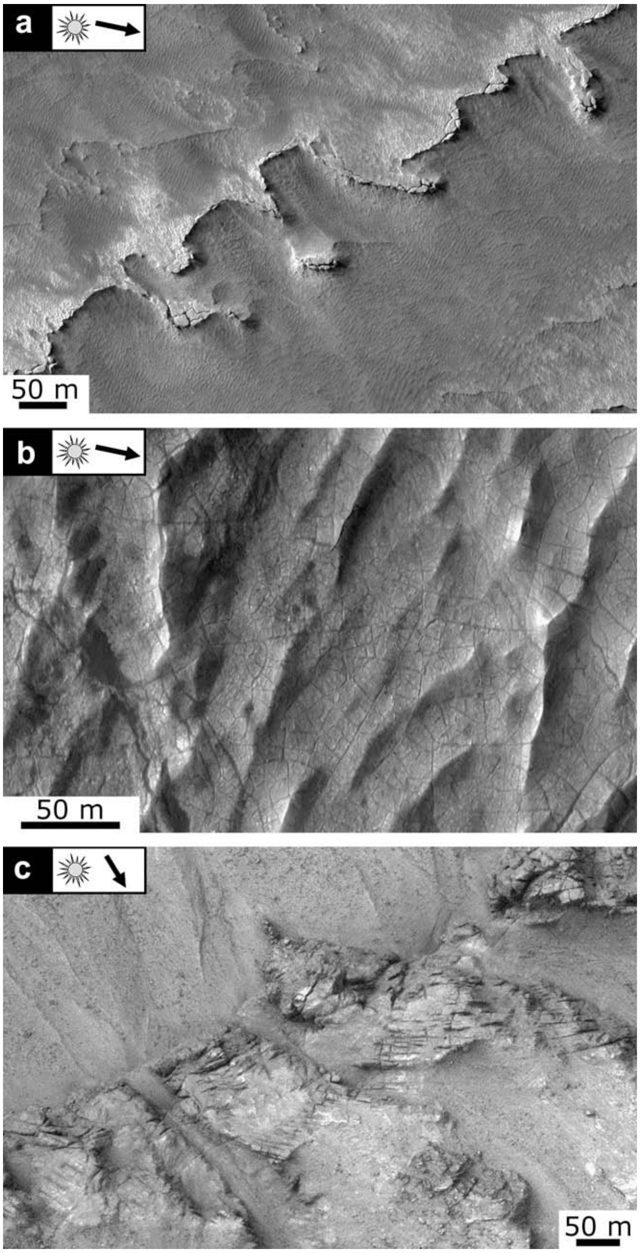

Fig. 7. Fracture networks that do not meet the criteria outlined by Levy et al. (2009c) for identification of permafrost-related thermal contraction crack polygons. (a) Desiccation-like fractures in chloride-bearing deposits (Osterloo et al., 2007). Portion of HiRISE image PSP_003160_1410. (b) Bedrock jointing located neat the Argyre Basin. Portion of HiRISE image PSP_003934_1275. (c) Fractures identified as columnar joints by Morgan et al. (2009) in Asimov Crater. Portion of PSP_010710_1320.

et al., 2009c), ranging from flat-topped polygons with depressed bounding troughs, to dramatically pitched, nearly conical peak-topped polygons. Polygons vary in trough intersection angle and the degree to which troughs are networked over hundreds of meter length scales. In addition, morphologically different groups of polygons (e.g., Levy et al., 2009c) are commonly present in a single HiRISE image, suggesting that local heterogeneities in the polygon-forming substrate are important controls on martian polygon morphology (as on Earth, e.g., Fig. 4). Conversely, morphological groups of polygons can be mapped across martian mid-to-high latitudes in both northern and southern hemispheres (Fig. 1), suggesting that global scale climate properties such as surface temperature (and accordingly, insolation) strongly affect the distribution and development of martian polygons (analogous to climate controls on transitions between polygon types on Earth) (e.g., Marchant and Head, 2007). Alternatively, transitions from high latitude, flat-topped polygons, to mid-latitude peak-top polygons, to lower-mid-latitude subdued polygons (Fig. 1) may reflect a maturation of polygon micro-topography due to ice loss proceeding from polygon margins to polygon interiors over time (Fig. 2, left column, and Fig. 8) (Marchant et al., 2002; Mangold, 2005). Such a maturation sequence is broadly consistent with increasing polygon network age from the poles to the equator (Levy et al., 2009c), and is consistent with more recent latitude-dependent mantle emplacement at higher latitudes (Kostama et al., 2006; Kreslavksy, 2009; Schon et al., 2009b).

