

Ancient Habitable-Trinity Mars and Future Targeting of potential Signs of Life

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Mars, the most Earth-like planet in our solar system, once had Habitable-Trinity conditions: an interfacing ocean, atmosphere, and nutrient-enriched primordial crustal materials with energy circulation driven by the Sun. Mars is thus considered the best target to search for life beyond Earth, as there are no other planetary bodies in our solar system that record Habitable-Trinity conditions. Following the termination of Habitable Trinity conditions nearly 4.0 Ga, when a strong dynamo shut down prior to the post-heavy-bombardment Hellas and Argyre impact events, the atmosphere was thinning, and plate tectonism was ongoing though waning, life would have found it increasingly difficult to survive at or near the surface, and thus would have migrated to the subterranean to persist. Vent structures, such as those located in the western part of Elysium Planitia where oceans once occupied the Martian surface and long-term magma-water interactions (billions of years) may be still ongoing, as evidenced through pristine lavas, faults that cut youthful surfaces, and geologically-recent flood events, are thus considered to be optimal targets to search for signs of life on Mars. The vent structures were formed by the transferal of subterranean materials to the surface likely due to magma-water interactions. The geologically youthful vent structures could be readily investigated in situ through current mission design.

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