VARIATION OF SMALL CRATER DEGRADATION ON THE MOON. S. Bouley [1], D. Baratoux[2] [1]Institut de Mécanique Céleste et de Calcul des Ephémérides, UMR8028, Paris, France. [2] Observatoire Midi-Pyrénées, Institut de Recherche en Astrophysique et Planetologie, 14, Avenue Edouard Belin, Toulouse, France. Mail : sylvain.bouley@gmail.com

Introduction: With the release of LRO data it is now possible to study precisely the morphology of small craters (D<1km) and to observe the diversity of degradation features. The simplest method to describe crater degradation was presented by [1][2][3]. [1] observed the morphological differences between fresh and degraded craters and assumed that fresh crater undergo modification from small impactors, which cause erosion of the rim crest and infilling of the crater floor. Using current dating methods on Lunar Mare [4], this study has for main goal to explore the evolution of crater degradation with time on the moon.

Data and method: We used one LRO image (M102293050RE) with a resolution of 1.44 m covering a small fraction of Mare Imbrium. This image has an large sun incidence angle around 80° which allows the observation of both fresh and very degraded small craters. In order to describe the morphology of small craters (D>65m), we used a photoclinometric method to determine for each crater the maximum slope of inward crater rims. Qualitatively, smaller is the slope, more important is the degradation and older is the crater (Figure 1). We realized this measurement for 662 craters with diameter between 65 m and 1 km.

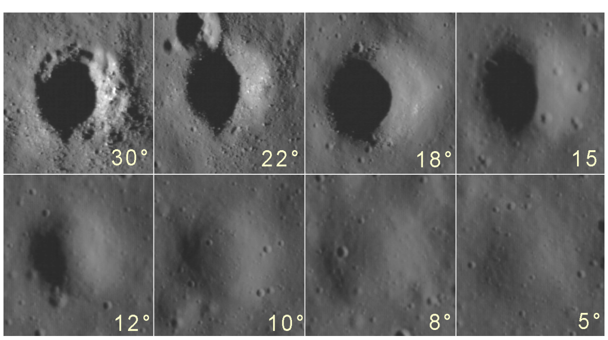

Figure 1 Examples of various stages of degradation and maximum rim slopes for a 200 m crater diameter. 30° is the slope of fresh crater and 5° the slope of an old crater

Age of Mare Imbrium: Counting small craters on Mare Imbrium allows to date this terrain and to determine for which crater diameter saturation is reached. Figure 2 shows that craters with a diameter D> 180 m indicates a formation age around 3.5 Gyr. This age for Mare Imbrium is consistent with [5][6]. Saturation is reached for craters with a diameter smaller than 180 m.

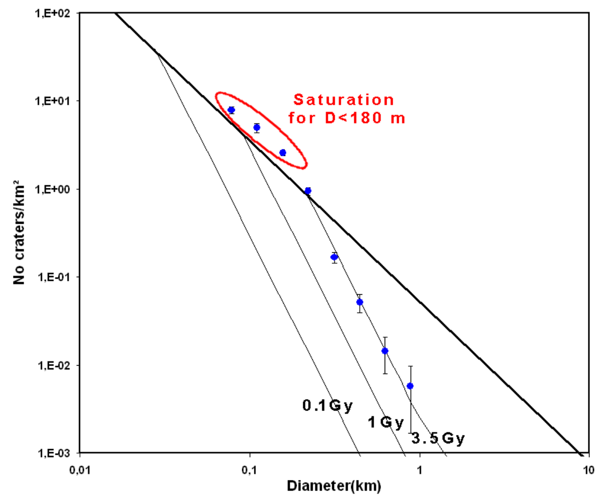

Figure 2 Crater count result for Mare Imbrium. Crater count has been achieved for diameters ranging between 65 m and 1 km.

Variability of crater slope: For six different classes of crater diameter, we studied the variability of the maximal crater slope. Figure 3 shows typical results for 4 different sizes of crater (90m to 367 m). We observe first that the slope distribution is quite similar for all different classes. There are 15% of craters with slopes stepper than 15°, but 70% of craters have medium slope ranging from 8 to 15°. A few craters (15%) have low slope (S < 8°). Moreover, we note that the peak of the slope distribution is shifted as a function of crater diameter. For the 90-130 m class it occurs at a slope of ~6°. For the 130-180 m class it occurs at at slope of ~8°. For the 180-260 m class, it occurs at a slope of ~10° and for 260-360m class the peak appears to be at ~12°. Therefore, the slope for the peak of the distribution increases with diameter. This non-uniform distribution suggests that the rate of slope change during the degradation is not constant.

