SPLOSH CRATERS: EVIDENCE FOR THE REPLENISHMENT OF GROUND ICE IN THE EQUATORIAL REGION OF MARS. S.M. Clifford* and L.A. Johansen**. *Dept. of Physics and Astronomy, University of Massachusetts, Amherst, MA 01003; **Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 9003.

It is generally accepted that if ground ice is now present in the latitude band of \( \pm 30^\circ \) on Mars then it must have been emplaced quite early in Martian geologic history and under substantially different climatic conditions. Based on a recent analysis of past climatic conditions on Mars (Toon et al., 1980), it appears likely that the mean annual temperature near the Martian equator, at least since the formation of Tharsis some 3.5 billion years ago (Wise et al., 1979), has always remained well above the frost point of \( \text{H}_2\text{O} \). Under such conditions the loss of ground ice from the equatorial regolith appears irreversible - once ice has evaporated, or been removed by some other process, it is difficult to see how the lost ice could be replenished by any atmospheric means (e.g., see Flasar and Goody, 1976).

Consider then the results of a major impact in the near equatorial regolith. Estimates of the thickness of ground ice in the equatorial region are commonly on the order of \( \sim 1 \) km. (Fanale, 1976; Rossbacher and Judson, 1981). Therefore, as first noted by Allen (1979), a crater several tens of kilometers or more in diameter will have a depth which extends well below any such ground ice layer. The production of such a crater should result in the excavation of virtually all ground ice which existed, in the region interior to the crater walls, prior to the impact (Figure 1). While backfilling and melting of nearby permafrost may partially replenish some of this \( \text{H}_2\text{O} \) near the crater periphery, it appears unlikely that its lifetime would be very long given the high temperatures and porosity of the post-impact environment. It is therefore interesting to note that within a number of large impact craters in the equatorial region of Mars there appear clearly defined splosh craters (Allen, 1979). The distinctive morphology of this type of crater is thought to result from an impact into a water or ice-rich regolith (Johansen, 1978, 1981). If one accepts this interpretation, then the presence of splosh craters within the interiors of numerous older craters in the equatorial region of Mars presents a serious problem. It is difficult to conceive of a scenario by which any ground ice that existed prior to the original cratering event could have managed to survive to produce the distinctive fluidized ejecta pattern often seen as the result of a second (Figure 2) and sometimes third (Figure 3) consecutive impact.

One possible explanation which could account for these observations is that the ground ice which was removed by the original impacts was thereafter replenished by some non-atmospheric means. Such a mechanism has been proposed by Clifford (1980), whereby ground ice in the equatorial region of Mars could be replenished on a global scale by an upward thermal migration of \( \text{H}_2\text{O} \) from a subpermafrost groundwater system (see Figure 4).

A more detailed discussion of this question and its possible implications is in preparation.

Acknowledgements: This research was supported under NASA Grant NSG 7405.

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MARS: GROUND ICE REPLENISHMENT

Clifford, S.M. and Johansen, L.A.


Figure 1. Ground ice distribution resulting from a major impact.

Figure 2. Splish crater within an older impact feature (21°S, 206°E).

Figure 3. A splish crater within two earlier and concentric impact features (20°S, 203°W).

Figure 4. Vertical vapor and liquid moisture transport driven by the local geothermal gradient (Clifford, 1980).