NEW GEOLOGIC MAP OF THE ARGYRE REGION OF MARS: DECIPHERING THE GEOLOGIC HISTORY THROUGH MARS GLOBAL SURVEYOR, MARS ODYSSEY, AND MARS EXPRESS DATA SETS. J.M. Dohm[1], M. Banks[2], D. Buczkowski[3]; [1]University of Arizona, Tucson, AZ (dohm@hwr.arizona.edu), [2]Smithsonian Institution, Washington, D.C., [3]John Hopkins University, Washington, D.C.

Introduction: The primary objective of the mapping effort is to produce a geologic map of the Argyre basin and surrounding region at 1:5,000,000 scale in both digital and print formats that will detail the stratigraphic and crosscutting relations among rock materials and landforms (30°S to 65°S, 290°E to 340°E) (Fig. 1). There has not been a detailed geologic map produced of the Argyre region since the Viking-era mapping investigation of [1]. The mapping tasks include stratigraphic mapping, crater counting, feature mapping, quantitative landform analysis, and spectroscopic/stratigraphic investigation feature mapping. The regional geologic mapping investigation includes the Argyre basin floor and rim materials, the transition zone that straddles the Thaumasia plateau, which includes Argyre impact-related modification, and the southeast margin of the Thaumasia plateau using important new data sets from the Mars Global Surveyor, Mars Odyssey, Mars Express, and Mars Reconnaissance Orbiter. The geologic information unfolded by this new mapping project will be useful to the community for constraining the regional geology, paleohydrology, and paleoclimate, which includes but is not limited to the assessment of: (1) whether the Argyre basin contained lakes, (2) the extent of reported flooding and glaciation, (3) existing interpretations of the origin of the narrow ridges located in the southeast part of the basin floor, and (4) the extent of Argyre-related tectonism and its influence on the surrounding regions.

Methodology: The mapping investigation will include stratigraphic mapping, crater counting, feature mapping, quantitative landform analyses, and stratigraphic/spectroscopic investigation.

Stratigraphic mapping. Identification, characterization, and relative-age analyses of map units with presently available data will be vastly improved over those based solely on Viking images. Using the new data, the stratigraphic and crosscutting relations among rock materials and landforms can be mapped, characterized, and interpreted. Geologic cross sections will cover mountainous impact crater rim materials (Charitum Montes and Nereidum Montes) and adjoining highland materials of Noachis Terra, valleys and elongated basins that are radial and concentric about the primary Argyre basin, and faults, sinuous ridges, lobate debris aprons, polygons, and valley networks. The mapping effort will also characterize the stratigraphic relations among basin infill materials (e.g., massive vs. layered vs. sequence stratigraphy). The mapping results will provide the planetary science community with better constraints on regional geology, paleohydrology, and paleoclimate.

Crater counting. Careful interpretation of crater density data is required due to the following factors: (a) crater density reflects a mean surface age (some grasp of potential relative-age range can be obtained by performing crater counts in multiple locations); for example, total crater counts of a map unit can help constrain its emplacement history, while counts of only superposed craters (pristine ejecta blankets that overlie the map unit and/or erosional, depositional, and/or tectonic structure) reflect an upper time limit for the resurfacing of that particular unit [e.g., 2]); (b) resurfacing activity causes degradation and/or embayment of craters as well as inflections and roll-offs in crater-size distributions due to crater obliteration [e.g., 3]; (c) possible secondary and non-impact craters, particularly at smaller diameters, which can alter crater size-frequency distributions [4]. Keeping the above mentioned factors in mind, we intend to produce detailed summary crater counts for all map units, as well as multiple counts for more broadly occurring units. These should help establish ranges and spatial variability of ages of surface and near-surface units, as well as resurfacing ages.

