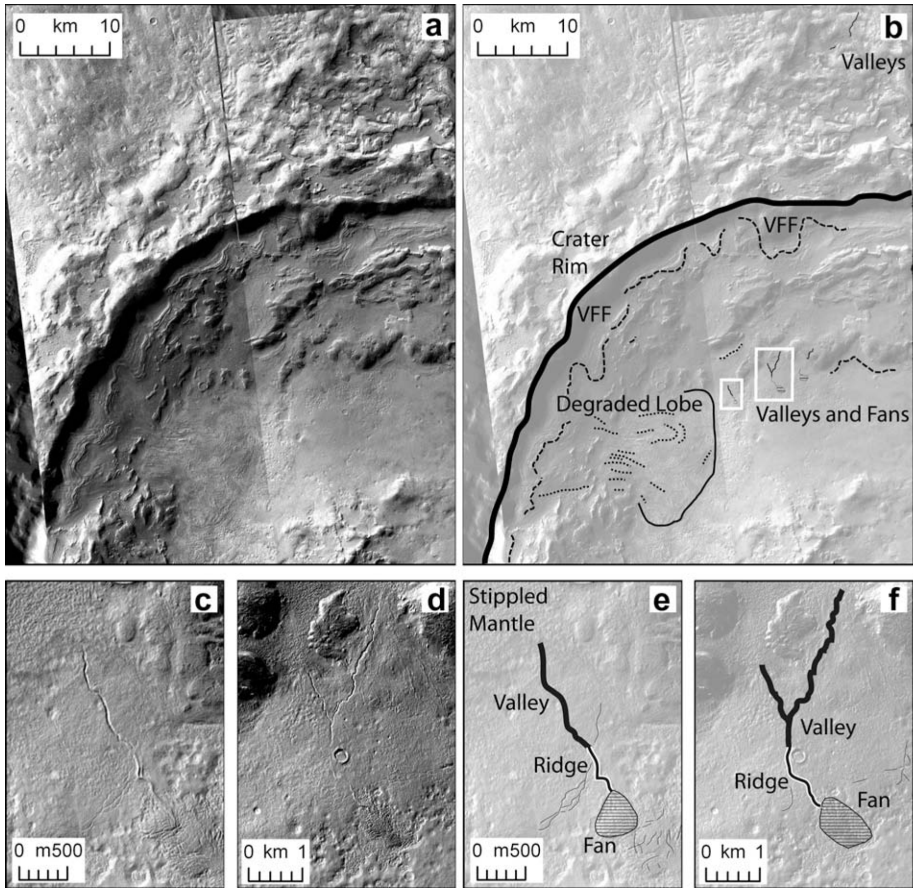


**Fig. 2.** (a) Context image and mapping (b) of glacial units and small valleys on the interior of an 80-km, unnamed crater (11.8°E, 40.0°S). Glacial or ice-rich flow features on the crater interior include viscous flow features (labeled vff) and a large lobate flow on the crater floor; white context box shows location of detail view. (c–f) Details of small valleys with deformed fans, located beneath viscous flow features. Towards their fans, the valleys transition into ridges. (CTX images P13_005950_1401 and P15_006807_1391, with HRSC nadir image 2694_0001 in the background.)

fans of material are observed, similar in morphology to fans in Lyot crater (Dickson et al., 2009). The fan surfaces are rough-textured and highly modified. Near their termini, valleys transition into ridges, which we interpret to be due to post-fluvial terrain inversion (e.g., Williams and Edgett, 2005; Fassett and Head, 2007a; Pain et al., 2007; Williams et al., 2007; Burr et al., 2009). Terrain inversion may result from surrounding materials being removed (by erosional processes, such as aeolian erosion or sublimation of ice), leaving the coarser and more stable valley sediments as a high-standing ridge.

On the basis of the measured Amazonian age of ice-related deposits in these mid-latitude environments, valley formation in this location is thought to have occurred at a similar time. However, a firm upper limit for valley formation comes from the age of the host crater itself. We conducted crater counts on the host crater and infer a Late Hesperian age for its formation based on its superposed crater population, although the small surface area for the ejecta imparts some uncertainty to this age (Fig. 3a). This crater age is also supported by the fresh preservation state of the crater and its ejecta, as well as the fact that secondary craters at sizes of only a few hundred meters still remain recognizable on surrounding plains. Thus, these valleys are clearly distinguished in time from valley networks formed earlier, in the Noachian/Early Hesperian on Mars (Fassett and Head, 2008a).

*2.1.2. Valleys in a 70-km crater, 352.5°E, 41.5°S*

Valleys are also found eroding material inside an unnamed 70-km crater (Fig. 4a and b), with small exposures of concentric crater fill material on the interior of the northern rim (Fig. 4c and d). The host crater has an estimated crater retention age in the Late Hesperian or Early Amazonian (Fig. 3b) and a morphologically fresh appearance consistent with this crater population. The concentric crater fill we observe here has long been interpreted as ice-rich (e.g., Squyres and Carr, 1986), an interpretation which has been bolstered by recent spacecraft analyses which suggest that lobate-debris aprons, lineated valley fill, and concentric crater fill all have a similar origin (e.g., Head et al., 2006, 2009; Levy et al., 2009) and in some instances, have clear signs of extant ice (Holt et al., 2008; Plaut et al., 2009; Safaeinili et al., 2009). Thus, we interpret this fill material as a remnant glacial deposit. At present, the accumulation zone directly adjacent to and south of the crater rim (Fig. 4c) is generally free of the fill material, probably because the glacier was beheaded (see Milkovich et al., 2006; Head et al., 2008).

Although a few other valleys of <1 km in length are found inside this crater, the only valley of substantial length is a 5.5 km long, single valley that terminates in an elongate fan (Fig. 4e and f). This valley has nearly constant width, a lack of tributaries and moderate sinuosity, similar characteristics to valleys described in Section 2.1.1 and Fig. 2, which are at approximately the same latitude and ~850 km away. The average slope of the eroded valley floor is ~5°. The valley headwaters were located at a re-entrant where a remnant lobe remains today (Fig. 4e and f). We infer that ice was advanced ~1 km further into this re-entrant when melting occurred (where the valley originates) and has since retreated to its present stand (Fig. 4f). This interpretation is consistent with previ-