INVESTIGATING SOME ALLEGED SUBAQUEOUS MORPHOLOGIES AND THE DYNAMICS OF SEDIMENT FLOW IN THE NORTHERN LOWLANDS OF MARS. Fabio Vittorio De Blasio[1], [1]Dept. of Earth and Environmental Sciences, University of Milano Bicocca, P.zza Scienza 4, Milano, Italy. E-mail: fabio.deblasio@unimib.it

Introduction: This composite investigation deals with the hypothesis of an Oceanus Borealis that might have filled the northern Martian lowlands. The ocean has been suggested as soon as the global Martian dichotomy and the smooth characteristics of the Vastitas Borealis formation were recognized [1-2]. Apart from the search for ancient shorelines and fluvial deltas [2,3,4], there has not been much work on peculiar subaqueous morphologies that could still be noticeable, such as subaqueous mass flows [5]. Fewer still contributions have addressed the dynamics of water and sediment flow in the hypothetical ocean. On Earth, clastic sediments are mobilized differently in the ocean compared to land. While subaerial clastic sediments (e.g., fluvial) tend to be dumped *en masse* in correspondence of topographic hiatuses where water loses competence, the subaqueous ones (oceanic and lacustrine) are more dispersed in the whole basin of deposition and susceptible to water currents as well as being strongly affected by their granulometry.

Observations: Further observations supported by images and (or) numerical calculations to investigate the nature of clastic deposition in the northern lowlands are being considered. A partial (and by no means complete) list of features that may indicate a subaqueous deposition include, in addition to the mentioned shore lines and deltas:

(1). Landslides from the Olympus Mons. The aureole is a composite system of enigmatic deposits, likely the product of catastrophic landslides from Olympus Mons [6]. The very long runout (>700 km for the NW aureole unit which rests on the flat area of Amazonis Planitia) as well as the low effective friction experienced by these landslides indicate that the aureole are likely the product of subaqueous, rather than subaerial landslides [7].

(2). The basal scarp of Olympus Mons. The similarity between the Olympus Mons edifice-aureole and the periphery of the Canary and Hawaii islands has been noticed [8]. It is argued that the scalloped, 8-km high basal scarp around Olympus Mons, interpreted as the scar of the multiple catastrophic failures that gave origin to the aureole deposits (Fig. 1), would not have been created in the absence of water. This is because the numerous subaerial lava flows from Olympus Mons typically exhibit gentle slope angle (indicating very fluid lavas), to give onset to gravitative instability [9].

(3). Subaqueous morphologies. The images of channels and deltas and their possible subaqueous origin are being considered especially in the region of Amazonis Planitia (Fig. 2) [10].

(4). Water channels parallel to altitude level. While channels eroded by sediment-laden water normally travel down-slope, the ones at constant level, if truly erosional and not tectonic, can be formed exclusively under water as consequence of a balance between gravity and Coriolis accelerations [11].

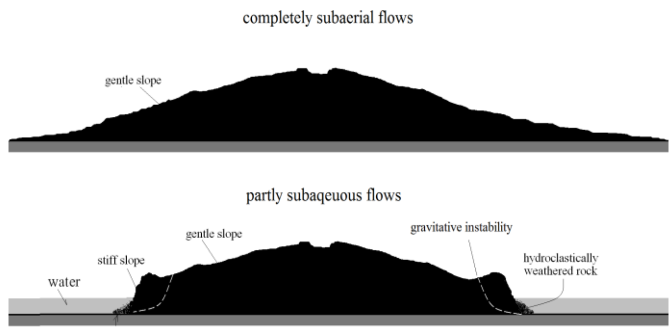

Figure 1. The basal scarp surrounding Olympus Mons can be interpreted as the scar of the aureole landslide deposits. However, while a compleyely subaerial flow would have formed a gentle volcanic edifice (top), the presence of a medium like water would have altered the otherwise gentle slopes and also weathered the basalt, causing the gravitational instability.

Sediment flow in water: Related problems under study deal with the dynamics of subaqueous sediments in the alleged Oceanus Borealis. The gradual northward decrease in elevation of the Vastitas Borealis formation as a function of the distance from the dichotomy line may indicate a oceanic-like control of the sediment input from the southern lowlands. Temporary pulses of catastrophic floods in a subaerial setting would have more likely dumped the sediment load exclusively at the slope break (i.e., in the vicinity of the dichotomy line), rather than in the whole lowlands. Calculations on the distance of reach of oceanic sediments are attempted assuming result from the deposition of acquatic sediments from the outflow channels and the dichotomy boundary. Thus, as a working hypothesis, a northern plains-sized ocean and the flow of sediment from the southern boundary (corresponding to the dichotomy) northward into the basin, is considered.

