	Class 1	Class 2	Class 3	Class 4	Class 5
SELECTION CRITERIA					
• Elongate crater shape	●	●	●	●	●
• Butterfly-wing ejecta	●	●	●	●	○
• Saddle-shaped rim	◒	◒	◒	◒	●
• Median floor ridge	◒	◒	◒	◒	◒
PRESERVATION STATE OF EJECTA					
• Best preserved	●	○	○	○	○
• Slightly degraded	○	●	○	○	○
• Moderately degraded	○	○	●	○	○
• Heavily degraded	○	○	○	●	○
• Absent	○	○	○	○	●
CALIBRATION	Olympus Mons	Young Tharsis volcanics	Lunae Planum	Older highland craters	Oldest highland craters

Fig. 1. Summary of criteria used to select and classify low-angle impact craters used in this study. Closed circles indicate that criterion is always met; half-filled circles indicate that criterion may be met; open circles indicate that criterion is not used by definition.

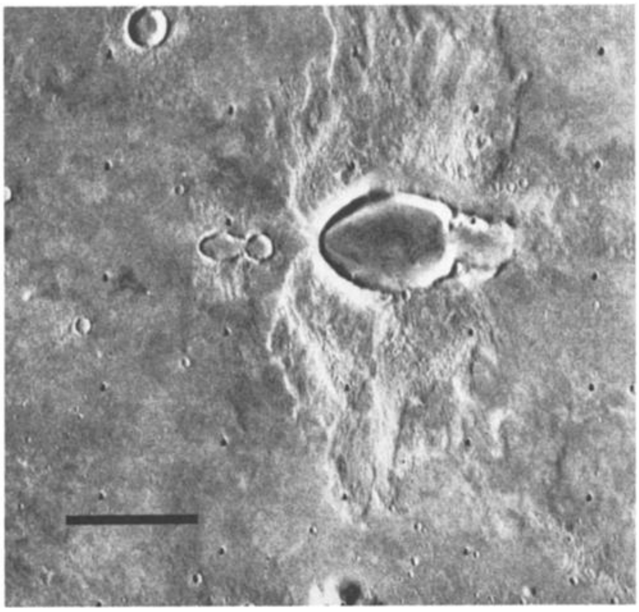

Fig. 2*b*. A Class 2 impact where the very fine scale ejecta patterns are absent but the remaining ejecta facies indicate a very well-preserved state. The tight grouping of this and smaller grazing impacts may represent tidal disruption of a single impactor *(Gault and Wedekind, 1978)*. Viking Frame 039B13.

and commonly occur in clusters. Consequently, this potential contaminant was reduced by selecting only craters larger than 3 km and eliminating multiple and irregular craters. The elimination of doublet and multiplet craters also removed any possible ambiguity in the inferred direction of impact. Two projectiles impacting a few diameters apart can produce an elongate crater that may resemble, at first glance, a highly oblique impact. However, such impacts do not produce the true 'butterfly-wing' ejecta patterns but exhibit significant deposits along the major axes. Moreover, the saddle-shaped rim is typically absent, and the floor may contain paired central peaks or a median ridge perpendicular to the major axis, the latter feature also having been produced in the laboratory [*Oberbeck and Morrison*, 1974].

With the above selection and exclusion criteria, summarized in Figure 1, 176 probable grazing impact craters were identified in subquad mosaics, special scale mosaics, and individual Viking frames. They were classified into five categories based on the degree of preservation as revealed in individual Viking frames. The best preserved examples (Class 1) met most of the selection criteria and retained very fine scale features in the ejecta deposits comparable to the best preserved impact craters on the youngest geologic units on Mars (Figure 2*a*). Class 2 grazers were only slightly more degraded than members in Class 1 and have preserved ejecta facies comparable to those around the oldest craters on the Tharsis volcanic plains (Figure 2*b*). Class 3 grazers also met most of the selection criteria, but the very fine scale patterns were heavily degraded or missing (Figure 2*c*). The older impact craters on Lunae Planum appear to have comparable states of preservation. Craters that met most of the selection criteria but had ejecta facies only barely visible were grouped into Class 4 (Figure 2*d*). Such craters are similar in age to older craters in the highlands. Lastly, craters

Fig. 2*a*. Example of Class 1 grazing impact crater where fine-scale ejecta patterns are well preserved. Viking Frame 864A01.

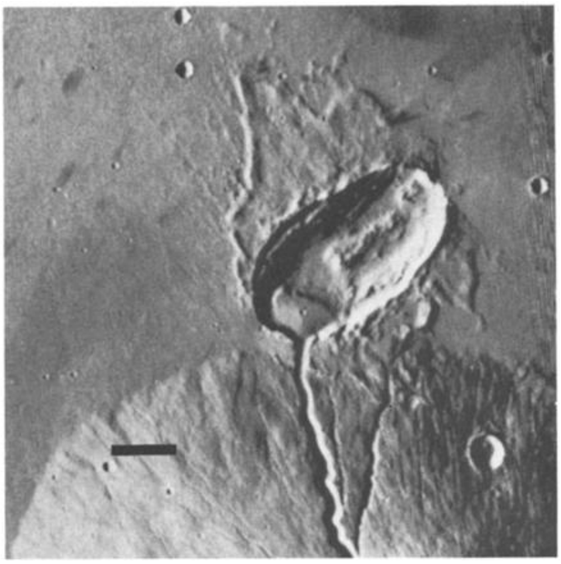

Fig. 2*c*. Class 3 craters have degraded ejecta facies typical of the older craters on Lunae Planum. Viking Frame 516A24.