HIGHLIGHTS FROM 1:500K GEOLOGIC MAPPING OF CENTRAL AND SOUTHERN ARGYRE PLANITIA. Timothy J. Parker; Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109.

The floors of the Argyre and Hellas basins contain etched layered material that is probably thick sedimentary deposits from channels that once flowed into them. Argyre is unique, however, because Uzboi Vallis flowed out of the basin, implying overflow of a lake within the basin. This makes it the largest impact basin on Mars with channels both draining into it and flowing out from it. Geologic mapping of the central and southern Argyre Basin has revealed a long and complex history of water and wind-related processes acting to shape the region over Martian geologic time. The following paragraphs summarize my inferences about the geologic history of Argyre. The more important conclusions are: (I) There is no evidence to suggest that Argyre Planitia is younger than any other large impact basin on Mars; (II) the channels radial to the basin are subsequent streams that developed after the elevated rim (or multiple rings) of Argyre had been breached by valley networks draining both inward and outward from an ancient drainage divide at the basin's rim; (III) Uzboi Vallis is late Noachian in age, and probably drained a lake within Argyre northward through Ladon Valles, Margaritifer Valles, through a predecessor to Ares Valles, and into Chryse Planitia; (IV) The layered material in the basin interior is lacustrine and ranges in age from late Noachian through early Amazonian; (V) the sinuous ridges developed with the accumulating interior sediments and emanate from Surius Vallis, and are likely aqueous sedimentary structures, either lacustrine barriers or glacial eskers; (VI) the debris aprons in Charitum Montes are very young (late Amazonian), but not modern, as they are lightly cratered.

Basin Degradation: Many of the Nereidum and Charitum rim mountains are flat-topped erosional remnants of the surrounding Noachian highlands surface (figure 1). Prior to late Noachian, this surface probably sloped gently into the basin's interior, similar to the nearby, but very degraded Ladon Basin. The tallest of the rim mountains, at several kilometers high, are along the basin's inside southern rim. Several of the mountains in this area have large, knobby terraces several hundred meters below the highest peaks that may be the erosional remnants of an early stage of basin broadening (and thus local deepening). The modern, "fresh" appearance of Argyre is due primarily to erosional "enhancement", rather than its "pristine" state of preservation relative to that of other large basins. Argyre's rim is, in essence, a model of the extensive fretted terrains along the lowland/upland boundary, and may have developed in the same way.

Channels: Surius, Dzigai, and Palacopas Valles are Hesperian in age, but probably occupy valleys that formed during the Noachian. Valley networks that flowed outward from a drainage divide at the basin's rim may have been captured by the inward-draining systems at this time. At least two episodes of outflow through the Chryse trough are evident in Uzboi, Ladon, and Margaritifer Valles (I) in the form of terraces and abandoned channels.

Interior Deposits: The most extensive layered deposits within the basin date to the Hesperian, though the plains surfaces in reentrants into the rim mountains are late Noachian. The interior deposits are etched, possibly by eolian deflation, such that the crater size-frequency curve is rounded off at smaller diameters (gradually, there is no distinct size cutoff). This etching appears to date to the late Hesperian or early Amazonian, though the rounding of the crater curve could indicate the process is active today.

Sinuous Ridges: A great deal of discussion has been devoted to the mechanism of origin for the sinuous ridges that are best imaged in Argyre, but can be found in Mare Australe (primarily in Dorsa Argentea, but in several other locations near the margins of the Dorsa Argentea formation), in Hellas, and Aeolis (near the equator). The direct link to Surius Vallis in Argyre seems to indicate an aqueous sedimentary origin, though perhaps eolian reworking of outwash sediments into linear dunes (e.g., I) should also be considered. The lacustrine barrier (2) and esker (3) models both raise difficult questions regarding the paleoclimate: If lacustrine, polar temperatures would have been above freezing (Mare Australe sinuous ridges), at least seasonally; and if eskers, basal melting of ice sheets would have to have been possible at all latitudes (Aeolis ridges).

How it Came About: Based on these inferences, I suggest the following scenario for Mars' climate history.

(I) The early Noachian was warm and wet, with atmospheric precipitation and surface runoff responsible for early degradation of the Argyre Basin (and other large impact basins).
Figure 1: Charitum Montes and southern Argyre Planitia. Flat-topped rim mountains (P) are probably remnants of a continuous Noachian highland surface that was deeply incised (as much as 5km or more along inner rim mountains) through erosional broadening of the basin interior. Knobby terraces (T), lie several hundred meters below the highest peaks and mesas and may represent an earlier base level of erosion. Portions of VO images 352s32-34. North is toward upper right.

(II) The late Noachian saw a change from this warm/wet climate to a drier climate that allowed surface water (channels and lakes), but in which atmospheric precipitation was very limited.

(III) Surius, Dzigai and Palacopas Valles could have been fed by polar cap melt and runoff, or overflow of a circumpolar lake during the late Noachian through the Hesperian. The climate at this time would have been wetter than today, but still arid relative to the Noachian, and either warm or cold (but above freezing seasonally at high latitudes).

(IV) Lakes may have existed intermittently in Argyre and the surrounding region from the Noachian through the early Amazonian, a span of more than two billion years.

(V) During the Amazonian, the planet's atmospheric pressure declined, and the climate changed gradually to its modern very cold, very dry condition. Eolian deflation of the Argyre interior sediments was probably initially intense during the early Amazonian, but fell with the steady drop in pressure and temperatures to the present day.