**NORTHERN AND SOUTHERN PERMAFROST REGIONS ON MARS WITH HIGH CONTENT OF WATER ICE: SIMILARITIES AND DIFFERENCES**. I.G. Mitrofanov[1], M.L. Litvak[1], A.S. Kozyrev[1], A.B. Sanin[1], V.I. Tretyakov[1], R.O.Kuzmin[2], W.V. Boynton[3], D.K. Hamara[3], C. Shinohara[3], R. S. Saunders[4], [1]Space Research Institute, RAS, Moscow, 117997, Russia, imitrofa@space.ru, [2]Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, Moscow, 119991, Russia, [3]University rsity of Arizona, Tucson, AZ 85721, USA, [4]NASA Headquarters, Washington, DC 20514, USA.

**Introduction.** The measurements by neutron detectors on Odyssey have revealed two large poleward regions with large depression of flux of epithermal and high energy neutrons [1-3]. The flux of neutrons from Mars is known to be produced by the bombardment of the surface layer by galactic cosmic rays. The leakage flux of epithermal and fast neutrons has regional variation by a factor of 10 over the surface of Mars (e.g. see [3-5]). These variations are mainly produced by variations of hydrogen content in the shallow subsurface. On Mars hydrogen is associated with water. Therefore, the Northern and Southern depressions of neutron emission could be identified as permafrost regions with very high content of water ice [1-5]. These regions are much larger than the residual polar caps, and could contain the major fraction of subsurface water ice. Here we present the results of HEND neutron data deconvolution for these regions and describe the similarities and differences between them.

**Data Analysis.** The structure of the subsurface is not obtainable unambiguously by neutron data. One has to use the procedure of model dependent data deconvolution, in which numerical calculations for selected models of the subsurface are compared with the measurements (see [6]). By testing models one may characterize the structure of subsurface, the composition of the soil and the content of water. The best fitting values of parameters of test models are determined by statistical criteria of consistency between the model and observations. Some models must be rejected, where they do not fit the observations for any values of the parameters. If a test model is accepted, the best fitting values of the parameters are considered, as the “measurements” of the structure of subsurface. If more than one model agrees with the same set of data, we prefer the most simple among them.

**Results.** The neutron permafrost region is well described by the simplest model with homogeneous distribution of water ice though the depth. This model uses soil with fixed composition according to APXS observations [7] and variable content of water. The Northern region was divided into 74 surface elements for independent data analysis, and a homogeneous model was found to be acceptable for all of them [6]. Estimations of water content (homogeneous model) for the Northern permafrost region are presented in Table 1 and in Figure 1. The map of water distribution in the northern region is very similar to that obtained from Neutron Spectrometer data analysis [8].

For the Southern region the simplest model with homogeneous subsurface distribution does not work [6]. The model with double-layered subsurface was tested for this region, with 2 wt% of water in the top layer of variable thickness and variable content of water in the bottom layer. The double-layered model was consistent with observations for the Southern region. The best fitting parameters present the estimations of the thickness of the top dry layer and of the content of water ice below the top one (see Table 1 and Figure 2). The map of water distribution for the southern region of permafrost is quite different from NS observations [8]. The reason for this difference is the application of the homogeneous model for mapping in [8], which we reject in our analysis of HEND data for the southern polar regions.

**Conclusions and Speculations.** The northern and southern regions of permafrost contain quite similar patterns of subsurface water ice at high latitudes, about 50-55 wt%. However, in South this water-rich layer must be in places covered by a dry layer with thickness about 15-30 g/cm$^2$. In both regions the boundary of the water-rich subsurface occurs at latitudes of 55$^o$-65$^o$; at some longitudes the boundary goes down to 45$^o$, while in others it shifts up to 70$^o$ (Fig. 1 and 2). The ice in both regions contributes the major fraction of the volume, which is much larger than the porosity volume of typical soil.

The layer of water ice is covered by dry soil in the South. There may be little interaction at the present time between the ice beneath this dry soil and the atmosphere. In the North, the water ice continues to the surface, and here the ice shield could interact with the Martian atmosphere. One may speculate that the southern hemisphere water ice shield was produced a long time ago, and that the top layer has lost water due to sublimation into the atmosphere. On the opposite hemisphere, the absence of a dry layer at the top of the northern ice shield could indicate that water exchanges with the atmosphere at the present time, and the thickness of Northern ice shield increased in the present epoch of Mars climate history.