4.2. Ice distribution and origin in martian polygons

What do the morphological characteristics of martian polygons observed with HiRISE indicate about the amount, distribution, and origin of ice in polygonally-patterned portions of the martian LDM? (Lefort et al., 2009; Levy et al., 2009c,d; Mellon et al., 2009). In particular, can martian polygon morphology be used to

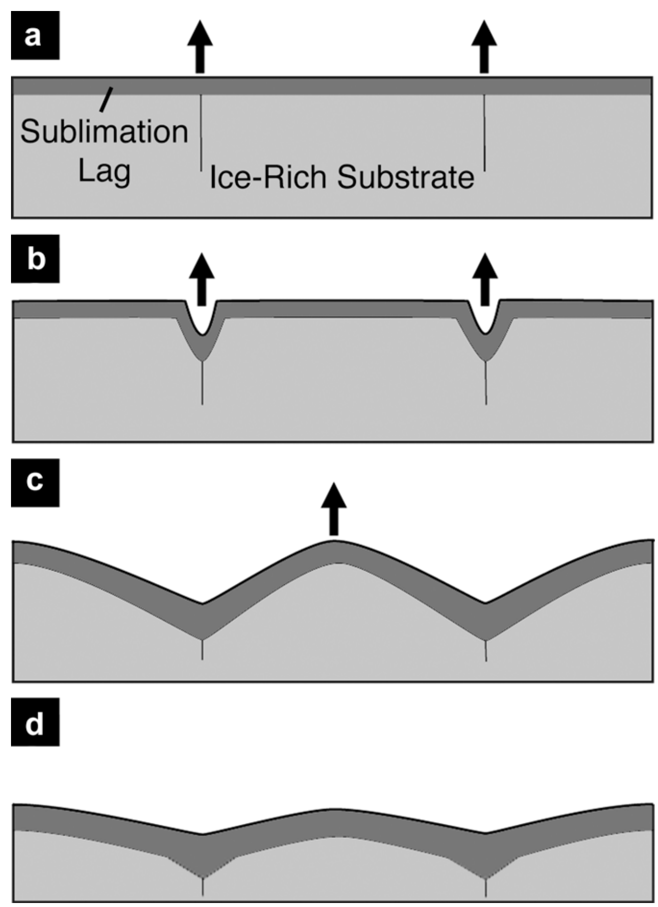

Fig. 8. Schematic illustration of a potential sequence for martian polygon micro-topography development, after Mangold (2005). Arrows indicate loci of increased sublimation due to disrupted and thinned till cover, and/or increased ice surface area in contact with a dry atmosphere. (a) An ice-rich substrate (light gray) covered by a sublimation lag deposit (dark gray) is fractured by thermal contraction (dark lines), focusing sublimation along cracks. (b) Flat-topped, small polygons develop as ice is preferentially removed along polygon margins. (c) Continued ice removal along polygon margins produces peak-topped and highly domical sublimation polygons. In response to thickened till cover at polygon margins, and slumping of till on steep ice slopes, sublimation shifts towards the polygon interior. (d) Subdued polygons result from loss of polygon core ice, producing little microrelief as the ice surface approaches an equilibrium level across the polygonally patterned surface.