**EVIDENCE FOR REMOVAL EPISODE ON NORTHERN PLAINS FROM THE MARTIAN FLUIDIZED EJECTA VOLUME.** S. Meresse, F. Costard and N. Mangold, UMR 8148, IDES, Université Paris-Sud, Bât. 509, 91405 Orsay cedex, France, meresse@geol.u-psud.fr

**Introduction:** Lobate ejecta blankets surrounding impact craters constitute a singular and widespread morphology of Martian craters. Their formation involves subsurface volatiles (water or ice) in the permafrost. Till then, in order to estimate the proportion of groundwater in the substrate at the time of crater formation, researchers used the maximal extension of the ejecta layer. It is defined by the ejecta mobility ratio (E.M.) [1-3]. However, this method does not take into account the exact volume of the ejecta blanket. The measurement of ejecta volume seems to be more appropriate and will also give new informations about the morphometry and the characteristic of Martian craters. Here, we have used MOLA altimetry data for the determination of ejecta volume. Our research is limited to specific regions including the most numerous and fresh craters: Lunae Planum on the one hand and the Northern lowlands with Utopia and Acidalia Planitia on the other hand.

**Ejecta volume.** An interactive computer program, called “IMPACT”, was developped at the Hawaii Institute of Geophysics & Planetology to investigate the geometry of Martian impact craters [4]. We use it with the 1/128th degree MOLA Digital Elevation Model (DEM) to measure about 80 craters with a diameter D between 4 and 32 km.

We find that for a given diameter, the craters in Northern lowlands have higher ejecta volumes (Fig. 1). The observed volumes in Utopia or Acidalia are often 2 to 6 and sometimes 10 times greater than those in Lunae Planum. These discrepancies are too large and can not be only related to differences in the rheology, structural properties [5] or water content of the two terrains, even more so the substrate of lowlands is supposed to look like wrinkled ridges of Lunae Planum.

Moreover, it is also interesting to compare the measured ejecta volume with the estimated volume of excavation from models [6,7]. In figure 2 we can see the ratio of ejecta volume to excavation volume, (Vej/Vex), which is assumed to be equal to 1 for fresh craters. This estimation shows some particularities: the ratio is always smaller than 0.5 for the craters of Lunae Planum. We can explain this result by the composition and the geology of the terrain. On the surface, Lunae Planum is composed of lava flows which are supposed to be 1 km thick [8]. The volcanic shallow layer contains less water than the substrate, so the ejecta arisen from it are drier. These “Dry” dust falls are scattered and are not visible as lobate ejecta. We estimate that it represents globally a half of the whole ejecta. For the Northern lowlands many craters exhibit relatively high ratio. They can reach values as high as 2 or 2.8 (Fig 2). The ejecta volumes in the Northern plains are abnormally high and can only be caused by post-impact modifications. This is not the only specificity of the Northern lowlands.

**Particular morphologies of lowlands.** Thanks to MOLA and THEMIS data, a lot of morphologic details, invisible in Viking imagery, are discovered. For example, we can identify craters which seem to be perched. Every elements of the crater (ejecta blankets, cavity, rim) are above the pre-existing surface (Fig. 3A). Those craters look like lobate ejecta craters but clearly differ from fresh craters. They have some distinct features. First, the cavity has undergone a filling up over a hundred of meters and its average depth is smaller than 200m (Fig 3B). Secondly, the boundaries of the ejecta blanket are very pronounced and the ground at the vicinity of the ejecta is often deeper than the pre-existing surface (Fig 3, black arrows). It is clear that the “perched crater” morphology is shaped by weathering and especially by volatile activity and ground ice related processes.

The other typical morphology of Northern lowlands is the ghost craters. They are smooth shallow flat-floored circular depressions which underwent modification and shallowing [9].

These two type of craters are solely detected between 40° and 70° N. These distributions appear to support the theory that Northern lowlands experienced several episodes of resurfacing involving deposition and erosion.

**Northern lowlands resurfacings.** The different modifications of Utopia/Acidalia’s surface consist of a filling of crater’s cavity on the one hand and of a removal of material on the other hand.

The deposits visible in the cavities can result from many origins (sedimentation within an ocean, widespread volcanism, eolian activity, discharges of sediment). Nonetheless, they do not constitute the main modification of the surface. The removal of material is more striking because it is interpreted to be responsible for the unusual ejecta volumes and the perched craters. The loss of material happens around the ejecta blankets and decreases the pre-existing surface. This decreasing of surface’s altitude is most likely caused by cryokarstic process like the sublimation of the ice restrained in the deposit layers or in the permafrost. So in Northern
lowlands, the surface used in the ejecta volume measurements is not the pre-existing surface what is explain
the results. Moreover, the ejecta blankets, strengthened by the impact, protect the underneath ice-rich terrains from sublimation. The erosion is concentrated around the ejecta blankets as we see in the perched craters. It is consistent with the observations of [10] between ~30°-70°N. They have reported on the presence of a layer of ice-cemented dust that has been initially cemented and then partially dissected or disaggregated.

We can suppose that there is not a only resurfacing episode in the Northern lowlands. Deposition and removal of a ice-rich layer form a cycle which regularly modified the Martian surface. This Cycle is probably related to changes in orbital parameters like the obliquity excursions [10].

Conclusion. No correlation was found between ejecta volume and volatile content of the Martian substrate. The measurement of the ejecta volume constitute nonetheless a good method for the observation and the quantification of the surface modifications. In the near future, systematic morphometric analyses on perched craters will allow us to know the resurfacing history of Mars.

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Fig. 1. Ejecta volume for Lunae Planum and Utopia/Acidaia Planitia

Fig. 2. Ejecta volume to excavation volume ratio for craters observed in Northern lowlands and Lunae Planum

Fig. 3A. “perched crater” morphology. Black line indicates the location of the MOLA cross section in Figure 3B. MOLA shaded relief map at 1/128th degree resolution. B. MOLA cross section of the perched crater. Note the double layer ejecta (DLE) morphology of the crater. The grey line is the surface used in the ejecta volume measurements. The dashed line represents the real pre-impact surface.