Groundwater control on the Martian Concentric Crater Fill deposit

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Concentric Crater Fill (CCF) are concentrically lineated ice-related talus creep deposits preserved on the flat crater floors of Mars. Recent investigations of these deposits suggest that the features form from ice-covered lag deposits because of multiple cycles of ice deposition (Levy et al., 2021). In the past, with high orbital inclination, craters with CCF deposits formed even at the low to mid-latitudes of Mars. The Compact Reconnaissance Imaging Spectrometer for Mars (CRISM; Murchie et al., 2007) identified strong signatures of water-containing minerals or water ice from these deposits. The High-Resolution Imaging Experiment (HiRISE; McEwen et al., 2007) images complement this observation with the presence of ring mold crater and both closed and open brain terrain-like landforms, which are typically associated with subsurface ice deposits. Therefore, following the objectives of the Mars Ice Mapper mission, these low to mid-latitude deposits on the flat crater floors could be ideal candidate locations for the future exploration of water-ice.

Here, we report our preliminary observation of CCF deposits from more than 700 craters (> 2 km in diameter) distributed in the Arabia Terra region. Detailed morphological observation of the deposits helped us to divide them into five distinct groups (named as Type 1-5) with increasing intensity of the CCF deposit. We noticed that the craters with low-definition deposits occur in older craters (with eroded ejecta), and the deposit thickness/intensity increases in the case of the younger craters (with preserved ejecta). Alternatively, in the case of ‘Type 1’ (low definition) CCF deposits, the extent of the deposit partially covers the southern part of the crater floor which is less illuminated during the northern summer (Ls 270-360). For ‘Type 5’ craters (high definition), the crater floor is entirely filled and elevated occasionally.

In addition to the photogeological observation, we used digital elevation models from the Mars Orbital Laser Altimeter (Smith et al., 2001). The extracted profile sections along the same latitude suggested that the craters with low-definition CCF deposits have comparatively shallower crater floor depth than the craters with high-definition crater deposits. This observation intrigues the possibility of the presence of water table depth at a certain level. The craters that had crater floors much below the water table possibly received more water which eventually led to the formation of ice, and hence the CCF deposit.

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