GEOMORPHIC EVIDENCE FOR SIGNIFICANT GLACIAL AND FLUVIAL ACTIVITY IN CANDOR CHASMA, MARS. K. T. Thaisen[1], J. Schieber[2], A. Dumke[3], E. Hauber[4], and G. Neukum[3],[1]Department of Earth & Planetary Sciences, 306 Earth & Planetary Sciences Bldg. Knoxville, TN 37996 (kthaisen@utk.edu), [2]Indiana University 1001 E. 10th St. Bloomington, IN 47405, [3] Freie Universitaet Berlin, 12249 Germany, [4]DLR-Institut für Planetenforschung, 12489 Berlin-Adlershof Germany.

Introduction: Water and ice have shaped the surface of the Earth in many ways, leaving distinct geomorphic expressions associated with these different processes. These processes, however, are not unique to the Earth, and with the improved image resolution from the surface of Mars, features reminiscent of glacial and fluvial activity are increasingly being recognized. Candor Chasma in central Valles Marineris contains many geomorphic features that bear a striking similarity to glacial features on Earth, such as troughs, moraines, hanging valleys, asymmetrical spurs, and molded junctions between troughs. In addition to the glacial features, several features attributable to fluvial activity, such as erosional remnants, channels, scarps associated with headward erosion, paleo-shorelines and possible deltas have been identified in and around the vicinity of Candor Chasma.

Methods: Imagery from the High Resolution Stereo Camera (HRSC) and THEMIS were spatially referenced and used as base images of the Candor Chasma area. Higher resolution Mars Orbital Camera (MOC) images were processed in ISIS and then referenced to this base map in order to provide greater detail of surface features. All imagery was then draped onto Digital terrain models (DTM) generated from the HRSC imagery and MOLA data of the area in ESRI ArcGIS to explore apparent morphological relationships that exist. Martian features were then compared to Earth features that have been recognized as being the result of glacial and/or fluvial activity.

Observations: The possibility of glacial activity around the equatorial regions of Mars has been suggested by others [1, 2]. Here we propose new glacial and fluvial features in and around the Candor Chasma region of Valles Marineris.

Glacial features: Several features related to the troughs leading into central Candor Chasma have been previously suggested as being glacial in origin [2]. Additional features that we have recognized are located in Fig. 1, showing several troughs that have a roughly parabolic cross-section. Trough A has a spur with a corresponding recessed alcove on the opposite side of the trough. Molded junctions exist between troughs A and B, as well as C and D where two troughs intersect. The polygonal ground features that are seen where trough B opens into central Candor Chasma resemble sub-glacial fluvial activity seen in Wright Valley Antarctica [3]. The trough labeled E also has a number of features associated with glaciers. This trough has a roughly parabolic cross-section and the eastern end terminates at a notched ridge which sits more than 1000 meters below the adjacent ridges to the north and south. We interpret this ridge as a terminal moraine. The notches in the ridge lead to incised channels on the opposite side, suggesting that water may have been dammed behind the inferred terminal moraine and formed a glacial lake which breached the ridge in various locations. Furthermore, the floor of the trough has a hummocky texture reminiscent of sublimation till [4].

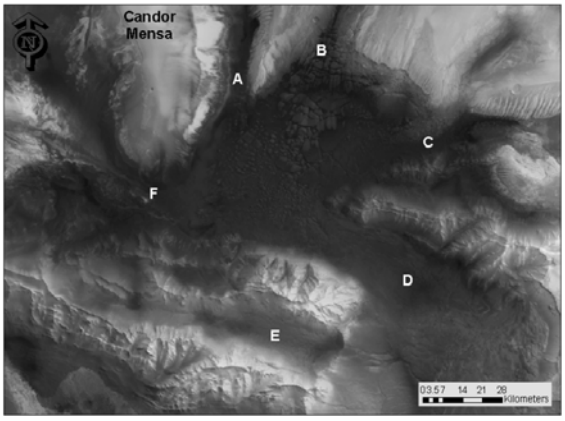

Figure 1. Central Candor Chasma has six troughs that display glacial features, labeled A, B, C, D, E and F.

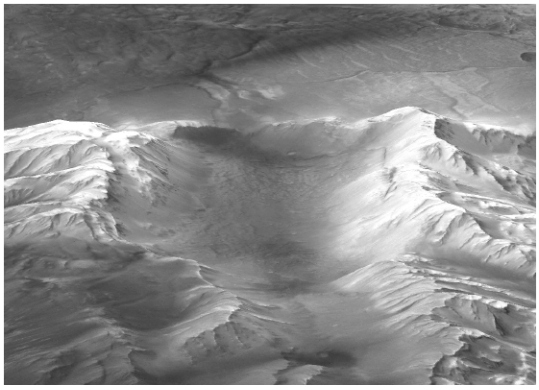

Figure 2. Oblique view of trough E from Figure 1 looking to the southeast. Notice the lack of dissected slopes inside the trough and what appear to be channels emanating from the central notch.

Another feature that was recognized in the central Candor Chasma region is hanging valleys. The floors of these hanging valleys are 900 – 1000 meters above the Chasma floor and can be found at locations on

adjacent sides of trough D from Figure 1. Unlike typical Alpine glacial valleys found on Earth, these hanging valleys have a V-shaped cross-section and do not appear to have been carved by ice. Dissected slopes have been scoured away to an elevation approximately 2000 meters above the surrounding chasma floor.

