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Recent (Late Amazonian) enhanced backweathering rates on Mars: Paracratering evidence from gully alcoves

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Mars is believed to have been exposed to low planet-wide weathering and denudation since the Noachian period (∼4.1 - 3.7 Ga). However, the widespread occurrence of alcoves at the rim of pristine impact craters suggests locally enhanced recent backweathering rates. Here we derive Late Amazonian backweathering rates from the alcoves of 10 young equatorial and mid-latitude craters, ranging in age from 0.2 to 45 Ma.

The enhanced Late Amazonian Martian backweathering rates (10^{-4} - 10^{-1} mm yr^{-1}) are approximately one order of magnitude higher than previously reported erosion rates, and are similar to terrestrial rates inferred from Meteor crater and various Arctic and Alpine rock faces, when corrected for age. Alcoves on initially highly fractured and oversteepened crater rims following impact show enhanced backweathering rates that decline over at least 10^1 - 10^2 Myr as the crater wall stabilizes. This 'paracratering' backweathering decline with time is analogous to the paraglacial effect observed in rock slopes after deglaciation, but the relaxation time scale of 10^1 - 10^2 Myr compared to 10 kyr of the Milankovitch-controlled interglacial duration questions whether a paraglacial steady state is reached on Earth.

The backweathering rates on the gullied pole-facing alcoves of the studied mid-latitude craters are much higher (∼2 - 60 times) than those on slopes with other azimuths and those in equatorial craters. The enhanced backweathering rates on gullied crater slopes may result from liquid water acting as a catalyst for backweathering. The decrease in backweathering rates over time might explain the similar size of gullies in young (<1 Ma) and much older craters, as alcove growth and sediment supply decrease to low background rates over time.