# The Eastern Outlet of Valles Marineris: A Window into the Ancient Geologic and Hydrologic Evolution of Mars

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Over its 3,500 km length, Valles Marineris exhibits enormous range of geologic and environmental diversity. At its western end, the canyon is dominated by the tectonic complex of Noctis Labyrinthus while, in the east, it grades into an extensive region of chaos - where scoured channels and streamlined islands provide evidence of catastrophic floods that spilled into the northern plains [1-4]. In the central portion of the system, debris derived from the massive interior layered deposits of Candor, Ophir and Hebes Chasmas spills into the central trough have been identified as possible lucustrine sediments that may have been laid down in long-standing ice-covered lakes [3-6]. The potential survival and growth of Martian organisms in such an environment, or in the aquifers whose disruption gave birth to the chaotic terrain at the east end of the canyon, raises the possibility that fossil indicators of life may be present in the local sediment and rock. In other areas, 6 km-deep exposures of Hesperian and Noachian-age canyon wall stratigraphy have collapsed in massive landslides that extend many tens of kilometers across the canyon floor. Ejecta from interior craters, aeolian sediments, and possible volcanics (which appear to have emanated from structurally controlled vents along the base of the scarps), further contribute to the canyon's geologic complexity [2,3].

The proposed landing site is located at the eastern end of Vallis Marineris ($-4.1^{o}$, $-35.2^{o}$), to the northeast of Aurorae Chaos, where a single 50-75 km-wide channel represents the sole exist of the canyon system to the northern plains. The landing site has an elevation of -3.9 km, has local slopes of $<8^{o}$, does not contain thick deposits of fine-grained dust, and provides a suitable landing and habitation site.

Within the Exploration Zone (EZ), which extends 100 km around the landing site (latitudes: $-3.0^{o}$ to $-6.2^{o}$, longitudes: $-36.7^{o}$ to $-33.6^{o}$), there are multiple locations where each of the 6 Threshold (and several 'Qualifying') Scientific Regions of Interest (ROIs) (addressing astrobiology, atmospheric science, and geoscience) can be accessed -- as well as all of the Threshold and several of the Qualifying Resource ROIs identified in the Exploration Zone Rubric (including hydrated minerals [which can serve as a source of water], abundant cobble-sized and smaller rocks [which can serve as construction materials and be found throughout the EZ], and potential sites for the acquisition of metal or silicon feedstock [associated with likely sites of past igneous and hydrothermal activity]) [4,7.8].

The proposed EZ lies near the point of maximum constriction in the sole channel that drains Valles Marineris to the northern plains. It lies on smooth canyon floor material that is likely a mixture of rocks and sediment transported from both local and distant sources [4]. The canyon and surrounding plateau display considerable evidence of the planet's fluvial history, including (1) several regions of chaotic terrain, streamlined islands, and likely paleo lakes, on the canyon floor, that are believed to have been eroded or fed by Hesperian-age catastrophic floods [4, 9] and (2) valley networks, dating from the Late Noachian to Early Hesperian, that are found on the nearby plateau – which caps ~3-km exposures of older Noachian stratigraphy [3,7]. These landforms provide important clues to understanding the distribution and cycling of water in the ancient Martian crust.

**Summary.** The proposed EZ, at the eastern end of Valles Marineris, offers a unique potential for conducting geologic, hydrologic, and astrobiologic investigations of the planet's past. For this reason, it is an ideal target for future robotic and human investigations. Its location provides direct access to a stratigraphic record whose exposure and accessibility is unequalled by any other location on the planet. Given the geometry, and hydraulic history of the canyon, eastward flowing floodwaters may have

deposited rocks and sediments that represent a wide range of physical environments, origins, and ages, within the stratigraphic column – with a high potential for preserving evidence of past life. In addition, the local canyon walls provide access to ~3 km of Noachian stratigraphy, which is thought to preserve a record of the planet's most active period of volcanism, hydrologic activity, and possible evidence of an episodically warm early climate. For this reason, Valles Marineris represents an optimal location for conducting both an initial human reconnaissance and establishing a sustainable, long-term base of operations where long-distance traverses, geologic and hydrologic fieldwork, shallow and deep drilling, geophysical investigations, and astrobiological exploration, can be conducted for decades to come.

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