AN APPROACH TO DETERMINING MINIMUM AREAS FOR USEFUL MODEL AGES.

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Introduction: We have determined model isochron ages of 44 landslides in Valles Marineris (VM) that are ≥400 km^2 in area [1]. Almost 50% of these landslides have age's ≤1.0 Ga. If these ages are valid, then it has important implications for the origins of these landslides. One common hypothesis is that the landslides are initiated by the seismic waves generated by meteorite impacts. The study presented here and other studies suggest that the cratering rate has declined exponential since 3.8 Ga [2, 3]. Valles Marineris (VM) initiated about 3.6 Ga [4, 5], so if meteorite impacts are the cause of VM landslides the ages of landslides should show an exponential decline in age. This is not consistent with the results described above.

Another possibility is that the landslide model ages are unreliable because of resurfacing. Our previous work suggests that landslides composed of chaotic material with undulating topography are susceptible to rapid degradation of impact craters resulting in model ages that are too young, even though the landslide is ≈3600 km^2 in area. A critical factor in the reliability of isochron model ages is the area of the feature being dated[6]. This work suggest that reproducible isochron can be determined for areas of 1,000 km^2. The long-term aim of this study is to try to establish a minimum area for useful isochron ages.

Methods: Robbins et al. [7] developed a classification scheme based on the degradation state of impact craters and a database of 400,000 craters. In previous studies, we found that crater degradation states of craters near VM are related to age [8]. 90% of craters of degradations states 1 and 2 are older than 3.5 Ga, whereas degradation state 3 craters range from 1.0 to 3.6 Ga. The number of craters of degradation state 4 near VM are small in size, ≤30 km diameter, and relatively few in number. Preliminary ages degradation state 4 craters are <1.0 Ga.

These results suggests that degradation state 3 craters are most likely to be linked with landslides in VM. Our control group were 38 impact craters of degradation state 3, >40 km in diameter, and lying within 2,000 km of the nearest landside in VM and are drawn from the above database [7]. Only one of these craters was misclassified. Thus, we determined model isochron ages using Craterstats II [9] of 37 craters and crater counted using JMars . Our experimental group are 40 craters of degradation state 3 lying within 1200 km of landslides in VM and 15 to 20 km in diameter. These craters were selected using the same database, culling out 20% of the craters that were misclassified. We noted that about 35% of craters contained impacts ≥1 km, so we also dated craters using Neukum [10]. We then tested whether our control and experimental group were drawn from the same distribution using a Kolmogorov-Smirnov statistical test. Our plan is to date additional size ranges of impact craters and additional degradation state 3 craters we have identified ≥40 km diameter near VM. Our choice of studying craters near VM to understand landslide ages in VM are 1) the crater fill and landslide material should be similar in terms of source rocks and material characteristics. 2) The landslides and craters are at nearly the same latitudes so they should have similar climate histories.

Results: Figure 1 shows the age frequency distribution for degradation state 3 craters ≥40 km in diameter. The figure shows an exponential decay in the number of craters over time. Figure 2 shows the Isochron ages of craters 15 to 20 km in diameter. Most of the crater ages are ≤1.6 Ga. In Figure 3 Neukum ages [10] were determined using the areal density of craters ≥1 km in diameter which were then substituted for the isochron ages. The curve is considerably more bimodal than figure 2. Figure 4 shows a typical isochron for which a Neukum age was also calculated. The isochron age of 1.5±0.6 was used in Figure 2 and a Neukum age of 3.6 Ga was used for Figure 3.