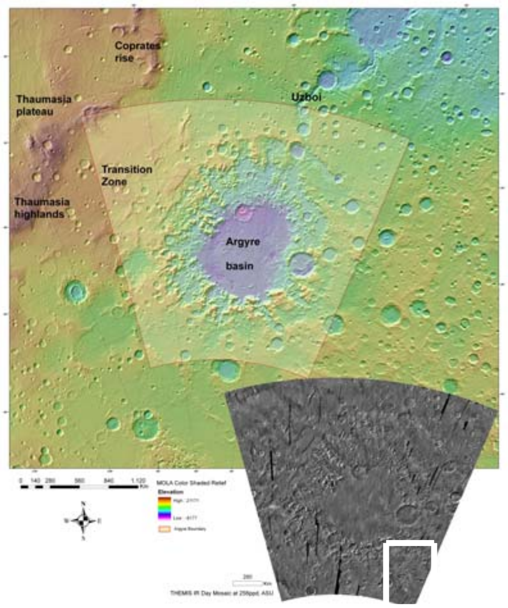

Fig. 1. MOLA color shaded relief map centered on the Argyre region (transparent outline). The image on the bottom right shows a 256 pixels/degree THEMIS IR day mosaic, to show the coverage available for mapping. Our regional 1:5,000,000-scale mapping investigation will include the Argyre floor and rim, transition zone, and the southeast margin of the Thaumasia plateau [2].

Structural and feature mapping. Tectonic, collapse, depositional, and erosional features will be mapped in detail including wrinkle ridges, lobate scarps, faults, fluvial channels, enigmatic ridges, lobate debris aprons, polygons, and valley networks, to help unfold the geological history (e.g., Fig. 3). Detailed crater statistics and MOLA-based cross-sectional information will assist in the determination of stratigraphic and crosscutting relations among rock materials and landforms. This includes Argyre basin infill materials (massive vs. layered vs. sequence stratigraphy), mountainous impact crater rim materials (Charitum Montes and Nereidum Montes) and adjoining highland materials of Noachis Terra, valleys and elongated basins that are radial and concentric about the primary Argyre basin, and faults, enigmatic ridges, lobate debris aprons, polygons, and valley networks.

Quantitative landform analyses: Multiple modern datasets will be used to identify landforms in the Argyre region, and various techniques will be implemented to quantitatively analyze these landforms to constrain the processes involved in their formation and to compare them with terrestrial analogs (Fig. 2 based on [5]). Such analyses will provide important insight into possible formation mechanisms of the various landforms observed in the region and, based on the distribution and abundance of the landforms, indicate how active and widespread these formation processes are/were. In assessing different formation mechanisms, a "landsystems" approach will be used similar to [5]. In this approach, landforms will be considered in context and relation to each other, and the entire pattern and regional assemblage of landforms will be considered in regard to a typical terrestrial landscape. Altogether, this will provide important insight into the geologic history of the Argyre region.

Spectroscopic/stratigraphic investigation. Comparative analyses among the stratigraphic information based from this mapping investigation and the CRISM data will be performed to further unfold the geologic history of the Argyre region. Fig. 3 based from the work of [6], for example, shows a laterally-extensive, phyllosilicate-enriched deposit on the western wall of a shallow graben related to the seventh (of eight) ring structures associated with the Argyre basin, as mapped by [7].

Summary: The proposed investigation will have a direct bearing on the understanding of the geologic evolution of Mars. Furthermore, a new regional geologic map of the Argyre region of Mars will have wide-ranging significance and application, including: (1) the establishment of a spatial and temporal geologic context for local to regional geologic, geophysical, geochemical, hydrologic, and climatic studies, (2) the refinement of the regional stratigraphic scheme for establishing chronology and estimating rates of geologic activity, and (3) spatial and temporal information from which to assess whether the Argyre basin contained lakes [e.g., 8] and whether flooding and glaciation contributed significantly to the geologic and paleohydrologic records of the Argyre region [e.g., 7,9,10], as well as determining the extent of Argyre-related tectonism [2].

