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Age and erosion rates of sulfate-rich Interior Layered Deposits of Valles Marineris

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Since their discovery by Mariner 9, the Interior Layered Deposits (ILD) of Valles Marineris are still one of the most puzzling feature at the surface of Mars. Since the early investigation by the OMEGA spectrometer onboard Mars Express, it is known that these voluminous deposits are enriched in sulfates and may represent one of the largest reservoirs of hydrated minerals at the surface of Mars. Nowadays, with MRO dataset-especially HiRISE and CRISM-, we have a better knowledge of their composition, structure and stratigraphy. However, their age is still unknown and is subject of speculation. Three main theories are being debated. The first interprets the ILD to be older than Valles Marineris formation and to have been exhumed by the chasmata opening. Their composition enriched in sulfates is in agreement with this hypothesis; diapirism may have occurred. The second hypothesis argues that the ILD have filled the canyons during or right after their formation. Some observed stratigraphic relationships with the troughs are consistent with this hypothesis. The last theory argues that the ILD could be recent and be related to Amazonian equatorial ice deposition. One of the arguments supporting this theory is the lack of impact craters on the outcrops of these ILD, especially at high resolution.
To address this question, we performed for each canyon of Valles Marineris a systematic analysis at high resolution of the stratigraphic relationship between the ILD and the others landforms observed in the canyon. We also systematically investigated the impact crater retention of the ILD over a large range of scales from chasmata scale to HiRISE image scale. We also counted crater on CTX images on landforms in stratigraphic relationship with the ILD. Our results allow us to deduce the timing of events and the erosion rates of the different surfaces.
The investigation of stratigraphic relationships attests that the ILD postdate the formation of the canyons. Our crater counts on landforms postdating the ILD revealed that the ILD formed and were eroded early in the canyon history near 3.5 Gy. In almost each chasma, large impact craters have been emplaced on the ILD attesting to their old ages. The crater size distribution on ILD also reveals a long erosional history. Using the age deduced by that portion of the crater size distribution that follows the crater production slope, and the largest impact diameter not affected by erosion, we deduced the erosion rate of the different surfaces. At similar ages of formation, the ILD are one order in magnitude more erodible than others materials (landslides, trough floors...). According to these results, a simple aeolian erosion over the last 3.5 Gy is sufficient to explain the observed depletion in small impact craters on the ILD as compared to the surrounding surfaces.