USING JMARS AS A TEACHING TOOL IN UNDERGRADUATE PLANETARY COURSES. C. E. Viviano, J. E. Moersch and H. Y. McSween, Planetary Geosciences Institute, Department of Earth & Planetary Sciences, University of Tennessee, Knoxville, TN 37996; <cviviano@utk.edu>

Introduction: The Planetary Geosciences course at the University of Tennessee is the capstone course of our core curriculum for junior and senior undergraduate geology majors. This course utilizes the fundamental Earth-based geology the students have learned in their core courses towards studying other solar system bodies, as well as global-scale processes on our own planet. We have implemented the Java Mission-planning and Analysis for Remote Sensing (JMARS) program [1] into the laboratory experience of this course. The JMARS package, developed by the Mars Space Flight Facility at Arizona State University, provides tools for both mission planning and data analysis. JMARS affords the simultaneous viewing of multiple datasets, including topographic context, spectroscopic data products, and visible imagery, which is essential for geologic analyses of other planets. The JMARS public version is free to download (http://jmars.asu.edu/) and functions autonomously on common computer operating systems. Using a layer-based graphical user interface, JMARS operates as a simple GIS tool for novice users. These aspects make JMARS a uniquely useful teaching instrument for exposing undergraduate students to current Martian datasets and analysis tools.

JMARS Applications: *An Introduction to Crater Counting.* One lab in the course is devoted to learning about the important technique of age dating planetary surfaces using crater counts. Students use the crater counting tool in JMARS to determine the approximate ages of two terrains on Mars. The sample terrains are located ~15° north of Valles Marineris, within Lunae Planum and Xanthe Terra (Figure 1). JMARS crater counting allows for quick determination of crater diameter, which can then be exported as a .csv file, readable in Microsoft® Office Excel. Measurements may then be binned by diameter, normalized per square kilometer, and plotted to determine surface age (Figure 2). The functionality of this application allows for a much quicker method of teaching crater counting than the traditional printed map and ruler method.

Mars Lander Road Map: Planning a Geologic Traverse on Mars. The final lab project for this course involves using multiple datasets to plan a rover traverse at one of the 2011 Mars Science Laboratory (MSL) prospective landing sites. The goals of this project are to 1) see how field geology can be done remotely, using the capabilities of a present-day rover mission, 2) apply key concepts from the course about spectroscopy, geologic mapping, geochemistry, and planetary evolution, and 3) investigate and characterize the geology and geochemistry of the region surrounding the landing site. We place constraints on the traverse distance, terrain, total travel time, and total number of stops, in order to design a realistic mission traverse. For each stop along the traverse, there are limited power and time constraints for use of the scientific payload. This allows students to experience limitations comparable to planning an actual rover traverse. Small groups of students are asked to collectively plan a 50-km traverse (Figures 3,4) with an associated geologic sketch map and topographic profile (Figure 5). The JMARS MOLA

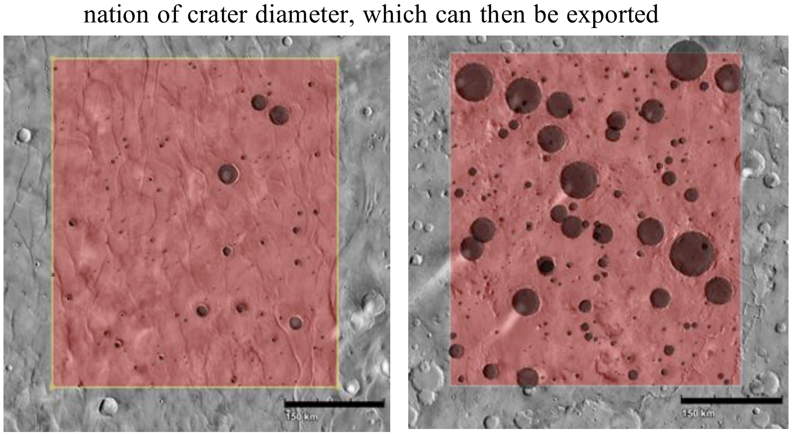

Figure 1. *Left*: Craters selected in JMARS with the crater counting tool in Lunae Planum. Image centered at ~9.3°N, 296.3°E. *Right*: Selected craters from the Xanthe Terra region, centered at ~9.3°N, 308.2°E.

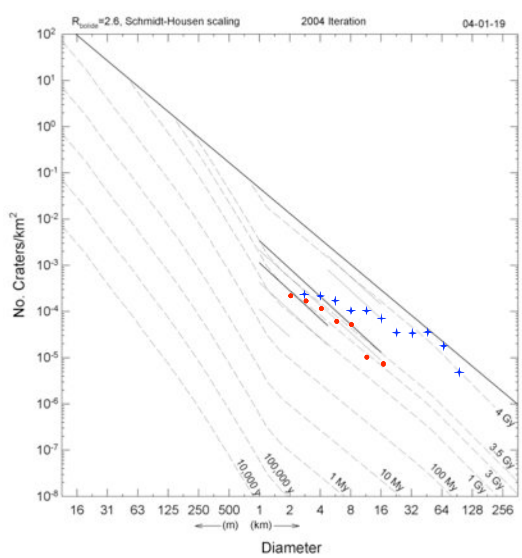

Figure 2. Crater counts plotted from the images in Figure 1 on the Hartmann (2004) iteration isochrons [2]. Red circles are from Lunae Planum and blue crosses from Xanthe Terra.

