Mars for Earthlings

LESSON 19: Extremophiles

In-Class Activity 1

Tardigrades: Living Extremely

Purpose: Become acquainted with the Tardigrade ("water bear") extremophile, its living conditions, and importance of its scientific study.

Introducing the Tardigrade:

Watch the following You Tube Tardigrade video from the SciShow:
http://www.youtube.com/watch?v=6H0E77TdYnY&continue_action=r7OE3bLJMHT8fAwevwnX9Oh_0zzl6Ajt2P3129QN588gcYR6MkEN_obkOAtaq5MUvFV4Yiq09ljbJDp8wedzPE1U417RionrJuPdT2CAALc=

As you watch the video answer the following questions:

1. What is the *Tardigrade*?

2. What type of environments can the *Tardigrade* live in?

3. What is its importance to science?

Extremophiles

- Acidophile- high pH
- Alkaliphile- low pH
- Anaerobe- no need for oxygen
- Endolith- lives inside rocks
- Halophile- requires salt
- Piezophile/Barophile- requires high pressures
- Thermophile- lives in 40°C or higher
- Xerophile- limited water supply
- Psychrophile- lives in 15°C or lower

Consider the above list. What classification does the *Tardigrade* belong to and why?

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Where could the *Tardigrade* live on Mars?

1. Observe a global Map of Mars. Where could the *Tardigrade* potentially live on Mars? Explain your reasoning.

2. Is studying the *Tardigrade* and other organisms like it useful to space research? Why or why not?

3. What other Extremophiles classifications (see above) could be present on Mars?

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Homework 1
Extremophiles_MFE
Sea Monkey Experiment

Starting thinking: What is an extremophile?

Resources:
On brine shrimp (see materials needed on these sites)

- http://wildlife.utah.gov/gsl/
- http://www.youtube.com/watch?v=kUN61qJtp6s (tutorial on raising brine shrimp)

On extremophiles

- http://www.spiritus-temporis.com/extremophile/types-of-extremophiles.html
- http://www.daviddarling.info/encyclopedia/E/extremophile.html
- Example: Deinococcus radiodurans can withstand 1,500,000 "rads". 500 rads can kill humans!

Introduction:
Sea monkey eggs (like Great Salt Lake brine shrimp) reportedly can survive dormant for > 20,000 years without water. They breathe through their feet and are born with 1 eye but develop 2 more. They are ideal for testing life's response to extreme conditions since they can survive (or remain dormant) in a wide variety of conditions (pH of 2-10, high salinity, various radiation environs, range of temperatures, etc.).

Experiment - Project Assignment:

1. Design a scientific experiment to examine some kind of extreme conditions (without destruction) on the revival and/or survival of dormant life forms (your brine shrimp eggs). You might bake the eggs, drown them in your favorite soda, soak them in acidic lemon juice, or subject them to other extreme conditions or combinations!
2. Carry out a scientific experiment following the scientific method. Record all condition information of time, methods, amounts, solutions etc.
3. After this we will do a "blind test" and your sea monkey eggs will be given to someone else to raise (so you are not tempted to bias the experiment).
4. Meet with the group that attempted to hatch your eggs. Discuss the results in terms of your hypothesis.
5. In a clear and concise write up of your experiment, discuss the results in the broader terms of astrobiology.

In-Class Discussion
Discuss the design of your experiment and outcomes with the class following the submission of your assignment.

Limits of the Brine Shrimp
Were there any conditions too extreme for the brine shrimp?

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Homework 2
Extremophiles_MFE
The Color of Temperature

Objective: Identify why an environment is considered "extreme" and draw inferences about life based upon the attributes/characteristics of these environments.

Extremophiles in Hot Water
Watch the following YouTube video created by GNC Science and answer the following questions: http://www.youtube.com/watch?v=VU-A6Sx7k-U

1. Why is this environment extreme? List characteristics of the environment that would classify this environment as extreme.

2. Given the list of characteristics you provided in #1, name the types of extremophiles that could exist there [refer to the list of extremophiles provided by your instructor].

3. The colors of the hot spring have meaning. What do the colors represent? Which colors represent warmer water and, conversely, cooler water?

Yellowstone: An Earth case study
The photograph (Figure 1), taken in Yellowstone National Park, is a hot spring with outflow channels (hydrothermal environment, similar to above).

4. Determine how many colors you observe and assign a hypothetical temperature range to each color.

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5. Using your temperature ranges, outline the area of each temperature range (at least three but no more than six) to create a temperature map of the photograph provided (this will look similar to a contour map). You may use trace paper over the image to represent the changes you see in color.

Figure 1: A hot spring in Yellowstone National Park (Image Credit: nps.gov Source: http://earthobservatory.nasa.gov/Features/Zircon/zircon3.php)

Draw your map below (be sure to annotate your outlines):

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Holden Crater, Mars

Holden Crater, a potential landing site for MSL Curiosity, is thought to have hydrothermal deposits similar to the Earth environments above. Below in Figure 2 is an example of the terrain provided by HiRISE.

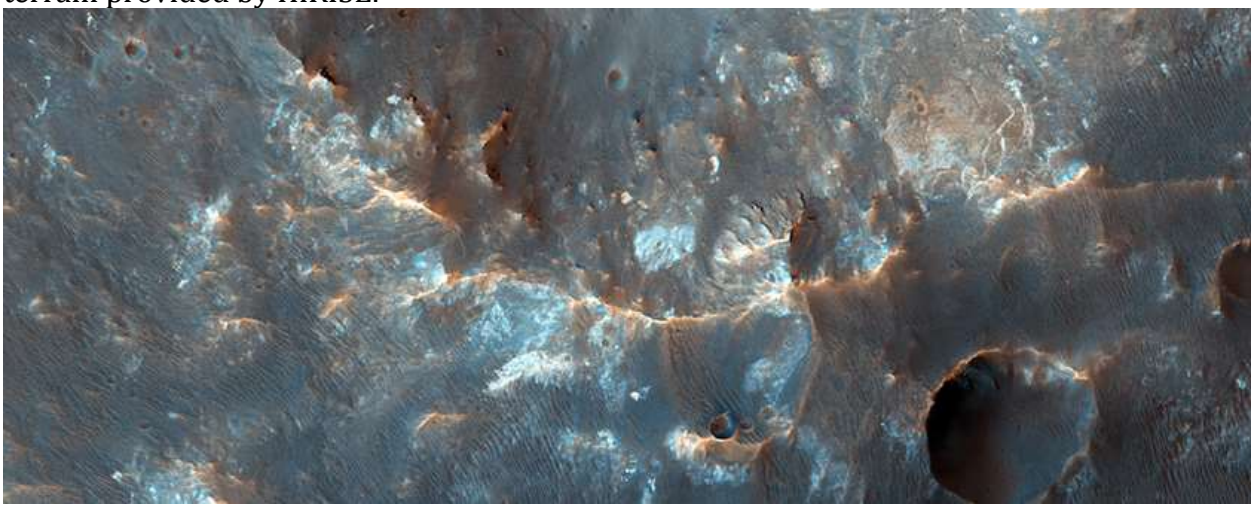

Figure 1: The Western Wall of Holden Crater, HiRISE Image ESP_021946_1535; (Image Credit: NASA/JPL/Univ of Arizona)

1. What do you think the colors represent in the HiRISE image?

2. Using JMARS, capture one CRISM image that would infer a hydrothermal environment and paste below. Hints: (1) Review navigation in JMARS if necessary and investigate the crater walls/rims. (2) Think about what mineral assemblages would suggest a hydrothermal environment.