RELATIONSHIP BETWEEN IMPACT CRATER DEPOSITS, SMALL SCALE CHANNELS AND LINEATED VALLEY FILL AT THE DICHOTOMY BOUNDARY IN THE NORTHERN MID LATITUDES. Gareth A. Morgan[1] and James W. Head[1], [1]Dept. Geol. Sci., Brown Univ., Providence, RI 02912 (james_head@brown.edu).

Introduction: The origin of the dichotomy boundary is a major unresolved question in the geological evolution of Mars. Understanding the subsequent degradation of this global escarpment is essential to assess its original position and hence provide constraints for its formation. The occurrence of integrated Lineated Valley Fill (LVF) systems within the fretted terrain that characterizes this region has supported the interpretation that they are of glacial origin [1-6], thus providing a mechanism of erosion to at least partly explain the boundary's degradation. Such research in turn explores the martian paleoclimate and the history of glacial activity on the planet.

We have used an array of spacecraft data to investigate a region within the northern extent of the boundary (centered at: 32º E, 39ºN, see Fig 1) adjacent to a previously studied integrated LVF flow system [3]. This system was found to originate in 1) dozens of alcoves and several tributary valleys, and 2) from a region in the southern part of the study area.

Our investigation supports this previous work and further finds that 1) to the west a similar source region exists where the valleys are almost completely filled with LVF, 2) the emergence and flow of LVF from localized alcoves can be observed throughout the region and 3) the features described provide evidence for a system comparable to that previously investigated [3].

Description and importance of the region: The integrated LVF system described here extends throughout a region of 7500 km^2, and continuous linear flow patterns can be identified for distances of ~100 km. Dozens of small alcoves (around 2 km in diameter) are found feeding the main trunk of LVF. The source of both LVF systems is situated around the southeastern edge of a large plateau (300 km across) that constitutes the northern section of our study region. It was made identifiable by the fretted valleys in that area being almost completely filled with LVF.

The spatial relationship between this plateau and the LVF argues that much of the valley fill may have originated on top of the plateau as well as within alcoves that have formed along its flanks and within the surrounding cliff faces. A large ~ 50km diameter crater is situated within the center of the plateau. The stratigraphy of such an extensive geomorphic feature is important in order to reproduce accurately the geological history of the region and assess the history and influence of the LVF processes.

Linear clusters of secondary craters are present across the surface of the plateau, but are found to abruptly terminate at its edge, and are not found on the intervening LVF. Secondary craters, made apparent by their elongated form and clustered spatial distribution, have been identified on the plateau to the south and on a mesa to the east. No such craters are found on the surface of the LVF itself, meaning that the parent impact crater must pre-date or at least have formed during the period when the LVF was being emplaced (see Fig 2).

Valley Networks: The occurrence of a high density of valley networks on the crater-bearing plateau is of significant interest, and particular care was given to understanding their role in the history of the region due to their apparent uniqueness. The channels are sinuous, approx 300 m wide and largely braided in appearance. Evidence of ponding is also prominent as channels are observed to disappear into hollows and reemerge from the down-slope side. Fig 3 shows the spatial distribution of the channels which clearly flow down the flanks of the crater in some regions and are not dissected by it or the ejecta associated with it.

It is also significant that, in some instances, the channels are found to drain into the alcoves within the cliffs of the plateau, but appear to pre-date the LVF. The valley networks appear then to be linked to the formation of the crater, possibly the result of groundwater or snow melt initiated by heat generated from the impact event. This is supported by the occurrence of similar relatively fresh valley networks found associated with several other similar-sized craters in the region (e.g. crater centered at: 31º E, 37º N).

Modeling has revealed that hydrothermal systems can be established and remain over relatively long periods within craters [7-11]. Indeed channels are observed within the crater itself, but it is the occurrence of channels on the outside that suggests that the impact may have occurred during a glacial period and distributed ejecta onto large amounts of snow and ice in order for the channels to form.

Some of the channels are observed to drain into a number of the alcoves located to the south of the crater, raising the possibility that the erosion that generated the channels also created or helped to modify the alcoves. However, high resolution MOC images of the alcoves to the south of the crater reveal that the channels do not cut down into the edge of the alcoves themselves, indicating that separate erosional processes were responsible for alcove formation. This evidence along with the occurrence of alcoves without channels elsewhere in the region strongly argue that there is no direct relationship between channels and alcoves except that they provide local topographic lows into which the channels drain. The LVF in alcoves appear to postdate the channels, and are interpreted to be responsible for enlargement of the alcoves.

Conclusion: Our investigation shows that 1) alcoves are a significant source region of LVF, and in relation to terrestrial analogs are comparable to cirques [12], hence supporting the glacial hypothesis; 2) that the LVF in the region forms an integrated system with a common source region, possibly to the southeast of the plateau.

