ARGYRE PLANITIA AND THE MARS GLOBAL HYDROLOGIC CYCLE. T. J. Parker[1], S. M. Clifford[2], and W. B. Banerdt[1], [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109 (timothy.j.parker@jpl.nasa.gov, william.b.banerdt@jpl.nasa.gov), [2]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058 (clifford@lpi.jsc.nasa.gov).

Introduction: This work is an update of previous studies of fluvial systems associated with Argyre Planitia in light of the recent acquisition of high-resolution topography data by the Mars Orbiter Laser Altimeter on MGS [1]. Geomorphic observations by Parker [e.g., 2,3], coupled with the global hydrologic models of Clifford and Parker [4] and the MOLA topography appear to confirm that the basin and the channels flowing into and out of it comprise the longest known fluvial system in the solar system.

Argyre lies at the southern end of the "Chryse Trough" [5], a broad topographic trough identified based on the Mariner 9 and Viking low-resolution topography that can be verified by the new MOLA-based high-resolution topography (Fig. 1). This trough dips gently northward from Nereidum Montes to Chryse Planitia.

Channel flow into Argyre: Three large valley networks and two outflow channels cut through the rim of Argyre on its southeast and north sides. The three valley networks – Surius Valles, Dzígai Valles, and Palacopas Valles – all drain into Argyre from the south and east, through the southern rim mountains (Charitum Montes). Parker [2] suggested that these valleys once flowed outward from the rim of Argyre during the early Noachian, but that they were captured by steeper interior-draining systems that eroded headward into the rim mountains, also during the Noachian. Surius and Dzígai Valles both head near the Dorsa Argentea Formation [6].

The two outflow channels are Nia Valles and Uzboi Vallis. Nia Valles is a relatively fresh-looking, small outflow channel that superposes the mouth of Palacopas Valles in southeast Argyre, south of Galle Crater. Nia Vallles probablly formed during the early Amazonian, after the major fluvial and lacustrine episodes had concluded [3].

Catastrophic flooding out of Argyre: Uzboi Valles is a relatively large, Nocahian outflow channel that cuts the northern rim of Argyre (Nereidum Montes) and drained northward toward Holden Crater, into Holden Basin [7]. Without good topograpy, however, Uzboi Valles is somewhat confusing. With both ends obliterated by large impact craters and the channel floor exhibiting few streamlined forms, it isn't even obvious which way the channel flowed. However, even the gridded MOLA topography clearly shows Uzboi probably linked the Argyre interior with Holden Basin and Ladon Valles prior to formation of the large craters (Fig. 1).

Next in the system is Holden Basin [7], into which Uzboi Vallis flow continued prior to formation of Holden Crater [2]. The northeast rim of Holden Basin is "gone" even though this basin superposes Ladon Basin. Instead, a broad "ramp" was identified in Viking Orbiter stereo pairs [2]. Ladon and Arda Valles converge on this ramp and drain into the interior of Ladon Basin. Parker [2] inferred that the rim of Holden Basin failed catastrophically during flooding from Argyre to produce this ramp, which drained a temporary lake that had formed in Holden Basin. Continued flooding from Uzboi Vallis favored Ladon Valles' course, so Arda Valles was quickly abandoned.

Channel morphology disappears just inside the inner rim of Ladon Basin, but resumes on the basin's northeast side, at Margaritifer Valles [8].

"Oceanus Borealis", the end of the line? Margaritifer Valles quickly branches into a large, complex distributary system at about 13°S, 24°W, that broadens to about 300 width and eventually fades into the highland terrain around 8°S, 23°W. Individual branches of Margaritifer Valles exhibit two distinct preservation states – one that appears sharply defined and another that is quite subdued with walls that often appear "gullied". Uzboi and Ladon Valles similarly show two distinct morphologies, suggesting there were at least two catastrophic flood episodes from Argyre [2].

The termination of Margaritifer Valles coincides with the location of the proposed "Meridiani Shoreline" [4], the westward extension of a contact separating subdued highlands on the north from "rugged," channeled highlands to the south in Terra Meridiani [9].

The implication of this distributary pattern to distal Margitifer Valles is that it may represent a delta that formed where catastrophic flooding from Argyre reached base level in an ocean occupying the northern plains. The Meridiani Shoreline is the highest stand of the ocean proposed by Parker et al. [10,11] that has been identified to date.

