THE ENHANCEMENT OF WATER ICE CONTENT IN THE LOCAL AREA NORTHEAST OF ARCADIA PLANITA: EVIDENCE FROM NEUTRON DATA FROM HEND (MARS ODYSSEY) AND ELEVATION FROM MOLA (MGS). A.B. Sanin[1], I. G. Mitrofanov[1], A.S.Kozyrev[1], M. L. Litvak[1], V. Tretyakov[1], D.E. Smith[2], M.T. Zuber[3,2], W. Boynton[4], R. S. Saunders[5]. 1 – Space Research Institute, RAS, Moscow, 117997, Russia, max@cgrsmx.iki.rssi.ru; 2-Laboratory for Terrestrial Physics NASA/Goddard Space Flight Center, MD,20771,USA; 3- Massachusetts Institute of Technology, Cambridge, MA, 02139-4307,USA; 4 - University of Arizona, Tucson, AZ 85721, USA, 5 - Jet Propulsion Laboratory, Pasadena, CA 91109, USA.

Introduction. The first year of neutron mapping measurements from the Mars Odyssey spacecraft revealed enormous hydrogen-rich regions in the southern and northern hemispheres of the Martian crust that imply significant amounts of near-surface water ice [1-4]. The hydrogen-rich areas of the southern and northern regions appear generally comparable in spatial extent and water ice content [4]. This observation is interesting in light of topography measured by the Mars Orbiter Laser Altimeter (MOLA) [5, 6, 7] on the Mars Global Surveyor (MGS) spacecraft, which shows a significant difference in elevation between northern lowlands and southern highlands [8] that could imply a difference in seasonal CO_2 condensation. In this study we correlate the high energy neutron flux observed by HEND (Mars Odyssey) and surface elevation measured by MOLA in order to interpret the seasonal change in epithermal neutron flux in terms near-surface water ice content.

Approach. We divided the surface of Mars into several latitude belts and studied the behavior of epithermal neutron flux within these belts versus longitude and MOLA surface elevation for different periods of time. Latitudinal annuli above 60°N/60°S are of greatest interest because these regions contain a considerable amount of water ice and in addition exhibit significant seasonal circulation of CO_2. In the interpretation of the HEND data we note that a deficit of high-energy neutrons corresponds to the likely presence of water ice in the subsurface because neutrons moderate to thermal energies in the presence of hydrogen [8, 9].

Local Analysis. Initial ODYSSEY mapping measurements obtained during late NH winter revealed a local area, northeast of Arcadia Planita (55°N-75°N, 210°E-270°E), with very low epithermal neutron fluxes [1-4]. The observed deficit of neutrons was comparable with deficits seen in water ice rich regions in the southern hemisphere. During northern winter this area was covered by a thick layer of CO_2 snow, while the southern hemisphere was free from seasonal CO_2 cover. Based on longitudinally averaged MOLA observations of surface height change, the snow depth at this latitude was observed to accumulate to ~50 cm on its northward border one Mars year earlier [10]. Taking into account the fact that the maximum efficiency of neutron measurements occurs within 1-2 m of subsurface layer, the depressed flux of neutrons in this region could conceivably be explained either by a thinner winter CO_2 cover in comparison with adjacent regions, or by the presence of a significantly larger concentration of water ice below the CO_2 snow cover. Analysis of the neutron flux in concert with MOLA elevation permits these possibilities to be distinguished.

Correlation of HEND with MOLA. The top panel in Fig. 1 shows the longitudinal dependence of neutrons at the latitude midpoint of the region in which the neutron fluxes were measured (70°N) at two different times: late NH winter (L_s=345°) and early NH summer (L_s=74°). In the figure the neutron flux during winter and summer is different because of the presence and absence of the CO_2 frost cover, respectively. The fact that the the neutron fluxes at two different times are parallel suggests that the CO_2 cover that was removed between late winter and suummer was of approximately uniform thickness over longitude. This is predicted by GCM simulations of CO_2 deposition [11] and is consistent to within a factor of two with spatial maps of surface height change from MOLA [12].

