LESSON 8: Rock Evolution & Change

In-Class Activity 1

Cooking Rocks: Diagenesis

Objective: Observe and understand how iron oxide minerals are affected by diagenesis on Earth and apply this thinking to diagenesis and iron oxide minerals (e.g., hematite) on Mars.

Materials Needed: Rock sample (your own pet rock picturestone), oven access, digital camera. *Note: This assignment may take up to a few hours.

Experiment Steps:

1. Read through all steps and the instructions for your report.
2. Get your piece of "Kanab Picturestone" rock. Make note of its color, size, and any other identifying features. Your rock is an ancient (Triassic) porous sandstone that has liesegang bands (iron –oxide mineral bands), a record of past fluids that moved through the rock during its burial history.
3. Carefully document all steps and experiment conditions.
4. Take a "before" picture with a ruler for scale.
5. Decide on an experiment to test how goethite (FeOOH) can transform to hematite (Fe_2O_3). In general the change can occur at temperatures of about 400 degrees F (~ 204 degrees C) in a normal oven for about an hour or more. Experiment with some different conditions (e.g., you may want to vary the time, and/or temperature). If you have access to a chemistry hotplate, you could try the experiment on it as well.
6. Be sure to use some aluminum foil or something underneath your sample as you heat your sample so sand grains don't get all over your oven, and/or it can protect your container if you are using one. ***If using a microwave, do not use foil***!
7. Leave the rock in the oven to cool before attempting to remove it!
8. Take an "after" picture with a ruler for scale (same position, conditions as step 4).

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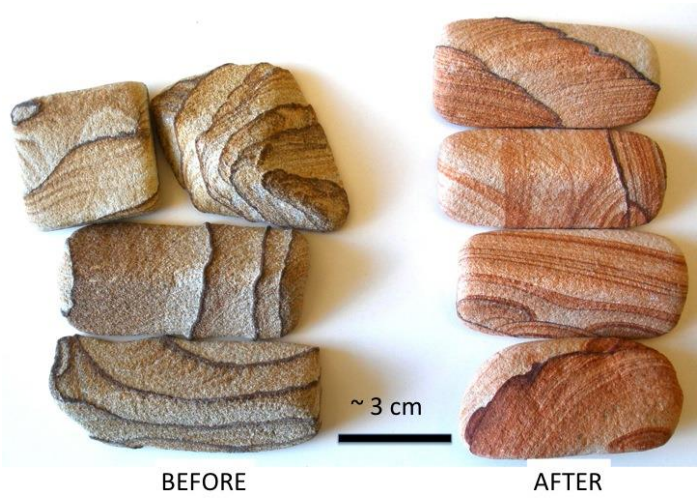
Safety:
Observe safety and caution at all steps (e.g., use safety goggles, and use insulated gloves/potholders). If your rock contains water, it is possible something could pop so it is advisable to have some aluminum foil around it loosely, and let it cool before trying to examine it. Be sure to keep track of your sample in the oven so you do not forget it and leave it unattended.

Sample from Triassic Chinle Formation (Shinarump Member), (samples available from www.westernhills.com), Kanab UT. Image: M. Chan, University of Utah.



Report your Experiment results

1. What was the purpose?

2. What was your Hypothesis?

3. State your Methods (conditions of the experiment). Make sure you document the actual conditions (temperature of oven, duration of time sample spent in oven, etc.) of your experiment and any other unusual circumstances.

4. **<u>Include a before and after picture of your sample in the same position and location with a consistent scale</u>** (show a ruler or similar measuring tool to indicate scale when taking photos). This can go on a separate page if you wish.
   Label your pictures and include appropriate explanatory photo captions.

Experiment Analysis & Follow-up:

1. What is the dominant change you observe (before vs. after experiment)?

2. Explain your reasoning for the dominant change you observe.

3. Explain the relevance of your experiment to understanding Earth processes and why this might help us understand similar mineralogies on Mars (e.g., hematite "blueberries" at Meridiani Planum, Mars).

4. What are the limitations of this experiment (scale, time) and why are Earth examples not perfect analogs to Mars (e.g., what are some of the differences between Earth and Mars sandstones or chemistry)?

5. If any failures or issues presented themselves, why did they occur? How could you mitigate them?

IN CLASS ACTIVITY (prep for Cooking Rocks)

What do you think?

1. What holds sand grains together in a sandstone?

2. How does the cementing mineral form?

3. Can some of these minerals change?

4. Do similar minerals occur on Mars?

5. What might happen when you "cook" a rock with minerals containing water?

A Mars correlation?

1. Are there diagenetic minerals on Mars? (more than one type?)

2. What is the origin of the hematite in the Thermal Emission Spectroscopy (TES) imagery?

Diagenesis

1. In your own words, define the term diagenesis:

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2. How do goethite and hematite differ?

3. Would adding water into/onto the "after" sample change the mineralogy? Why or why not?

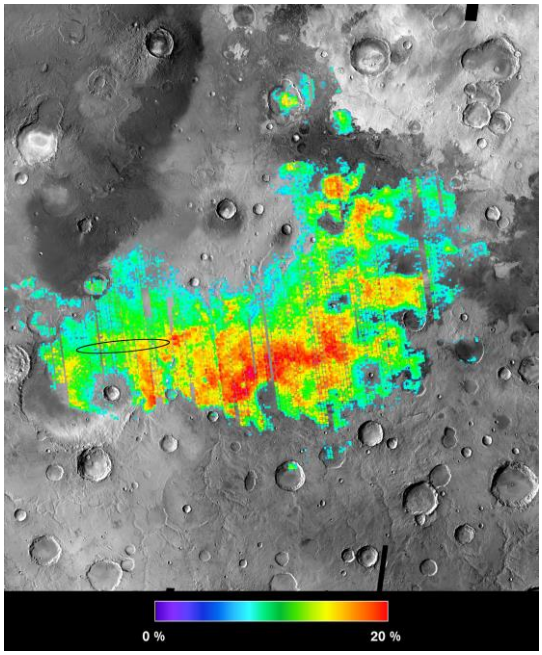

Figure 1: The distribution of hematite in Merdiani Planum; Image credit: NASA/JPL/Arizona State University