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Ausonia Cavus and Environs – A geologic record of early Mars climate conditions

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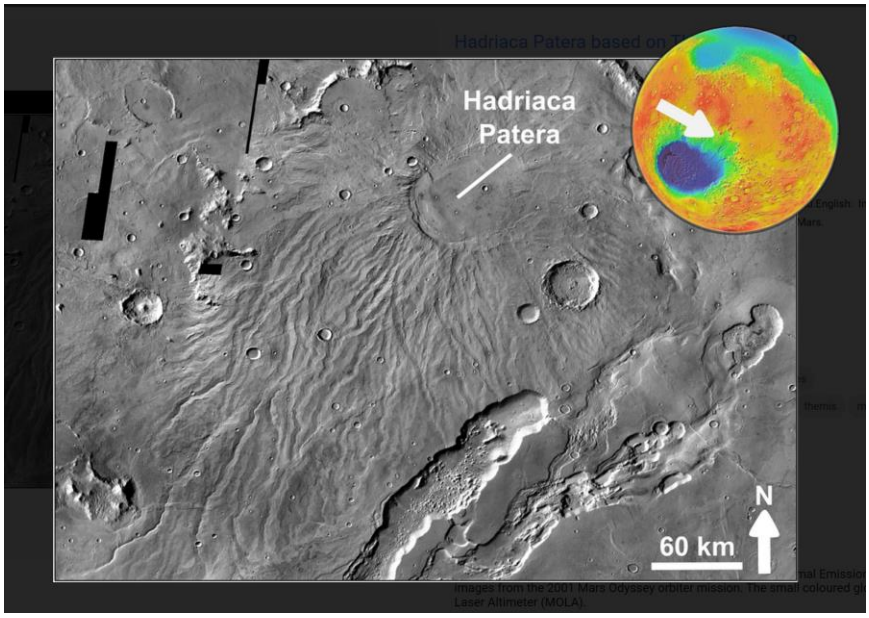
Ausonia Cavus (-31.92 °, 96.55 °) is a paleolake located on the northeast edge of the Hellas Basin. This area provides a geologic record of several diverse episodes which can lend insights into the climate during these actions. In particular, the morphology hints at various water interactions from ice underground to fluvial surface flows. Most of the activity here occurred from 3.5-4 Gya starting with the Hellas impact and extending into the early Hesperian. Events here contain information on the change of the atmospheric composition and pressure along with global magnetic fields. Events here could help bridge the gap between climate theory and geological observations for early Mars as a Rosetta Stone.

These strong science drivers were the compelling reasons for nominating this area as one of the candidate sites at the First Landing Site/Exploration Zone Workshop for Human Missions to the Surface of Mars in 2015. It is an area of Mars rich with numerous diverse geologic past events surrounding the Naochian to early Hersperan eras that can evidence climatic conditions during the early geologic evolution of the planet.



Underlaying this entire area are ancient (Pre-Noachian) early crustal units, exemplified by Ausonia Mensa, a large remnant mountain to the north of the lake, rising above earlier basaltic sheet layers. These may have been uplifted by the large basin-forming impact. The stratigraphy of Ausonia Cavus should provide details of these upper layers.

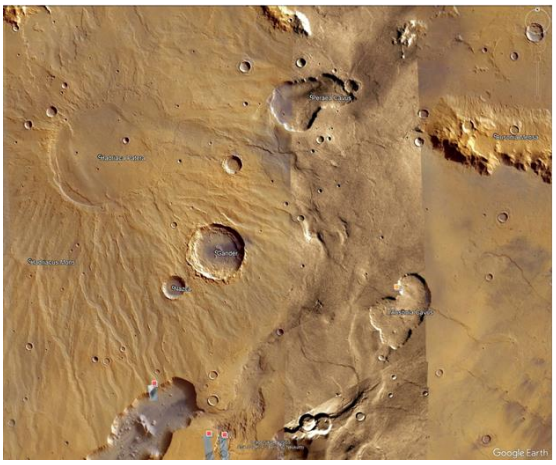
To the west lies Hadriacus Mons, one of the oldest central-vent volcanoes on Mars, a low-relief volcano with a central caldera complex which consists predominantly of pyroclastic material. The erosional structure of degraded valleys on its flanks is indicative of dissection by a combination of groundwater sapping and surface runoff, attributed to a hydromagmatic eruption scenario.

