MARTIAN PERMAFROST PROPERTIES AND FORMATION PROCESSES. A. A. Mardon[1], and G. Zhou[2], [1]University of Alberta (116 St. and 85 Ave. Edmonton, Alberta T6G 2R3, CANADA, aamardon@yahoo.ca), [2]George Washington University (2121 I St NW, Washington, DC 20052, USA, gzhou@gwu.edu)

Introduction: Terrestrial permafrost is sustained on Earth in vast expansive regions with surface temperatures below the water freezing point. Specifically, in Antarctica where the average surface temperature does not exceed the freezing point, specific surface change processes are not present. This includes frost heaving, patterned ground formation, soifluction, gelifluction, cryoplanation, thermokarst, etc. [1] This is because a water-containing active layer does not form at the top layer.

These features characteristic of active layer processes are apparent on Martian surface, especially, at the northern and southern polar caps. Using highresolution surface images provided by MOC camera, several types of permafrost-related features are witnessed but we will focus on Martian polygons.

Martian polygons share similarities to terrestrial ice wedges which is the result of surface modifications due to activities of the active layer of permafrost. Terrestrial polygon-shaped areas are also common in regions with fine-grained sediments such as in the North and Norwegian Sea. [2] This suggests that, where surface temperature routinely exceeds the water freezing point such as around the equatorial zone, there may have existed seasonal temperature fluxations. This condition may have created an ideal environment for the thawing and sublimation of ice in Martian permafrost. However, the current data that has been collected in this region, suggests that there is currently no water available for the creating of an active zone. Since there is currently no permafrost present, it is assumed that if Martian polygons were to have formed due to permafrost-related processes that it needed to have been from a different climatic regime.

The probable explanations for the formation of an active layer in pre-historic times are many. Astronomical forcing which describes the planetary spin and orbit parameters may have greatly influenced the creation of an active layer. The eccentricty of Mars and the characteristics of its spin axis may cause regular patterned fluctuations that can influence surface temperature. The obliquity of the planet's axial tilt is also thought to be a strong driver for planetary climate change that may have given rise to an active layer in pre-historical Martian permafrost. [3]

If Martian permafrost exists today, there should be substantial differences in characteristics between terrestrial and Martian permafrost. Assuming the atmospheric properties were relatively similar in the past as it is in the present, the thin atmosphere, as well as, the non-existence of green house gases, suggests that the planet has an annual average surface temperature below the water freezing point. Cold permafrost would form in this condition; however, no active layer would be present due to lack of temperature fluctuations.

Should there be fluxations above the waterfreezing point such as in the summer around the equatorial zone, the thickness of an active layer is likely to be similar between that of Mars and Earth. The reasoning behind this is because although there may be a thinner active layer due to lower cold-season temperatures slowing the propagation of the thawing wave, this is off balanced by the warmer season due to longer summer days at high obliquity. [4]

Based on historical data relating to the changes of Martian obliquity, the angle of twist is likely to remain the same. With the understanding that the obliquity of the planet to be a major driver of climate change, it is not likely that temperature conditions will change substantially from what exists today and therefore permafrost and the formation of an active layer is unlikely.

References:

[1], [3], [4] Kreslavsky, M. A., Head, J.W. ,and Marchant D.R. (2007). Periods of active permafrost layer formation during the geological history of Mars: Implications for circum-polar and mid-latitude surface processes. *Planetary and Space Science: 56*, 289–302.

[2] Moscardelli, L., Dooley, T., Dunlap, D., Jackson, M., and Wood L. (2012). Deep-water polygonal fault systems as terrestrial analogs for large-scale Martian polygonal terrains. *The Geological Society of America Today, 22,* 4-9.