3-DIMENSIONAL TOPOGRAPHIC MODELS FOR THE CLASSROOM. J. W. Keller[1], J. H. Roark[2], S. E. H. Sakimoto[3], S. Stockman[2] and H. V. Frey[4], [1]Astrochemistry Branch, Goddard Space Flight Center, Greenbelt, MD 20771, John.W.Keller@nasa.gov , [2]SSAI at the Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, roark@core2.gsfc.nasa.gov stockman@core2.gsfc.nasa.gov , [3]GEST at the Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, sakimoto@core2.gsfc.nasa.gov , [4]Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, Herbert.V.Frey@nasa.gov .

Introduction: We have recently undertaken a program to develop educational tools using 3-dimensional solid models of digital elevation data acquired by the Mars Orbital Laser Altimeter (MOLA) for Mars as well as a variety of sources for elevation data of the Earth. This work is made possible by the use of rapid prototyping technology to construct solid 3-Dimensional models of science data. We recently acquired rapid prototyping machine [1] that builds 3-dimensional models in extruded plastic. While the machine was acquired to assist in the design and development of scientific instruments and hardware, it is also fully capable of producing models of spacecraft remote sensing data. We have demonstrated this by using Mars Orbiter Laser Altimeter (MOLA) topographic data (Figure 1) and Earth based topographic data (Figure 2) to produce extruded plastic topographic models (Figure 3) which are visually appealing and instantly engage those who handle them.

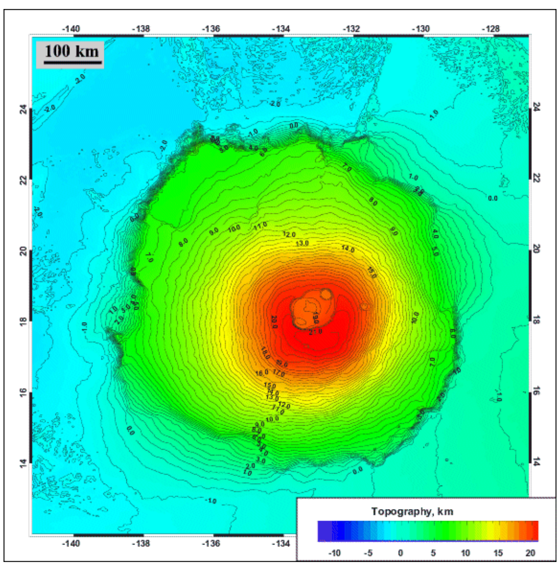

Figure 1. Topography contour plot for Olympus Mons, Mars, showing the MOLA data used to produce the plastic model.

The plastic models provide significantly improved representation of the three-dimensional character of a planetary surface, which is often difficult to visualize from 2-dimensional maps. We are now developing a carefully selected suite of models and supporting

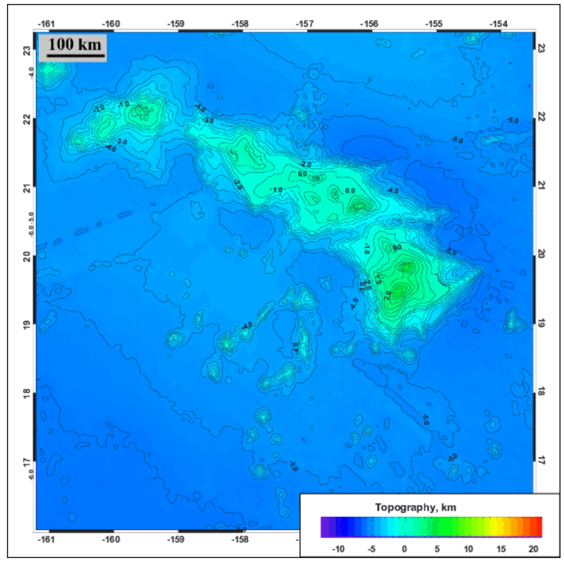

Figure 2. Topography contour plot of the Hawaiian Island volcanic chain, Earth, showing the data (gtopo30 and etopo2) used to produce the plastic model.

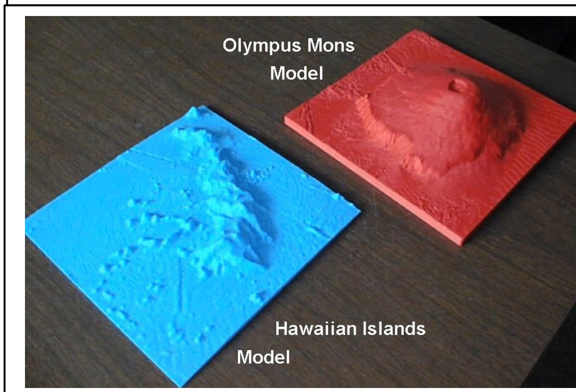

Figure 3. Three dimensional extruded plastic models of the Hawaiian Island volcanic chain (Earth) and Olympus Mons (Mars). Both models were produced at the same scale, approximately 850 km per side with a vertical exaggeration of 7 times allowing students to compare the largest volcano in the solar system with the largest volcano on Earth.

classroom materials which will be made available to students to aid exploration of the nature of topography and its fundamental importance to understanding planetary structure and evolution.

