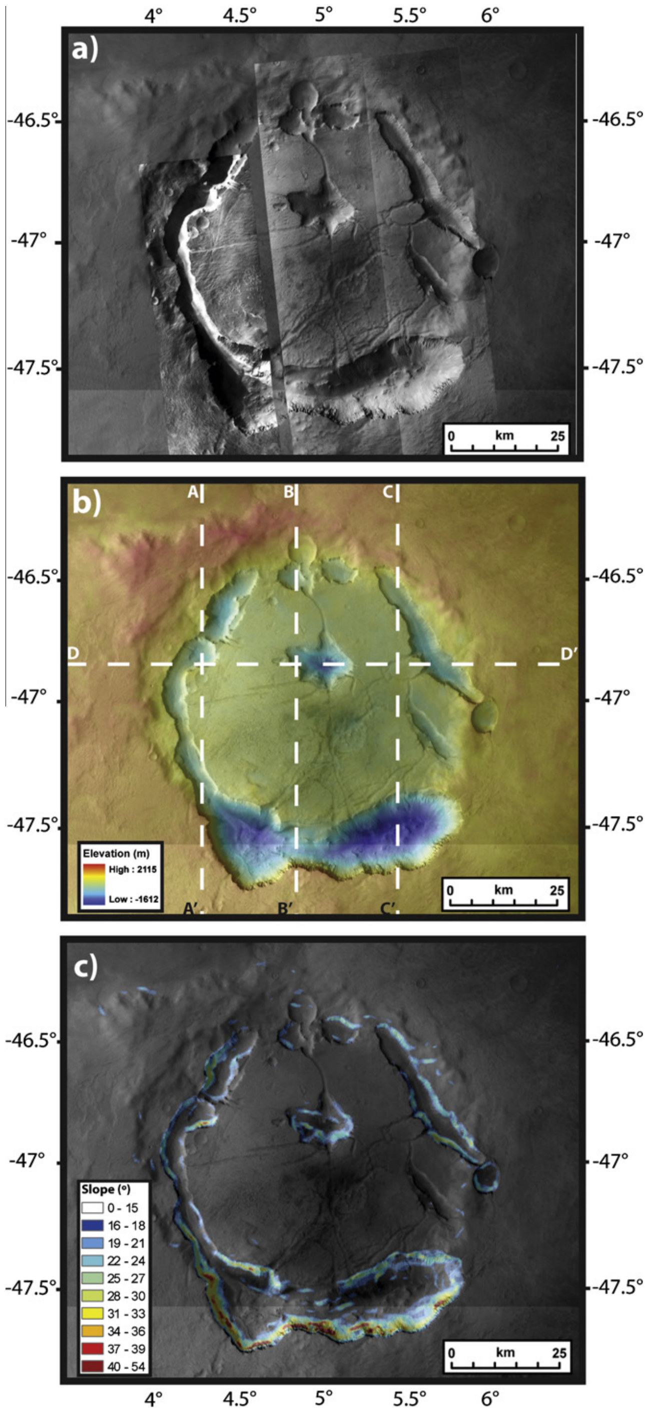

Fig. 2. Asimov Crater in Noachis Terra located at 46°S, 5°E. (a) The interior of the crater contains an annulus of valley systems and an off-center depression. CTX data over HRSC image: h1932_0000. (b) DTM of the study region. The degraded rim of the crater can be seen in the topographic data to the northwest. The deepest valley is 2000 m below the average surface elevation of the crater floor. The dashed white lines are the location of topographic transects in Fig. 4. DTM derived from HRSC orbit: h1932_0000. (c) Slope map of slopes >15° in the study area. Slope measurements derived from HRSC orbit: h1932_0000.

profiles from the HRSC DTMs. In the areas where detailed measurements of slopes were required, individual MOLA points were extracted to provide the most accurate account of the topography. The GIS software also enabled crater diameter surveys to be conducted and size–frequency distribution plots to be compiled in order to estimate the age of surfaces. Thermal infrared data from daytime and nighttime THEMIS infrared images (band 9, 100 m/pixel) were used to characterize the thermal inertia of the surface, which in turn provides a proxy for the physical properties of the surface (such as grain sizes).

3. Geological setting of the Asimov Crater study region

Research was focused within the 80-km diameter Asimov impact crater located within the heavily cratered plains of Noachis Terra to the west of Hellas (Fig. 1). This region of Mars has been mapped within the Southern Highlands hilly and cratered unit (Nhc) and is interpreted to be the oldest extensively exposed surface of the planet (Scott and Carr, 1978). The crater has no identifiable ejecta deposit and its remaining rim is both discontinuous and heavy degraded (Figs. 2 and 3), suggesting that it is Noachian in age. The floor of the crater is highly modified and filled and consists of a relatively flat unit that forms a surface ~1500 m below the highest portion of the crater rim crest (~900 m below the surrounding terrain outside of the crater, Fig. 4). Depths for a fresh crater of this scale are empirically found to be >3 km according to the depth (h) to diameter (D) relationship compiled by Garvin et al. (2003):

$$h = 0.36D^{0.49} \quad (1)$$

This suggests that the crater has been significantly in-filled since its formation in the Noachian. The crater interior is unusual in that there is an annulus of disconnected valleys adjacent to the interior flanks of the crater wall (Figs. 2 and 3). These valley systems extend for a collective length of over 200 km, and their widths range from 3 km in the eastern basin interior to over 18 km at their widest in the south (Figs. 2 and 4). The valleys range from 200 to 2000 m below the current crater floor (1700–3500 m below the crater rim crest, see Fig. 4), and thus the floors of the valleys might represent a portion of the original crater floor, prior to it being filled with material. An irregular ~20 km wide depression is also present north of the center of the crater (Figs. 2–4). The depression is connected to surrounding valley complexes by a network of radial ~1 km wide, shallow (~20 m deep) troughs.

A fine-grained deposit is draped along the majority of surfaces within the study area and is interpreted to be related to the latitude-dependant mantle that has been observed poleward of 30° latitude on Mars (Kreslavsky and Head, 2000; Mustard et al., 2001). This mantling unit has been attributed to an atmospherically derived layer of dust-rich ice which formed during the most recent Mars 'ice age' when obliquity values were higher than today (Head et al., 2003). Although smooth in appearance relative to all other surfaces within the crater, the mantle unit exhibits several different textures including ~10 m wide isolated pits and extended regions of cuspate depressions (Fig. 7). Similar dissected morphology has also been observed in the global mantle unit in the latitude range of 30–60° (Mustard et al., 2001; Milliken et al., 2003). This has been attributed to sublimation of water ice within the mantle caused by the current instability of near-surface ice-rich material at these latitudes (Mustard et al., 2001; Mellon and Jakosky, 1995).

In the highest-resolution image data sets (MOC and HiRISE) a discrete layer is observed in section along the upper, steeper portions of the valley slopes where it is exposed from beneath the upper mantle layer (Figs. 5–7). This unit is also apparent in the THEMIS nighttime infrared data where it correlates with a layer of higher nighttime temperatures relative to the slopes directly below (Fig. 8). This indicates that it corresponds to a material with a higher thermal inertia value, and likely represents a rock outcrop similar to others identified on Mars with THEMIS (Christensen, 2003). The layer appears to be actively eroding, providing a source of scree and large boulders (>5 m) that are present across all slopes directly below outcrops (Figs. 5 and 7). Boulder tracks, 1 m in