(Mars Orbiter Laser Altimeter) elevation layer is used to visually view elevation data with a color-enhanced topographic map and plot the topographic profile of the traverse. High Resolution Imaging Science Experiment (HiRISE) and Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) stamps, or image outlines, may be rendered through the stamp layer as different product types and overlaid on the map (Figure 4). CRISM full-resolution rendered products include hydroxylated silicates, bound water, and mafic mineralogy, which are particularly useful for geologic interpretation with topographic context. For each of the 15 stops along the traverse, students come up with a testable hypothesis that applies to the overarching MSL mission goals, which are provided in the lab instructions. They also plan which instruments can be used to test their hypothesis for each site, while considering time and power constraints. This final project merges multiple concepts covered throughout the course into one hands-on group learning experience.

Conclusion: The application of the JMARS package to an undergraduate course in planetary geology provides students with a convenient, modern learning tool. Using JMARS as a teaching resource not only exposes undergraduate students to state-of-the-art analytical tools for planetary geoscientists, but also provides for analysis of multiple datasets through an easy-to-use, free platform. We have developed multiple learning tasks that utilize the JMARS tool and advance the fundamental planetary science concepts covered in the course. We encourage other programs looking to develop or update their planetary courses to consider using JMARS as a teaching tool.

References:
[1] Christensen, P. et al. (2007) *AGU*, P11E-01. [2] Hartmann, W. K. (2004) *Icarus*, *174*, 294-320.

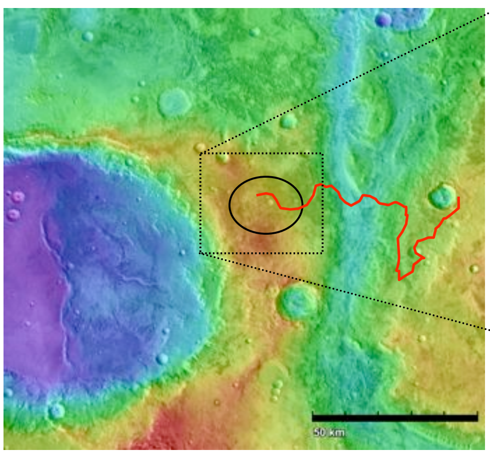

Figure 3. One of the MSL candidate landing sites, in Mawrth Vallis (landing ellipse shown in solid black) is overlaid on MOLA topography data. The red line indicates a hypothetical traverse a student might design for this project. The location of Figure 4 is outlined with a dotted black rectangle.

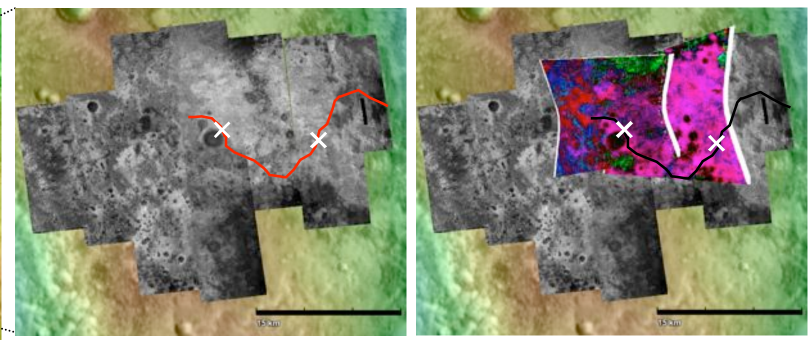

Figure 4. *Left*: The hypothetical lander traverse overlaid on rendered High Resolution Imaging Science Experiment (HiRISE) data from JMARS. Two stops from the traverse are shown with a white 'X'. *Right*: Rendered hydroxylated silicates products derived from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) is overlying the HiRISE imagery.

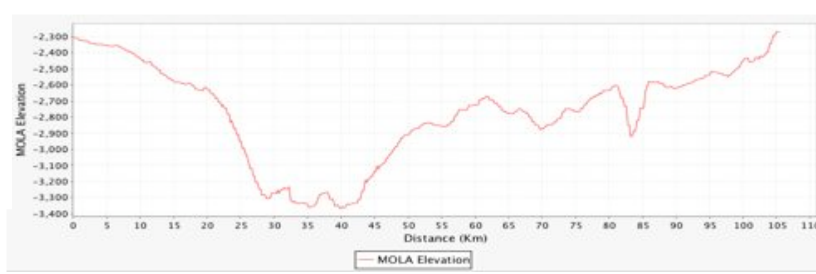

Figure 5. A topographic profile of the hypothetical traverse derived from MOLA topography data (note vertical exaggeration). This product is automatically plotted and viewable within the JMARS MOLA elevation layer.