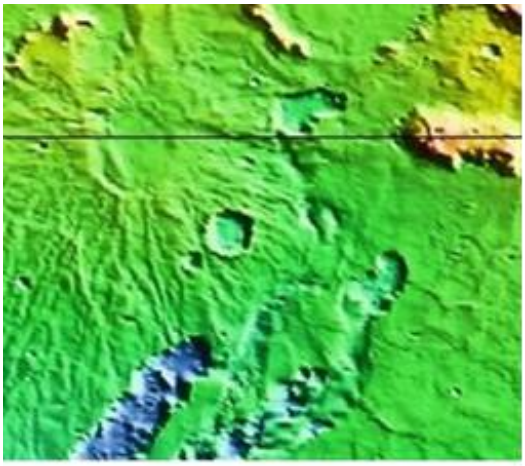
It also contains flows after the Hellas Planetia impact. Flows exhibit entrain magnetic direction, indicating that global magnetic field still existed. The flows also melted underground ice, causing the

collapsed morphology. This implies that all of the underground ice was not from sequestation by the cooling of the climate and loss of magnetic field. The origin of the paleolakes here may have been groundwater seepage and/or fluvial collection.

Another prominent feature is the Niger Vallis network which extends into the Hellas basin. The Niger Vallis formation was a multi-stage event. Both the stratigraphic analyses and crater counts suggest that the formation of southern Niger Vallis started from Ausonia Cavus ~3.7–3.9 Ga ago, soon after the formation of the plains and the first activity stage of nearby Tyrrhenus and Hadriacus Montes. The northern branch of Niger Vallis formed a bit later from neighboring Peraea Cavus, ~3.3–3.4 Ga ago. The lava channels on the flanks of Hadriaca Patera are clearly truncated by Dao Vallis and appear to be truncated by the channeled plains, indicating that the erosion of Hadriaca Patera preceded erosion on the plains.

Hellas Planitia was a southern sea when the Ocean Borealis filled 3.8 Gya. Both were important reservoirs for replenishing the early atmospheric water. Time lines for the filling and evaporation of Hellas reflect global climate conditions.





References:

Ausonia Cavus and Kasei Valles: Complementary Exploration Zone Sites for Biology, Geology and ISRU. J.C. Hamilton, S. Lundblad, D.L. Clark, N.G. Purves, C.T.Milovsoroff, N. Thomas First Landing Site/Exploration Zone Workshop for Human Missions to the Surface of Mars (2015)

Mapping and dating based evolution studies of the Niger Vallis outflow channel, Mars S. Kukkonen,V.-P. Kostama Planetary and Space Science Volume 153, April 2018, Pages 54-71

Paleolakes of Northeast Hellas: Precipitation, Groundwater-Fed, and Fluvial Lakes in the Navua–Hadriacus–Ausonia Region, Mars Henrik I. Hargitai, Virginia C. Gulick, and Natalie H. Glines Astrobiology 2018 18:11, 1435-1459

Precipitation and aridity constraints from paleolakes on early Mars. Gaia Stucky de Quay; Timothy A. Goudge; Caleb I. Fassett Geology v48 no12 1 Dec 2020

Mapping and dating based evolution studies of the Niger Vallis outflow channel, Mars S. Kukkonen , V.-P. Kostama Planetary and Space Science V153, April 2018, pp54-71

Geologic Evolution of Eastern Hellas, Mars: Styles and Timing of Volatile-driven Activity Crown, Bleamaster, & Scott Second Conference on Early Mars (2004)