PTYS 442/542 – Mars Homework #1

Evaluation criteria or answers in red

1) HiReport is an online tool that will allow you to view HiRISE images of the martian surface. For this question, you'll open up HiReport and provide some comments about 2 previous suggestions for which HiRISE images have been acquired. First go to:

http://hireport.lpl.arizona.edu/hireport/hi

username: MarsClass password: MarsClass2015

Scoll down the page a little to where you see '**Bookmarklets'** and click on '**Last 10 Days'**. This will open up a table of observations recently acquired on Mars.

Pick 2 images from the list and click on their **'OBSERVATION ID'** to bring up a page on that image (choose something where the STATUS says COMPLETE). You should click through several images until you find one that looks interesting. On the right of the image page is thumbnail version of the image, in the drop down box above the image change the image selection to RED. You can click on the thumbnail to bring up a browse image (still not full resolution).

Based on your examination of the image as well as the title and science rationale on the image page write a short paragraph about what you see for each of the images you chose. What would you interpret to have happened in this location on Mars? Does it agree with what was expected in the science rationale? The context map on the left of the image page shows the HiRISE image location and can also help interpret what you're seeing.

This is hard to do at first so don't worry too much about getting the interpretations of what's in the image correct, but do worry about accurately describing what you see. We'll repeat this exercise as the course moves forward.

You need only look at monochrome browse images for this homework (I'll show you in class how to go beyond this though). In future homework, we'll expand this to color products, full resolution data and 3D anaglyphs.

Grades for this part are based on:

A: good description of image and answered all questions above

B: fair description of image and some questions answered

C: completed and turned in something

2) Here we'll think about insolation conditions on the martian surface. It will help to sketch cross-sections of Mars to figure out the geometry and consult the lecture slides for the description of where the sub-solar latitude is at different seasons.

Let's say it's summer solstice (L_s 90) at the north pole of Mars.

- How many degrees above the horizon is the Sun? 25 degrees
- What range of seasons (in degrees of L_s) is it daylight for? 0 to 180
- How steep would a slope have to be here for the Sun to be shining directly on it 65 degrees, facing south

(i.e. if you were lying on that slope the Sun would appear to be directly overhead)

At the Equator:

- What L_s is it when the sun is directly overhead (there are two answers)? 0/360 and 180
- If a 25° slope there points South, then what season does the sunlight most directly shine on it? 270, southern summer solstice

There are streaks that grow incrementally on slopes in Eastern Coprates Chasma in Valles Marineris at a latitude of 15° South that we call Recurring Slope Linae (RSL). In this location, they begin on north-facing slopes of approximately 40°.

- In what season do these slopes have the most direct insolation? Ls 90, at end of northern spring and beginning of northern summer
- The RSL are actively elongating during L_s 50-196, does this agree with your calculation? should be "yes" if you got ~Ls 90

It's currently near L_s 360 (or 0) on Mars.

- What is the subsolar latitude on Mars? 0 degrees (the equator)
  What does this mean for picking your HiRISE targets? What parts of the planet are off limits (in darkness)? We'll actually acquire images near L_s 190-210 deg.—what does that mean for picking targets? nearly entire planet illuminated, but very oblique at the poles so best avoided for HiRISE targets. North pole in darkness during Ls 190-210. Illumination angles near 45 degree at equator (at ~3 PM), so very few hard shadows (only east-facing slopes steeper than 45 deg. in shadow). If looking for subtle topography with small slope angles, the mid-latitudes are better in this season with illumination angles near 70.

3) Find the thermal conductivity of typical martian dust. ~0.001 $Wm^{-1}K^{-1}$ *for fine dust*
Look up the thermal conductivity of Styrofoam online and compare it to this. less than 0.05 $Wm^{-1}K^{-1}$

If a dusty surface gets hot during the day then would it also be warm below the surface? The temperature rapidly decreases with depth

Temperature changes generally penetrate into the surface to a depth called the thermal skin depth. This depth depends on both the timescale of the temperature changes and the thermal inertia of the material.

- What are typical thermal skin depths of dust and rock (basalt) for daily temperature variations? Remember a day on Mars, one sol, is about 24.5 hours. Thermal inertia (I) is sqrt(k*rho*c) and skin depth is I/(rho*c) x sqrt (P/pi), where k is the thermal conductivity, rho is the density, c is the heat capacity, and P is the period of the temperature oscillation (24.5 hrs). Need to convert hours to seconds for consistent SI units, so P = 88200 s (just -2% for getting this wrong). Pick reasonable values for k, rho, and c to get ~0.006 m for dust and ~0.18 m for basalt.
    - I dust = sqrt(0.001x 1000 x 800) = 28.3
    - Skin depth dust =28.3(1000 x 800) x sqrt(88200/3.14) = 0.0059 m
    - I basalt = sqrt(2.5 x 2600 x 800) = 2280
    - Skin depth basalt = 2280/(2600 x 800) x sqrt(88200/3.14) = 0.18 m
- What are these depths for the temperature variations over the entire year (668 sols)? Same calculation but for P = 668 x 24.5 = 16366 hrs = 5.9 x 10^7 s. Answers near 0.15 m for dust and near 4.7 m for rock. Answer should be larger than diurnal skin depth by the sqrt of time scale ratio, sqrt(5.9 x 10^7/88200) = 26 times deeper.
- Based on this, if you had to bury astronaut accommodations on Mars to keep temperatures stable over years, then would you prefer to use dust or rock? Best to use dust rather than rocks so that they would not have to be buried as deep to stay at a stable temperature. 5 m thickness of rock is a lot of mass to move around.