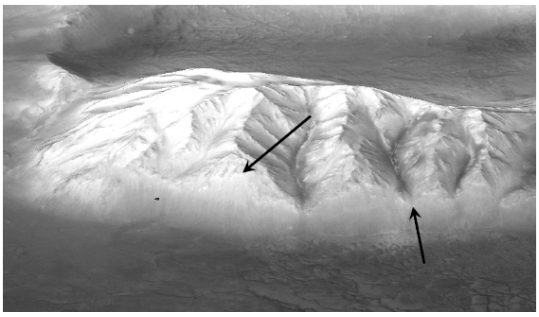

Figure 3. Oblique view of the ridge to the north of trough E from Figure 1, looking south. Arrows indicate hanging valley and scoured slope.

Fluvial features: There are several features within west Candor Chasma which suggest significant fluvial activity. We have identified possible shoreline terraces, in THEMIS and MOC imagery, on the outer slopes of west Candor which correlate well across distances of 10's to >100 km. This suggests the presence of a large body of water within the chasma for an extended period of time. Five hanging valleys have also been identified in western Candor; three that appear to have been associated with surface run-off and/or water draining from craters into the chasma, and two that resemble groundwater sapping features [5]. Streamlined erosional remnants, the apparent removal of surface material from the floor of the chasma, and a trough between Candor and Ceti Mensa also suggest significant fluvial activity. Figure 4 represents the location and profile of the trough between Candor and Ceti Mensa. In general, the profile represents a gradual slope with large scarps and depressions which we interpret as being the result of headward erosion and the generation of plunge pools during a cataclysmic drop in water level. A possible scenario that combines both the glacial activity in central Candor and the fluvial activity in western Candor would be the failure of a glacial dam in central Candor Chasma, similar to the failure of the ice dam that held back the waters of glacial lake Missoula [6]. If waters from west Candor flowed through central Candor and into Melas Chasma, deposits should be evident where the two chasma meet. Figure 5 outlines a number of lobate deposits that can be recognized in HRSC imagery.

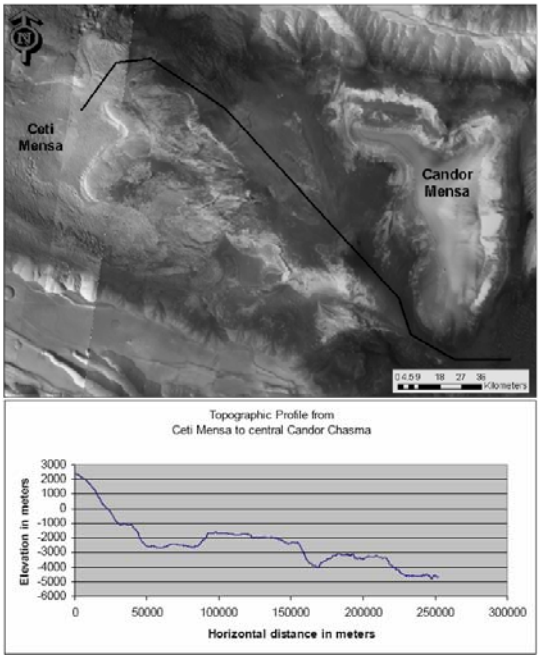

Figure 3. Location and topographic profile from the top of Ceti Mensa through the trough and into central Candor Chasma. Material appears to be preferentially removed from the sloped surfaces within the trough.

Summary: The presence of parabolic-shaped troughs, molded junctions, polygonal ground features, a notched ridge which leads to incised channels, hanging valleys, and scoured slopes, as well as previously proposed features [2], suggests that there has been significant glacial activity in and around the Candor Chasma region. Western Candor Chasma appears to have experienced a period of powerful fluvial activity resulting in: terraced slopes, several streamlined erosional remnants, preferential removal of surface material and incision of the trough between Candor and Ceti Mensa, and deposition of material into Melas Chasma.

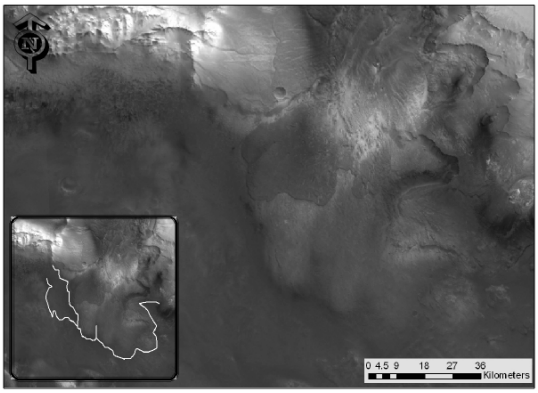

Figure 5. Lobate features on the floor of Melas Chasma where it connects to Candor Chasma.

References: [1] Head J. (2003) Geology, 31, No. 7, 641-644. [2] Chapman M.G. et al. (2005) *LPS XXXVI*, Abstract #1850 [3] Lewis A.R. et al. (2006) Geology, 34, No. 7, 513-516. [4] Marchant D. R. (2002) GSA Bulletin, 114, No. 6, 718-730. [5] Howard A.D. et al. (1988) NASA SP-491, 1-108. [5] Bretz J. H. (1969) Journal of Geology, 77, 505-543.