An Exploration Zone in Cerberus Containing Young and Old Terrains, Including Fossae/Faults and Shergottite Distal Ejecta

S.P. Wright[1], P.B. Niles[2], M.S. Bell[3], C. Milbury[4], J.W. Rice, Jr.[1], A.S. Burton[2], E.B. Rampe[3], P.D. Archer, Jr.[3], S. Piqueux[5], [1]Planetary Science Institute, Tucson, AZ; [2]NASA Johnson Space Center, Houston, TX; [3]Jacobs, Houston, TX; [4]Purdue University, Lafayette, IN; [5]Jet Propulsion Laboratory, Pasadena, CA

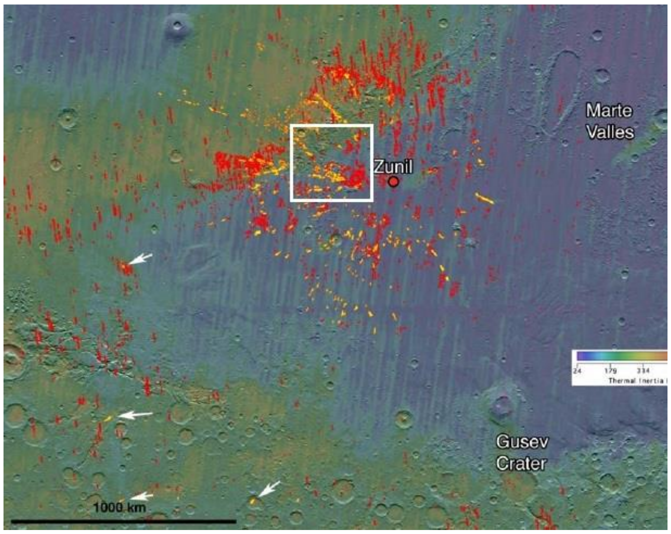
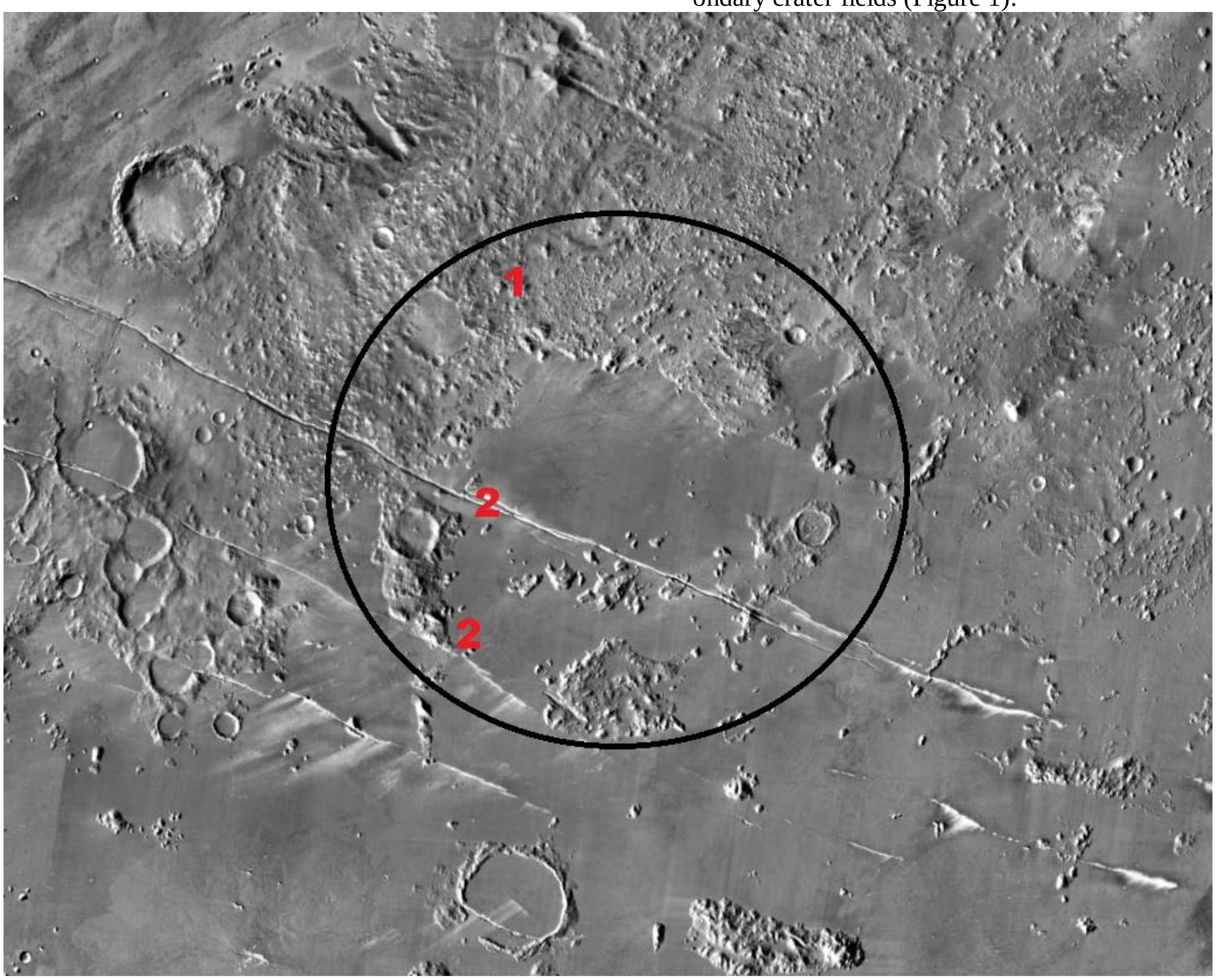


Figure 1. Regional (20° S to 34° N, 138° to 180° E) TES Thermal Inertia overlaid on a shaded relief map adapted from *Preblich et al*., 2007 and *Putzig et al*., 2005 showing the geologic context of the Exploration Zone (EZ) of Cerberus to the west of Zunil Crater in Figure 2. Ejecta rays from 10.1 km Zunil Crater are shown in yellow and secondary crater fields are shown in red. White arrows call attention to distal rays. White box is context of Figure 2.

