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NASA Astrobiology Early Career Collaboration Award Report

My NASA Astrobiology Early Career Collaboration Award (ECCA) supported a research visit to the Department of Earth, Atmospheric and Planetary Sciences at the Massachusetts Institute of Technology (MIT), where I worked with Dr. Gaia Stucky de Quay. My aim was to record evidence of hydrologic reoccurrence within the established Martian crater lake system by integrating morphologic and mineralogic observations. We expanded from the original idea of only using ratio of inlet valley network (VN) and lake volumes to quantify number of hydrological cycles.

Specifically, I examined closed basin Martian paleolakes and their respective watersheds to constrain areas that preserved evidence of more than one hydrological events. At this outset, I used combination of multiple morphological, morphometric and mineralogical datasets for analysis which include Thermal Emission Imaging System (THEMIS)-IR Day and Night Mosaic [1] and HRSC and MOLA Blended Digital Elevation Model [2] for overall visualization of the study area and demarcation of its boundary; ConTeXt (CTX) Camera [3] and High-Resolution Imaging Science Experiment (HiRISE) [4] for detailed morphological and morphometric analysis; Full Resolution Targeted and Half Resolution Long/Short Targeted Reduced Data Record (TRDR) data products of Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [5] for mineralogical analysis. I used combination of observations suggests at least two discrete hydrologic events such as a. desiccation cracks overlaying bright-toned deposits, b. terraces within craters, c. presence of U and V shape of valleys within the same region, d. concentric ring craters, e. kink within the Crater Frequency Size Distribution plot, and f. presence of distinct minerals that need different formation environments in the same region (Fig. 1).

During my three-week visit, I leveraged the expertise at MIT in planetary surface processes and geomorphology to refine my analytical techniques. Beyond the data analysis, I met with the Gaia lab members weekly (in addition to personal meetings with my mentor) where, we gave weekly updates to each other and discussed a new article every Thursday. These meetings exposed me to ongoing research in the group, ranging from sediment transport modeling to the latest discussions on Martian fluvial geomorphology. I learned techniques for analyzing sediment transport dynamics in Martian valleys and developed a new proposal on layered ejecta craters, which we are planning to pursue in latter half of the year.

I also had a chance to visit Dr. Robin Wordsworth at Harvard University at Dept. of Earth and Planetary Sciences. I attended his lab meeting which provided a fascinating window into the broader planetary science community. I got to discuss different dimensions of planetary based studies ongoing in his lab with implications for future NASA missions focussing on thermal modeling of planetary bodies, exoplanets, Enceladus plumes and possibility of methanogens on Enceladus through microbial kinetics. My visit enabled an opportunity to discuss future collaboration that extend beyond Mars to icy worlds and exoplanets.

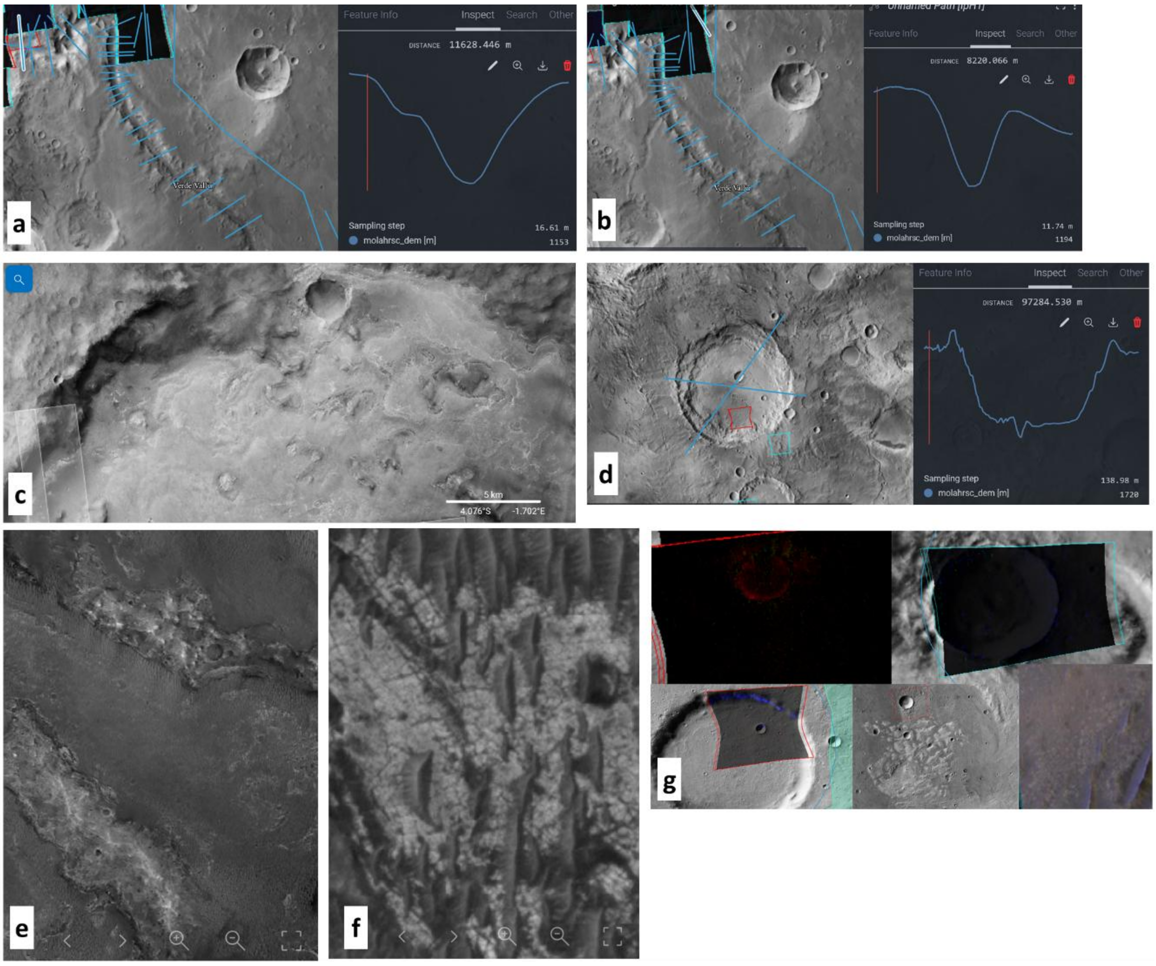

Fig. 1. Examples of different morphologic, morphometric and mineralogic features analysed to evaluate the number of hydrological events within the paleolake and its watershed region. a and b show change in valley shape. c denotes concentric bright toned rings within a crater. d. denotes terrace formation within a crater through topographic profile. e. depicts a bright a toned deposit and f is a zoomed in version showed bright toned deposits overlaying desiccation cracks. g. depicts CRISM images showing phyllosilicates/other hydrated minerals in the rim of crater ejected during the impact indicating presence of phyllosilicate layer underneath and bright toned deposits as seen on the surface of the same area in the present day, suggesting two different environments.

References

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