On the mobility of large Martian landslides. A. Lucas[1,2], A. Mangeney[1], D. Mège[2], Bouchut, F[3]. 1 - Institut de Physique du Globe de paris, UMR CNRS 7154, Université Paris Denis Diderot, France. 2 - Laboratoire de Planétologie et de Géodynamique, UMR CNRS 6112, Université de Nantes, France. 3 – Département de Mathématiques et Applications, Ecole Normale Supérieur, UMR-CNRS 5881, Paris, France. (lucas@ipgp.fr).

Abstract:
A new landslide mobility parameter that takes the friction angle into account can shed new light into the dynamics of large Martian landslides.

Introduction:
Landslide morphologies have been identified on Mars [1-2]. Some similarities between experiments on dry granular spreading and Large Martian Landslides (LML) convey to conlude on dry conditions [3]. However, normalized runout on Mars is twice as large as those observed in laboratory. Numerical simulations on theoretical 2D and real 3D topographies reconstructed from remote sensing data show that slope effects significantly reduce the discrepancy between experimental results and Martian observations [4]. However, topography effects are not strong enough to explain the high mobility of Martian landslides, which requires a very small friction angle ($\delta < 10°$), much smaller than required in dry granular spreading simulations ($\delta = 32°$) [4].

As a result, physical processes such as air cushioning or lubrication by a fluid phase should play a key role in the dynamics of Martian landslides.

We investigate landslide mechanics using a new mobility parameter [4] that makes it possible to characterize the flow dynamics regardless of the geometry of the released mass and of the underlying topography.

Morphometric parameters of LML:
Quantin et al. [5] have performed a systematic geomorphology analysis of VM landslides using THEMIS, MOC and MOLA data sets. More recently, Lajeunesse et al. [3] have performed a morphometric analysis of these landslides. From these studies, some landslide morphometric parameters can be defined (fig. 1).

Morphometric Survey:
From THEMIS, MOLA and MOC data available from PDS [6], we performed a morphometric survey using these parameters on five large Maritan landslides (fig. 2).

Mobility of Martian landslides:
The classical mobility is defined as:

$$m_e = \frac{\Delta L}{H},$$

It is volume-dependant. We define instead a new mobility parameter m'_e, which reads [4]:

$$m'_e = \frac{1}{\tan\delta} = \frac{1}{\tan\theta + \alpha\frac{H_i}{\Delta L}},$$

where θ is the bottom slope, and $\alpha = 1.24$ a dimensionless parameter introduced by [7]. The mobility parameter is independent of the initial landslide volume, its aspect ratio, and the underlying topography. This mobility m'_e is thus a function of the friction angle δ. We calculate m'_e for the following landslides:

Landslides	Mobility (m'_e)	δ (°)
Ophir	5.8	9.8
Candor	5.6	9.9
Ganges	6	9.4
Coprates	7.7	7.3
Melas	6.9	8.1

Tab 1 – Mobility *m'e* and angle of friction δ calculated for a few landslides on Mars.

Mobility m'_e is useful for numerical simulations of Large Martian Landslides. Based on thin-layer approximation model, we performed a series a simulations of large Martian landslides in which the topography is taken into account [4,8].

Results and discussion:
Calculation of the mobility (m'_e) for the 5 Valles Marineris landslides studied give a similar angle of friction. This result is consistent with the similar geological context of these landslides, and the presumed similar composition of the slided material involved.This indicates that the mobility parameter we used is makes sense and provides a good effective friction estimate.

The friction angle values do not allow us to conclude as to the presence or not of a liquid phase in the dynamics of the large Martian landslides. We will discuss the implications of the use of this new mobility parameter for large Martian landslide numerical modeling, following the path opened by an earlier Ophir Chasma landslide study [4].

References:
[1] Lucchitta, *JGR*, 1979; [2] McEwen, *Geology*, 1989; [3] Lajeunesse et al., *GRL*, 2006; [4] Lucas and Mangeney, *GRL*, 2007; [5] Quantin et al., *PSS*, 2004; [6] *http://pds-geosciences.wustl.edu*; [7] Lube et al., *J. Fluid Mech*, 2004 ; [8] Mangeney et al., *JGR*, 200

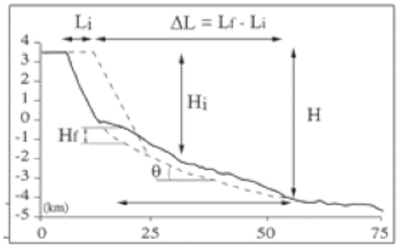

Fig 1 – Morphometrics parameters used in this study. L_i is the initial mass length, H_i is the initial mass height, ΔL is the final runout, H is the total height (topographic slope is taken into account), θ is the slope, and H_f is the final deposit thickness (modified after [4]).

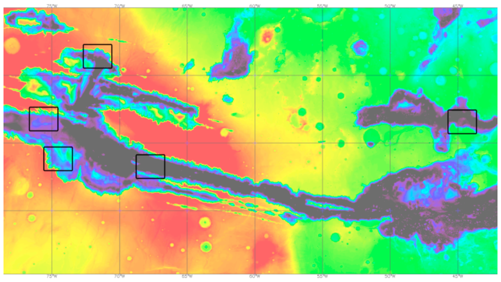

Fig 2 – Valles Marineris Map. The 5 studied landslides are in the 4 black squares.