Name:
Group Members:

Lab 3

There are 3 main sections to this lab, corresponding with the Earth, Mars, and the Moon. You'll need access to a computer for everything, so we'll be putting the lab rooms to use again or you can use your own laptops.

I. **The Earth:**

(A) Navigate your way to http://www.willamette.edu/~jjrembold/classes/wu110/lab3/ for the following images. Look at the images in Figures 1 and 2 to answer the following questions:

1. Did the mountains in both images form the same way? For each image, what was the principle geologic process that raised the shown mountain(s), and how can you tell?

2. What is primary responsible for eroding the mountains in Figure 2? (Hint: The white patches are not *not* clouds.)

3. Given the island nature of Figure 1, what agent would you suppose is primarily responsible for that mountain's erosion?

(B) Now check out the rippling sand structures in Figure 3. What force of nature (or agent) is likely most responsible for these structures?

(C) Finally, examine the lake shown in Figure 4. What agent is most likely the cause of the peculiarly shaped lake?

II. **The Martian Surface:**

The following questions will utilize several different online mapping and image sources, so you will need access to a computer. I'll be providing links in the pdf, so you may also want to pull up an electric version of the pdf if you don't want to type in links by hand.

(A) Navigate your way over to https://marstrek.jpl.nasa.gov/. You can think of this essentially as Google Earth but for Mars. In the bottom left of the screen, you can see your planetary coordinates, in °N,°E order.

1. Find your way to the region near 50 °S, 114 °E. What agent is largely responsible for the mountains and structures in this region?

2. Navigate your way a bit to the west, to the Hellas Planitia (Plains). To see features named on the map, click the Layers icon in the lower right, select Static, and then click the eyeball next to Nomenclature. If you are still unsure if you are looking at the correct feature you can always search for the name using the magnifying glass in the upper left. This region exhibits many fewer craters than most the locations in this region. Why? (Hint: You may get some useful information by clicking the feature name, selecting More, and then clicking the Additional Info link. Does that height map of the region help?)

3. Navigate your way to Ceraunius Tholus (24 °N, 97 °W). What agent is responsible for the formation of Ceraunius Tholus? How can you tell?

4. To the west of Ceraunius Tholus are the Tractus Fossae. What would you say is likely the cause of these structures? Have you seen many such structures on Earth? (Hint: Pay particular attention to the straightness of the ravines)

5. Travel even further west, past Olympus Mons, to the Amazonis Planitia. What is likely the reason for this smooth, mostly craterless region?

(B) Jumping to a different mapping software now, proceed to http://www.uahirise.org/hiwish/browse. This map should look familiar, but if you zoom in several steps you'll see hundreds of pins appear across the map. The red pins indicate sets of extremely high-resolution data that you can look at! (You can get rid of the other pins by just unchecking the Suggestions boxes on the bottom.)

1. The "Find" function below the map seems broken, so in the Search bar near the top search for "ESP_035199_2035". Only one search result should appear, for the Flood-Eroded Surface in Kasei Valles, which you should click to answer the following questions.
   a) How high was the Sun above the Martian horizon when the image was taken?

a) _____

b) Click the link for the B&W jpeg, map projected, image. Aproximately how wide is the main valley at its narrowest point? Measure from the tops of the canyon walls, not the bottom.

b) _____

c) Do you see signs of erosion here? What agent or agents are the cause? Think back to what agents cause different appearing structures on Earth if you need.

2. Return to the main map screen, and browse around to find two structures you think look interesting. Open them up and examine their black and white map projected jpegs to fill out the table below:

Image ID	Time Image Taken	Summary of interesting features

III. **The Lunar Surface:**

We will now shift our focus to the Moon. Similar to the MRO orbiter images that we were just looking at, there is also a LRO orbiter that we'll use for the Moon. Navigate your way to http://wms.lroc.asu.edu/lroc.

(A) Your homework already has focused on how various geological features stack on top of one another. We'll use this time to point out some particular features of craters, because the Moon is chock full of them! In the Map Options box, enter in a Latitude of $-11.53°$ and a Longitude of $26.27°$ and Recenter and Reproject. You may want to zoom in some afterwards. Does this crater have anything odd about it? What seems different?

This feature is actually fairly common in some craters, and is caused in the same way that a drop of water falling into a cup causes an upsurgence after the initial wave. Craters with this feature are commonly called "Complex Craters", vs the "Simple Craters" that are just a dent in the ground.

(B) Navigate to 8.08° latitude and −37.9° longitude. This crater has distinct "rays" radiating out from it. (Zoom out some if you can't see them.) These rays are caused by ejecta from the impact site being blown outwards when the asteroid impacted. Sometimes "chain craters" are visible radiating away from a larger crater, where large rocks fell to make their own craters. (See 8.51°,5.55° for a lovely example of a crater chain.) On the Layers box, select the Miscellaneous Category and then check Lunar Nomenclature. What is the name of *a different* crater on the Moon that shows signs of rays?

(B) _____

(C) Explore several of the other options on the Miscellaneous tab. Explore them to decide in what direction the LRO is mapping the near side of the moon at the moment:

A. North to South
B. South to North
C. East to West
D. West to East

(D) Sometimes the reflections from the lunar surface that an orbiting spacecraft sees do not closely approximate what we see from Earth. Under the Layers window, select "Base Layer" and then choose the "LROC WAC Normalized Reflectance" option. The shown image may look more similar to what you recall seeing from Earth now. In particular, this highlights one very bright crater to the south with very visible rays extending over a large distance. You may need to zoom out away again to see them. What is the name of this crater?

(D) _____

IV. **Extra Credit!**

It is indeed possible to observe the locations, landing module, and even the footpaths of the actual lunar landings from the LRO imagery. But you will need to bring up special high-resolution images like you did for Mars, and even then you'll need to look hard. It is pretty rewarding though if you are up for the challenge. But I won't think less of you if you are not! (**cough** ...weakling... **cough**)

(A) A table of the lunar landings and their approximate latitude and longitude are below, choose one!

(B) Center your map on that location

Mission	Lat °N	Long °E
Apollo 11	0.67409	23.47298
Apollo 12	-3.01381	-23.41930
Apollo 14	-3.64544	-17.47139
Apollo 15	26.13224	3.63400
Apollo 16	-8.97341	15.49859
Apollo 17	20.18809	30.77475

Table 1: Table of Apollo Landing Coordinates

(C) Under the Layers, you'll need to select "Instrument Observational Footprints", then "LROC NAC", and then the "ESM" option for the latest and greatest imagery. This will bring up an utter mess of red rectangles everywhere.

(D) Under the map options, change your "Single Click Action" to "Get Footprint Info"

(E) Making sure that you are hovering your mouse over the needed coordinates, click to bring up another window with all the available footprints of that region. There will be a LOT probably.

(F) Choose one footprint that feels lucky to you. A new tab should open with this particular image. Zoom in and check things out.

(G) It will help you a lot to know at least approximately what coordinate correspond to what parts of the picture. In the Image details on the left side, scroll down some and find what the center latitude and longitude of your image is. This should give you an idea of whether you should be looking up, down, left or right of the center of your image.

(H) Zoom WAY in (all the way or nearly all the way) to start your search. The easiest thing to spot about the landings will be darker trails wandering around caused by the astronauts driving/walking. A brighter point of the lunar landing module may also be visible. If you think you've found them, come grab me. You will not get your extra points unless I see that you've found it!

(I) If successful, grab a screen shot or something to send to your friends and family to show them how awesome you are (if they weren't already aware)!