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Search for Climatic Signal in Pavonis Mons Fan Deposits, Mars

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Introduction: Mars has experienced large variations in its orbital parameters throughout its history. They are calculable for the last 10 million years, with periodicity of 120 000 years for its obliquity, 95 to 100 000 years for its excentricity, and 51 000 years for its precession, however they become undetermined beyond 20 Myr [1]. Laskar et al [2] define a standard model of Mars' insolation parameters over 4 Gyr with the most probable values 0.068 for the eccentricity and 41.80° for the obliquity.

Climatic consequences: At high obliquity, significant amount of ice can be deposited as ice at low latitudes. General circulation models predict an annual net accumulation rate of ice on the west of Tharsis volcanoes.

Pavonis fan shaped deposits: We analysed Mars Express images obtained over orbit 946, of the west fan deposit at Pavonis Mons. The analysis of the HRSC images shows around 15 ridges, with interval 0.5 - 4.5 km. The interaction with the underlying surface can be seen, indicating the overlap of different episodes. The ridges are interpreted as drop debris on the front edge of a cold glaciar during its slow retreat. On the other hand isotropic knobbies , circular sub-km-scale hills are interpreted as results of fast glaciar sublimation. By texture analysis we could distinguish ridges, knobbies from various episodes and relate them with geological studies [3].

Glaciar model: For this basic study, we choose the simplest model of glacier. The bed is believed to be horizontal, and does not interfere with the glacier. If the ridges are due to obliquity oscillation, the rate of snow fall and sublimation must depend slightly on obliquity. Indeed, with accumulation rates and ablation rates at the same order, we are able to find oscillation of the glacier extent. We can see oscillations of the glacier

extent from the beginning. It is interesting to notice that this shape is consistent with the observation of older outer sets of ridges, and young inner ones. The maximum extents, which we intent to link to the position of the ridges are organized by groups of 4 or 5.

The outer ridges we see on Pavonis Mons date back to 10-200 million years ago. We know that the obliquity raised 5 million years ago. The recent lowering of the obliquity could have triggered inner ridges too, but the outer ones we see look older. To account for their formation, we have to find an area of great variation in obliquity, allowing the glacier to form and retreat, before 10 millions years ago. A threshold obliquity angle above 35 deg for effective ice deposition is needed to account for a glacier older than 10 million years.

Conclusions and Perspectives: Ridges in Pavonis Mons Fan deposits could be interpreted as cold glaciar debris tracing climate changes. Texture analysis to distinguish units and episodes from different obliquity and climate variations. We developed a simple qualitative glaciar progression/recession model. One needs to better quantify ice deposition/ablation net rates vs obliquity. We find that a 45 deg obliquity deposition threshold could better describe the Pavonis Mons Fan deposits data. Next steps in modeling should include the effect of topography, slopes, orientation. The geologic stratigraphy can constrain the evolution of fan deposits [3], in conjunction with crater counts dating and chronology . The climatic signal imprinted as ridges could be determined over the period of large extend of glaciar, and could permit to constrain the undetermined obliquity variations beyond 15 Myr [2].

References: [1] Laskar et al 2002 Nature 419, 375, [2] Laskar et al (2004, Icarus, Volume 170, Issue 2, p. 343-364. [3] Shean, D.E., Head, J.W., Marchant, D.R. 2005, JGR, 110, E5