FROM THE SOUTH POLE TO THE NORTHERN PLAINS: THE ARGYRE PLANITIA STORY. T. J. Parker[1], J. A. Grant[2], F. S. Anderson[3] and W. B. Banerdt[2], [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109, timothy.j.parker@jpl.nasa.gov, [2]Center for Earth and Planetary Studies, Smithsonian Inst., 4th and Independence SW, Washington, D.C. 20560-0315, [3]University of Hawai'i at Manoa, Hawai'i Institute of Geophysics and Planetology, 1680 East-West Road, POST 526B, Honolulu, HI 96822.

Introduction: Parker (1985, 1994) first described evidence for catastrophic flooding from a large lake or sea within Argyre Planitia through the Uzboi-Holden-Ladon-Margaritifer Valles system during the Noachian. The channel connection to Argyre had been recognized during the mid-1970s, based primarily on Russian orbiter images taken at that time (Kuzmin, pers. comm.). The most critical reviews of these inferences related to the relative timing of the plains materials, sinuous ridges, and debris aprons in southern Argyre, and the connection, via Uzboi Vallis, of ponding within Argyre to flooding through the Chryse Trough. The prevailing "competing" hypothesis for formation of materials within Argyre is that they are a result of south circumpolar glacial processes, with glacial scour and stagnation producing the pitting and sinuous ridges (eskers) on the basin floor (e.g., Kargel and Strom 1992) rather than lacustrine erosion and deposition followed much later by a process akin to rock glacier formation of the debris aprons in a colder Amazonian climate. Argyre was part of a larger surface hydrological system (the Chryse Trough (Saunders, 1979) that also included two large valley networks draining the Margaritifer Sinus region northwest of Argyre. The morphometry of these systems suggest a combination of precipitation and groundwater sapping, with surface runoff for their formation (Grant and Parker 2002).

Real Topography! The inference that a sea within Argyre drained catastrophically through Uzboi Vallis could not be verified with the low-resolution topography available prior to MOLA, because the source of Uzboi is obscured by two large craters (Hale and Bond) where it approaches Argyre's north rim, and the downstream end is overlain by Holden Crater. Viking data doesn't clearly show which way Uzboi Vallis flowed.

Results from the MGS mission (and now the Mars Odyssey Mission) offered the opportunity to revisit the controversial origin and timing of putative sedimentary deposits within Argyre, and test the inferences made about the history of fluvial and lacustrine degradation of the basin and Chryse Trough that were made by Parker based on Viking data.

Argyre Basin and the Chryse Trough Channel Systems: Argyre lies at the southern end of the "Chryse Trough," a broad topographic trough identified based on the Mariner 9 and Viking low-resolution topography (Fig. 6) which dips gently northward from Nereidum Montes to Chryse Planitia (Saunders 1979). The Mariner 9 and Viking Orbiter-based topographic maps that were available prior to MOLA were not of sufficient quality to map the continuity of this channel system, or even to verify that Uzboi Vallis flowed out of Argyre rather than into it. The new data from MOLA and MOC (and now THEMIS) is of sufficiently high resolution that this and a number of other nagging questions regarding Argyre Basin evolution and associated channels can now be addressed in detail. Geomorphic observations by Parker (1985, 1994), coupled with the global hydrologic models of Clifford and Parker (2001) and the MOLA topography appear to confirm that Argyre and the channels flowing into and out of it comprise the longest known fluvial system in the solar system.

Valley Networks draining 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 (1997) 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 more quickly than the outward-draining systems advanced headward, also during the Noachian. Surius and Dzígai Valles both head near the Dorsa Argentea Formation (Tanaka and Scott, 1987). This formation may be the remnants of a circumpolar lake or sea that overtopped the drainage devides at the heads of Surius and Dzigai Valles.

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 this lacustrine origin. Based on the hydrologic model described in Clifford and Parker (2001), 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 (necessary, unless polar temperatures were above freezing at the time). Such conditions are a plausible consequence of the planet's higher early geothermal heat flux and the high rates of polar deposition that are thought to have occurred at this time. The resulting lakes formed by this discharge would have spilled over local topographic divides into neighboring basins. But 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, catastrophic overflow through the Chryse Trough could commence.

Catastrophic flooding out of Argyre: The two outflow channels radial to Argyre 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 probably formed during the early Amazonian, after the major fluvial and lacustrine episodes had concluded (Parker 1989, 1994), and is unrelated to flow out of the basin.

Uzboi Valles flowed into Holden Basin prior to formation of Holden Crater (Parker 1985). 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 by Parker (1985). Ladon and Arda Valles converge on this ramp and drain into the interior of Ladon Basin. Parker (1985) 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 (Grant 1987).

The "Mouth" of Margaritifer Valles: 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 (MDIM-1 Areographic). 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 (Parker 1985).

The termination of Margaritifer Valles coincides with the location of the proposed "Meridiani Shoreline" (Clifford and Parker 2001), or Meridiani Level, the westward extension of a contact separating subdued highlands on the north from "rugged," channeled highlands to the south in Terra Meridiani (Edgett and Parker 1997).

The implication of this distributary pattern to distal Margaritifer Valles is that it may represent a delta that formed where catastrophic flooding from Argyre reached its base level in an ocean occupying the northern plains to about the -1500m elevation. The Meridiani Level is the highest stand of the ocean proposed by Parker et al. (1989, 1993) that had been proposed prior to preparation of this proposal.

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. 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 postdates the proposed Meridiani Level feature. It also post-dates the Arabia Level (above), and may be contemporaneous with the Deuteronilus Level (Clifford and Parker 2001).

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