RECONSTRUCTION OF DIGITAL ELEVATION MODEL FOR PHOBOS FROM HIRISE DATA. A. B. Ivanov[1] and N. Thomas[2], [1]Planetary Science Institute, Tucson, AZ (anton@psi.edu), [2]Uni Bern, Inst Phys, Bern, Switzerland

Introduction. The origin of Mars' largest moon Phobos is still being debated as well history of its crater population. We know from Viking observations that Phobos is compositionally similar to type I or II carbonaceous chondrites (*1, 2*) or may be even to a more primitive type D asteroids (*3*) and has very low density (*4*). Surface features have been studied and documented based on Viking Orbiter data (*5*), where it has been suggested that formation of grooves has been linked to catastrophic crater impacts on Phobos. This work conducts a feasibility study to derive a high resolution digital elevation model (DEM) using HIRISE image data. This DEM can be used for analysis of crater and groove depths and better understanding properties (e.g. thickness) of the surface regolith.

Stereo DEM generation. Stereo imaging has been employed for a long time to create elevation models. This technique was used to analyze images from Viking Orbiter images to generate digital elevation models (similar term is Digital Terrain Model, DTM) (*6*). High Resolution Stereo Camera (HRSC) camera on the European Mars Express mission (*7*) is a camera optimized for observations in stereo. It has proved to be very successful for DEM generation at 50 m (on Mars) and higher scale and it performed observations of Phobos in stereo (*8*). Mars Reconnaissance Orbiter (MRO) is equipped with a telescope (High Resolution Imaging Science Experiment, HiRISE).

We employed stereo matching methods and approaches utilized for the Mars Orbiter Camera (MOC) stereo data (*9, 10*), in conjunction with radiometric and geometric image processing in ISIS3 (*11*). This technique is capable of deriving tiepoint co-registration at subpixel precision and has proven itself when used for Pathfinder and MER operations (*12*). This work has also benefited from an excellent ISIS3 Application program Interface (API). ISIS3 API is used to derive ray origin and direction and then calculate intersection coordinates for pixels identified by image correlation. Once ray intersections have been calculated they give precise XYZ information in a Phobos Reference frame. XYZ values are then converted into triplets of (Latitude, Longitude, Radius). Final product is created by triangulation and gridding of this dataset.

Reconstruction of Phobos surface model. In March of 2008 HIRISE camera took two images of Phobos: PSP_007769_9010 and PSP_007769_9015 (these images have been released to PDS prior to January 2009). They provide a very detailed look at an area of Phobos around 0 longitude. We employed this stereo pair to perform a feasibility study to derive a high resolution (~20 m /pixel) digital elevation model. Previously stereo and limb figure observations were done using Viking imagery (*4, 13, 14*) which provided first estimates for the shape. Recently HRSC camera on Mars Express (*8*) was able to map Pho-

bos and produce DEMs at 240 m/pixel. They have also studied properties of crater distribution and grooves.
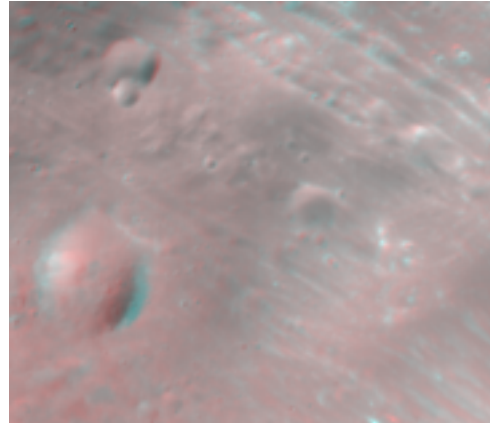

Figure 1. Fragment of a stereo anaglyph which is composed from two images taken by the HIRISE camera. The anaglyph was composed as a proof-of-concept that DEM information ca be extracted from the stereo pair. HIRISE images PSP_007769_9010 (Blue and green filters) and PSP_007769_9015 (red filter) taken in March of 2008. Details of craters and grooves can be extracted.

Phobos is a small body and one HIRISE observation contains the whole body. Although observations were taken at a very short interval (10 min), geometry has changed significantly between two observations due fast relative motion of spacecraft relative to Phobos. It is possible to run a fully automated image correlation algorithm on Phobos. Therefore we focused on a small area and derived some matching points by hand. We have created anaglyph as first step in the proof-of-concept. It allows visual analysis and see how images can be registered to each other. The next step was to manually pick a set of control points (similar to approach taken by (*15*)) and then run them through our geometry software to find XYZ locations of intersections in Phobos reference frames. Results are shown in Figure 2. XYZ points were triangulated to obtain a simple shape of surface. Comparison with the current Phobos figure (*13, 14*) showed that our approach is valid and we can now proceed with automated tiepoint generation. This will be a time consuming task because we will have to split one image into at least nine and determine optimal parameters for tiepoint collection. Original HIRISE images have approximately 7 m/pixel resolution, which will allow us to construct a DEM which is will be 20-30 m/pixels, depending on quality of automatic correlation.

Summary. This study is very successful and we are now working on the next step to allow automatic correlation algorithm to find tiepoints in images. Once DEM is de-

rived we plan to map grooves and construct a database of profiles, following previous mapping efforts (*5, 8*). These profiles will help understand process of groove formation and their morphology can be interpreted for understanding of Phobos' near surface properties. We will also look at crater profiles to understand d/D (depth to diameter ratio). This work will contribute to constraining properties of Phobos regolith. These data can also be used topographic clutter models for radar simulations (*16*). Digital elevation models will be made available to all interested researchers.
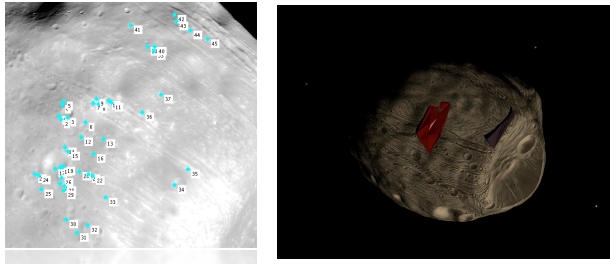

*Figure 2. Testing proof-of-concept: tiepoint collection and figure reconstruction. (**Left**) illustrates manually picked control network on the surface of Phobos. First 30 points were used to reconstruct a 3D shape and compared with the current figure of Phobos (14) (**Right**)Simulated observation of Phobos by HIRISE camera in a 3D environment with test models shown in shades of red.*

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