

Lab 4 - Thermophysics on Mars

Part 1a

CTX and THEMIS Images

Launch JMars on your computer by going to <http://jmars.asu.edu> and clicking on Cross-platform WebStart Installer under the Download JMARS menu on the right-hand side of the page

In the Lon, Lat box in the map window enter the following: 238.69E, -12.94

In the Layer Manager window, pull down Add New Layer → Stamps → CTX Stamps
In the Add CTX Stamps window add the following EXACTLY in the Image ID's box then hit the Okay button: P18_008117_1647_XN_15S121W

You should see the outline of the CTX image near the center of your JMars window. Right click on the image outline and render the image (Just like lab 1). Zoom in and out to observe the local and regional surface features.

Questions:

What is the geologic context of the region surrounding the CTX image?

What features are observable in the local area within the CTX image? Does this make sense when compared to the regional context?

In the Layer Manager window, pull down Add New Layer → Stamps → THEMIS Stamps
In the Add THEMIS Stamps window add the following EXACTLY in the Image ID's box then hit the Okay button: I06939013

You should see the outline of the THEMIS image near the area covered by the CTX image. Right click on the THEMIS image outline and render the BTR (not BWS) image. When you hover the mouse over the image, the dialog box should show you the temperature.

Questions:

At what local time was the THEMIS image acquired (use the Web Browse option)?

What are typical temperatures near the north end of the CTX image?

What are the temperatures near the south end of the CTX Image?

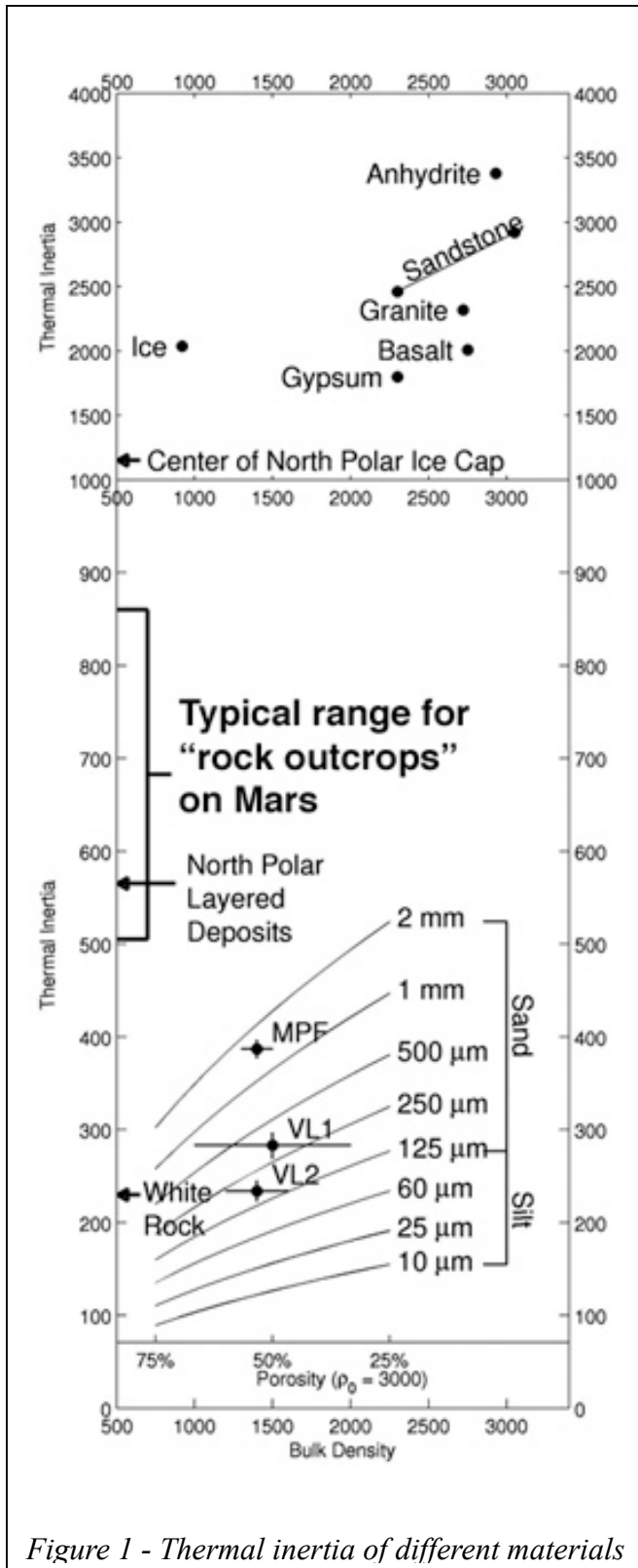


Figure 1 - Thermal inertia of different materials

Render THEMIS image I01453001 (again BTR, not BWS).