The craters may degrade quickly until to reach the slope given by the peak in the distribution. Degradation may then continue, but at a smaller rate until the crater disappears entirely. The small number of gentle slopes may be associated, at least in part, to the non linear evolution of the slope with time. This

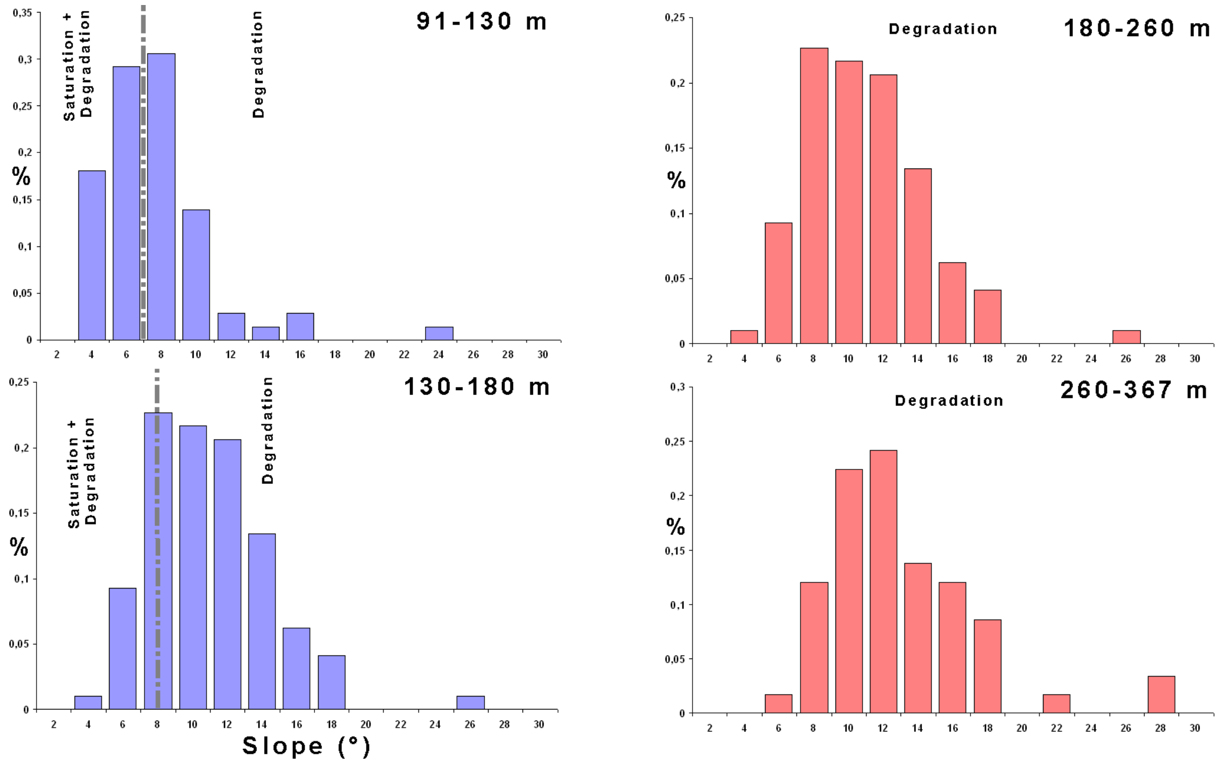

Figure 3 Variability of crater slope for 4 different sizes of craters

behaviour is typical for erosion processes, or diffusion processes, where the rate of slope change should depend on the slope gradient, which is necessarily smaller for already degraded craters. However, as we showed before, crater smaller than 180m are saturated. This means that the slope distribution is affected by the saturation. The slopes associated with some of the older crater do not appear in the bar plots as some of these craters have been simply in erased following the concept of saturation. There is thus certainly also a deficit in the left side of the distribution resulting for the saturation effect.

Variation of the crater slope: In counting cumulative craters for a given size and for a minimal slope, it is possible to draw the variation of the crater slope along the time. For a [180-260]meters crater, Figure 4 shows that it takes around 500 millions years to degrade a crater from 30° to 15°, 3 billions years from 15° to 8°. In summary, these first results emphasize that degradation by micro bombardment and associated mass-wasting produces a non-linear evolution of the time.

Discussion: In the future, we will realize similar studies on different Lunar Mare with different formation ages. We would like to constrain the variation of degradation and model the degradation produce by micro-bombardment. These efforts are motivated by addressing the issues concerning the cratering rate on the moon. Crater counting methods are based on a constant cratering rate for the last 3 Gy and we hope to be able to test this hypothesis from our further studies.

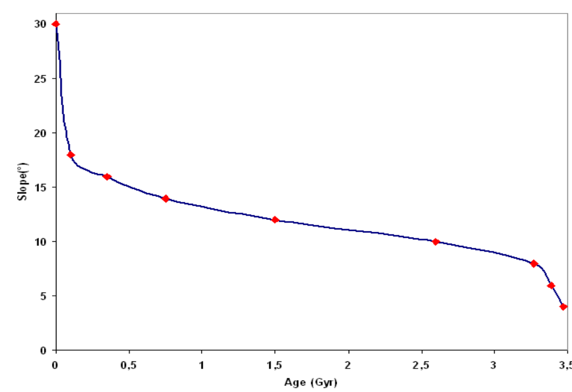

Figure 4 Variation of the crater slope along the time

[1] Trask, 1969, U.S. Geol. Surv. Maps. 1-616-1-627, 4 [2] Offiel and Pohn, 1970, U.S. Geol. Surv. Prof. Pap. 163-169 [3] Pohn and Offield, 1970, U.S. Geol. Surv. Prof. Pap. 153-162 [4] Hartmann, 2005, Icarus, 174 [5] Hiesinger, 2000, JGR 105 [6] Hiesinger 2010, JGR 115