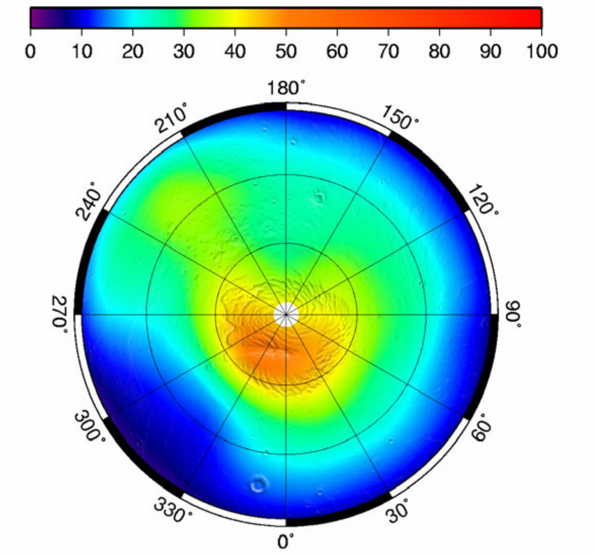


**Fig 1.** Map of water ice content (wt%) for the Northern permafrost region.

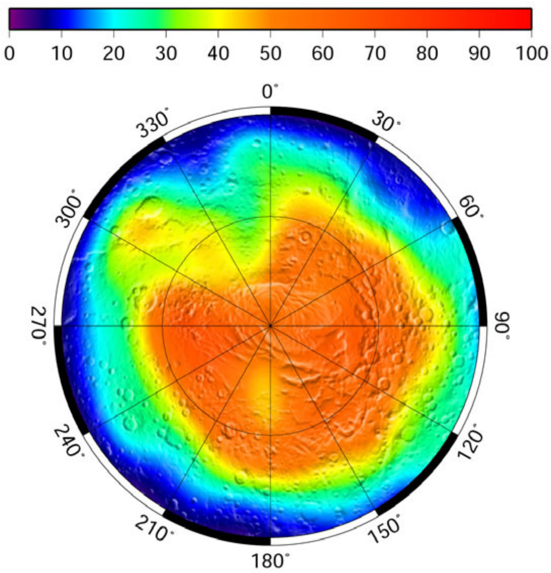


**Fig 2.** Map of water ice content (wt%) for the Southern permafrost region.

**Table 1.** Estimated parameters of water distribution for latitude belts at North and South.

| Names of latitude belts and seasons of data accumulation $L_s$ | Latitudes and longitudes | Average content of water (wt%) and thickness of top dry layer according to homogeneous model (HM) and double-layer model (DLM) |
|---|---|---|
| Northern polar region $L_s$=(120°-150°) | 0°- 360° E >80° N | 44.1 wt% (HM, no dry top layer) |
| Northern high latitude belt $L_s$=(120°-150°) | 0°- 360° E 70°-80° N | 24.8 wt% (HM, no dry top layer) |
| Northern boundary belt $L_s$=(120°-150°) | 0°- 360° E 60°-70° N | 12.5 wt% (HM, no dry top layer) |
| Northern spot of absolute minimum of neutrons emission $L_s$=(120°-150°) | 24°-28° E 86°-90° N | >55 wt% (HM, no dry top layer) |
| Southern polar region $L_s$=(330°-360°) | 0°- 360° E >80° S | 55.0 wt% 16 g/cm$^2$ (DLM) |
| Southern high latitude belt $L_s$=(330°-360°) | 0°- 360° E 70°-80° S | 54.0 wt % 19.2 g/cm$^2$ (DLM) |
| Southern boundary belt $L_s$=(330°-360°) | 0°- 360° E 60°-70° S | 25.3 wt% 22.4 g/cm$^2$ (DLM) |
| Southern spot of absolute minimum of neutrons emission $L_s$=(330°-360°) | 220°-224° E 78°-82° S | >55.0 wt% 16.0 g/cm$^2$ (DLM) |

**References:**

[1] Boynton W.V. et al. (2002) *Science*, 297, 81-85. [2] Mitrofanov I.G. et al. (2002) *Science*, 78-81. [3] Feldman W. C. et al, (2002) *Science*, 75-78. [4] Mitrofanov I.G. et al. (2003) *Science*, 300, 2081-2084. [5] Mitrofanov I.G. et al., (2003) *Solar System Research*, 37, 366-377. [6] Mitrofanov I.G. et al. *(2004) Solar System Research*, in press., [7] Wänke H. et al. (2001), Space Science Reviews, 96, 317-330. [8] Feldman W. et al. (2003), 6th conference on Mars, Abstract # 3218.