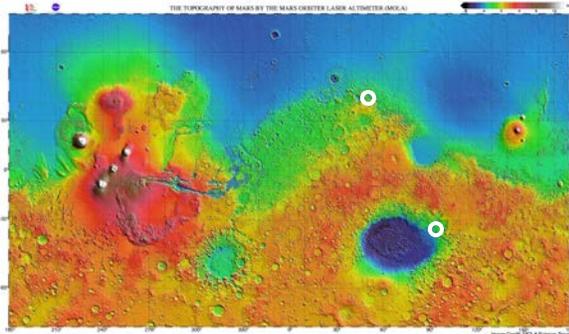


## NEW HIRISE OBSERVATIONS FROM TWO CANDIDATE HUMAN EXPLORATION ZONES ON MARS: MESOPOTAMIA AND PROTONILUS MENSÆ.

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**Introduction:** The Mesopotamia and Protonilus Mensae regions of Mars (**Figure 1**) are proposed as candidate exploration zones for the first human missions to the Red Planet [1]. Both of these 200 km diameter exploration zones are geologically intriguing and supply access to a necessary mission requirement, water, in the form of lobate debris apron glacial ice. Newly acquired HiRISE observations at these sites, two images from Mesopotamia and one image from Protonilus Mensae, are described in this study.



**Figure 1.** Locations of the Mesopotamia (southern hemisphere) and Protonilus Mensae (northern hemisphere) human exploration zones on Mars.

**Mesopotamia:** On the eastern rim of Hellas impact basin two large drainage valleys, Dao Vallis and Harmakhis Vallis, confine the area colloquially referred to as Mars' Mesopotamia. The Mesopotamia candidate human exploration zone (**Figure 2**) is a geologically diverse area featuring: Noachian impact massifs, Hesperian volcanics, impact craters, fluvial landforms, and glacial landforms. The glacial landforms will prove valuable for a human mission as a water resource.



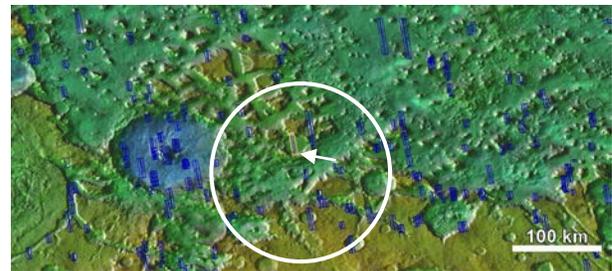
**Figure 2.** The Mesopotamia exploration zone (circled). HiRISE observations in blue, Figure 4 indicated by arrow.

**New Mesopotamia observations.** HiRISE image **ESP\_046587\_1435** (centered at  $-36.278^\circ$  x  $94.934^\circ$  East) was acquired at an altitude of 255.8 km with a resolution of 50 cm/pixel (**Figure 4**). Starting from the bottom and moving upward, this image shows: a high

elevation, glacially polished, Noachian-aged, Hellas basin impact massif with an interesting ridgeline; a debris apron deposit with glacial characteristics; a low-lying ground moraine; and the glacial drainage system.

HiRISE image **ESP\_045308\_1445** (centered at  $-35.311^\circ$  x  $93.648^\circ$  East) was acquired at a range of 254.8 km with a resolution of 25 cm/pixel. This image was acquired for landing site engineering purposes and is not featured below.

**Protonilus Mensae:** Along the planetary dichotomy boundary in the northern hemisphere, Protonilus Mensae is a uniquely fretted terrain with excellent prospects for future missions. The Protonilus Mensae human exploration zone (**Figure 3**) features: Noachian/Hesperian highland materials, impact craters, lineated valley fill, and glacial landforms. The glacial landforms will prove valuable for a human mission as a water resource.