At what local time was this image acquired?

What are the typical temperatures near the area covered by the CTX image?

Describe the differences in the two THEMIS images and what might be causing the differences.

Running the Mars Thermal Model

The Mars Thermal Model calculates surface and subsurface temperatures as a function of time for any location on Mars, using the input parameters you enter in the GUI. This model can be used in conjunction with the observed THEMIS surface temperatures to estimate the thermal inertia of any location in the THEMIS image.

Thermal inertia (I_{th}) is a thermophysical property that controls the amplitude of surface temperature variations on daily and seasonal timescales. It is defined as $I_{th} = \sqrt{k \cdot \rho \cdot c}$, where k is the thermal conductivity, ρ is the bulk density, and c is the heat capacity. Materials with high thermal inertia heat up slowly during the day and cool off slowly during the night. Thermal inertia is of particular interest because: (1) it is a quantitative measure of the physical character of surface materials; (2) it is a *bulk* property, so it includes

thermal conductivity k which can vary by a factor of 1000 due to variations in particle size, air pressure (in the pore spaces), and the nature and degree of intergranular bonding or cementation. The thickness of the layer that contributes to the derived value of I_{th} is approximately equal to the skin-depth of the diurnal thermal wave, which ranges from 1-cm in fine Martian dust to nearly 20 cm in rock or ice.

- Go to the class website (<http://earthweb.ess.washington.edu/ess-306>)
- Click on the “Labs” link, then click on the “lab4” folder
- Right-click on each of the two files in that folder, select “Save link as...”, and save them to the D--Temp folder on your PC
- Close the web browser, and double click on the Matlab icon on your PC Desktop to start Matlab
- In the Matlab Command Window, type “cd D:\D--Temp”
- In the Matlab Command Window, type “mtm_gui_v10pc” and hit return
- You should now see displayed a GUI (Graphical User Interface) for a Mars Thermal Model

To estimate the thermal inertia of a given pixel in a THEMIS BRT image:

- Enter the image latitude and L_s in the GUI input parameters
- (The remaining input parameters – Dust tau_vis, Slope, Azimuth, and Surface Albedo – can be left with their default values)
- Under “Run Options”, select “VARY Thermal Inertia”, and enter the Local Solar Time of the THEMIS image
- Click the button labeled “Run Thermal Model”
- Wait for the model run to complete (usually about 30 seconds)
- The display will show a plot of model-calculated surface temperature at the time and location of the image for a range of different values of the surface thermal inertia. (The values are also printed out in the Matlab Command Window).

Questions:

Using these model values what is the approximate thermal inertia of the northern and southern regions of the CTX image?

Based on Figure 1, what do these thermal inertia values indicate about what the surfaces in the regions are made of?

HiRISE Images

In the Layer Manager window, pull down Add New Layer → Stamps → HiRISE Stamps
In the Add HiRISE Stamps window add the following EXACTLY in the Image ID's box
then hit the Okay button: PSP_008117_1670_RED

You should see the outline of the HiRISE image near the areas covered by the CTX and THEMIS images. Right click on the image outline and select View HiRISE Stamps → Stamp PSP_008117_1670_RED → Launch IAS Viewer for PSP_008117_1670_RED.
This will launch another Java based program that let's you zoom in and out.

Using the IAS Viewer, zoom in to view the image at various locations at full resolution (25 cm/pixel).

Questions:

Does the highest resolution surfaces look like what you expected based on the regional context and the CTX image? Describe the surface at the highest resolution and how it may have formed.

Is the high resolution surface consistent with the thermophysical information derived from the nighttime THEMIS data?

What geologic scenario is consistent with the low and high resolution imaging as well as the thermal inertia data?

Part 1b

In the JMars Lon,Lat window, enter: 302.25E, -11.344

Render the following images using the same procedures described at the beginning of Part 2 of this Lab:

THEMIS: I14163002, CTX: P13_006137_1655_XN_14S058W

Questions:

What is the geologic context of the region surrounding the CTX image?

What features are observable in the local area within the CTX image? Does this make sense when compared to the regional context?

At what local time was the THEMIS image aquired?

What are the typical temperatures of the following features seen in the CTX image:
Dunes:

Canyon walls?

Estimate the thermal inertia of these regions using the Mars Thermal Model GUI

Do your derived thermal inertia values make sense for each feature? Why or why not?