MORPHOLOGICAL EVIDENCE FOR A SEA-ICE ORIGIN FOR ELYSIUM PLANITIA PLATY TERRAIN.

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Introduction: Platy plains terrain in Elysium and Amazonis Planitia consist of fractured plates up to 10s of kilometers in size that show evidence of break-up, rotation and horizontal drift. This suggests initial formation as a two-phase material (fluid interior, brittle 'crust') which later completely solidified, fixing the rafted crust in place. The origin of this terrain is controversial [1] and the debate continues as to whether it is lava plains [e.g. 2, 3] or remnants of a lake or sea of frozen water [e.g. 4, 5].

We have begun mapping the platy deposits to the West of the Cerberus Fossae (145-160^o E) using HRSC (12-25m/pixel), THEMIS vis (18-40m/pix), THEMIS IR (100-300m/pixel) and MOC-NA (1.5-5m/pixel) images together with MOLA, HRSC and MOC-NA DEMs. The combination of a regional view and high resolution details has revealed new evidence supporting a pack-ice style of emplacement.

Regional observations: The regional view (figure 1) suggests that the entire Elysium platy terrain complex was emplaced as a result of flow(s) from the Cerberus Fossae. The complex consists of several individual 'lakes' connected by erosional channels up to ~20m deep and ~2km wide and there is a consistent decreasing topographic trend from one 'lake' to the next.

The main feeder channel for the Elysium complex is Athabasca Vallis, a ~10km wide, ~100m deep erosional channel bounded at the south by a wrinkle ridge. In general the channel floor shows evidence of fluvial erosion and deposition but platy terrain is visible in places. The terminations of Athabasca Vallis and its smaller overspill channels do not appear to disappear under the platy terrain of the Elysium complex, but instead continuous platy terrain can be traced from the floor of Athabasca, through overspill channels and into the various 'lakes'.

The horizontal movement directions of the plates in the Elysium complex (figure 1) can be mapped using clear 'lanes' behind topographic obstacles and rubble piles in front of obstacles. Streamlined islands and other fluvial directional indicators within channels show similar directional trends.

At the extreme West of the study area, over 700 km away from the Cerberus Fossae, the main Elysium 'lake' drains into a series of erosional channels which feed a larger channel running northwest. Thus the entire complex was, at some point, filled with a fluid capable of eroding deep channels at great distances from its source. These observations indicate the platy terrain forming material was sourced from Cerberus Fossae, travelled down Athabasca Vallis or its overspill channels and then solidified in place in the Elysium plains.

Morphological observations:

1.Sinusoidal ridges are present in the platy terrain, especially in the inter-plate regions (figure 2a). These ridges show very similar morphologies to finger rafting and sinusoidal ridges found in sea ice on the Earth (figure 2b) but, to our knowledge, are not found in lava.

2. Near the margins of the platy terrain are fractures up to 80km long parallel to the 'shore' that show plate movement *away* from the margin (figure 2c). This suggests retreat of the fluid before complete solidification. These are analogous to 'tide cracks' at sea ice margins on the Earth.

3. Where flow is confined by a channel or by obstacles, the plates show a distinctive 'arching' pattern that is concave downslope (figure 2d). This is similar to sea ice within channels on Earth, but opposite to channelised platy lava flows-such as Burfellshraun, Iceland that are concave upslope.

4. 'Shear zones' (figure 2d) and shear fractures with rhomboid openings are seen in the platy terrain. Again, these feature are similar to those found in terrestrial sea ice and imply deformation of a material with weak resistance to fracture (fracture toughness of sea ice is ~ 0.1-0.3 MPam$^{1/2}$ [6] compared to ~ 2-3 MPam$^{1/2}$ for basalt [7]).

5. Multiple episodes of large scale fracturing and re-freezing of plates are visible, again suggesting a material with poor resistance to fracture.

6. The stratigraphy/topography of the deposits within the (almost certainly) water-carved inter-lake channels (figure 2e) is difficult to reconcile with a lava flood genesis. Multiple water-lava-water events are required. A single water flow episode that erodes channels and forms platy terrain is a simpler explanation.

Conclusion: Mapping is revealing more and more evidence supporting a sea ice origin for Elysium platy terrain. In the Western part of the study area the morphologies are particularly well explained by the sea ice hypothesis. Nevertheless, there are features to the East of the study area such as very low slope shield-like edifices, flows with lobate edges and small vents with associated platy flows that could be explained as either very low viscosity lava or mud volcanoes and their associated flows. Further study of HRSC DEMs and particularly HiRise images and DEMs is required.

References: [1] Sakimoto, S., (2006) *LPSC XXXVII* abstract 2384. [2] Keszthelyi, L., et al., (2000) *JGR 105*, 15,027-15,050. [3] Plescia, J.B. (2003) *Icarus 164*, 79-95. [4] Brakenridge, G.R. (1993) *LPSC XXIV* pp175-176 [5] Murray, J.B. et al. (2005) *Nature 434*, 352-356 [6] Sammonds et al. (1998) *JGR 103*, 21,795-21,815. [7] Balme at al. (2004) *J. Volc. Geotherm. Res*. 132, 159-172.

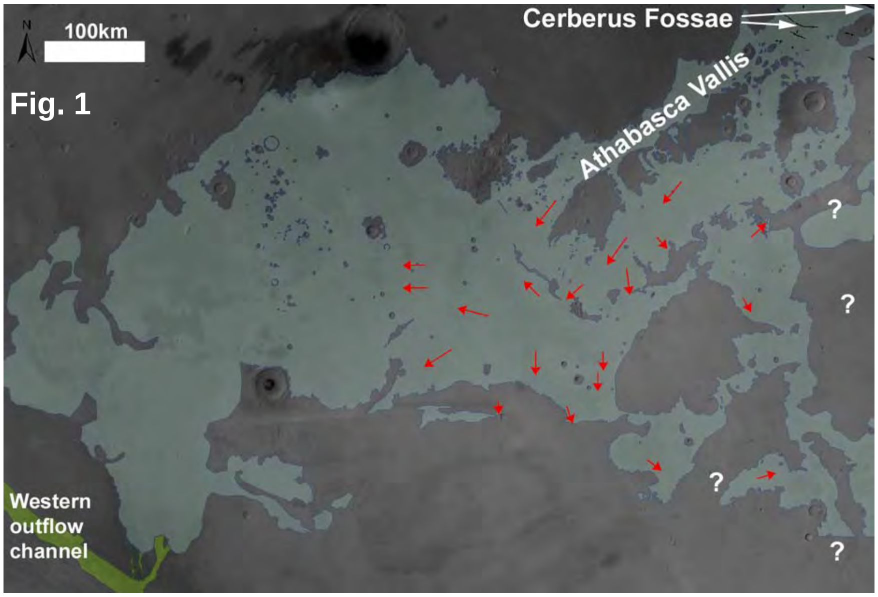

Fig.1. Outline of Elysium platy terrain complex and associated channels. Plate movement directions shown in red. Background is MOC WA mosaic. **Fig.2a**. Sinusoidal/finger rafting in Elysium complex (MOC NA M21-00131). **Fig.2b**. Aerial photo of sinusoidal ridging in sea ice on Earth. **Fig.2c**. ‘Tide crack’ in the Elysium region.(HRSC h2165 **Fig.2d**. A channel of platy terrain within the main Elysium complex. Flow is top right to bottom left. Note the shear zone ridges and the concave downflow shape of the plates. (HRSC h2121) **Fig.2e**. Inter-lake channel (marked X on fig 1) showing erosion by water and superposing plates (HRSC h2121).