But this isn't the end of the line. Ares Valles originates at 2°S 18°W, from Iani and Margaritifer Chaos, and flows north through the Chryse Trough, Through Chryse Planitia and disappears in Acidalia Planitia at 32°N, 29°W [e.g., 11]. Ares is a younger channel than Margaritifer Valles, however, as the Chaotic Terrains from which it flows formed at the expense of the terrain that is cut by Margaritifer Valles (i.e., the floor of Margaritifer Valles is consumed by collapse of the chaotic terrain). So Ares Valles post-dates the proposed Meridiani Shoreline feature. It also post-dates "Contact 1" of [10], renamed "Arabia Shoreline" [4], and may be contemporaneous with "Contact 2" [10],

renamed "Deuteronilus Shoreline" [4].

Where did all that water come from? As noted above, Surius and Dzígai Valles both head near, or within the deposits of the Dorsa Argentea Formation. Since this formation appears, for the most part, to be relatively flat-lying sediment occupying several broad intercrater depressions in the south polar region, we infer that it may be lacustrine in origin. Based on the hydrologic model described in [4], we propose that large volumes of basal meltwater may have been discharged to the surface from beneath the south polar cap when the rate of basal melting exceeded the infiltration rate of the underlying crust. Such conditions are an expected consequence of the planet's higher early geothermal heat flux and the high rates of polar deposition that are thought to have occured at this time. The resulting lakes formed by this discharge would have spilled over local topographic divides into neighboring basins. The topographic divide between the Dorsa Argentea Formation and Hellas Basin appears to be slightly higher (in the global topography) than that between the formation and Argyre Basin, and no channeling is evident into Hellas. Once Argyre captured drainage from the south polar region and was itself filled, flow through the Chryse Trough could begin. The total length of this system, from the source of Dzígai Valles through Ares Valles, as reported by Parker [12], is over 8000 km.

What about ocean volume implications/requirements? The elevation of the proposed Meridiani Shoreline, ~-1500m, is more than a kilometer higher than the Arabia Shoreline around Chryse Basin to the north. If tectonism is not considered, this would imply a much greater volume of water required to form this highstand. But looking further north in central Acidalia Planitia, the Arabia Shoreline is again identified around a local "island" of highland terrain, where it lies at over a kilometer lower in elevation than it does around southern Chryse. If this is the same feature, it suggests that the northern plains were downwarping due to the influx of so much water and sediment into the northern plains, and that this downwarping continued after emplacement of the younger shorelines.

References: [1] Smith D. E. et al. (1999) Science 284, 1495-1503. [2] Parker T. J. (1985) M.S. Thesis 165p. [3] Parker T. J. (1994) PhD, 200p. [4] Clifford S. M. and Parker T. J. (2000) Icarus in press. [5] Saunders R. S. (1979) USGS Map I-1134. [6] Tanaka K. L. and Scott D. H. (1987) USGS Map I-1802-C. [7] Schultz P. H. et al. (1982) J. Geophys. Res. 87, 9803-9820. [8] Grant J. A. (1987) Nasa Tech. Memo. 89871, 268p. A. B. and Author C. D. (1997) *JGR*, *90*, 1151–1154. [9] Edgett K. S. and Parker T. J. (1997) Geophys. Res. Let. 24, 2897-2900. [10] Parker T. J. et al. (1989) Icarus 82, 111-145. [11] Parker T. J. et al. (1993) J. Geophys. Res. 98, 11061-11078. [12] Parker T. J. (1989) LPSC XX, 826-827.

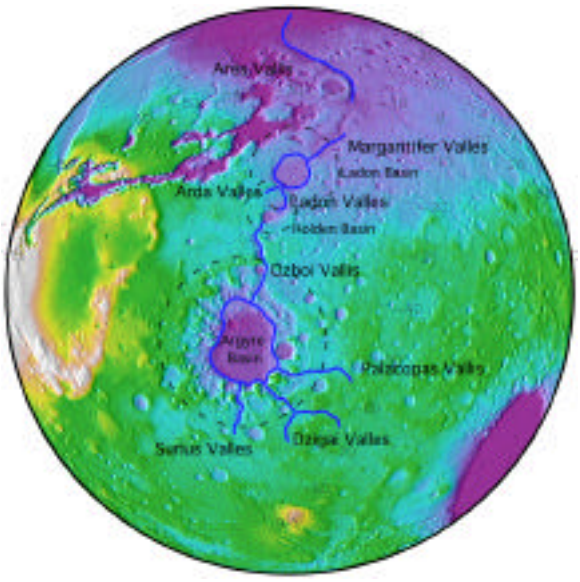

Figure 1: Hemisphere view of gridded MOLA topography, centered northeast of Argyre Planitia, with major channels and basins plotted.