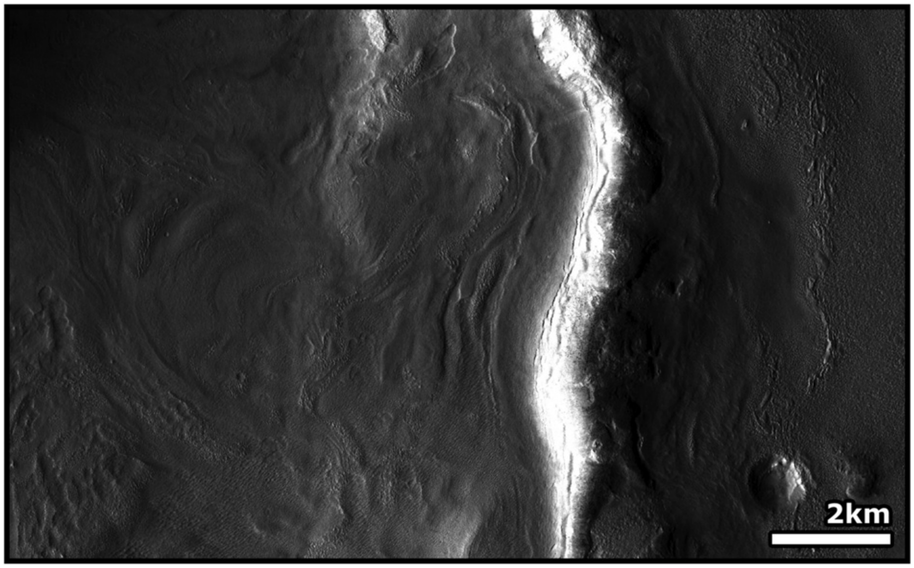

Fig. 6. The eastern rim of the older, larger crater (part of CTX image P01_001553_2232) (Context provided in Fig. 2B). Material along the interior rim converged and constricted between obstacles to flow onto the crater floor, leaving concentric ridges. The exterior crater wall is characterized by a sinuous ridge that trends parallel to the wall itself.

show a high concentration of pedestal craters, where impact ejecta has been armored relative to the surrounding plains (Fig. 1B). Analysis of marginal pits on pedestals in the nearby Utopia Planitia provides new evidence that implicates ice as the material underlying the pedestal surface (Kadish et al., 2008), suggesting that ice (of unknown thickness) has been areally expansive in this region during the Amazonian period of martian geologic history. The westernmost ejecta deposits from this impact event are still preserved on the surface, while all other ejecta has been mantled or removed. Due to the extensive resurfacing that has occurred within and around this crater, reliable crater size-frequency information is not available, and a formation age is not yet known, though it cannot predate formation of the Vastitas Borealis Formation in the Hesperian.

Superposed on the northeastern rim of this larger crater is an ~8 km impact crater. The ejecta deposit of this crater has mostly been removed, although its distal northeastern margin is observed in CTX data beneath a thick mantling unit. The southern rim of this crater has been completely removed, while the rest of the rim remains intact (Fig. 3).

4.2. Filling of larger crater and flow north into smaller crater

The two craters are presently separated by a ~8° south-facing scarp (Fig. 2). Draped over this scarp are the southernmost extents of the lobate ridges that trend north onto the floor of the younger crater (Fig. 3). This draping relationship and the north-trending convex-up lobes provide strong evidence that material flowed from the larger crater into the smaller crater, reversed from what would be expected from the current topographic relationship. For this to occur, material must have filled the larger crater to the elevation of the floor of the smaller crater (~ −3700 m). Using MOLA gridded data, we calculated a volume of the larger crater beneath the −3700 m contour of ~265 km^3 and a minimum thickness of ~640 m of crater-filling material. We interpret these measurements to be the minimum thickness and volume of material necessary to induce gravitational flow into the smaller crater to the northeast.

4.3. Flow of material on the exterior plains

Evidence is found on the external margins of the smaller crater for overtopping of the crater rim and flow of material onto the adjacent plains (Fig. 3). These lobate ridges emanate from depressed portions of the crater rim, suggesting that the material that flowed into the crater from the south overtopped the rim and became concentrated at these locations. Similar lobate ridges are observed on the outside of the northwestern crater rim, also emanating from depressed sections of the rim (Fig. 5). If this interpretation is correct and material overtopped the crater rim at multiple locations, this significantly increases the minimum amount of material that filled this two-crater system. We used HRSC and high-resolution CTX imagery to map the crater rims of both craters and, using MOLA data, calculated the present-day volume of the two-crater system. A volume of ~750 km^3 of material and a minimum thickness of ~1000 m must have been present for material to flow in the observed patterns. Provided that the floor of the larger crater has been significantly modified by CCF, this volume is interpreted to be a minimum volume necessary and is likely to have been greater than this measurement suggests.

After overtopping the rims of both craters, conditions at the surface dramatically changed and large amounts of material were removed to reveal the two-crater geometry that we observe today. There is no evidence of meltwater distributary features or deposits (e.g., fluvial channels, deltas, fans) that would lead to the interpretation of wet-based glacial activity. Instead, we interpret the observed features to be consistent with cold-based glacial behavior, similar in nature to that proposed by Dickson et al. (2008) for a similar stranded lobe of LVF located along the dichotomy boundary in Coloe Fossae/ Protonilus Mensae. As cold-based glaciers are welded to the surface and deform internally (Benn and Evans, 1998), they are capable of flowing over terrain without significantly eroding the substrate. As the climate changed and accumulation waned, the ice receded in thickness and the rims of the craters became exposed, leading to the shedding of debris onto the glaciers and the development of supraglacial sublimation lags or tills. This debris would form the series of lobate ridges on the exterior plains of each crater, and on the floor of the smaller crater (Fig. 3).

As the ice thickness decreased and the glacial system underwent recession, there appears to have been enough ice at certain locations along the ~8° scarp face that separates the two craters to initiate small amounts of backflow southward towards the center of the larger crater (Fig. 7). This flow reversal would represent the waning phase of glaciation as the system as a whole recessed. Along other portions of the scarp face, the lobate ridges that extend northward into the