**STABILITY OF GROUND ICE ON MARS AND ODYSSEY GRS RESULTS.** M. A. Chamberlain, W. V. Boynton and the Mars Odyssey GRS Team

**Introduction:** After a few months of the science phase of the Mars Odyssey mission the initial Gamma Ray Spectrometer (GRS) results[1] were published. The distribution of gamma and neutron fluxes observed at the time were explained with a two layer model of the Martian regolith, an ice-rich rich layer buried below an ice-poor layer. These models agreed with diffusion models[2] that had predicted the presence of ground water ice extending from the poles equator ward to ~60 degrees. Improvements have been made to both the data acquired and the models of ice stability and will be discussed.

**New results:** Since the initial publication, the gamma and neutron flux measured by the spacecraft have been recalibrated. Hydrogen gamma radiation has been calibrated to the pure water ice cap in the north which was exposed in the northern summer. Neutron flux was calibrated to the thick carbon dioxide cap in the north during winter there.

With these new calibrations the fit to the simple 2 layer model is no longer consistent with the data [3]. There is more ice than previously thought. In the north, ice is implied to be present at the surface by gamma rays and epithermal neutrons, however thermal neutrons suggest ice should be at depth of a few tens of g/cm$^2$. It is thought that mixtures of ground with different ice content could explain the data, though no combination has been found yet to agree with the data.

Hydrogen gamma rays produce maps of limits to the maximum ice in the regolith and also a maximum depth for a buried ice-rich layer (Figure 1).

**Initial model**: It has long been expected that water ice would be stable at depth in the Martian regolith (e.g. [4]) wherever the average surface temperature is less than the frost point of the mean atmospheric water vapor (~10 precipitable microns). Mellon and Jakosky [2] calculated the depth to this ice as a function of latitude, albedo and thermal inertia. Temperature profiles were calculated with these thermophysical inputs and water vapor was allowed to diffuse into ground from the atmosphere. Within the regolith, adsorbed water is allowed to form slowing the rate of diffusion and ice condenses when partial pressure of water exceeds the ice vapor pressure. The results of this diffusion model showed an good match to the distribution of hydrogen seen GRS.

**New models:** The main improvement to the initial diffusion model has been the inclusion of the thermal properties of ice in the ground to update the thermal profiles. The thermal conductivity of ice-cemented soil is 3 orders of magnitude greater than that of the dry dust at the surface (and measured by Viking and TES). The shape of the temperature profiles changes significantly, more heat is conducted away from the surface allowing the top of the ice table to be stable closer to the surface (Figure 2). A typical value for the model depth to the top of ice in the polar regions is 8 cm, or 10 g/cm$^2$ which are within the range indicated by the GRS.

**References:** [1] Boynton W. V. et al. (2002) *Science, 297,* 81–85. [2] Mellon M. T. and Jakosky B. M. (1993) *JGR, 98,* 3345-3364. [3] Boynton W. V. et al. (2003) *Mars Conf*, #3259. [4] Leighton R. B. and Murray B. C. (1966) *Science, 153,* 136-144.

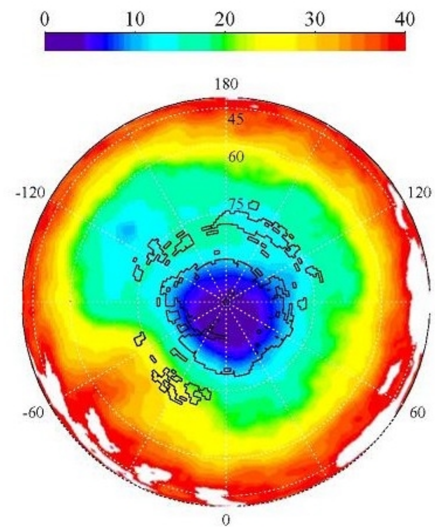


Figure 1: Maximum thickness of the dry layer over the North Martian Pole, from [3].

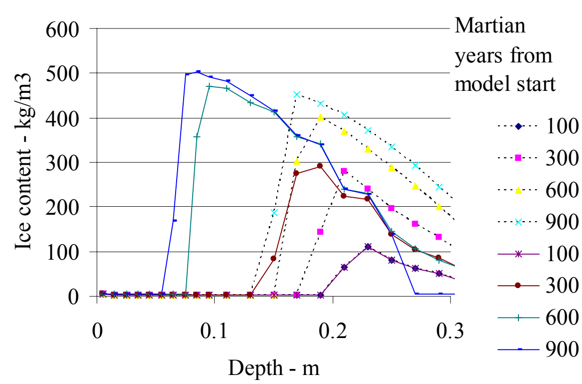


Figure 2: Condensation of ground ice at 77.5º N, solid lines show model that includes thermal properties of ice-rich soil, dashed lines shows a model that doesn't.