A HUMAN EXPLORATION ZONE ON THE EAST RIM OF HELLAS BASIN, MARS: MESOPOTAMIA.

Z. E. Gallegos[1] and H. E. Newsom[1,2], [1]University of New Mexico (Institute of Meteoritics, MSC03 2050, 1 University of New Mexico, 87131; zachegallegos@gmail.com), [2]ChemCam (Mars Science Laboratory).

Introduction: The exploration zone concept for the human exploration of Mars provides the opportunity to consider many new scientifically compelling areas for future human missions. These exploration zones (EZ) offer a wide variety of scientific value from astrobiology to geochronology and direct new attention at the potential for resources, including access to useful materials and H_2O in the form of ice or mineralogically bound H_2O.

Astrobiology investigations may answer some of humanity's deepest scientific and philosophical questions. Currently, one of NASA's highest priorities is understanding if life ever arose, or even still exists, on Mars. Identifying areas with geomorphologic and/or chemical potential for preservation of biosignatures is central to the scientific goals for the EZ concept. A qualifying EZ will also provide outcrops that lead to understanding Mars' past and present. Observations can lead to inferences about the regional climate, and past environments for the planet as a whole.

Establishing a semi-permanent base for reoccurring missions to Mars requires *in situ* resource utilization (ISRU). Possibly the most important commodity for a Mars missions will be H_2O. Too heavy to transport from Earth, most water used by the astronauts for feedstock and civil engineering purposes must be locally derived. Silicon and metals (Fe, Al, Ti, Mg, etc.) will need also be mined on site.

Landing Site (Figure 1): The proposed EZ (94.02E, 35.352S) is located on the east rim of the Hellas Basin, between Niger/Dao Vallis and Harmakhis Vallis: Mesopotamia. This area is of scientific interest, however no past mission has ever landed in the region.

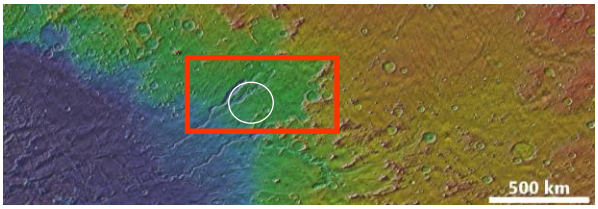

Figure 1a. Regional context. Figure 1b outlined in red.

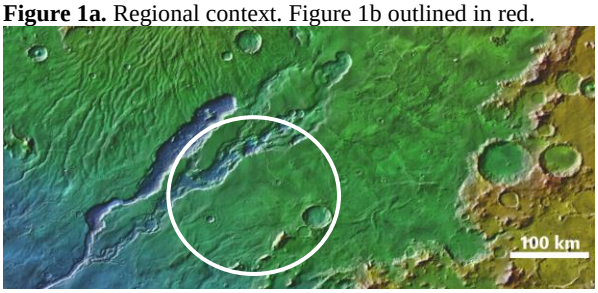

Figure 1b. EZ outlined in white.

Geologic units (**Figure 2**). The oldest geologic unit in the area (eNhm - grey) is the Early Noachian highland massif unit, and is the result of uplift from the Hellas impact. It comprises high-relief massifs separated by broad troughs and valleys. The next oldest unit (eHv - dark purple) is an Early Hesperian volcanic unit. Superposed on this unit is a Late Hesperian volcanic unit (IHv - light purple). Hadriacus Mons (Hve - red) is a volcanic edifice in close proximity to the EZ. The Amazonian and Hesperian impact unit (AHi - yellow) is also represented within the EZ. The youngest unit is an Amazonian and Noachian apron unit (ANa - light brown); the unit comprises primitive Noachian crustal remnants, most likely eNhm, draped by ice-rich Amazonian materials.

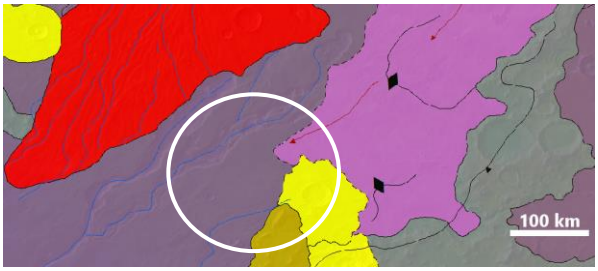

Figure 2. Geologic context in the EZ region [1].

Other features. This site is crosscut by a number of valley networks, of multiple scales, for investigation. Niger Valles, and other small networks to the south, are within the EZ and accessible by away missions. The margin of Dao Valles is within the EZ but may be inaccessible due to Niger Valles. Harmakhis Valles, the other large valley network in the region, is outside the EZ by ~75 km.

There are a number of impact craters, of varying scales, in the EZ area. Negele Crater is a young, complex impact crater ~37 km in diameter. Craters of this size can significantly alter the local geology/hydrology and are worth investigating. There are many simple craters to study in the area, the largest of which is Cue Crater (~11 km). Gander Crater (~36 km) and Nazca Crater (~15 km) are outside of the EZ by ~90 km, but proximal enough to potentially provide sampling of the Hve unit by their ejecta.

This EZ is located in an area of remnant magnetism as seen in MAG/ER data. Investigations of magnetic fields within samples may shed light on the issue of Mars' past magnetics and interior. The nearest band of negative magnetism would require unmanned, base-controlled rovers for sampling return.

