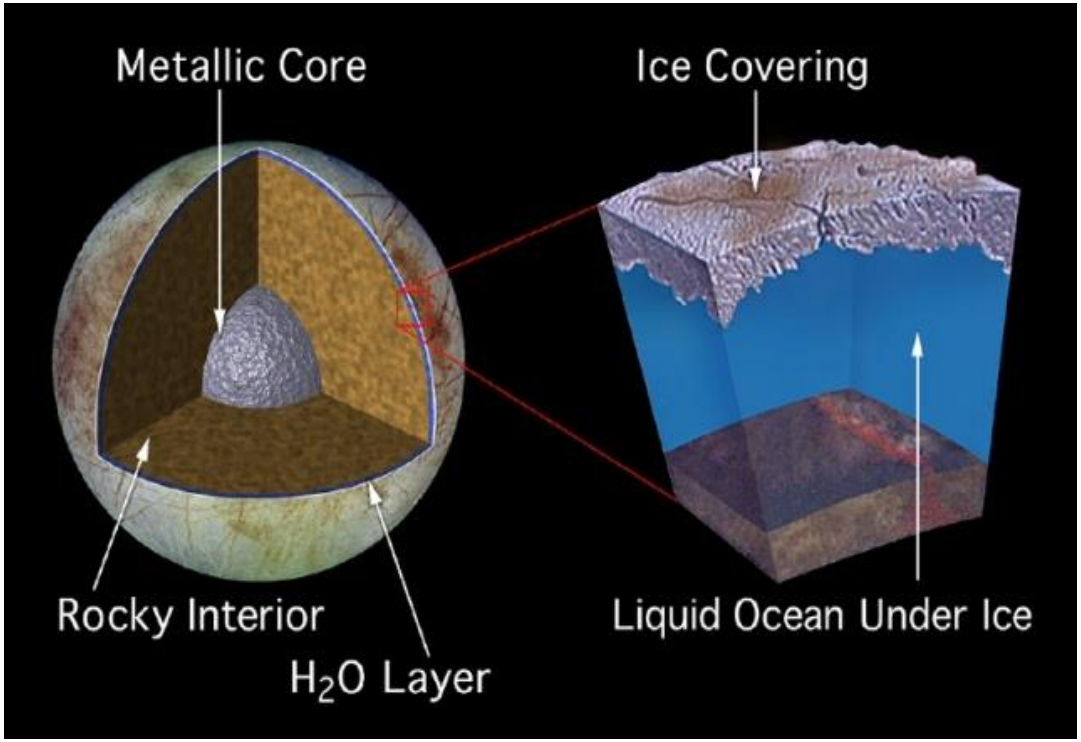
Europa



- Icy moon of Jupiter
- Thought to have plates and be geologically active like Earth
- With liquid water analogous to the magma on Earth

Possible Subsurface Ocean on Europa

- Europa has a magnetic field
  - This indicates liquid convection within
- There are also cryovolcanic features on its surface



•These environments resemble ones on Earth that are capable of supporting life

What are the Criteria for life?

Say we saw something like fire while looking for life on a different planet…how would we figure out if it were alive or simply a chemical reaction/combustion?

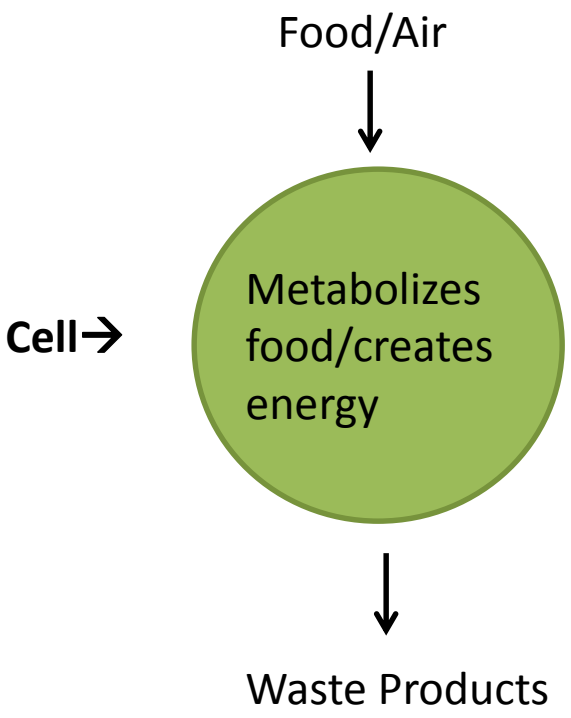
Criteria for Life

- **Homeostasis:** Regulation of the internal environment to maintain a constant state; for example, electrolyte concentration or sweating to reduce temperature.
- **Organization:** Being structurally composed of one or more cells, which are the basic units of life.
- **Metabolism:** Transformation of energy by converting chemicals and energy into cellular components (anabolism) and decomposing organic matter (catabolism). Living things require energy to maintain internal organization (homeostasis) and to produce the other phenomena associated with life.
- **Growth:** Maintenance of a higher rate of anabolism than catabolism. A growing organism increases in size in all of its parts, rather than simply accumulating matter.
- **Adaptation:** The ability to change over a period of time in response to the environment. This ability is fundamental to the process of evolution and is determined by the organism's heredity as well as the composition of metabolized substances, and external factors present.
- **Response to stimuli:** A response can take many forms, from the contraction of a unicellular organism to external chemicals, to complex reactions involving all the senses of multicellular organisms. A response is often expressed by motion, for example, the leaves of a plant turning toward the sun (phototropism) and by chemotaxis.
- **Reproduction:** The ability to produce new individual organisms, either asexually from a single parent organism, or sexually from two parent organisms.

Credit: Wikipedia

If we can't see things, how can we indentify them as alive?

- Metabolism—chemical process for maintaining life
- Look for waste or byproduct of cellular metabolisms
- Example: Humans breathe out CO_2, photosynthetic organisms give off O_2



Could aliens identify life on Earth from Space?

- From Space, we can see that Earth has liquid water
- The atmosphere contains ~ 20% Oxygen
  - Oxygen is a byproduct of life
  - Cyanobacteria and other CO_2 respiring organisms produce it

Activity—The Recipe for Life

- You will be given spores and a number of ingredients
- If you create the right environment/feed the spores the right thing, they will come to life.

Something to consider when creating your environments

- Remember your scientific method—you can only draw conclusions about something if you change ONE variable at a time
  - If you had a pet slug, how would you figure out which food it liked best?
  - If you wanted to see what type of food plants like, how would you figure that out?

Feel free to get in touch with me!

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