

DID A LARGE ARGYRE LAKE SOURCE THE UZBOI VALLIS DRAINAGE SYSTEM?: POST-VIKING-ERA GEOLOGIC MAPPING INVESTIGATION. J.M. Dohm¹, J.C. Ferris², V.R. Baker¹, G. Komatsu³, D.L. Buczkowski⁴, M.R. El Maarry^{5,6}, T.M. Hare⁷, W.C. Mahaney⁸, K.J. Kim⁹, A.F. Davila^{10,11}, A.G. Fairén^{10,11}; ¹Dept. of Hydro. and Water Res., Univ. of Ariz. (jmd@hwr.arizona.edu), Tucson, Arizona, 85721, USA, ²U.S. Geological Survey, Sacramento, California, USA, ³International Research School of Planetary Sciences, Università d'Annunzio, Pescara, Italy, ³International Research School of Planetary Sciences, Università d'Annunzio, Pescara, Italy, ⁴JHU Applied Physics Lab, Laurel, MD 20723, ⁵Max - Planck Institut für Sonnensystemforschung, 37191, Katlenburg - Lindau, Germany, Geowissenschaftliches Zentrum, Georg-August University, Göttingen, Germany, ⁶Geowissenschaftliches Zentrum, Georg-August University, Göttingen, Germany, ⁷U.S. Geological Survey, Flagstaff, Arizona, USA, ⁸Quaternary Surveys, Toronto, Ontario, Canada, ⁹Geological & Environmental Hazards Division, Korea Institute of Geosciences and Mineral Resources, Daejeon, South Korea, ¹⁰Space Sciences and Astrobiology Division, NASA Ames Research Center, Moffett Field, CA, USA, ¹¹SETI Institute, Mountain View, CA, USA.

Introduction: Did a large Argyre lake source the Uzboi Vallis drainage system during the Noachian Period, as hypothesized during Viking-era investigation [1]? This and other significant questions concerning the geologic and paleohydrologic histories of the Argyre impact basin and surroundings at local to regional scales are being investigated through a new post-Viking era geologic mapping investigation. The primary objective of this investigation 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 340.0°E; Fig. 1); the most recent published geologic map of the Argyre basin and surroundings was based on Viking data [2].

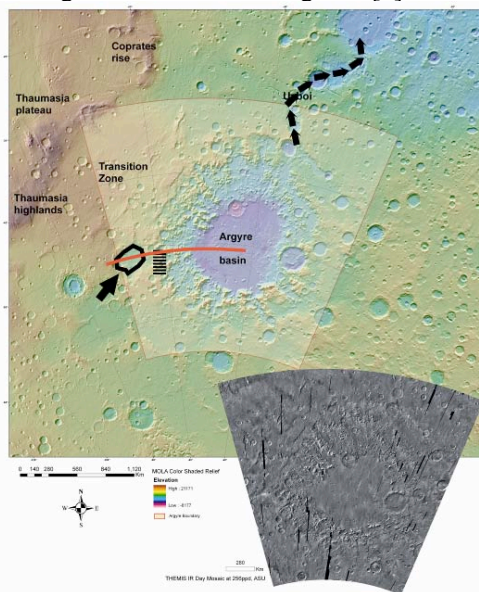


Fig. 1. MOLA color shaded relief map centered on the Argyre region (transparent outline). The image on the bottom right shows a 256 pixels/degree THEMIS IR day mosaic. The regional 1:5,000,000-scale mapping investigation includes the Argyre floor and rim, transition zone, and the southeast margin of the Thaumasia plateau [3]. Also shown is a newly identified paleolake basin (wide arrow) located on the western margin of the Argyre impact basin and the Uzboi

drainage system (narrow arrows), referred to hereafter as the Argyre west margin paleolake (AWMP), possible spillway separating AWMP from the Argyre basin at a present-day topographic interval nearing 1.5 km (dashed line), and a transect for topographic profile shown in Fig. 3 (red line).

AWMP: A clue to whether a large Argyre lake sourced the Uzboi Vallis drainage system during the Noachian Period may be a newly identified paleolake basin located on the western margin of the Argyre impact basin (Fig. 2), AWMP. A paleolake is inferred by the series of distinct drainage systems that debouched into the basin (Fig. 2) and terminate near a geomorphic bench that occurs at a topographic interval ranging from 1 to 1.5 km and a possible spillway that separates the paleolake basin from the Argyre basin (Figs. 1 and 2). Observations by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) suggest that there are hydrated minerals such as phyllosilicates in the spillway wall and on the floor of AWMP, consistent with the past presence of water in these regions. The spillway divide occurs at ~ 1.5 km, realizing that paleotopography may vary significantly from present-day topography due to factors such as impact-induced tectonism and erosion.

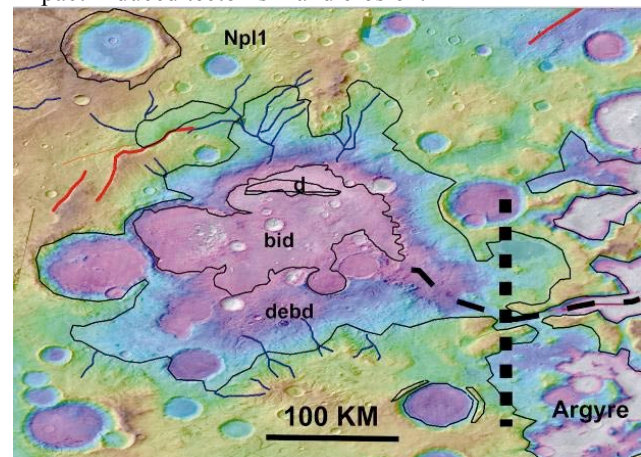


Fig. 2. MOLA color shaded relief map coupled with a THEMIS IR daytime mosaic highlighting AWMP. Argyre-induced tectonic structures (red lines), drainage systems that