Mission Requirements: The proposed EZ lies at ~35°S, within the ±50° latitudinal constraints set for the mission. The maximum altitude in the EZ is also well below the +2 km limit. Moderately low thermal inertia and moderately high albedo in the EZ signifies a relative lack of thick, fine grained dust deposits.

Landing Site (LS). A large area (~25 km^2) to the NW of the EZ center has been chosen as a reoccurring LS. The area is relatively flat lying, contains few craters, and no inescapable bedforms are currently observed within the LS.

Habitation Zone (HZ). At the center of the EZ lies the HZ, where the base of operations will be established. The location of the HZ is not final; this is an approximate location and can be up for discussion.

Regions of Interest: The initial stages of site selection for human missions rely on the identification of regions of interest (ROI). An ROI must be within 100 km of the HZ; however, unmanned, base-driven rovers may be able to traverse farther and retrieve samples. ROIs qualify an EZ on the basis of science and/or resource value. There are many potential ROIs in this EZ (**Figure 3**).

Science ROIs. This is a compelling site for astrobiology studies. The ANa unit (ROI 1), the multiple valley networks (ROI 2), and Negele Crater (ROI 3) will be investigated for past and present signs of life. ANa may be a current refugium for life, as the thick ice deposits may create pressures conducive for liquid H_2O, and possibly life. The valley networks are evidence for large amounts of past water flow and current H_2O ice. Whether they were long lived enough to preserve, or even harbor, life is still to be determined. Negele Crater offers a look at past atmospheric gasses trapped within its impact glass; impact glass is also a potential medium for biopreservation. Giant impact structures like Hellas can produce hydrothermal systems that persist for millions of years. This may have been a nursery for early life on Mars. Hydrothermal systems have yet to be confirmed in or near the EZ.

This site is also intriguing geologically. Units in the area range in age from Noachian to Amazonian, providing a large range of rocks and environments to study. ROI 1 offers a chance to sample Noachian age rocks within the moraines and till eroded from the high-relief massifs. Two identifiable volcanic units (eHv - ROI 4, iHv - ROI 5), will provide radiometric dating within the EZ to relate with the regional, and global, geologic context. Craters in the EZ are also of scientific interest. Negele Crater (ROI 3) offers a look at a young, complex crater impacting into Hesperian volcanics and possibly the ice-rich apron units as well. Several simple craters in the EZ (e.g. Cue Crater) will be investigated but are not considered ROIs. Craters Gander and Nazca are not ROIs themselves because they are outside the EZ, but they do offer a chance to sample Hve (a possible ROI 6) through their ejecta.

ISRU ROIs. The ANa unit (ROI 1) offers a large supply of H_2O ice [2]. Previous studies using SHARRAD radar data confirms these lobate debris aprons to contain one of the largest amounts of H_2O ice on Mars accessible with current engineering parameters [3]. The lineated valley fill features in the area (ROI 2) are a geomorphologic indication for large supplies of H_2O ice. The two volcanic units within the EZ (ROI 4, ROI 5) show localized concentrations of Fe in TES observations. TES observations also show sheet silicates/hi-Si glass within the EZ. They are concentrated in the volcanic units (ROI 4, ROI 5) and around Negele Crater (ROI 3) possibly as impact glass.

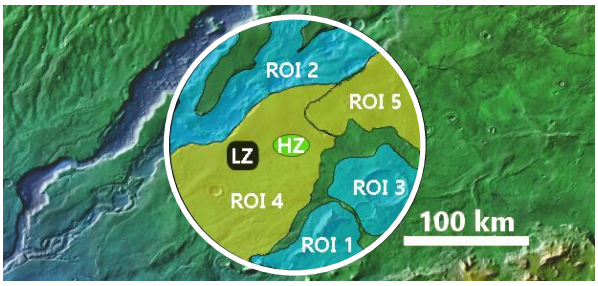

Figure 3. Science ROIs: yellow; ISRU ROIs: blue.

HIRISE, CRISM, and Future Datasets: There are abundant HIRISE and CRISM observations of the valley networks in the EZ (**Figure 4**); however, other units in the area would benefit from more data. Current and future orbiting missions should target this area to enable future lander, rover, and human missions.

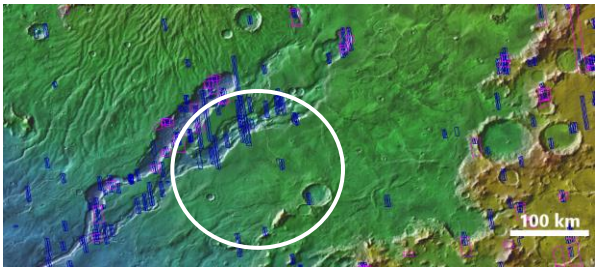

Figure 4. HIRISE (blue) and CRISM (magenta) coverage in the EZ region.

Conclusions: The proposed EZ, dubbed Mesopotamia, offers a new, scientifically exciting region with abundant resources for future human missions to Mars.

References: [1] Tanaka K. L. *et al*. (2014) USGS, Scientific Investigations Map 3292. [2] Levy J. S. *et al*. (2014) *JGR Planets, 119*. [3] Holt J. W. (2008) *Science*, V322, 1235-1238.