GEOLOGIC HISTORY OF CENTRAL CHRYSE PLANITIA AND THE VIKING 1 LANDING SITE, MARS; Robert A. Craddock, L.S. Crumpler, and Jayne C. Aubele; 1Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560; 2Department of Geological Sciences, Brown University, Providence, R.I. 02912

1:500,000 scale geologic mapping was undertaken to synthesize the broad-scale geology of Chryse Planitia [1] with the local geology of the Viking 1 landing site [2]. The geology of MTM's 20047 and 25047 has been presented previously [3]. As part of the goals for the Mars Geologic Mapping program, the rational and scientific objectives for a return mission to Chryse Planitia and the Viking 1 Lander have also been presented [4]. However, in mapping central Chryse Planitia our principle objective was to determine the depositional and erosional history of the Chryse Planitia basin. These results are outlined and illustrated (Figure 1) below.

The Chryse Planitia topographic depression was formed during the Noachian (~4.2 Ga), probably as the result of a giant impact [5]. The northern rim of this basin was destroyed when Acidalia Planitia was formed, which may have also been the result of a giant impact [6]. The intersection of these two basins, or the resulting overlap in topography, produced a large trough connecting Chryse Planitia to the northern plains (topography from [7]).

Emplacement of the Ridged plains materials, unit 1 (Hr.), occurred during the early Hesperian (~3.5 Ga). These materials are seen primarily in southern Chryse Planitia and also as windows (i.e., fensters) in the central portion of the basin. Because they pre-date most of the other material in the region, their exact extent is uncertain. Morphologically they are very similar to ridged plains materials seen elsewhere on Mars. Crater size-frequency distribution curves indicate that they are also identical in age to the ridged plains materials in Lunae Planum bordering Chryse Planitia immediately to the west. They probably represent flood lavas extruded through deep-seated faults associated with the formation of the Chryse Planitia impact basin or, alternatively, they may represent fluvial sediments from early channel forming events. The sharply defined wrinkle ridges suggest that regardless of lithology, these materials have been subjected to a compressional stress regime which was stable for a long period of time (early Hesperian through at least the middle Amazonian; ~3.5-1.5 Ga).

During the late Hesperian (~2.8 Ga), Maja Valles formed. These channels cut volcanic material from Lunae Planum and carried the sediments into Chryse Planitia, debooching them into the lowest portions of the basin. Perhaps as much as 62,500 km³ of volatiles were released during the formation of these channels [DeHon, personal communication, 1992], forming a standing body of water several hundred meters deep in the central portion of the basin. Formation of the circum-Chryse outflow channels to the south occurred soon after, releasing as much as 6.3 x 10⁶ km³ of water into the Chryse basin [8]. Such a large volume of water would have exceeded the volume of the basin contained within the ~1 km topographic contour line and flowed northward into Acidalia Planitia.

Kasei Valles appears to have been the last outflow channel to have debouched into Chryse Planitia, forming during the late Hesperian through the early Amazonian. Sediments from the formation of these channels would have debouched into a pre-existing standing body of water emplaced by the younger circum-Chryse outflow channels. Kasei Valles sediments may have discharge across Chryse Planitia by hypovolcanic flow so that suspended clays and silts were carried into Acidalia Planitia (as suggested by [9]). Because of the subdued nature of the wrinkle ridges in Ridged plains materials, unit 2 (Hr.), it is especially likely that these materials consist of fluvial deposits from the late-stage, Kasei Valles episodes of channel formation. Additional observation suggesting that these materials are fluvial in origin is the fact that they are at one of the lowest elevations on the planet (approximately ~2.5 km below Mars datum; topography from [7]), have a very gradational contact with Maja and Kasei Valles channel materials, contain several partially buried craters, and are surrounded by a large outflow channel complex.

Analysis of the buried and modified craters (i.e., eroded craters, Figure 2) in Ridged plains materials, unit 2 yield possible information about the spatial distribution of this material. Using equations for fresh martian craters [10], the rim heights for the buried craters (2.3-11.3 km in diameter) were calculated. These values were then compared to the actual rim heights calculated through shadow measurements. By subtracting the difference between predicted and measured rim height values, we calculated that Ridged plains materials, unit 2 are ~50 m thick along the southern contact and possibly become thicker towards the basin interior. This is probably the case because the sharp bend-over in the crater production curve at 5-km-diameter (Figure 2) suggests that most craters smaller than this diameter were eroded during the emplacement of the unit. This requires a substantially thicker deposit with a mean value of ~170 m. Throughout the Amazonian to the present, this unit has been reworked by aeolian activity.
Figure 1 (left). Geologic history of Chryse Planitia. Oldest is at the top. Noachian: 1. Formation of the Chryse Planitia depression from an impact. 2. Formation of Acidalia Planitia depression from an impact and possible subsidence of Chryse Planitia. Hesperian: 3. Emplacement of Ridged plains material, unit 1 in central and southern Chryse Planitia. Deposition of these materials in Acidalia Planitia is questionable. 4. Maja Valles debouches material from Lunae Planum into Chryse Planitia, perhaps filling the lowest portion of the basin with sediments and volatiles. 5. Kasei Valles debouches material from northern Lunae Planum into Chryse Planitia. The total volume of water discharged by the circum-Chryse outflow channel complex is approximately 6x the volume of the Chryse Planitia below -1 km in elevation. Volatiles would have overflowed into Acidalia Planitia, carrying finer-grained sediments into the northern plains. Were the boulders and rocks seen by the Viking 1 lander deposited by Kasei Valles as they emptied into a standing body of water? Amazonian: 6. Arcadia formation emplaced in northern Chryse Planitia and southern Acidalia Planitia (not seen in area investigated). If volcanic, the emplacement of these materials may have induced further Chryse basin subsidence. Note also continued formation of wrinkle ridges, suggesting that the compressional stress regime remained since the beginning of the Hesperian. Aeolian processes continued to winnow away finer-grained materials from Chryse Planitia.

Figure 2 (right). Crater counts for Ridged plains material, unit 2 (Hr2). Craters are classified as either fresh, rampart, or eroded (i.e., modified or buried). Note the bend over in the production curve at ~5 km suggesting that Hr2 is ~170 m thick.

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