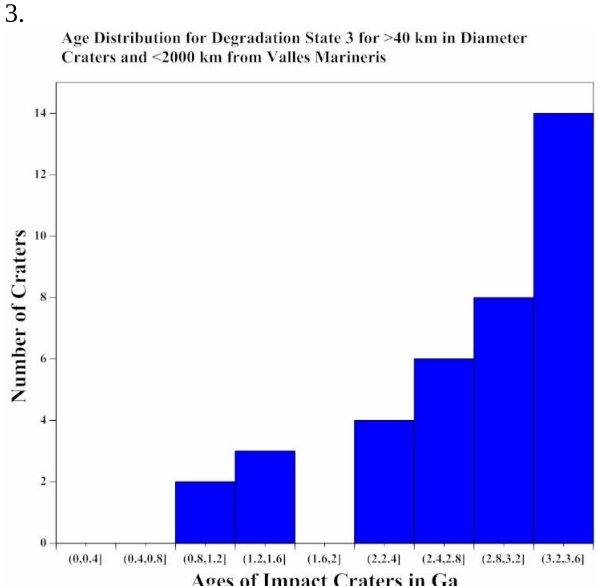

Figure 1

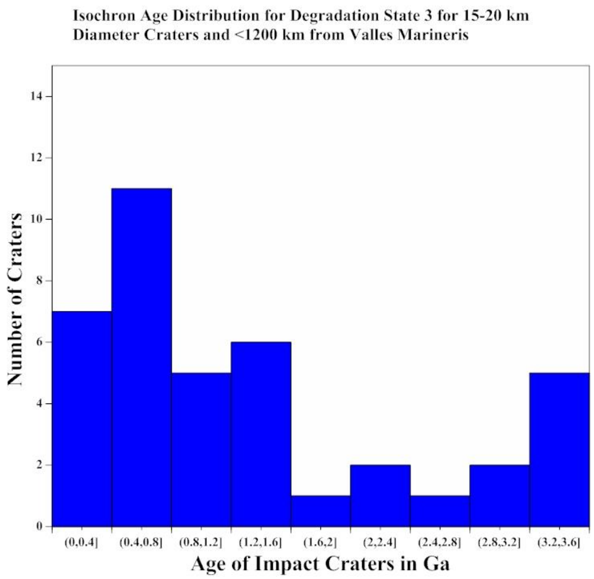

Figure 2

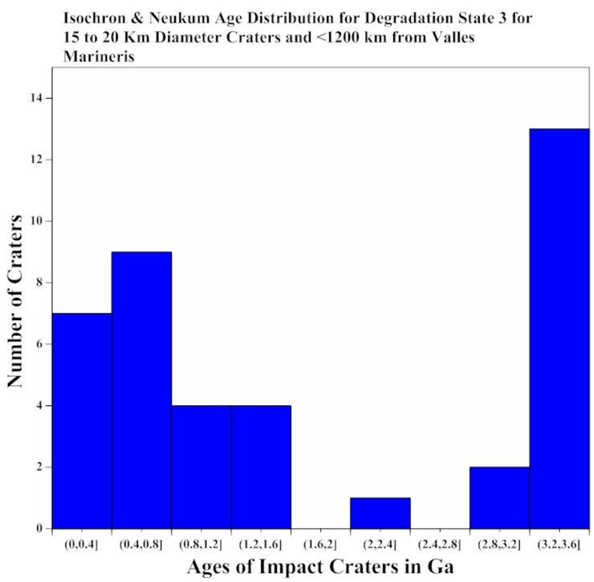

Figure 3

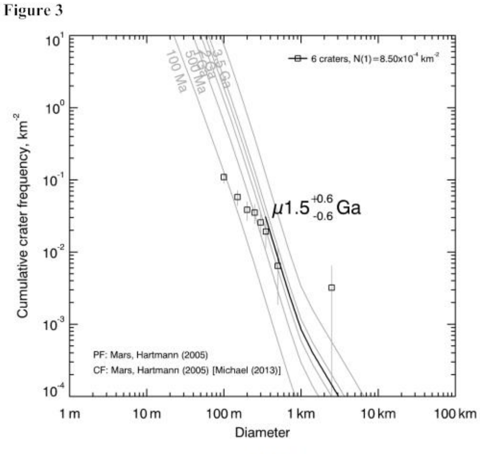

Figure 4

Interpretation: An exponential decrease in the rate of impact cratering (Figure 1) for Mars is consistent with data from the Earth [2] and the Moon [3]. Thus, the figure 1 is representative of the age-frequency distribution of degradation state 3 craters near VM. The Kolmogorov-Smirnov D =0.6189 for a comparison of the curves in Figure 1 and Figure 2 and Kolmogorov-Smirnov D =0.5189 for a comparison of the curves in Figure 1 and Figure 3. Thus, the probability that the data shown in figures 2 and 3 are drawn from the same distribution as the data in figure 1, P <<0.001. The difference in the distributions is probably the result of resurfacing. However, the lower D statistic for the curve in figure 3 and the percentage of ages between 3.2-3.6 Ga being nearly the same for figure 1 and 3, suggests that absent the effects of resurfacing the 15-20 km ages and the >40 km ages may be drawn from the same age distribution. Looking at age distributions for different size ranges may resolve the issue of being drawn from the same distribution.

References::

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