GEOLOGIC HISTORY OF ISIDIS PLANITIA AND SYRTIS MAJOR PLANUM, MARS; *Robert A. Craddock,* Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560

Isidis Planitia is an extensive, semi-circular basin situated along the martian dichotomy boundary separating the southern cratered highlands from the northern smooth plains. Evidence for an origin by impact is clear: numerous mountains, morphologically similar to the massifs surrounding lunar basins [1], are aligned concentric to the Isidis plains. Concentric faults also appear to have originated from the Isidis impact, and these may have served as conduits for the volcanic material composing Syrtis Major [2]. High resolution Viking orbiter images (149, 150, and 151Sxx) show mounds ~500 m in diameter scattered on the floor of the Isidis basin. The origin of these features is less clear as various investigators have proposed volcanic cinder cones [3], pingoes [4], and glacial features [5] to explain them. In contrast, Nili and Meroe Paterae have only been examined in cursory studies [6, 7] despite their location within the classical albedo feature Syrtis Major and the limited number of highland volcanoes on Mars. 1:500,000 scale geologic mapping was undertaken to synthesize the broad-scale geology of both Isidis Planitia and Syrtis Major. The principal goals of this study are: (1) determine the geologic history of both Isidis Planitia and Syrtis Major Planum; (2) examine the nature of the dichotomy boundary separating Isidis Planitia from the southern cratered highlands; (3) interpret the most likely mechanism(s) for the formation of the small mounds and arcuate ridges on the floor of Isidis Planitia based on regional and local geology; and (4) because it is a simple area in which to land [8], determine the most feasible scientific objectives for a future surface mission. Because of the influence volatiles and aerosols released from volcanoes may have had in inducing or prolonging an early warm and wet martian atmosphere, the atmospheric contribution by Nili and Meroe Paterae is also being evaluated. Preliminary results are outlined and illustrated (Figure 1) below.

As the result of a giant impact [1], the Isidis Planitia topographic depression was formed during the Late Noachian (~4.2 Ga). The northeastern portion of the Isidis rim may have formed in a pre-existing topographic depression caused by the proposed Borealis basin [9]. Thus this portion of the rim would have been easily buried by subsequent northern plains volcanism. Alternatively, this portion of the rim may have been destroyed through local crustal thinning [10] during formation of the martian dichotomy. Crater age dates by Tanaka [11] suggest that Isidis (~1,100 km in diameter) is older than Argyre or Hellas, the other two large, well-preserved basins in the southern highlands.

Based on Earth-based radar elevation data, Nili and Meroe Paterae are best described as shield volcanoes [7]. Emplacement of the Syrtis Major Formation (Hs), the units comprising Nili and Meroe Paterae, occurred through the Hesperian (~3.3 to ~3.75 Ga). Detailed age-relations between Nili and Meroe Paterae have not been determined; however, age-relationships of flows suggest that Meroe may post-date the formation of Nili Patera. Topographic data also indicate that Meroe may have formed on the flank of Nili Patera, suggesting migration of the magma chamber. Using the base level of the volcanoes as the elevation of the surrounding cratered highlands, Schaber [7] calculated the volume of Nili and Meroe Paterae as being ~0.2 x 10^6 km^3. Assuming a basaltic composition with an average density of 2.6 g/cm^3, the total mass of material erupted is ~5.2 x 10^{17} kg. Based on terrestrial values of 1 weight percent for the released water content, the amount of water released into the martian atmosphere from eruptions of Nili and Meroe Paterae is ~5.2 x 10^{15} liters, or ~3 cm of water distributed globally.

During the late Hesperian (~2.8 Ga), deposits interior to the Isidis basin formed (unit Hvr). These materials contain the enigmatic mounds mentioned above as well as curvilinear ridges and arcuate boundaries. Recently, these later features have been interpreted as shorelines and sediments deposited by a standing body of water in Isidis Planitia [12]. Apron materials (Am) formed along the boundary separating Syrtis Major from Isidis Planitia and were emplaced immediately after the Isidis plains materials. Interpreted as landslides, these units may be the result of mechanical failure due to loading from the formation of Nili and Meroe Paterae.

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Alternatively, undermining of Isidis rim material from ponded water in the basin may have caused the Syrtis Major Formation to collapse catastrophically. Since that time, and continuing into the present, chemical weathering and aeolian redistribution of materials have created the classical albedo features visible from Earth today.

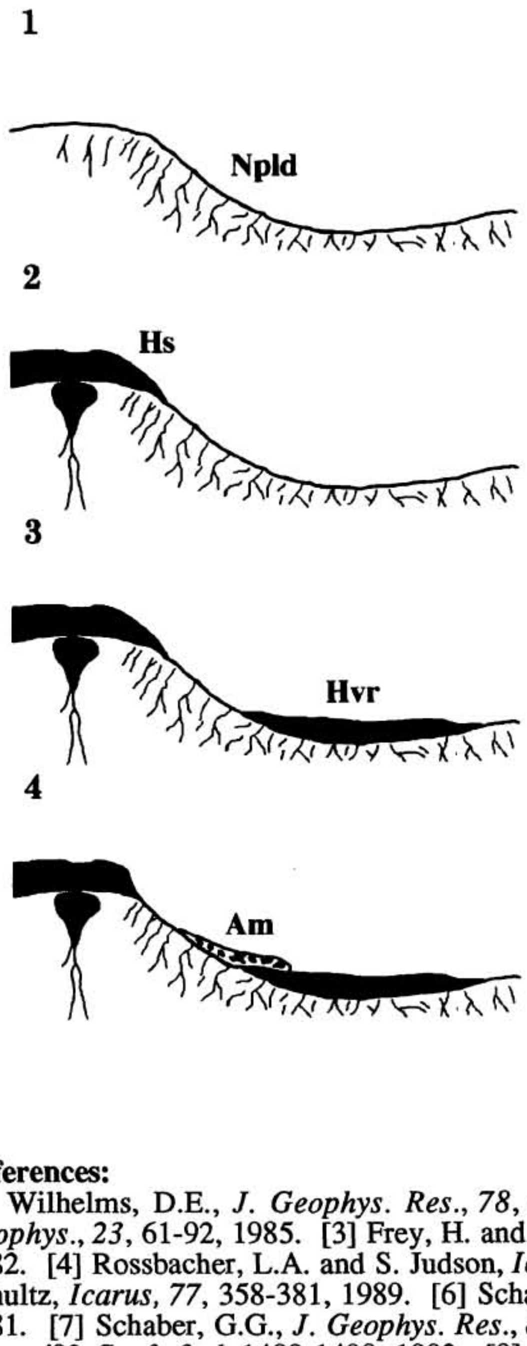

Figure 1. Generalized geologic history of Isidis Planitia and Syrtis Major Planum. Oldest is at the top. Profile is taken from the southwest to the northeast. Noachian: 1. Formation of the Isidis Planitia depression from an impact. Rim material remains visible in the cratered highlands as Npld materials. Hesperian: 2. Emplacement of Syrtis Major Formation (Hs). Meroe Patera appears slightly younger than Nili Patera. 3. Deposition of materials in the Isidis basin interior (Hvr). Presently, the origin of these materials is unclear. They are probably volcanic or sedimentary. Did they form in a standing body of water? Amazonian: 4. Apron materials (Am) form as the result of mechanical failure or undermining of Isidis rim material. Aeolian processes continued to redistribute materials within the region.

References:
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