Geology and mineralogy of the Auki Crater, Tyrrhena Terra, Mars: A possible post impact-induced hydrothermal system

F.G. Carrozzo[1], F. Altieri[1], G. Bellucci[1], G. Di Achille[2], F. Salese[3], E. D'Aversa[1], F. Oliva[1], G. Sindoni[1]

[1]Istituto di Astrofisica e Planetologia Spaziali, INAF, Rome, Italy
[2]Osservatorio Astronomico di Teramo, INAF, Teramo, Italy
[3]International Research School of Planetary Sciences, Dipartimento di Ingegneria e Geologia, UniversitàGabriele D'Annunzio, Pescara, Italy

Introduction: A variety of hydrothermal environments have been documented in terrestrial impact structures. Due to both past water interactions and meteoritic bombardment on the surface of Mars, several authors have predicted various scenarios that include the formation of hydrothermal systems. Geological and mineralogical evidence of past hydrothermal activity have only recently been found on Mars. Hydrothermal systems can also occur in impact structures, where the high temperature is due to the large amount of kinetic energy released and deposited into the rocks of the central up- lift by the passage of the shock wave (Osinski and Pierazzo, 2013).

The impact cratering process led to the exhumation of material from depth to the surface, and in some cases to the formation of hydrothermal systems in the presence of water, fractures/open porosity in the rock and a heat source. Additional heat is generated from the rocks of the central uplift due to the increased geothermal gradient (Osinski et al., 2013).

For these reasons, the central uplift plays a major role in the alteration mineralogy because that is the region with the highest temperatures.

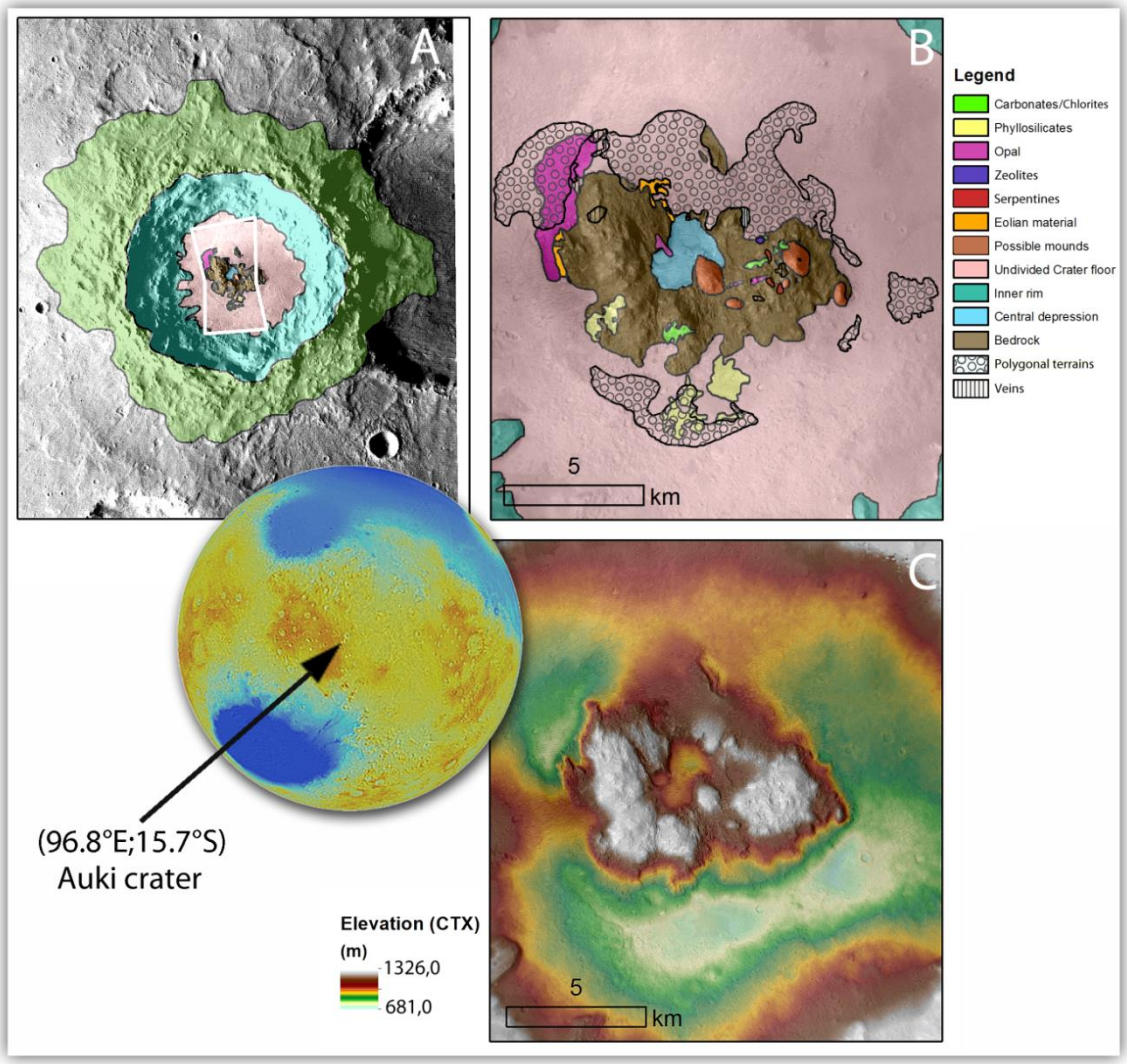

Figure 1: Location map of the Auki Crater (globe) and overall geomorphologic map of the crater showing (A) the footprint of the CRISM observation; (B) close-up of the geomorphological map for the central peak pit; (C) stereo-derived topography of the same region as figure B.

Results: Here, we present a geological and mineralogical study of the central uplift in Auki Crater using the spectral and visible imagery data acquired by the CRISM (Compact Reconnaissance Imaging Spectrometer for Mars), CTX (Context Camera) and HiRISE (High Resolution Imaging Science Experiment) instruments on board the NASA MRO mission. The Auki Crater is a complex crater that is ~38 km in diameter located in Tyrrhena Terra (96.8 °E and 15.7 °S) and shows a correlation between its mineralogy and morphology. The presence of minerals, such as smectite, silica, zeolite, serpentine, carbonate and chlorite, associated with morphological structures, such as mounds, polygonal terrains, fractures and veins, suggests that the Auki Crater may have hosted a post impact-induced hydrothermal system. Although the distribution of hydrated minerals in and around the central uplift and the stratigraphic relationships of some morphological units could also be explained by the excavation and exhumation of carbonate-rich bedrock units as a consequence of crater formation, we favor the hypothesis of impact-induced hydrothermal circulation within fractures and subsequent mineral deposition. The hydrothermal system could have been active for a relatively long period of time after the impact, thus producing a potential transient habitable environment.

References:

Osinski, G.R. , Pierazzo, E. , 2013. Impact Cratering: Processes and Products. Wi- ley-Blackwell, p. 330.

Osinski, G.R., et al., 2013. Impact-generated hydrothermal systems on Earth and Mars. Icarus doi: 10.1016/j.icarus.2012.08.030 .

Acknowledgements: This work was supported by ASI, Agenzia Spaziale Italiana , and the Italian Ministry of University and Research through the ASI grant no. I/06/08/0 and FIRB grant no. RBFR130ICQ . We thank Giuseppe Marzo for his useful suggestions that improved the data analysis.