Geophysical Research Abstracts
Vol. 21, EGU2019-7805, 2019
EGU General Assembly 2019

The Origin and Distribution of Icy Material in the Nereidum Montes; Mars

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Mars possesses a suite of water-ice features in its mid-latitude regions, between 30° and 60° north and south of its equator, yet these features could not have formed in these regions under the climate regime that is dominant on the planet today. It is hypothesized during periods of high (>30) obliquity, that ice is redistributed from polar to lower mid-latitude regions. However, it is currently unknown how local topography influences this process of ice deposition and subsequent preservation.

On Earth, the distribution of ice is the result of the interaction of precipitation and temperature, which are influenced by latitude, as well as local topographic factors, including altitude, slope, aspect and relief. Such topographic factors also likely play an important role in determining the distribution of icy material on Mars. To evaluate the importance of these topographic factors, we investigated the distribution of icy material in the Nereidum Montes mountain range in Mars's southern hemisphere. We mapped all icy deposits at a scale of 1:25,000 using CTX imagery, and investigated the elevation, slope, relief and aspect of this material and the surrounding landscape with reference to the MOLA digital terrain model.

Our data show that latitude, altitude, elevation, slope and relief influence the presence of icy material. In line with theory, the area of icy material increases at higher latitudes. However, this relationship is not linear, and there are localized areas where the concentration of icy material is greatest, suggesting that latitude is not the only factor influencing ice deposition. Elevation shows a complex relationship with ice distribution when normalized for area, with three distinct peaks in abundance at: -3500 m to -3500 m, -500 m to 0 m and 2000 m to 2500 m. Relief (local elevation range) is strongly linked to the presence of icy material. Areas of the Nereidum Montes with high relative relief almost always possess icy material, whereas areas with low relative relief are almost entirely devoid of any deposits. Icy material is comparatively rare on flat surfaces compared to moderate slopes (i.e. between 3-6°). While pole-facing slopes do exhibit more icy material than north-facing ones, aspect does not appear to be strongly tied to the presence of icy material. However, even in regions with apparently ideal combination of latitude, elevation, slope and relief, there are areas not covered in ice. This suggests that more localized factors, such as wind patterns, may influence ice formation or preservation at smaller scales. Our results indicate that topography does influence where ice is deposited and preserved in the Nereidum Montes, and future work will assess how these results relate to outputs from numerical climate models.