Such observations are the basis for a geological history of the region that begins with the formation of the fretted valleys in the Noachian (by such mechanisms as outflow and/or sapping activity [13,14]). This was followed by continued impact cratering and finally frost, snow and ice accumulation in the later stages of Martian history (Amazonian, see [14]) leading to glacial flow, which in turn has further modified the fretted terrain. The presence of small scale valley networks is interpreted to be linked to impact generated hydrothermal systems, their occurrence on the major plateau is evidence for the existence of pre-impact, large scale ice deposits.

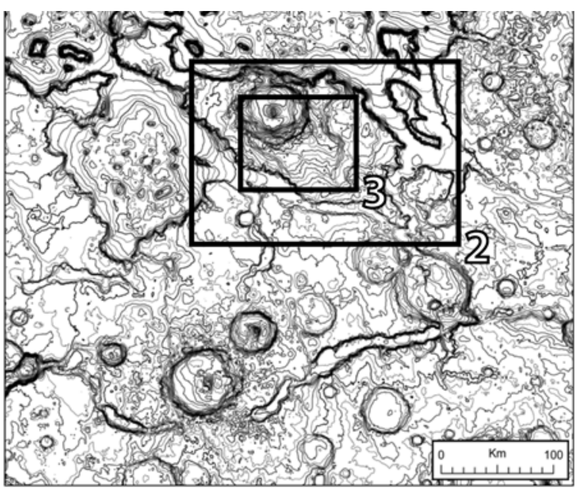

Fig. 1. Topographic map of the study region; contour interval 100m.

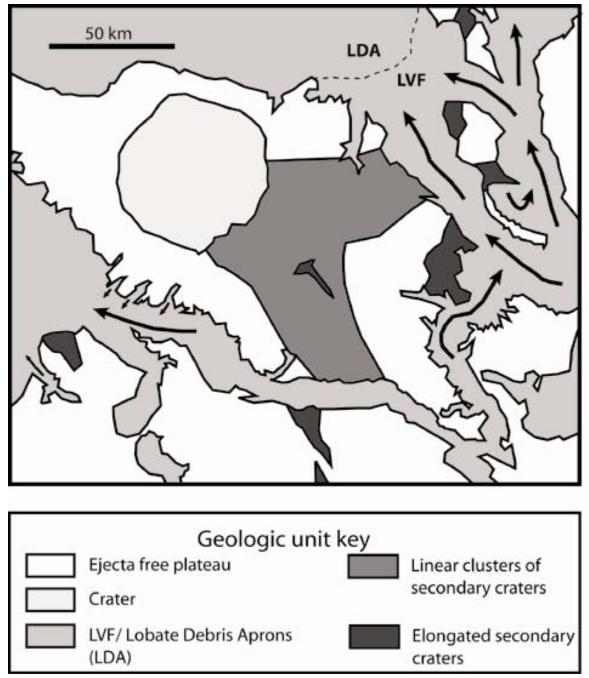

Fig. 2. Sketch map of the spatial distribution of ejecta from the study region's major crater, and flow direction of LVF.

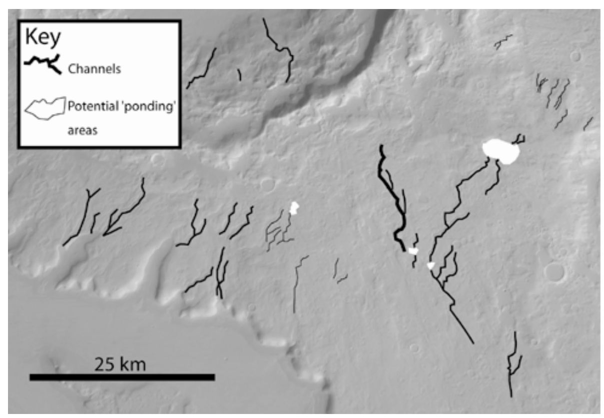

Fig. 3. Distribution of valley networks on the main plateau.

References: [1] B. Lucchitta, *JGR*, 89, b409, 1984; [2] J. Head et al., *EPSL*, in press, 2005; [3] J. Head et al., *GRL*, in press, 2005 [4] J. Head and D. Marchant, *LPSC 37*, 1126, 2006; [5] J. Head and D. Marchant, *LPSC 37*, 1127, 2006; [6] A. Kress et al., *LPSC* 37, 1323, 2006; [7] D. Marchant and J. Head, *LPSC 37*, 1425, 2006; [8] J. Rathbun and S. Squyres, *Icarus*, 157, 362, 2002; [9] H. Newsom, *Icarus*, 44, 207, 1980; [10] I. Thorsos et al, *LPSC 37*, 2011, 2001; [11] J. Hagerty amd H. Newsom, *M & PS*, 36, 365, 2003. [12] D. Benn and D. Evans, *Glaciers and Glaciation*, 1998; [13] M. Carr, *Water on Mars*, 1996; [14] G. McGill, *JGR*, 105, 6945, 2000.