Mapping the Surface of Mars
Teacher Guide

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Mars Odyssey, Phoenix, and HiRISE Education and Public Outreach
Modeled after the "Exploring the Earth with Remote Sensing" activity developed by NOAO, Spring 2006

This activity is an open inquiry activity on remote mapping of the surface of another planet, namely Mars. The main goals are to get students using real data that is cutting edge and for them to get excited about new discoveries on Mars. Provided below are some topics you may want to help your students explore as they think about the questions in the activity. These questions are meant to help students think. The topics below are not answers but rather possible avenues of discussion. The student sheet is available as a word document so that you may include, cut out, and format in any way that suits your needs. There is no given format, so it is left for you to decide what will work best for your students.

You and your students will be provided with basic information about your HIRISE image in the form of a brief caption. The caption will provide information about how large the image is and where the Sun is coming from in the image. If you or your students would like more information on your specific HiRISE image, be sure to search for your image on the HiRISE website, http://hirise.lpl.arizona.edu/. Basic information about HiRISE can also be found here.

It is not necessary to do outside research to do this activity. This activity is about exploring images that scientists use to explore Mars and experience some of the excitement, wonderment, and frustrations that scientists experience. Speculation about what features are is perfectly acceptable and encouraged. You want to push students to think about how they could go about figuring out if their speculation is correct or not.

Questions for student thought and investigation from the activity
Full Global Image of Mars

What kinds of features can you make out in this full image of Mars?
Volcanoes, craters, canyons, dark regions, light regions, ice caps…..

Are they similar to structures you see on Earth? Which ones? Answers vary, Earth has all of those mentioned above – but students should not be limited to those answers.

What about features you cannot figure out? Again, this is about visual inspection, have students describe the features they cannot figure out, it may be that lots of features cannot be figured out.

Make a comment about what you can say about Mars as a whole planet. Have students think about the overall color, what could it be made out of? Is there a lot of liquid water present there? What about the large features?

Zoomed in Viking Image of Mars

What features can you make out in the zoomed in image that you could not make out in the composite image? What features can you make out on the global image of Mars that you cannot see in this higher resolution/zoomed in image? Answers will vary depending on which image you get. The main point is to guide students through a conversation about looking at a global image and looking at an up-close image. You can use Earth examples to compare this too, such as looking at the whole Earth and then just looking at one state. Perhaps rivers appear, or features are more defined. Students can use the surface feature ID chart to help them out with identifying features in these images.

What are things that you cannot make out in the zoomed image?
Have students investigate and describe what they see in each image and what some advantages or disadvantages might be to either image.

HiRISE Image(s) of Mars

What features can you make out in HiRISE image? What do they look like? How large are they? Again, answers will vary based on what image you get. If you have a computer and can zoom into the image, have students explore different parts of it. If you have paper copies, look at the blown up pieces for more information.

Make a list of interesting features you see and their actual sizes. Can you think of features on Earth that are about the same size? Are those features on Earth man made or natural? What about features on Mars? The key here is that they should be able to relate at least one feature to something on Earth, either man made or natural. Have them discuss this to get a relative idea of how large the features are and how large the HiRISE images are. Also, there are no man-made structures on Mars that students will be able to see (in fact the only man-made structures that are there are robots sent but they are not included in the images used in this activity).

Compare features you see in each of these images to what you see in the LANDSAT images of your city on Earth. What features look similar? What features look different?
Again, this is to get students to compare what they <u>see</u> on both planets to make some speculation about Mars.

Do you see any of the features that are the same on both planets? What other pieces of information would you need to know for sure? This gets at the idea that just looking at one image from one perspective does not give us absolute information. Have students think of other ways they could investigate these features to get more information about them (possible answers could be: additional images, closer up/farther away images, images in different kinds of light, going and touching them from the ground…..)

Characterize your piece of Mars using all the images you have of Mars. What information did each picture give you about your piece of Mars? What types of processes do you think shaped your part of Mars (wind, water, meteorites…)? What are some things that you could not figure out with these images that you would like to know? What would you need to get to answer those questions? What type of mission would you send to Mars to answer your questions? For this section you want to step

students through taking all their information and putting it together. Talk about the difference between a whole planet view and an up-close view. One gives a lot of context and the other gives a lot of detail. Both are important to understanding the planet (just like understanding other things in science including biological organisms, the ocean …). Again have them think about what types of information they will need to answer their questions. What kind of information will convince them? What type of mission would they need to send? (A rover, an orbiting space craft, a hot air balloon, an airplane – make sure they think about what information could be gotten from whichever they choose – that decision is not arbitrary but is determined by the information you hope to gather).

Now, it is time to decide the most important information to report about your area of Mars. Make sure to report information that will help other groups understand your region of Mars so that they can compare their own region to yours. It is acceptable to report features and your best guess as to what they are. Be sure to report your evidence and let your community of scientists discuss what you have found. Additionally, you may want to comment if you would like to send a robot to land on your part of Mars. What pieces of information do you need to think about when making this decision?
In deciding what to report, make sure student have a rationale for what they choose. What they present does not have to be complex. Being descriptive is important as are their speculation of what they are looking at and how they came to their conclusions. In thinking about sending a robot, you want to guide students through the discussion of going to investigate interesting things and the danger of landing someplace unsafe (lots of rocks, cliffs….)

Overall, students should have fun investigating. The focus is less on right answers and more about ways you want students to think about things. Using observation, previous knowledge, discussion among group members and additional research are all great avenues of discovery. Each of the locations chosen is of specific interest to Mars scientists currently investigating the geology and history of Mars.

Images provided include:

1. a global context sheet (E1_Global_Context.jpg)
   - shows the location of the HiRISE image on a regional and global scale
2. a full sheet global map (Mars_Global_Map_MDIM.jpg)
   - from USGS Astrogeology Map-a-Planet
3. a full sheet regional map (E1_Viking_Regional.jpg)
4. a full sheet HiRISE image (E1_HiRISE_PSP_001440_1255_RED.jpg)
5. a HiRISE context sheet (E1_HiRISE_Context.jpg)
   - shows the location of the HiRISE cut-outs provided to allow students to explore more details
6. high resolution cut-outs of parts of the HiRISE image
   - full resolution (very large files) (E1_HiRISE_zoomed1_full.jpg)
   - re-sized to print on 8.5x11 paper (E1_HiRISE_zoomed1.jpg)
7. a color HiRISE image (E1_HiRISE_PSP_001440_1255_COLOR.jpg)

You will need to download LANDSAT images from http://landsat.gsfc.nasa.gov/images/find.html if you wish to see how your town looks from space.