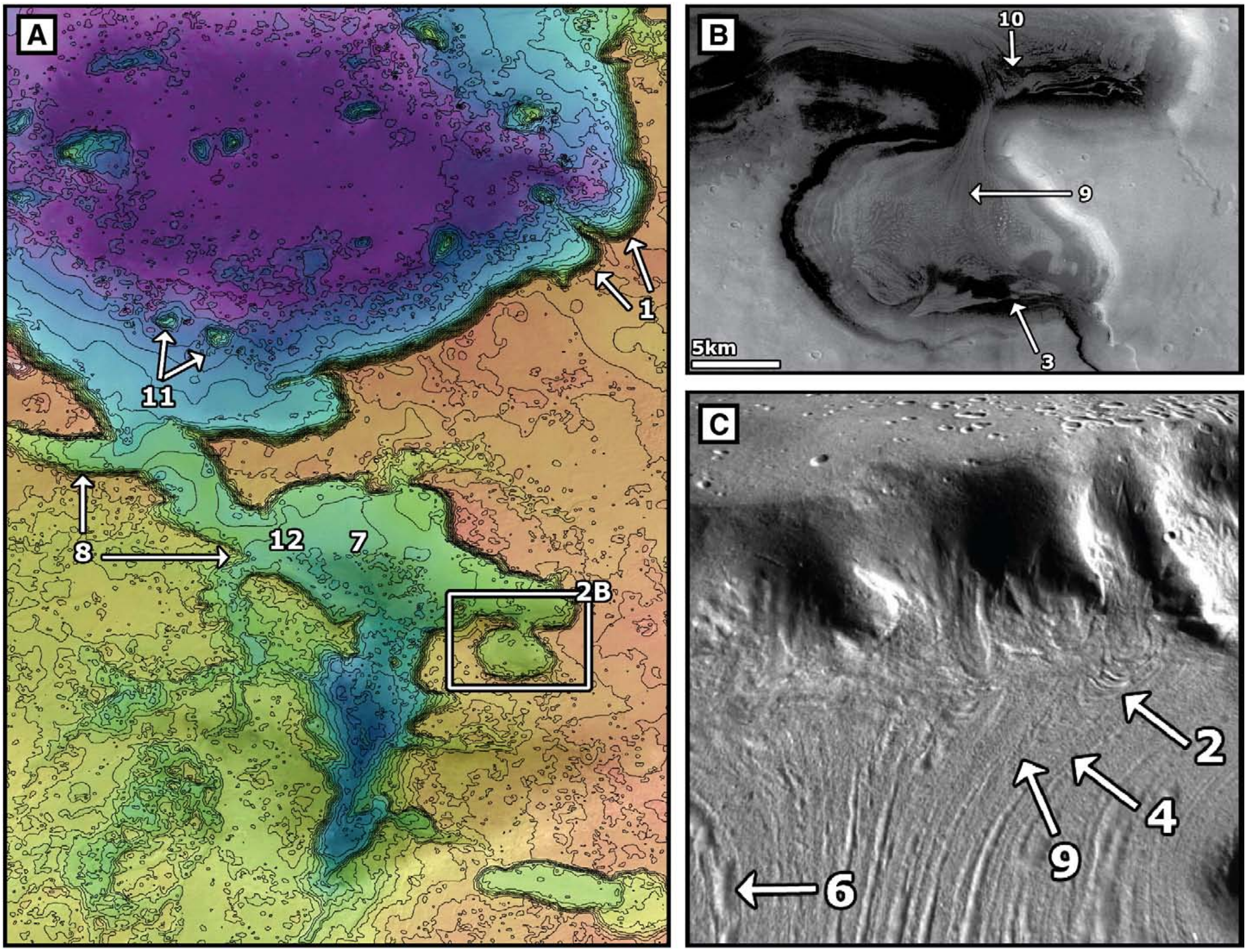

Fig. 2. A. Synoptic High-Resolution Stereo Camera (HRSC) image data superposed on HRSC DTM, with HRSC stereo-derived, color-coded topography and topographic contours displayed. This product is typical of those used in this study and is essential in showing the detailed relationships between topographic and morphologic features, particularly for determining E–W-oriented slope measurements where MOLA groundtracks are widely spaced. Northern Arabia Terra region (24° E, 39° N; Fig. 1, point 1). Numbers here, and in B and C show the types of features described in the text as criteria for recognition of glacial deposits. Inset box shows location of B. Contour interval is 250 m. Portion of HRSC images 1483_0000. B. Degraded impact crater and LDA and LVF. Accumulation of LDA along the crater walls has led to flow toward the breach in the crater rim, and out into the surrounding valley, where the flow joins LVF from the alcove to the east, resulting in complex patterns of folding and deformation. Location is shown by box in A. Portion of HRSC image 1201_0000. C. LDA at the edge of the dichotomy boundary converging northward downslope to form LVF; note that the LDA appear to emerge from the top of the plateau, suggesting the present of a plateau icefield feeding the valley glacial landsystem. The lobes are seen to transition form arcuate, outward-facing shapes, to chevron shaped, and then to compress further and merge into LVF. THEMIS V09872024 draped on MOLA; VE = 5×. Scene is ~16 km across at the crest of the slope face.

flow around obstacles) (Fig. 2A), 12) broadly undulating along-valley topography, including local valley floor highs where LVF flow is oriented in different down-valley directions (local flow divides where flow is directed away from individual centers of accumulation) (Fig. 2A), 13) integrated LVF flow systems extending for tens to hundreds of kilometers (intermontaine glacial systems) (Fig. 2A), and 14) rounded valley wall corners where flow converges downstream, and narrow arete-like plateau remnants between LVF valleys (both interpreted to be due to valley glacial streamlining) (Fig. 2A).

Taken together, the occurrence of these types of features is interpreted to represent the former presence of debris-covered glaciers and valley glacial systems in the Deuteronilus–Protonilus region (e.g., Head et al., 2006a,b). Snow and ice accumulating in alcoves, together with rock debris shed from adjacent steep walls, created debris-covered glaciers that flowed downslope, merging with other ice lobes to form ever-larger LVF glacial systems. Using these criteria, we now explore other parts of the mid-latitudes (Fig. 1) to assess evidence for similar features and processes.

3. Application of the criteria to other parts of the Deuteronilus–Protonilus region

Squyres (1978) showed that locations of LDA and LVF were concentrated in a distinct mid-latitude band, suggesting a climate control on their origin. We have applied the criteria for glacial deposits outlined above to detailed analyses of several additional areas in this northern mid-latitude region (Fig. 1), and we report a summary of our findings here. Although evidence has been presented for a debris-covered glacier origin for some occurrences of the LDA and LVF, a number of factors have remained uncertain, including: 1) determining the direction of flow in LDA and LVF, either normal to the valley (Squyres, 1978), or possibly parallel (down-valley) (Lucchitta 1984); 2) understanding of the detailed structure and texture of the LDA; 3) understanding of the relationships between the LDA and the LVF; 4) establishing the relationship of LDA and LVF to adjacent walls; 5) providing evidence for the origin of the lubricating agent and flow mechanism; 6) distinguishing the mode or modes of origin of the LDA