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Mars: Secondary cratering and its relevance to age dating techniques

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The processes of secondary cratering, studied for the moon, Mars and other solid surface bodies, is well known. The discovery of a secondary-crater strewn field generated by the 10-km crater Zunil provides a test case to study the Martian far-field secondary cratering process. Secondary cratering has always been an issue in the discussion whether or not the steep branch (below about 1 km diameter) of the observed crater size-frequency distribution is due to secondary or primary cratering. It also implies a discussion of what is the real shape of the primary production crater size-frequency distribution and if age determination based on craters in the smaller-crater size range is possible. Here, we present crater counts inside and outside the Zunil strewn field as well as a discussion based on empirical data of the implications on the crater size-frequency distribution if secondary cratering occurs. In general, we could show and confirm earlier studies that the secondary crater distribution follows a non-power law distribution which is statistically know as Weibull distribution. For basically understanding the secondary crater distribution, we tested secondaries against primaries being responsible for the steep branch of the size-frequency distribution. Comparison of a constructed and the observed crater distribution revealed that the crater size-frequency distribution composed of a primary distribution and a secondary component would change its shape with time. Older surfaces would show a contribution of more numerous and larger secondaries. Therefore, the onset diameter for the secondary crater distribution grows with age. No change, however, in the shape of the measured distributions on the moon and Mars is observed, i.e. the steep part of the distribution as measured is not compatible with a secondary-crater origin. Possible secondary crater contributions could show distributions varying between slope

indices of -3.0 and -3.5. Constructed curves can be compared to the predicted/observed crater size-frequency distribution given as a function of surface age. For a -3 slope, the contribution of secondaries to any measurement could be up to 10 %, while for a -3.5-slope the hypothetical secondary crater contribution would exceed the measured one by more than 100 %. The strongest effect is not observed for the smaller size range as commonly expected but for the crater size range around 1 km in diameter. This would imply that the shape of the distribution would vary with surface age; this is not observed on the surface of the moon and Mars.

Conclusion: Detailed measurements of the Martian crater SFD for surfaces reflecting a variety of ages confirm the stability of the shape in time. This has previously been shown for the Moon. The steep branch of the crater distribution is not dominated by secondaries, but might include up to 10 % craters formed through secondary cratering. The applicability of simple power laws to describe secondary cratering is not valid.