VERTICAL DISTRIBUTION OF SHALLOW WATER IN THE DISTINGUISHABLE REGIONS AT LOW AND HIGH LATITUDES OF MARS: NEUTRON DATA DECONVOLUTION OF HEND.

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Introduction: High Energy Neutron Detector (HEND) is the part of Gamma-Ray Spectrometer suite onboard NASA Mars Odyssey orbiter [1-4]. During 16 months of mapping stage of Odyssey mission HEND has accumulated the set of maps of neutron emission of Mars at more than seven decades of energies range from the Cadmium threshold of 0.4 eV up to 15 MeV. These maps present very large variations of neutrons at different regions of Mars and they also show quite strong changes along Martian seasons.

Data reduction: Neutron emission from the surface of Mars is produced by the bombardment of galactic cosmic rays, which freely propagate through the thin atmosphere. The flux of neutrons is generated in 2 meters of subsurface and leak up to the orbit of Odyssey through the atmosphere. HEND measures neutrons on the orbit with altitude of about 400 km. The flux of cosmic rays in the vicinity of Mars was quite stable. All strong solar particle events were excluded for 16 months of the accomplished mapping, but the thickness of atmosphere has been changed and the seasonal deposition of carbon dioxide took place at polar regions of Mars. Therefore, to study the content of water in different regions one has to study frost-free surface of Mars, when there is no seasonal deposition of CO_2, and to take into account the variable thickness of the atmosphere. Time variations of neutron flux from Mars due to winter deposition of CO_2 are considered in the another paper [5]. In the present paper we will study the spatial variation of neutrons from the frost-free surface of Mars, which represents the difference of water content in the subsurface. The maps of neutron flux on the orbit above the frost-free surface of Mars are presented in Figures 1 and 2.

We split the entire surface into 32 regions with similar fluxes of neutrons. The regions may be distinguished one from anther not only by neutrons emission, but by geological properties, elevation, surface morphology, etc. The key criteria for selection of a particular region is applicability of the single model for its description with the set of particular parameters for subsurface water distribution. The subject of this paper is to develop the models of vertical distribution of shallow water for the set of 32 distinguishable regions of Mars, which provide the best fitting of HEND observational data measured above them. The set of 32 regions include the Solis Planum, Terra Meridiani, Arabia Terra, Isidis Planitia, Elysium Planitia, Valles Marineris and Tarsis Monts at the equatorial belt, Hellas Planitia, Acidalia Planitia and Utopia Planitia at medium latitudes, several polar regions with water-ice rich permafrost around the north and south poles.

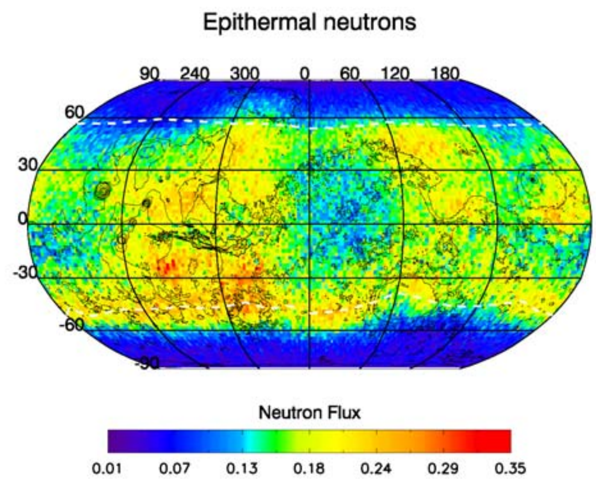

Fig 1. Emission of epithermal neutrons by frost-free surface of Mars.

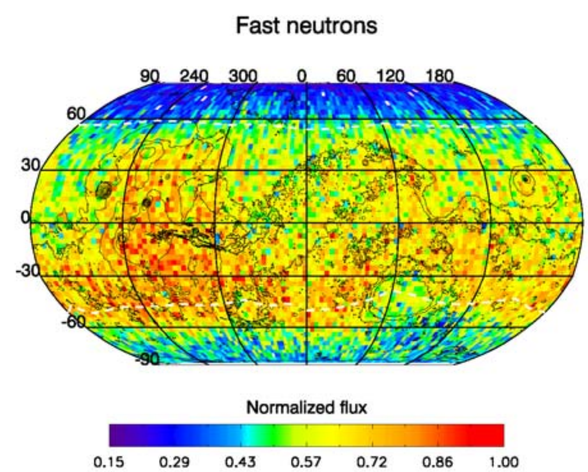

Fig 2. Emission of fast neutrons by frost-free surface of Mars.

Model: The simplest description of the vertical distribution of the water in the subsurface is associated with three-layered model of Mars subsurface. The uppermost layer is the atmosphere. It is known to vary from day to night and with Martian seasons. The thickness of atmosphere is determined according to commonly accepted NASA Ames model and according to the average elevation of the distinguished region. The subsurface is divided into two layers of horizontal stratification, which might have the different content of water. The upper most layer of tens centimeters may be relatively dry because water ice sublime into the atmosphere. Its has a thickness *h* and a water content η_{up}. The lower layer could have higher content of water η_{down}.

Results: The HEND observational data from 4 independent detectors is used to get the best fitting parameters (*h*, η_{up} and η_{down}) of water vertical distribution for each distinguishable region of Mars.

The variations of these parameters for different regions of Mars characterize the past hydrological evolution of the planet. Possible correlation is tested between statistics of these parameters for different regions and their geophysical properties and/or surface morphology. The origin of water-rich soil around equator is discussed using the models of vertical distribution of shallow water in these regions.

The nature of Martian permafrost around poles with high content of water ice is considered according to the best fitting models. The mechanism of layered deposition of water at epochs with high obliquity is discussed [6]. Using neutron data from HEND/Odyssey, the model with multiple deposition layers of water ice and soil is tested in the comparison with the model with two-layer of the subsurface.

References:

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