Figure 2. Mosaic of daytime THEMIS TIR images showing 200 km diameter Exploration Zone with center landing site at 10° N, 162° E. Regions of Interest (ROIs) #1 (older, ridged and knobby terrain) and #2 (Fossae/faults) are labelled. Not labeled in Figure 2 are more ROI's: ancient crater rims, Amazonian lava flows, Zunil Crater ejecta rays and secondary crater fields (Figure 1).



Science ROI's:

- Older terrains that pre-date Cerberus lava flows are likely Hesperian or Noachian in age (ROI #1 in Figure 2). Knobby and ridged terrains generally suggest sedimentary rocks subjected to aeolian processes. These have implications for habitability and trapping ancient gases. Nearby photogeologic units that *might* be embayed in the EZ include the Medusa Fossae Formation and Southern Highlands' Cratered Terrain.
- Fossae (faults) (ROI #2 in Figure 2) can be put in a stratigraphic and geologic context, along with perhaps showing some groundwater/ground ice flow in Fossae (*e.g.*, HiRISE ESP_018708_1960). The nature of the Fossae could be explored (*e.g.*, tectonic rifting or subsidence).
- The center of the EZ are flat basaltic lava flows that can be dated and provide a regional geologic context as nearby, likely contemporaneous Elysium has been well-dated with crater counts.
- In agreement with E2E-iSAG, there will be a variety of lithologies and geologic materials to collect: igneous rocks, impactites, ejecta, embayed older terrains, aeolian sediments, regoliths/soils, dust, and perhaps aqueously altered (due to groundwater/ice) and/or hydrothermally altered samples (due to Amazonian volcanism). With complementary field data, these samples can be put into a geologic context for a better picture of the regional or perhaps global geologic history.
- Mars' dynamo was likely active until 3.6 Ga [*Milbury et al*., 2012], and would have shielded the atmosphere and atmospheric species (water) from loss due to solar wind erosion. The EZ is located within a region that is magnetized, so outcrops may have remnant magnetization and this may have allowed water to persist in this region past the demise of the dynamo. The localized magnetic field in the EZ could shield future explorers from solar radiation.
- Per the matrix template for EZ rubric, "primary and/or secondary crater ejecta" is a bonus ROI seen on Figure 1. HiRISE images suggest that ~1-2 Ma ejecta from 10.1 km Zunil Crater ~500 km to the east/southeast have covered the region with basaltic ejecta and secondary craters [*McEwen et al*., 2005; *Preblich et al*., 2007; *Tornabene et al*., 2006]. These distal ejecta may prove that Zunil Crater is the source region for the basaltic shergottites (2.9 Ma ejection event), olivine-phyric shergottites (1.1 Ma) or lherzolites (3.9 Ma) [Fritz et al., 2005]. With evidence for two periods of flood basalt volcanism in the nearby region, Zunil could be the source of ~175 Ma basaltic shergottites stratigraphically overlying ~330 Ma basaltic shergottites [*Wright*, 2007]. This potential ground-truthing of both shergottites and crater counts of the surface would benefit Mars science tremendously.

Resource ROI's:

- *Water or water ice as an in situ resource utilization (ISRU)* Cerberus region shows a high hydrogen abundance on GRS maps. Geomorphology of region (rootless cones, flood features) suggest flooding of water and near-surface ground ice/water either during or after the most recent volcanism. There is preliminary evidence that 2 or 3 Recurring Slope Lineae (RSLs) [*McEwen*, Mars 2020 Workshop, 2015] exist in the alluvial fans (or perhaps washes) exiting the older knobby and ridged terrain (ROI #1) into the younger lava flows (flat center of EZ).
- *Materials* Older knobs in ROI #1 (Figure 2) may be high in silica.
- *Infrastructure* Cobbles, pebbles, sands, and fines will be available. Volcanic and/or tectonic constructs from lava flows and Fossae may provide shelter in addition to potential present-day habitable environments (*e.g.*, amino acids found in a shergottite [*Callahan et al*., 2013]).

References: Boynton et al. (2002) *Science, 297,* pp. 81-85, doi: 10.1126/science.1073722. Callahan et al. (2013) *Met. & Plan. Sci.48,* pp 786–795, doi: 10.1111/maps.12103. Fritz et al. (2005) *Met. & Plan. Sci.*, *40*, pp. 1393-1411. McEwen et al. (2005) *Icarus, 176,* pp 351-381. Milbury et al. (2012) *JGR*, *117*, 2156-2202, doi: 10.1029/2012JE004099. Preblich et al. (2007) *JGR, 112,* doi:10.1029/2006JE002817. Putzig et al. (2005) *Icarus, 173*, pp. 325 – 341. Tornabene et al. (2006) *JGR, 111*, doi:10.1029/2005JE002600. Wright (2007) *7th Mars Conf.*, #3399.