THE CHAIN OF ROOTLESS CONES IN CHRYSE PLANITIA ON MARS. L. Czechowski[1], N. Zalewska[2], A. Zambrowska[2], M. Ciążela[3], P. Witek[4], J. Kotlarz[5], [1]University of Warsaw, Faculty of Physics, Institute of Geophysics, ul. Pasteura 5, 02-093 Warszawa, Poland, lczech@op.pl, tel. +48 22 55 32 003, [2]Space Research Center PAS, ul. Bartycka 18 A, 00-716 Warszawa, Poland, [3]Space Research Center PAS, ul. Bartycka 18 A, 00-716 Warszawa, Poland (presently Institute of Geological Sciences, PAS. ul. Twarda 51/55, 00-818 Warszawa, Poland). [4]Copernicus Science Centre, ul. Wybrzeże Kościuszkowskie 20, 00-390 Warszawa, Poland, [5]Łukasiewicz Research Network - Institute of Aviation, Al. Krakowska 110/114, 02-256 Warszawa, Poland.

Introduction: We consider a small region in Chryse Planitia (~38º14′ N, ~319º25’ E) where several chains of cones are found – Fig. 1. The cones height are ~10-20 m. The considered region is at the boundary of smooth plain on west (AHcs) and complex unit (AHcc) on east. The small region (HNck) in north-west corner is the “older knobby material” – [1], where AH means Amazonian-Hesperian, and HN - Hesperian-Noachian. The region is covered by lacustrine deposits. Note also possible lava flows (in HNck).

Small cones are common on Mars. Many cones form chains several kilometers in length.. The mechanisms of their formation are not explained, nor processes responsible for their arrangement in chains.

The main subject of our research is the chain of cones labeled 7 in Fig. 1. This chain is in a valley.

Mechanism of cones formation: Generally there are 3 mechanisms of these cones formation: (i) a grains’ ejection, (ii) from mud or fluidized sand and (iii) explosive formation. Of course, the cones may be formed by several processes.

A rootless cone, known also as a pseudocrater, is a volcanic landform which resembles a true volcano but without vent from which lava could have erupted. Rootless cones are formed by steam explosions as a result of flow of hot lava over a wet surface, such as a permafrost or a swamp. The hot steam could break through the lava layer eventually forming a cone from tephra like a real volcanic phreatic eruption.

Our hypothesis: The chain 7 under consideration is located in a valley between two hills. The area west of the hills is higher than the area to the east. Therefore we suppose that the valley was formed by the flow of water (from west to east) during one of the flash floods. These floods were related to the emergence of large outflow channels.

The considered chain of cones follows the course of the valley quite well. Therefore, it is difficult to expect that the cones in the valley are cones of igneous volcanism.

Our hypothesis predicts that: (i) the regolith at the valley floor contained significant amounts of water left over from the floods. (ii) In the next stage, there was an overflow of lava in the vicinity of the area currently covered by "old knobby material" (HNck). This lava flowed into the valley creating a series of rootless cones. The material ejected by the explosion covered the valley and the slopes of the neighboring hills. (iii) Later, the lower structures (including the valley floor) were covered with fine aeolian sediments.

To test this hypothesis, we computed the apparent thermal inertia in this area.

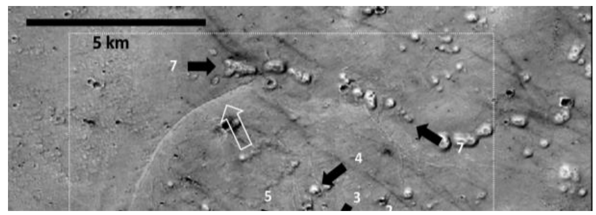

Fig. 1 The region considered in the abstract. The chains of cones are indicated by black arrows and numbers. Here we suggest that the chain 7 may be a chain of rootless cones formed at the bottom of the valley. NASA.

Fig. 2. ATI along chain 7 (see Fig. 1), calculated from the THEMIS thermal bands and CTX based albedo. Dark blue - low values, green-yellow - high values). The low values of ATI in the bottom of valley are probably a result of later fine aeolian deposits. The high values on the both sides the valley indicate larger grains on the surface.

Thermal inertia (TI or *I*): *I* describes reaction of the temperature of the planetary surface to the changes of insolation. The thermal inertia unit (in SI) is defined as: 1 tiu = 1 J m^{-2} K^{-1} $s^{-1/2}$. *I* is defined as:

$$I = (k \rho c)^{1/2}, \quad (1)$$

where k is the thermal conductivity [W m^{-1} K^{-1}], ρ is the density, and c is the specific heat capacity.

Apparent Thermal Inertia - data: Apparent Thermal Inertia (ATI) approximates the thermal inertia and is based on remote sensing data. Therefore it is used in planetary studies. The fundamental equation used for ATI calculation is:

$$ATI=(1-A)/\Delta T, \quad (2)$$

where ATI is in cgs unit (i.e., in: cal cm^{-2} K^{-1} $s^{-1/2}$ = 4.1855 10^4 tiu), ΔT is the diurnal temperature difference (in K), and A is the Lambertian albedo (dimensionless).

Interpretation: the value of *I* for non-indurated regolith is mainly controlled by the grain diameter *d*, i.e. unconsolidated fine material has lower TI than regolith covered by large grains or consolidated rocks. We found that [2]:

$$d=(I^2/ (CP^{0.6} \rho c))^{-1/ (0.11 \log(P/K))}, \quad (3)$$

where grain diameter *d* is in μm, ρ is density, *c* is specific heat, *C*= 0.0015, *K*=81000 Torr, *P*=5 Torr, i.e., average Martian atmospheric pressure (1 Torr = 133.322 Pa).

Conclusions and future plans;

A comparison of the maps in Figs 1 and 2 shows that the considered chain of cones sequence may be a chain of rootless cones. Accepting another hypothesis poses a number of difficulties. If it were to be igneous cones, then it would be necessary to explain why their chain corresponds exactly to the course of the valley formed by external factors. It is also difficult to accept the hypothesis considered by [2] that these cones were created as a result of the interaction of water in the regolith and the hot igneous intrusion beneath it.

In future research we plan to use numerical modeling of cone formation and to consider other chains of cones in similar situations.

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References

[1] Rotto, S., Tanaka, K. L. (1995) Geologic/ geomorphologic map of the Chryse Planitia: region of Mars. USGS. [2] Czechowski L., et al. (2020), Cones chains in Chryse Planitia and some thermodynamic aspects of their formations. submitted.