



Comparative Planetary Geology & Geomorphology: An Advanced Geomorphology Lab Exercise



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Introduction: Course & Student Background

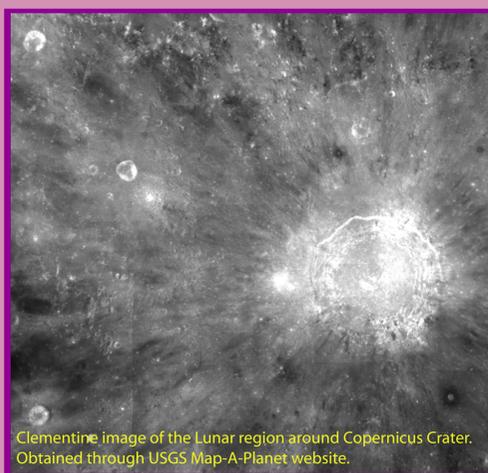
Winona State University is primarily a four-year public university with roughly 8000 undergraduate students located in southeastern Minnesota along the Mississippi River. The Geoscience Department has four full-time faculty with approximately 75 undergraduate students enrolled in one of the four Geoscience major tracks or Geoscience minor track.

The Geoscience program is very field-oriented and the undergraduate students have many opportunities to go out into the field and interact with geology in a very hands-on basis. As a new faculty member in 2005 with expertise in planetary science and geophysics, I was excited to develop a new laboratory exercise for the Advanced Geomorphology course that dealt with comparative planetary geomorphology and geology. The stated student learning objectives of the Geoscience Department include a graduate's ability to "interpret the geologic history of an unknown area" and "apply knowledge (skills) of geologic processes to other new or unknown situations (i.e., geologic processes on other planets)." What better field area to drop a student into during an upper-level geomorphology course than another planet?

In this poster, I will discuss the three main themes that I incorporated into this exercise: (1) Impact Crater Morphology, (2) Comparative Planetary Geology, and (3) Geologic Mapping on Other Planets. I will also reflect on the issues that I encountered when my field-based students were first asked to interpret the geology of planets other than the Earth.

Impact Crater Morphology

As an impact cratering scientist, I was eager to have my students compare impact craters observed on Earth and the Moon. Students used topographic maps of the Copernicus region of the Moon to create topographic profiles through complex and simple lunar craters. They then used a terrestrial map of Meteor Crater, AZ, to create a topographic profile of Meteor Crater. Using these topographic profiles, as well as the images, they were asked to classify the lunar craters into two general groups and then assign Meteor Crater to one of those two groups.



Clementine image of the Lunar region around Copernicus Crater. Obtained through USGS Map-A-Planet website.

Comparative Planetary Geology

In the lab exercise, I asked students to compare general planetary properties for Earth, Mars and the Moon. I then had two sections that dealt with general geologic interpretation using images taken from Martian orbit. Students examined volcanoes on Mars and Earth by comparing MOLA and Viking topography of martian volcanoes with topographic maps of Mt. Ranier and Mauna Loa. Students were asked to calculate average slopes for various volcanoes and then determine how they might classify martian volcanoes using terrestrial terms. They then speculated on why martian volcanoes have generally shallower slopes than even hot spot volcanoes on Earth. A second section had students using their terrestrial knowledge to interpret fluvial and tectonic features on Mars from Viking images, MOLA topography maps, and three-dimensional HRSC images. In particular, students examined Gusev Crater, Louros Valles, Acheron Fossae, and Phobos.

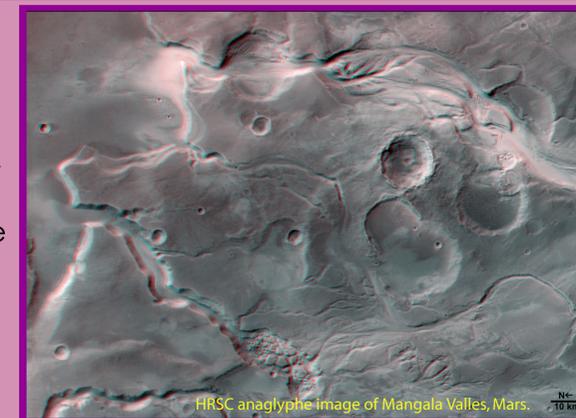


Viking orbiter image of Gusev crater region on Mars

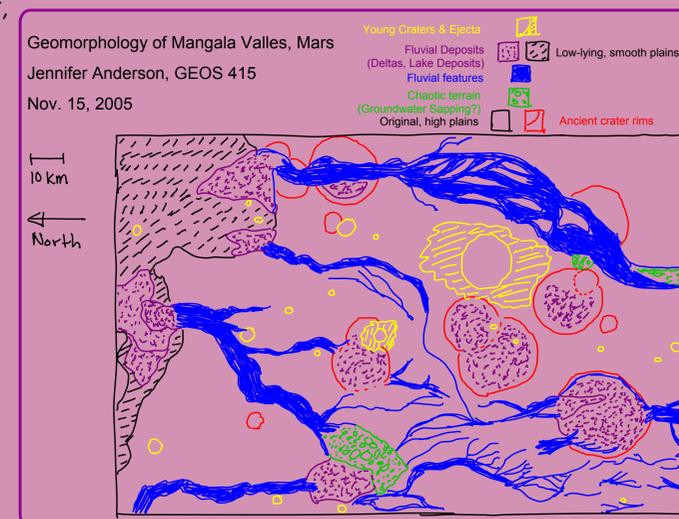
Geologic Mapping on Other Planets

Planetary geology is an excellent opportunity to really investigate a student's ability as a geologist because it requires a student to apply their knowledge in a completely new field area, one in which they have no (or very little) prior experience and their data is limited. Not only does this challenge the student to determine the geologic history of a region, but the physical parameters of the planet offer the opportunity to demonstrate an understanding of how gravity, for example, affects the topography of a surface. Further, students are forced to work with the knowledge that their interpretation may not be the "correct" one and they can determine and prioritize future data collection.

In this exercise, I had students create a simple map of the region surrounding Mangala Valles complete with an interpretation of the geologic history of the region that would be consistent with their final map. In this manner, students experienced the difficulty of creating a geologic map from aerial photos that is detailed enough to characterize a region.



HRSC anaglyph image of Mangala Valles, Mars.



Challenges and Insight

The primary challenge that I encountered when first introducing planetary geology to field-oriented students is their natural inclination to be skeptical of how geology can be done without the ability to physically see, touch, and feel the rocks themselves as they are used to doing on Earth. My students frequently asked, "But, how do you know?" Despite being a surprise to me (since I'm used to planetary geoscience), this offered me a tremendous teaching opportunity where I helped my students really recognize that, in any field of science, scientists need multiple lines of evidence that support a hypothesis, independent of whether the possibility exists to travel to the site and see it with your own eyes. It was an opportunity to point out that a set of facts can be obtained from an outcrop on Earth or an image from Mars, but the interpretations of those facts by different scientists can differ greatly and this happens throughout science. I think that one of the major benefits to incorporating quantitative planetary geoscience into undergraduate geoscience courses is the ability to fully remove the physical person from the data and embrace the concept of non-uniqueness in science.