Geophysical Research Abstracts
Vol. 16, EGU2014-15331, 2014
EGU General Assembly 2014

Impact craters and landslide volume distribution in Valles Marineris, Mars

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The landslides in the wide gorge system of Valles Marineris (Mars) exhibit volumes of the or-der of several hundred 1,000 km3 and runouts often in the excess of 80 km. Most landslides have occurred at the borders of the valleys, where the unbalanced weight of the 5-8 km high headwalls has been evidently sufficient to cause instability. Previous analysis has shown that the mechanical conditions of instability would not have been reached without external triggering fac-tors, if the wallslope consisted of intact rock.

Among the factors that have likely promoted instability, we are currently analyzing: i) the possibility of rock weakening due to weathering; ii) the alternation of weak layers within more massive rock; weak layers might for example due to evaporites, the possible presence of ice table at some depth, or water; iii) weakening due to impact damage prior to the formation of Valles Marineris; studies of impact craters on Earth show that the volumes of damaged rock extends much deeper than the crater itself; iv) direct triggering of a landslide due to the seismic waves generated by a large meteoroid impact in the vicinity, and v) direct triggering of a landslide con-sequent to impact at the headwall, with impulsive release of momentum and short but intense increase of the triggering force.

We gathered a large database for about 3000 Martian landslides that allow us to infer some of their statistical properties supporting our analyses, and especially to discriminate among some of the above listed predisposing and triggering factors.

In particular, we analyse in this contribution the frequency distribution of landslide volumes starting from the assumption that these events are controlled by the extent of the shock damage zones. Relative position of the impact point and damage zones with respect to the Valles Marineris slopes could in fact control the released volumes. We perform 3D slope stability analy-sis under different geometrical constraints (e.g. crater size and position, slope angle and height, size of the relative shock damage zone) starting from rock mass properties calibrated in a previous study (Crosta et al., 2014). We report about the synthetic volume frequency distribution gen-erated by considering the most critical failure surfaces for the different geometrical constraints and the frequency distribution of craters on Mars surface (e.g., Hartmann and Neukum, 2001).

1. Crosta, G.B., Utili, S., De Blasio, F.V., Castellanza, R. (2014)Reassessing rock mass properties and slope instability triggering conditions in Valles Marineris, Mars.Earth Planetary Science Letters, 338, 329-343. http://dx.doi.org/10.1016/j.epsl.2013.11.053
2. Hartmann, W., and Neukum, G., (2001). Crater Chronology and the evolution of Mars. Space Science Reviews 96: 165-194.