GEOMORPHOLOGIC EVOLUTION OF THE ZONE OF HADRIACA PATERA IN MARS.

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Introduction:

The procedure, analysis and results of photointerpretation of Hadriaca Patera region are presented in this work; this region is located in the southern hemisphere of Mars, and it contains a variety of distinctive landforms such as volcanic areas, areas of collapse and impact craters.

Photointerpretation:

The images obtained in JMARS (Java Mission-planning and Analysis for Remote Sensing) were worked in ArcMap, GlobalMapper and JMARS, on which the photointerpretation of the volcanic area and surrounding characteristics was performed.

Physical Features of Hadriaca Patera. It is a volcanic area characterized by a caldera, lava emplacements and pyroclastic flows. I also found two large structures collapse that formed channels Dao and Niger Vallis which have a NE-SW orientation. Northward of the channels there are two zones of collapse called Peraea and Ausonia Cavus (see Figure 1).

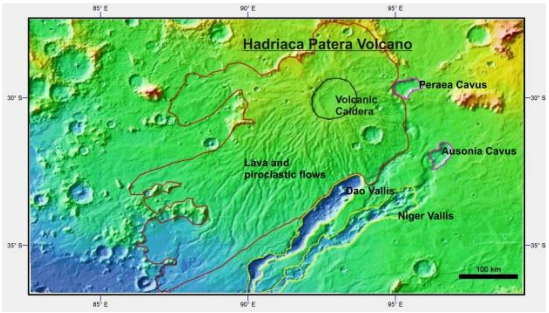

Figure 1. Delimitation of the major landforms of the Hadriaca Patera region.

Relative dating of events. In the area of study of Hadriaca Patera there is evidence of impact craters with variable diameters, ranging from hundreds of meters to tens of kilometers; a relationship exists between age and diameter of these craters because the larger the diameter, the older the age of impact allowing to establish a relative time scale of events. In the study area, the craters were counted according to their size and relationship with major geological events (lavas and pyroclastic flows, areas of collapse, and pre and post-eruptive events). From this, the relationship between the size and the relative age of the craters in Figure 2 is performed.

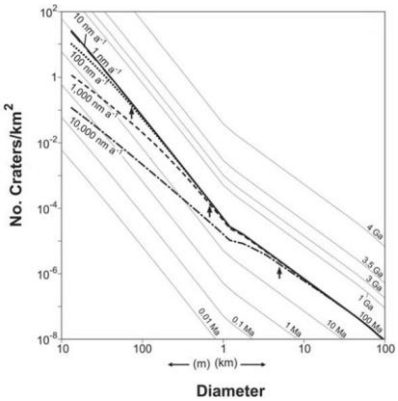

Figure 2: Association of number of craters per square kilometer vs crater diameter, establishing slopes indicating a relative age on Mars [1].

Geomorphological and volcanic zone analysis. One of the most significant features is the caldera, which has a diameter of about 80 km. Lava flows are the second feature whose extensions reach hundreds of kilometers; and the presence of a radial drainage on a planet that currently has no water.

First, Hadriaca's lavas must be ultrabasic i.e. very fluid, these conditions and a denser atmosphere that could keep them hot would let lava to move through great distances. Another feature of the volcano is its radial drainage; it must have been the product of strong erosion. One hypothesis states that Hadriaca Patera was built by pyroclastic flows from a freatoplinian eruption [2]; when the magma was raising, it met the "permafrost" increasing the content of volatiles in the lava and creating a freatoplinian eruption characterized by violent expulsions of gases, fine particles (ash), tuffs and volcanic mud [2]. Because the volcanic deposits are unconsolidated materials, they are easily eroded; this indicates that there was frequent rainfall and different atmospheric conditions which generated appropriate pressure and temperature in order to keep a liquid on Mars's surface.

Geomorphological analysis of the areas of collapse. Dao and Niger Vallis are channels in which old streams carried sediment to Hellas Planitia. On the other hand, Peraea and Ausonia Cavus are two cavities located northeast of Hadriaca Patera which subsidized but not formed any channel or connection between them. The edges in flower shapes or concave called "crowns of collapse" are evidence of collapse processes. Also, it was observed that Dao Vallis channel is younger than Hadriaca Patera's flows, using the principle of superposition.
The landforms of collapse support a freatoplinian eruption, because the existence of a permafrost, which interacted with the magma during its ascent [3], producing the fusion of frozen water and the formation of cavities under the surface.

Results

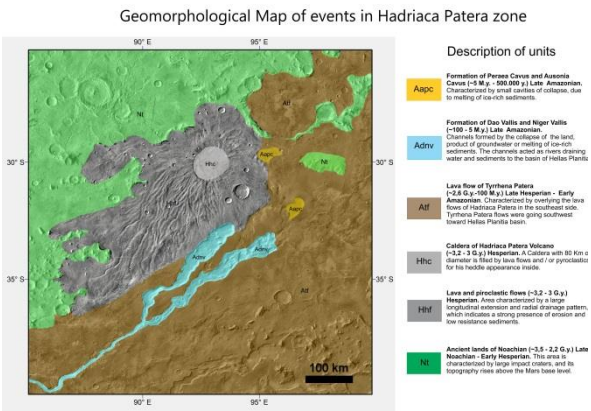

Figure 3. Final results of the work. Geomorphological Map of events in Hadriaca Patera zone.

Conclusions

By impact craters we can estimate the relative age of the studied events using the principle of superposition.

With a detailed study of landforms, we can infer the presence of a denser and more dynamic atmosphere in the past, which favored the development of drainage systems, basins and areas of collapse or subsidence by the action of some fluid (possibly water).

Another aspect that favors the idea of a different atmosphere is based on the extension of the lava flows of the study area, because a denser atmosphere would allow the lavas to keep warm in order to reach great distances; however, it cannot be excluded that during the Hesperian, lavas might have had a ultrabasic character favoring its fluidity and ability to cover large areas.

According to the topography, the extent of volcanic deposits and the caldera size, it can be inferred that these features were associated with an explosive event characterized by a contact between magma and groundwater levels, producing a freatoplinian eruption.

Finally, we must mention the importance of the comparative study of the internal and external geodynamics of the Earth in order to understand the geological processes that rule other celestial bodies; therefore, the interpretations made in this work were based on comparisons between Mars and Earth.

References:

[1] Smith, M., Gillespre, A., & Montgomery, D. (2008). Geophysical Reseachletters, Vol. 35, págL10202 –L10208. [2] Crown, D.A. and Greeley, R. (1993) J. Geophys. Vol. 98, 3431 – 3451., [3] Crown, D. A., Price K. H., and Greeley R. (1992) Icarus, 100, 1–25.