References: [1] Scott, D.H., et al., 1986-87, USGS Map I-1802-A-C. [2] Dohm, J.M., et al., 2001a, USGS Map I-2650. [3] Tanaka, K.L., et al., 2006, Workshop on Surface Ages and Histories: Issues in Planetary Chronology, Houston, Lunar and Planetary Institute, #6014. [4] McEwen, A.S., et al., 2005, Icarus, 176, 351-381. [5] Banks, M.E., et al., 2008, J. Geophys. Res., 113, E12015, doi:10.1029/2007JE002994. [6] Buczkowski, D.L., S. Murchie, R. Clark, K. Seelos, F. Seelos, E. Malaret, C. Hash and the CRISM Team (in revision), Investigation of an Argyre basin ring structure using MRO/CRISM, J. Geophys. Res. [7] Hiesinger, H., and J.W. Head, 2002, Planetary and Space Sci. 50, 939-981, 2002. [8] Parker, T.J. and D.S. Gorsline, 1993, Am. Geophys. Union Spring Meeting, 1pp. [9] Kargel, J.S., and Strom, R.G., Ancient glaciation on Mars, Geology, 20, 3-7, 1992. [10] Parker, T.J., et al., 2000, LPSC 31, abstract 2033.

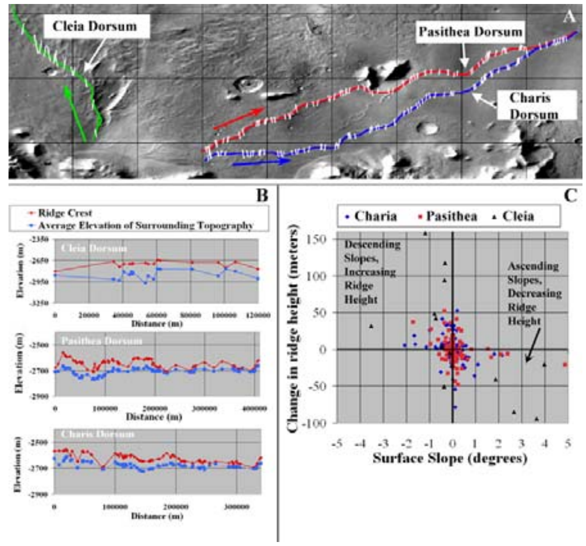

Fig. 2. Topographic analysis of the Argyre sinuous ridges. A) The locations of the three ridges used in the topographic analysis are marked in green (Cleia Dorsum), red (Pasithea Dorsum), and blue (Charis Dorsum) on a THEMIS daytime IR mosaic [http://jmars.asu.edu]. Multiple cross sectional profiles were derived from MOLA PEDR tracks along the extent of the three ridges. White lines in the mosaic indicate the location of the MOLA tracks on each of the ridges. The direction along each ridge in which the data was plotted in B is indicated by colored arrows next to the three ridges. B) The elevation of the surrounding surface was averaged at each profile location in A and plotted as a function of distance along the extent of each ridge (blue lines). For each of the ridges, the overall elevation at which they occur varies along trend indicating that the Argyre ridges cross topography. The height of each ridge was also plotted (red lines) and found to vary along the extent of each ridge. The vertical exaggeration differs for each plot. C) The change in ridge height between successive MOLA tracks along each ridge was plotted against the average slope of the surrounding surface. For slopes greater than 1º, ridge height generally increases with descending slopes and decreases with ascending slopes. This a characteristic observed in terrestrial eskers that is related to flow processes.

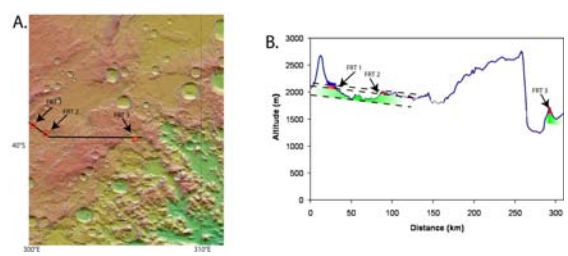

Fig. 3. Example of combining CRISM-based information with MOLA data for spectroscopic/stratigraphic investigation [6]. A) MOLA colorized topography draped over THEMIS daytime IR mosaic of the northwest part of the Argyre region. Red boxes indicate the CRISM observations noted in the text. Black line shows transect line of the topographic profile shown in B. B) Locations of CRISM FRT images are shown on a MOLA profile (vertical exaggeration = 67x). Steep peak separating FRT 3 from the other observations is a ridge used to infer the location of the sixth Argyre impact ring structure [7]. Red indicates phyllosilicate identifications, green high-calcium pyroxene, and blue low-calcium pyroxene. Dashed lines indicate probable layering of materials across the graben.