depth) and an irregular central depression. Studies of this crater and similar examples suggest that the initially fresh crater was infilled with material and that the valleys were subsequently formed by the preferential removal of the crater fill along the interior walls of the crater (Schultz and Glicken, 1979; Malin and Edgett, 2000b). Gullies are located along every slope within the interior valleys and central depression, though their morphology varies significantly with slope orientation. Despite morphological variations, the gullies are all composed of the three basic morphologic units used to define martian gullies (alcove, channel and fan; Malin and Edgett, 2000a) and therefore, are considered to represent morphologic variations of a single landform type.

A thick, resistant, cliff forming rock unit displaying columnar jointing and interpreted to be a lava flow is present along the upper portions of the valley walls and provides a source of boulders to the slopes below. This lava flow largely caps the interior crater fill and likely formed prior to the valley formation as lava does not appear to have flowed into the valleys. Gullies on the crater fill side of the valley typically originate close to this layer, suggesting that there is a relationship between the two. This type of relationship has been interpreted as evidence for a groundwater source through the containment of a perched aquifer by the rock layer (Gulick et al., 2007). However, the occurrence of gullies along isolated ridges formed by the narrow divides between adjacent valley systems (Fig. 4) is inconsistent with the groundwater hypothesis for gully formation (as proposed by Malin and Edgett (2000a), Heldmann and Mellon (2004), Heldmann et al. (2005)) and instead supports gully activity resulting from an external water source. It also implies that variations in gully morphology were the result of external forcing and were not influenced by endogenic processes (such as the geothermal heating of ground ice) undetectable from the spacecraft data.

The largest and most complex gully forms are located on pole-facing (PF) slopes, and typically consist of multiple branching

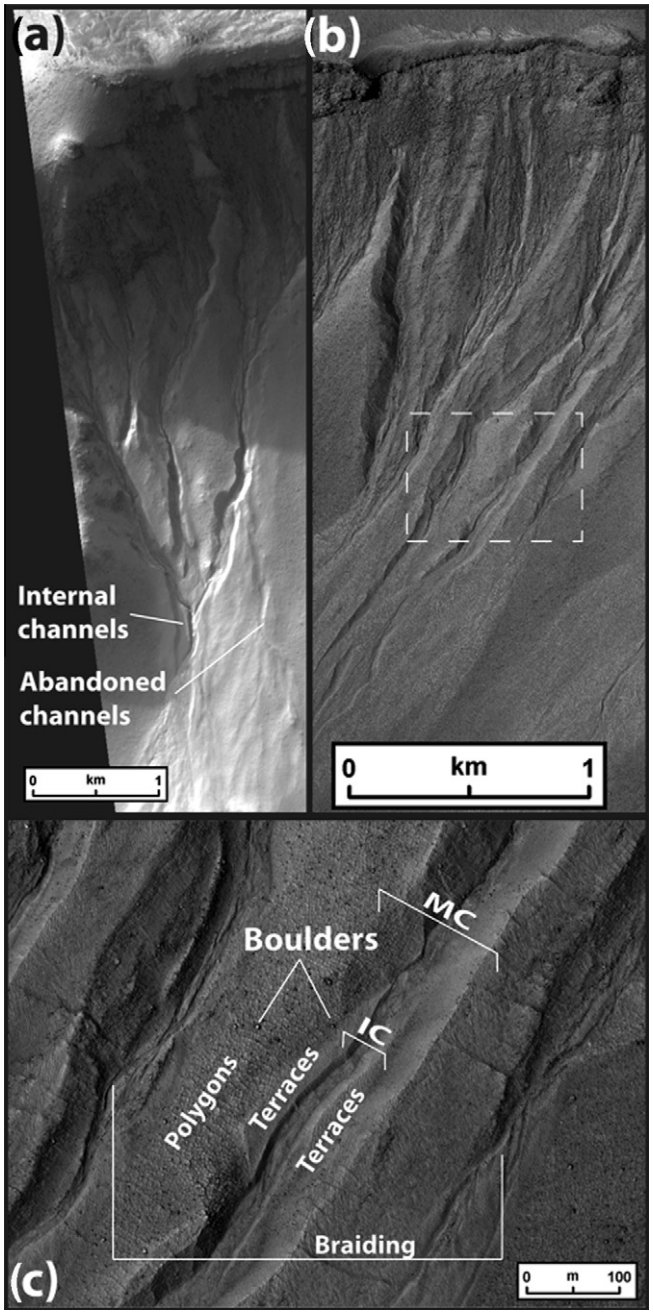

Fig. 5. High-resolution images of gullies on pole-facing slopes within the southernmost valley of Asimov crater. (a and b) These are the most complex and incised gullies found in the study area. (c) Close-up of box in (b) showing fine-scaled inner channel (IC) features suggestive of fluvial erosion within the main channels (MC). Compare this image with Fig. 1c from the Antarctic Dry Valleys, note the similarities in fluvial erosional features. Thermal contraction crack polygons can also be seen along the slopes the gullies are carved in. (a) MOC: E0301360, (b and c) HiRISE: PSP_004091_1325.

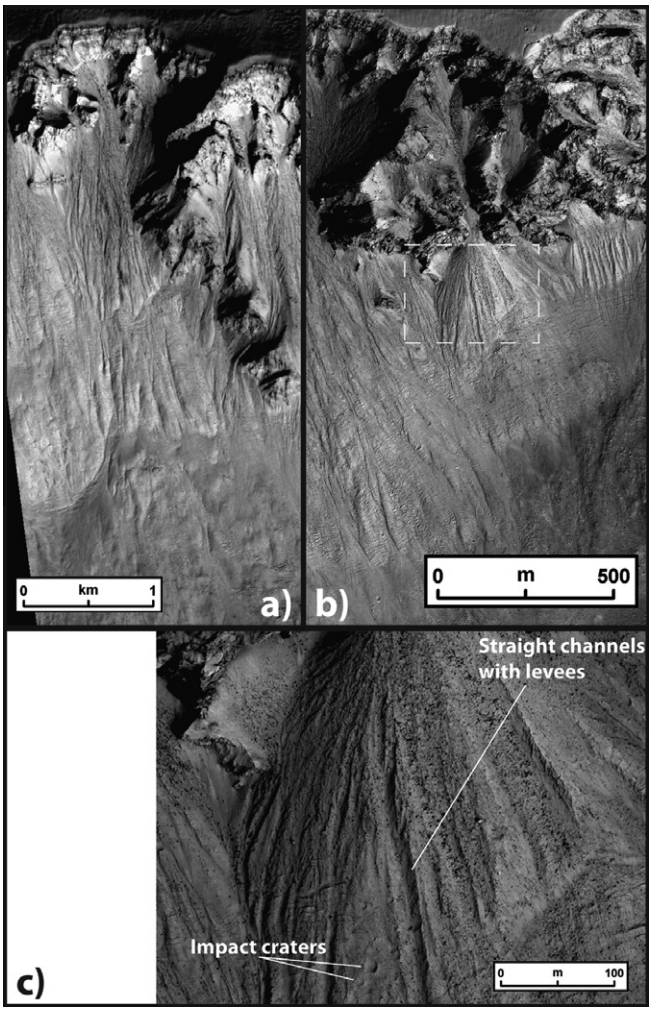

Fig. 6. High-resolution images of equator-facing gullies within the southernmost valley of Asimov crater; these represent the simplest of the gully types. (c) Close-up of box in (b) showing linear channels superimposed by impact craters, suggesting that the PF gullies have been active more recently than the EF gullies. (a) MOC: E1101724, (b and c) HiRISE: PSP_00 6926_1320.