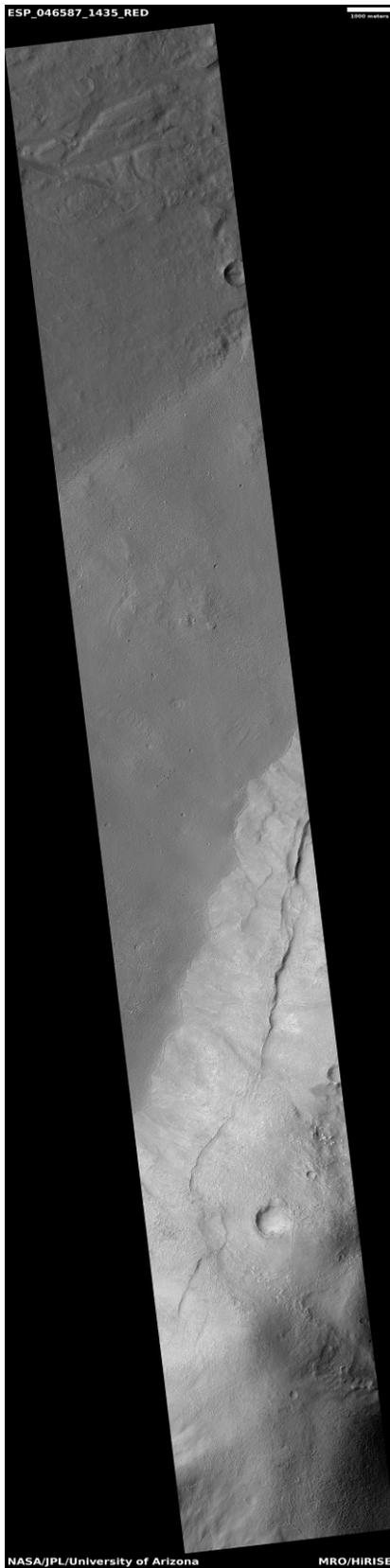


**Figure 3.** The Protonilus Mensae exploration zone (circled). HiRISE outlined in blue, Figure 5 indicated by arrow.

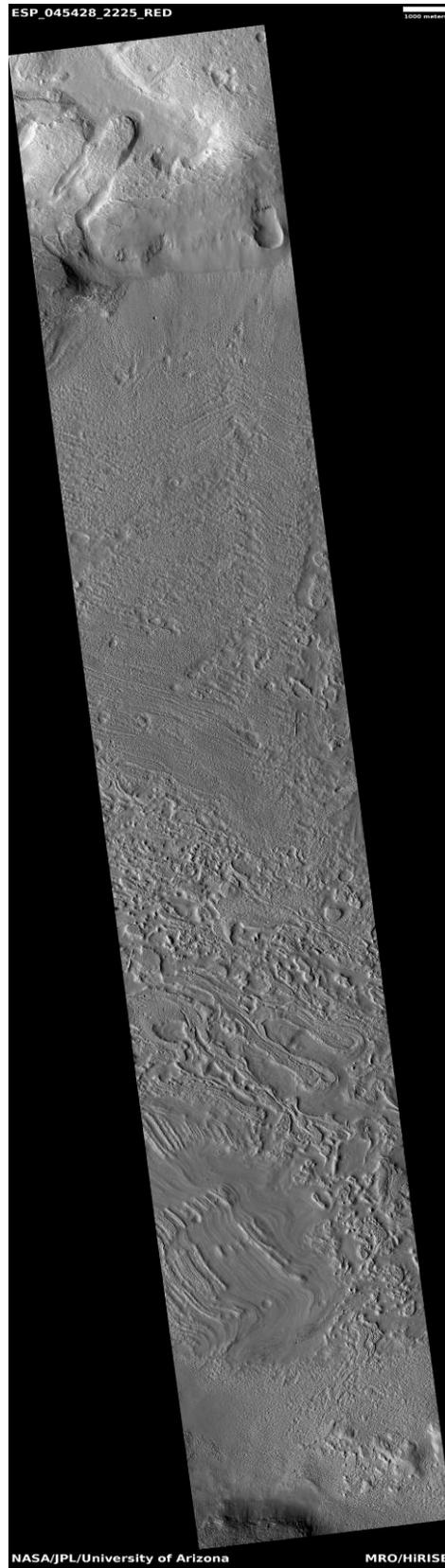
**New Protonilus Mensae observations.** HiRISE image **ESP\_045428\_2225** (centered at  $42.012^\circ$  x  $47.681^\circ$  East) was acquired at an altitude of 297.6 km with a resolution of 50 cm/pixel (**Figure 5**). The image spans the entire length of a XX km diameter crater, with the crater rim visible at each end. The top of the image shows evidence for waterflow into the crater. The interior of the crater is filled with sedimentary sequences, likely similar in deposition to the sediments of Gale Crater. Moving toward the center of the crater from top or bottom of the image reveals a sequence of brain terrain, to lineated terrain, to chaotic glacial terrain in the lowest elevations of the crater.

**Geologic Mapping:** Using the new HiRISE images presented in this study along with other observations in the area, updated geologic maps of the Mesopotamia and Protonilus Mensae regions are produced and will be presented at LPSC 2017.

**References:** [1] Gallegos Z. G. and Newsom H. E. (2015) *HLS2 Workshop*, abstract #1035 & #1053.



**Figure 4.** New HiRISE observation from Mesopotamia. Scale bar 1000 m, 50 cm/pixel.



**Figure 5.** New HiRISE observation from Protonilus Mensae. Scale bar 1000 m, 50 cm/pixel