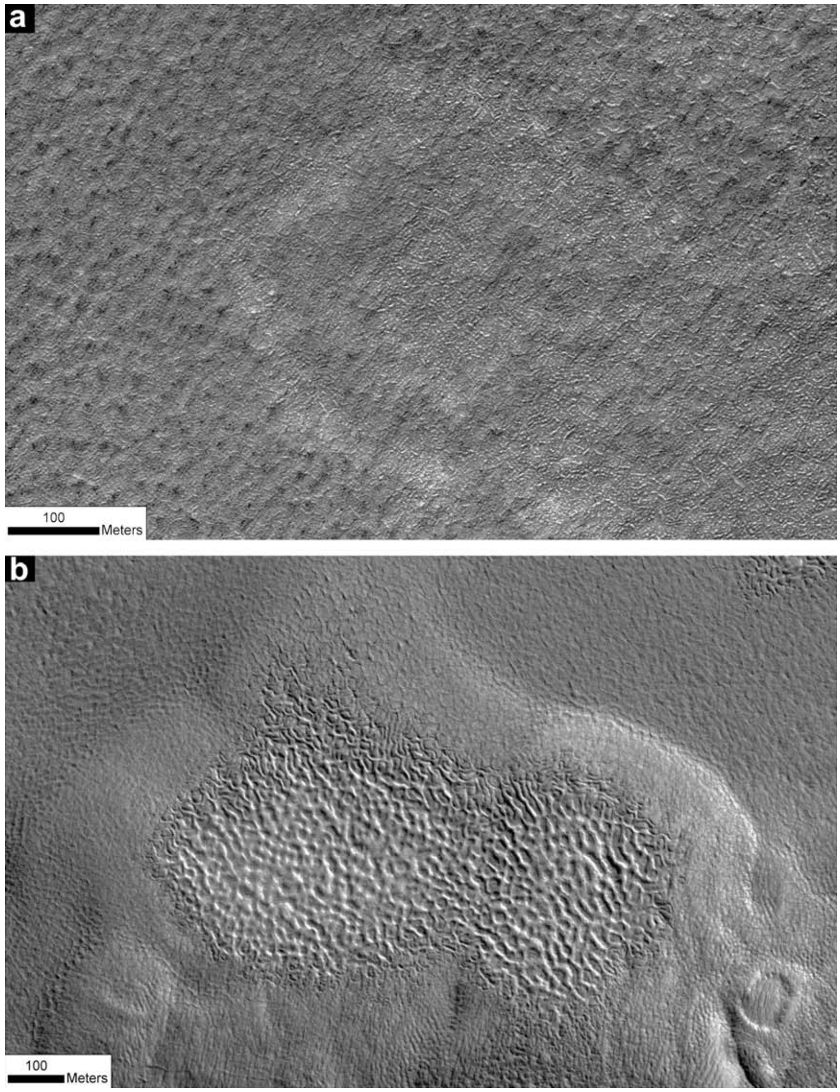

Fig. 13. Contacts between higher and lower lying polygonally-patterned LDM units, showing "windows" into underlying terrain. (a) Flat-top small polygons (perimeter of image) overlie irregular polygons (center and lower right of image). Portion of PSP_001880_2485. Illumination from image top. (b) Mixed-center polygons in a tens of meters thick layer of LDM (perimeter of image) overlie an exposed "brain terrain" concentric crater fill surface (image center). Portion of PSP_002175_2210. Illumination from lower left.

ter, rather than drainage and active layer processing, may be the ultimate fate of gully-related meltwater.

Some models for the formation of martian gullies suggest that the wholesale melting of "pasted-on terrain"—the morphological expression of LDM material present on many steeply sloping martian surfaces (Head et al., 2003, 2008)—is required for the formation of gullies (Costard et al., 2002; Christensen, 2003). Although the melting of pasted-on terrain is strongly implied in select locations showing dramatic evidence of wet debris-flow-like gully formation (Levy et al., 2009a), the presence of intact thermal contraction crack polygons both pre- and post-dating activity in many geologically-recent martian gullies suggests that widespread ground ice melting may not be required to produce all gully activity (Dickson et al., 2007; Head et al., 2008; Levy et al., 2009d). Given the association of some martian gullies with polygonally-patterned terrain (Levy et al., 2009d), and of many martian gullies with dissected latitude-dependent mantle material (Mellon and Phillips, 2001; Heldmann et al., 2005, 2007; Dickson et al., 2007; Dickson and Head, 2008), it is easier to reconcile the possibility that recent gully-related fluid flow is more closely linked to top-down melting of localized surface snow and ice and transport of desiccated surface sediments, than to widespread ground ice melting and thermokarst production derived from degrading LDM surfaces (Head et al., 2008).

Are there other polygonally-patterned landforms on Mars that may require larger or more widely distributed volumes of liquid water to form? A variety of landforms have been identified in polygonally-patterned portions of Utopia Planitia that have been interpreted to be pingos (Dundas et al., 2008; Burr et al., 2009a; de Pablo and Komatsu, 2009). These features are geographically distinct from equatorial landforms interpreted as pingos (Burr et al., 2005, 2009a; Page and Murray, 2006), the analysis of which is complicated by volcanic landforms also observed in Athabasca Valles (Jaeger et al., 2007) and Cerberus Fossae. Pingos form in tundra environments on Earth, and require saturated active layers, or even standing bodies of liquid water (and/or pressurized groundwater) to form (Washburn, 1973; Burr et al., 2009a,b). Pingos are of interest to thermal contraction crack studies in that pingos on Earth are commonly polygonally patterned, and because the putative martian pingos form in terrains surfaced by a range of young thermal contraction crack polygons and ancient glacial landforms. Although dramatic fracturing, and in some cases, organized crack-