debouched into the basin (blue lines), a possible spillway (dashed narrow line which also marks a graben-like structure that may have influenced water flow or later deformed the possible spillway), and from oldest to youngest, cratered highland materials (Np11), dissected and etched basin deposits (debd), basin infill deposits (bid), and dune deposits (d), are highlighted. Note that the drainage systems terminate within a contour interval ranging from 0 to 1.5 km (within debd which may mark a lake-related topographic bench), the latter elevation of which occurs at a possible spillway divide (thick black dashed line) at present-day topography.

Implications: Significantly, elsewhere in the Argyre impact basin at the contour interval which would include the spillway divide and the basin floor and the topographic bench of AWMP (ranging from about 0 to 1.5 km; see Fig 3), features such as sapping valley systems, topographic/geomorphic benches, a transition from broad valley systems to more narrowly confined systems outward from the basin, valley systems that debouched into local basins, and possible desiccation cracks [4], all collectively point to a large Argyre paleolake.

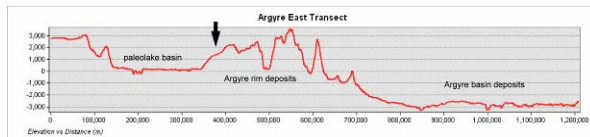


Fig. 3. Topographic profile transecting from west to east (see Fig. 1 for transect location) through AWMP and the Argyre rim materials and basin deposits. Note that a topographic bench (arrow) occurs near an elevation of ~1.5 km nearing the elevation of the possible spillway divide.

For example, by considering a lake that would reach the 0 km contour interval (Fig. 4), a conservative value (nearly the base of AWMP) based on geomorphic and topographic analysis of different parts of the Argyre basin, the lake maps out to distinct sapping valley systems, broad valley systems and local basins that occur among the basin rim materials, and the Uzboi drainage system. If the hypothesized Argyre lake reached an elevation of 1.0 km, then an estimated volume would near the Mediterranean Sea. CRISM observations of phyllosilicates along the boundaries of this hypothesized lake have been identified [e.g. 5]. However, continued detailed geologic mapping and further geomorphic analysis of the Argyre basin and surroundings must be performed to further test the lake hypothesis and assess the possible ancient and extensive hydrological system that potentially links the Argyre basin, the Uzboi Vallis system, and the northern plains. For example, further investigation includes differentiating between a possible Argyre lake and contemporaneous and/or later stage glaciation [6], colluvial activity, impact-driven tectonism including isostatic adjustment

and eolian modification, and whether the possible lake overtopped the giant impact basin [1] or the outlet area that fed the Uzboi system involved incision and sapping at a much lower water level [8]. Such merits detailed geologic investigation and construction of a post Viking-era geologic map.

References: [1] Parker, T.J., and Gorsline, D.S., (1993) *Am. Geophys. Union Spring Meeting*, 1pp. [2] Scott, D.H., et al., (1986-87), *USGS Map I-1802-A-C*. [3] Dohm, J.M., et al. (2001), *USGS Map I-2650*. [4] El Maarry et al., (2010), *JGR*, 115, E10006, doi:10.1029/2010JE003609. [5] Buczkowski et al. (2010) *JGR*, 115, E1201, doi:10.1029/2009JE003508. [6] Kargel, J.S., Strom, R.G., (1992), *Geology*, 20, 3-7. [7] Banks M.E. et al., (2009), *JGR*, 114, E09003, doi:10.1029/2008JE003244. [8] Hiesinger, H., and Head, J.W., III (2002) *Planet. & Spac. Sci.* 50, 10.1016/S0032-0633(02)00054-5.

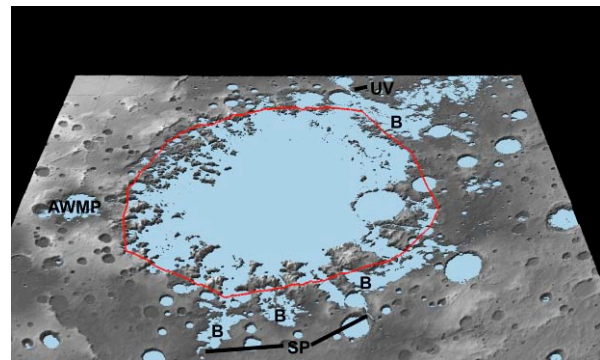


Fig. 4. Schematic paleolake map of the Argyre basin using a maximum topographic elevation of 0 km based on MOLA topography (regions in blue). An estimated extent of the hypothesized Argyre lake based on geomorphologic and topographic analyses, as well as detailed geologic mapping is also shown (red line). In addition to the estimated extent, sapping channel systems (SP), local basins (B) which occur among the crater rim materials, and the Uzboi Vallis system (UV) correspond to the blue-highlighted region. Also shown is a small extent (near base level) of AWMP. The volumes of the hypothesized AWMP and Argyre lakes are estimated to be 1.6×10^4 and 1.9×10^6 km³, respectively, using MOLA. There is significant evidence of water-ice modification (e.g., glaciation) as shown by [e.g., 8, 9]. The possibility of an interplay between lakes, ice sheets, glaciers, and ever changing conditions through time including waning water bodies? Further detailed geologic and geomorphic investigation is warranted.