Figure 3 shows the results obtained with a simple settling model. Here, a column of height H composed of uniform cloud of monosized particles with given sphericity index (0.2 in the example) settles in water under Mars' gravity field, and may increase due to turbulence. At the same time, the speed U of the column changes in response to gravity acceleration and drag force as

$$\frac{dU}{dt} \approx \frac{\Delta\rho}{\rho}\sin\beta - \frac{1}{2}C_D\frac{\rho_W}{\rho H}U^2 \qquad (1)$$

where β is the slope angle and $\Delta\rho/\rho = (\rho - \rho_W)/\rho$ is the Archimedean buoyancy (with ρ, ρ_W being the density of the column and water) while C_D is a drag coefficient. Fig. 3 shows the maximum distance reached by grains of given diameter (in the abscissa) and for different initial heights, obtained with parameters compatible with turbidity currents [12]. Note that in this model, submillimetric particles may well reach distances greater than some thousand of kilometers, while particles of the size of one millimeter or greater will travel only a short distance beyond the exit of the outflow channels.

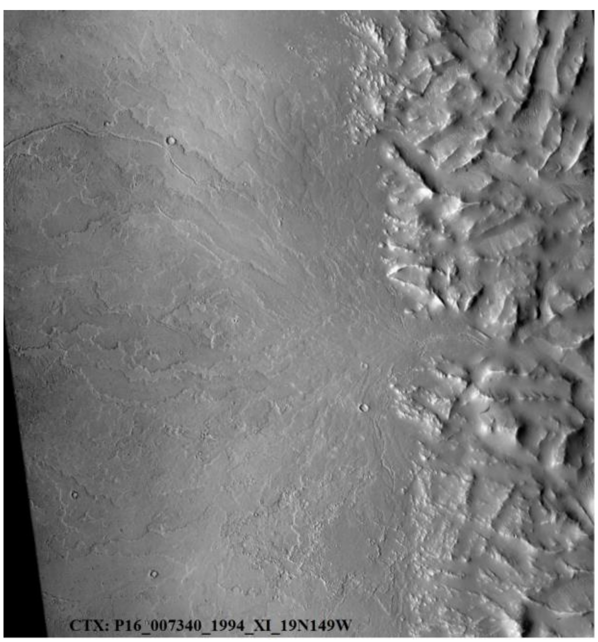

Figure 2. Radially-oriented depositional tongues interpreted as debris flow deposits departing from a channel on the NW aureole deposit.

Turbidity current are far more complex than Eq. (1) can describe. Moreover, the model is probably conservative, as larger particles may be potentially transported by a real turbidity current [13]. Even more efficient in transporting large clasts in their matrix are subaqueous debris flows and landslides, rather than turbidity currents. Debris flows (i.e., landslides normally rich in fines providing cohesion) are more mobile in the submarine rather than subaerial setting owing to the effect of hydroplaning or other processes [14]. The potential transport of subaqueous debris flows on the Martian norther lowlands is being investigated.

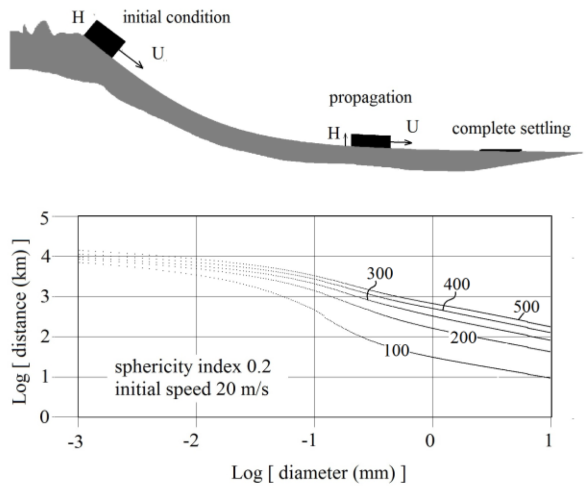

Figure 3. Distance reached by monosized grains after settling through a vertical section in water under the gravity field of Mars calculated in the model sketched in the text as a function of the grain diameter and for different initial heights between 100 m and 500 m. The scheme of the calculation model is shown at the top.

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