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Origin and nature of intercrater plains in northwestern rim of Hellas Basin

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1. Introduction

The nature and origin of intercrater plains within the martian cratered highlands is a major unresolved and controversial issue that have been somewhat enigmatic, receiving little attention since the Mariner era [1,2,3,4,5]. Are flat-lying smooth plains sedimentary or volcanic or both ? Whether these plains are mainly constituted of volcanic material or sediments is a crucial difference for understanding the surface environment of the Noachian period. In order to answer to previous question, we focus our study on the NW rim of Hellas basin defining first the relative stratigraphy and absolute age, throughout crater counting method, of the different units by a precise mapping and correlating then these units with mineralogy and texture.

Hellas region is a key because of the possibility to constrain these processes geographically and temporarily, including the presence of erosional windows, which is a key for enabling this work to distinguish the origin of layering. The study area could be of particular interest to the question of habitability. Indeed, there is the possibility that a variety of aqueous systems, in particular marine/lacustrine [6] and hydrothermal systems [7], may have formed in the region after the Hellas impact.

2. Data and methods

Visible light and thermal imagery was used for texture and stratigraphy from CTX (ConTeXt camera), HiRISE (High Resolution Imaging Science Experiment), HRSC (High Resolution Stereo Camera), THEMIS (Thermal Emission Imaging System) instruments. OMEGA (Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité) and CRISM (Compact Reconnaissance Imaging Spectrometers for Mars) data were used for detailed mineralogical analysis. Correlation between mineralogy, stratigraphy and texture is key in connecting together units and conclude for their origin.

Consistent with the approach that [8] applied to planetary mapping, we identify and map rock units and sedimentary cover on the basis of their apparent geologic uniqueness as defined by their primary physical features, areal extent, relative age, and geologic associations.

Primary features, including layering, albedo, and thermophysical character, formed during emplacement; whereas secondary features, including craters, ridge and valley networks or channels, are formed after emplacement. In many cases, especially in the presence of ghost, eroded craters or old ejecta, delineating primary and secondary features requires careful observation and may be difficult where overprinting of secondary features has masked, obliterated, or mixed with primary features. Units are primarily identified and delineated based on geologic relationships and relative ages. We determine the age of different units based on crater counting.

3. Preliminary Results

Hellas basin is characterized by the interaction between volcanism and sedimentary deposition as reconstructed by our geological map. The rim of the northern Hellas basin shows a complex geological history. There are sedimentary plains from which remnant buttes (ancient Hellas) standing up and locally crosscut/mantled by younger volcanic lava flows. We identify four kinds of deposits: bedrock, ejecta sedimentary and volcanic deposits. We focus our attention on intercrater plains and more specifically our analysis on sedimentary and volcanic deposits. Volcanic deposits are characterized by high thermal inertia in THEMIS nighttime images (Fig. A), rough surfaces (Fig. C) at CTX scale and they do not overlap high standing buttes (Fig. B).

Sedimentary deposits are characterized by low thermal inertia in THEMIS nighttime images (Fig. A) except for erosional windows with fresh material outcropping. They show very high thermal inertia, smooth surfaces (Fig. D) at CTX scale and they drape the morphologies. We use erosional windows and shoulder of fresh impact crater as natural cross-cutting section to reconstruct the stratigraphy of the studied area as shown in Fig. E, F, G. The analysis of crater statistics and derivation of crater model ages shows that sedimentary units were deposited at the end of the Noachian period whereas the volcanic unit represents a resurfacing event dated in the Hesperian. Sedimentary units drape bedrock hills postdating them.

Conclusions

These new data show a more complex geological history of northeastern rim of Hellas region. Our geological map reveals many previously unrecognizable units, features, and temporal relations. The presence of many sedimentary deposits question their origin as part of the sedimentary systems observed locally in Terby crater [9], linking the eroded region of Tyrrhena Terra to the putative paleolake inside Hellas Basin. Further work will attempt to correlate the geological units mapped with the mineralogy obtained from orbital spectrometers.

References

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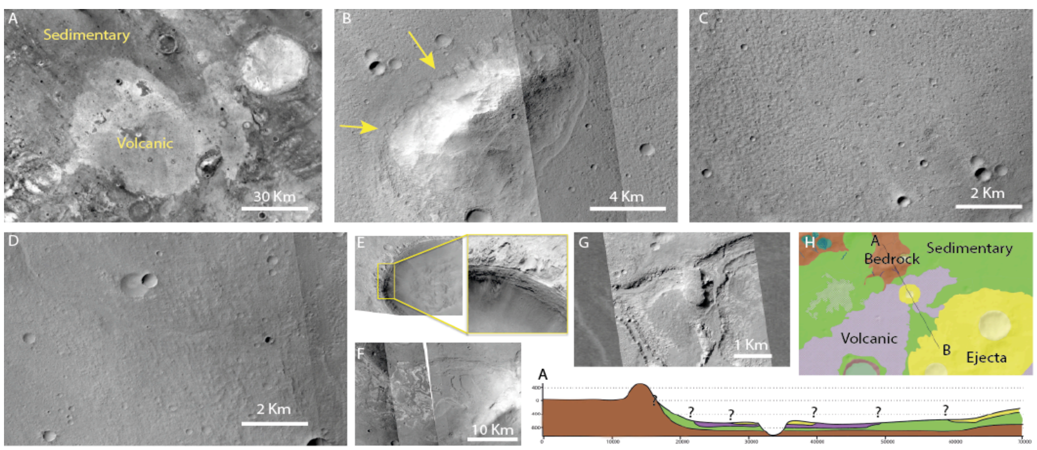

Figure A) THEMIS nighttime image shows sedimentary and volcanic deposits having respectively low (dark) and high (white) thermal inertia; B) Yellow arrows indicate that volcanic deposits don't drape the morphology; C) Particular of rough surface of volcanic deposit; D) Particular of smooth surface of sedimentary deposit; E) Shoulder of fresh impact crater in sedimentary deposits showing in the inset well stratified sedimentary deposits; F/G) Erosional windows in sedimentary deposits showing well stratified and laterally continuous sedimentary deposits. At CTX and HiRISE scale respectively; H) Example of geological map and stratigraphic profile of the study area.