Geophysical Research Abstracts
Vol. 13, EGU2011-6489, 2011
EGU General Assembly 2011

Morphologies associated with small impact crater clusters in the Western Elysium Planitia region of Mars.

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Elysium Planitia is a low-lying, equatorial plains region of Mars containing arealy extensive and continuous deposits of extremely flat terrain with unusual and distinctive "platy-ridged-polygonised" (PRP) morphology. The distinctive morphology allows this terrain-type to be easily mapped in remote sensing data. PRP has been interpreted to indicate extensive flood lavas by some authors, but also by others as the dust-covered surface of an ancient frozen sea, or to be the periglacially reworked remnants of a catastrophic fluvial flood landscape.

The Elysium PRP terrain contains many clusters of small secondary impact craters, the origins of which are thought to be kilometer-sized primary craters in the wider Elysium Planitia region. These secondary craters occur in "rays" radiating from one or another of the primary impact craters and are particularly obvious when viewed in night-time and daytime THEMIS (Thermal Emission Imaging Spectrometer) infra-red (IR) imaging data.

Using THEMIS IR data we have identified a number of approximately circular, kilometer-scale thermal anomalies in the west of the PRP region within Elysium Planitia. These anomalies occur only within the PRP terrain and are similar to secondary impact crater clusters in that they are only easily identified in IR imaging data. However, unlike the crater rays, they are usually almost circular and are always bright centered with dark haloes in night-time IR (and have the opposite signature in day-time IR) data. Interestingly, when examined in the 30cm/pixel "HiRISE" imaging data, the thermal anomalies are found to comprise a dense halo of very small (10-30 m diameter) impact craters surrounding a central feature. The central features are 100s of meters to nearly a kilometer in diameter and can take a range of morphological forms: shallow, circular central pits, sub-circular areas of rough terrain that sometimes include small cone-like structures, and, in a few cases, radial flow-like features that appear to superpose both the central pits and the surrounding craters.

The central structures do not appear to be simple impact craters but instead appear to be genetically related to the haloes of small impact craters that surround them. We have found at least 15 examples within a 100 km wide region so it does not appear that this is simply a case of a few morphological features coincidentally sitting at the centre of truncated impact crater rays comprising clusters of small craters. Also, fresh kilometre scale impact craters into PRP material have the opposite thermal signature (dark centred, bright halo) in night-time IR data. As this morphology is found only within the PRP terrain (at least in so far as we have examined the wider Elysium Planitia region) this implies a processes suite that is also restricted to within these terrains.

The discovery of central flow-like central features within haloes of small impact craters is particularly unexpected. Perhaps the simplest explanation for these anomalies is that they are clusters of secondary impact craters that have somehow reactivated their impacted substrates and allowed new landforms to form. Possible examples could be impact through the crust of active lavas into more liquid lavas beneath, or impact into "warm" ice-rich material. Another possibility is that there is something specific about the central morphological features and their neighbourhoods that somehow preserves impact craters more easily than other parts of the PRP.