The middle panel shows the MOLA elevation at 70°N. The neutron fluxes and topography show a generally poor longitudinal correlation, but the two quantities can be correlated more generally, as shown in the bottom panel of Fig. 1. This plot points out that the surface centered on 70°N has a lower neutron flux at higher elevations (-4000 to -4600) than at lower elevations (-5000 to –5200), suggesting that water ice in the substrate is more prevalent at higher altitudes than lower altitudes. But the correlation is more complex than a simple linear relationship. The bottom two panels of Fig. 1 collectively show that elevation alone cannot explain the implied variation in surficial water ice content.

Conclusion. The thickness of the seasonally-deposited CO_2 snow layer does not explain the depressed epithermal neutron flux in the area northeast of Arcadia Planita. The lower flux of neutrons in this area in comparison with other areas in the same latitude annulus is more likely due to local enhancement of water ice content in this part of the northern permafrost region. Further analysis, now underway, will be required to ascertain the reasons(s) for this enhancement.

References: [1] Boynton W.V. et al. (2002) *Science, 297,* 81-85. [2] Feldman W.C. et al. *ibid*, 75-78. [3] Mitrofanov I. et al. (2002) *Science, 297,* 78-81. [4] Mitrofanov et al. (2002) this conference. [5] Zuber M.T. et al. (1992) *JGR, 97*, 7781-7797. [6] Smith D.E. et al. (1999) *Science, 284,* 1495-1503. [7] Smith D.E. et al. (2001) *Science, 294,* 2141-2146. [8] Feldman W.C. et al. (1993) in *Remote Geochemical Analysis: Element and Mineralogical Composition,* ed. C.M. Pieters & P.A.J. Englert., Chap. 10, Cambridge Univ. Press, NY. [9] Boynton W.V. et al. (1993) *ibid,* Chap. 17. [10] Smith D.E. et al. (2001) *Science, 294,* 2141-2146. [11] Zuber M.T. and Smith D.E. (2003) manuscript in preparation. [12] Aharonson O. (2002) Ph.D. Thesis, MIT, Cambridge, MA.

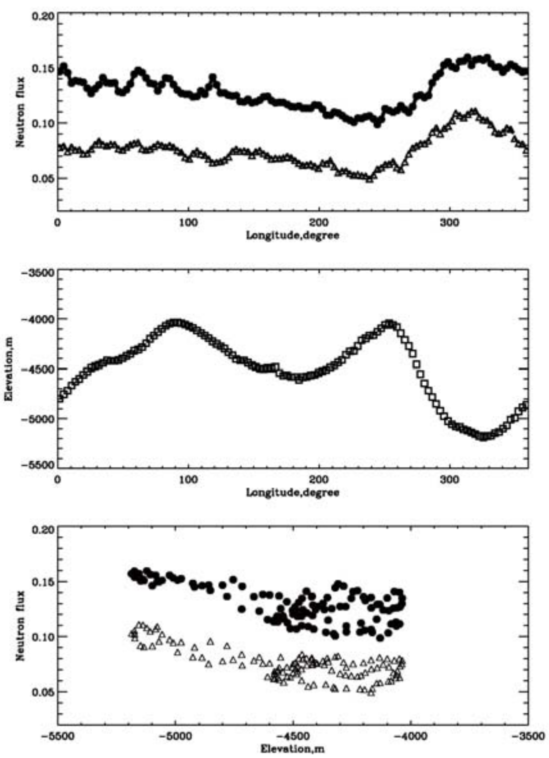

Fig. 1. Observed epithermal neutron flux and surface elevation change within the 65°N-75°N latitude belt. The top plot shows neutron flux vs. longitude for late NH winter (black dots) and for early NH summer (triangles). The central panel shows the elevation along the mid-latitude of the neutron measurements in the upper panel (70°N). The bottom panel shows the correlation between the neutron flux and elevation for late NH winter (black dots) and early NH summer (triangles).