These models and materials will be used to explore how data are represented as well as how topography is measured by planetary spacecraft, thus introducing a technology component to the classroom. Comparing historic representations of topography for Earth and Mars will also add a component of science history. In terms of scientific themes, model pairs of similar features on Earth and Mars (e.g., large volcanoes, canyons, ice caps and rift systems) (Figure 4) at the same horizontal scales and having the same vertical exaggeration will be used to help students understand similarities and differences in processes on both planets. The models are also useful in facilitating discussions of how conditions change from planet to planet. These topics are all key areas in the National Science Education Standards (NSES) [2] and the Benchmarks [3].

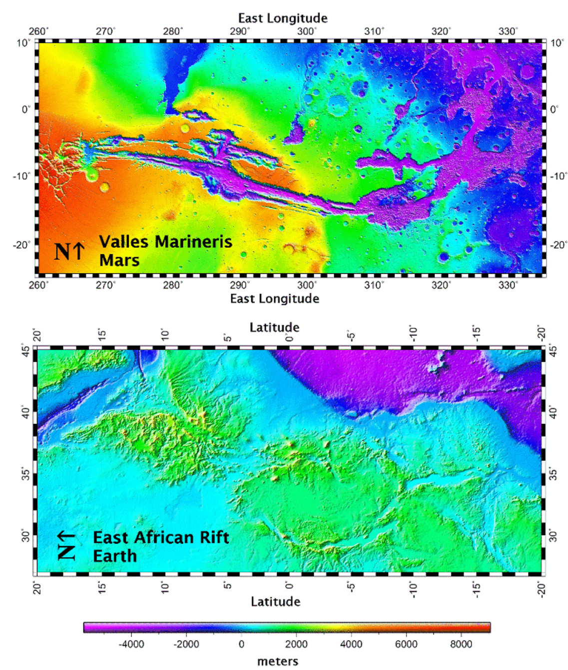

Figure 4. Models of the Valles Marineris canyon system (Mars) and the East African Rift (Earth) will be produced to help students visualize and understand the differences, similarities and scale of geologic features on both planets.

Production and Testing: Over the next year, we will develop and test several different kits based on specific science themes (e.g., comparing planetary volcanism, water or water cycles on Earth and Mars, tectonic structures, impact cratering, etc.) These kits will include the relevant 3-dimensional models (which we will produce) and the supporting documentation, including 2-dimensional maps, images of the selected features, descriptive text and suggested classroom activities that are aligned with the National Science Standards and Benchmarks. The kits will be distributed for classroom testing to middle school science teachers taking masters level course work in the Graduate Division of Education Masters of Science in Education Program at Johns Hopkins University. Their experiences and feedback will be used to modify and improve the kits during the summer and second year of this project which is supported by internal Goddard Director's Discretionary Funds.

Conclusion: Through its scientific programs and spacecraft missions, NASA has acquired tremendous amounts of data about the Earth and planets. While much of these data serve to facilitate highly specialized research in cutting edge science and technology, it is often possible to present data in such a way that is easily understood and visualized by students or the lay public. Topography is a particularly good example of a vital data type which is both critical to understanding fundamental geologic processes but which at the same time is common to our everyday experience. For example, if presented with 3-D models of the largest shield volcanoes on Mars and on Earth (Figures 1-3), a student will instantly recognize similarities and differences and this recognition can be used as a starting point for understanding both the technology that was used to gather the data and the scientific significance and uses of the data. The compelling advantage of a 3-dimensional model is improved visualization of the actual surface and surface structures and how those compare with similar structures on other planets, as well as enhanced engagement of the student or public with a tactile and easily understood example of the data. Preliminary demonstrations of the models suggest that they will be excellent resources for visually impaired students. These students will be able to literally feel the topography and gain insights into the 3-dimensional data that would otherwise be very difficult to convey.

References:

[1] Prodigy Plus manufactured by Stratasys Systems, Eden Prairie, MN. [2] National Research Council., *National Science Education Standards*, National Acad. of Sci., 1996. [3] Project 2061, American Association for the Advancement of Science., *Benchmarks for Science Literacy*, 418 pp., Oxford University Press, New York, 1993.