

Lesson 19: Extremophiles

Summary

This learning module and related laboratory exercise exposes students to extremophiles, their habitats, and the potential to find habitable environments on Mars.

Learning Goals

Students will be able to:

- Understand the environment in which the *Tardigrade* can survive.
- Explore hydrothermal environments on Earth and Mars.

Context for Use

This learning module is meant for adaptation in an introductory earth science course and/or planetary science course.

Description and Teaching Materials

In-Class Activity

In-Class Activity 1: *Tardigrades:
Living extremely*

Homework

Homework 1: *Sea Monkey
Experiment*
Homework 2: *The Color of
Temperature*

Teaching Notes and Tips

1. Students must be familiar with Mars environments of deposition, surface processes and climate.
2. To be successful in Homework 2 students need to have exposure and instruction in making contour maps.

Assessment

Each *In-Class Activity* and *Homework* has its own measure of Assessment.

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References and Resources

1. Image File: [Extremophiles](#)
2. Gale Crater Habitability via Curiosity:
<http://www.youtube.com/watch?v=oHLbXTOaw7w&feature=relmfu>
3. Tardigrades video from SciShow on YouTube:
http://www.youtube.com/watch?v=6H0E77TdYnY&continue_action=r7OE3bLJMH
[T8fAwevwnX90h_0zzl6Ajt2P3129QN588gcYR6MkEN_obkOAtaq5MUvFV4Yiq09ljbjDp8wedzPE1U417RionrJuPdT2CAALc=](http://www.youtube.com/watch?v=T8fAwevwnX90h_0zzl6Ajt2P3129QN588gcYR6MkEN_obkOAtaq5MUvFV4Yiq09ljbjDp8wedzPE1U417RionrJuPdT2CAALc=)
4. Additional Tardigrade link:
<http://serc.carleton.edu/microbelife/topics/tardigrade/index.html>



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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].
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 the students observe and assign a hypothetical temperature range to each color.



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- Using their 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). They students may use trace paper over the image to represent the changes they 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>)

Have the students draw their map below (be sure to have them annotate their 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.

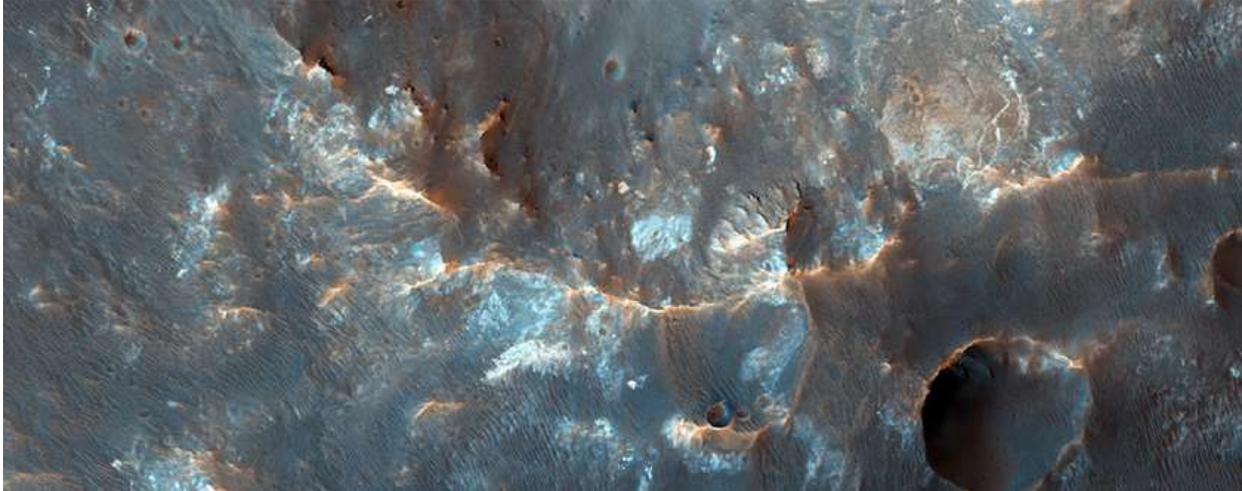


Figure 1: The Western Wall of Holden Crater, HiRISE Image ESP_021946_1535; (Image Credit: NASA/JPL/Univ of Arizona)

1. What do the students 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.