Measurements of subsurface water distribution in current and future orbital and landing missions: comparison between Mars Odyssey, MSL Curiosity and ExoMars missions. M. Litvak[1], I. Mitrofanov[1], A. Sanin[1], D. Lisov[1], A. Behar[2], W. Boynton[3], L. Deflores[2], F. Fedosov[1], D. Golovin[1], C. Hardgrove[4], K. Harshman[3], I. Jun[2], A. Kozyrev[1], R. Kuzmin[1,5], A. Malakhov[1], M. Mischna[2], J. Moersch[4], M. Mokrousov[1], S. Nikiforov[1], V. Shvetsov[7], R. Starr[6], C. Tate[4], V. Tret'yakov[1], A. Vostrukhin[1], [1]**Space Research Institute, RAS, Moscow, 117997, Russia, litvak@mx.iki.rssi.ru,** [2]Jet Propulsion Laboratory, Pasadena, CA USA, [3]University of Arizona, Tucson, AZ USA, [4]Univeristy of Tennessee, Knoxville, TN, USA, [5]S.I.Vernadsky Institute for Geochemistry and Analytical Chemistry, Moscow, Russia, [6]Catholic University, Washington DC USA, [7]Joint Institute for Nuclear Research, Dubna, Russia.

Introduction: Observations performed by the various space missions over the past decade have revealed a complex mineralogical and aqueous history of Mars, which could be associated with habitable environments, see for example [1-3]. The significant support of these studies has been provided with the orbital neutron and gamma spectroscopy measurements onboard Mars Odyssey [4-6] revealing global distribution of water ice poleward 60N/60S and distribution of bound water at equatorial latittudes with horizontal resolution 300 x 300 km. On figure 1 we hav epresented equatorial distribution of subsurface ewater measured by HEND instrument onboard Mars Odyssey (see figure 1).

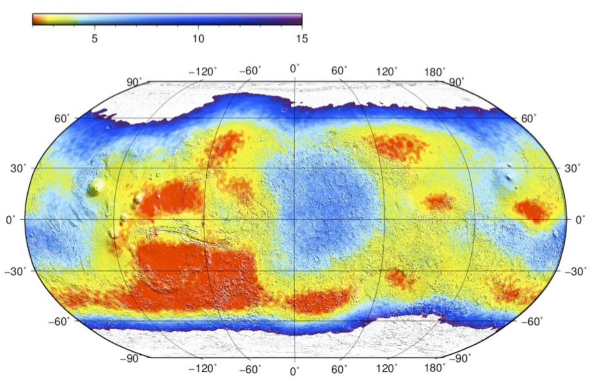

Figure 1. The global distribution of subsurface water at moderate and equatorial latitutdes on Mars measured by HEND instrument onboard Osyssey.

Now these global observations could be compared with local surface measurements are being performed with active neutron spectrometer Dynamic Albedo of Neutrons (DAN) installed onboard MSL Curiosity rover [7]. DAN is providing monitoring of subusrace water along Curisoity traverse (see for example 8-10). More than 6000 m has been travelled starting from the landing site during primary MSL mission. Example of subsurface water distribution derived from these measurements is shown on figure 2. The most of DAN measurements show significant discrepenacy in estimation of water abundance between low resolution Odyssey observations and in situ DAN measurements in vicinity of Gale crater [10]. The subsurface of Gale crater around MSL landing site is drier than expected from the orbital observations. Only 10% of DAN measurement corresponds to Odyssey observations of subsurface water. It should be subjected to the comprehensive detailed analysis using comparison of instrument data reduction procedures, instrument surface resolutions and different models of subsurface water depth distribution [10,11].

Instrumentation. In the nearest future we may signifycantly improve our knowledge about distribution of subsurface water at Mars equatorial latittudes. It will be based on incoming orbital and surface martian missions, such as ExoMars (ESA) including both orbital observation on Trace Gas Orbiter (TGO) in 2016 and rover in 2018. Possibly it will be also supported with Mars2020 (NASA) mission depending on the selected science payload. We expect that joint analysis should be implemented using a comparison between high resolution neutron spectroscopy orbital observations and network of surface measurement probes provided with similar neutron spectrometers installed onboard landing platforms and rovers.

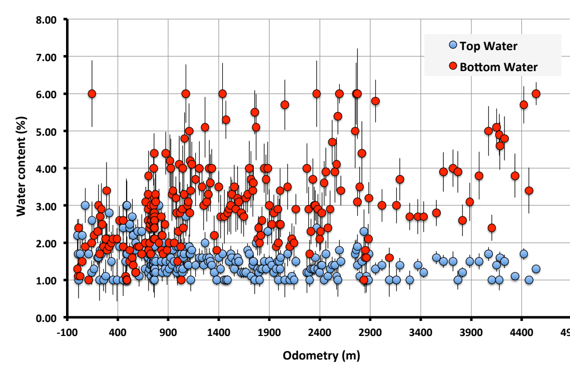

Figure 2. Variations of estimated content of water at top (blue) and bottom (red) layers along the Curiosity traverse.

The Fine Resolution Epithermal Neutron Detector (FREND) will be Russian contributed instrument for ESA's *TGO*. The FREND experiment concept is based on the heritage of neutron collimated instrument LEND onboard NASA moon LRO mission [12,13]. The TGO spacecraft will have the orbit with inclination of 74° and altitudes of 350 – 420 km. Such orbit allows to map the Martian surface from the equator upward to very high latitudes of 74° N and S. The primary goal of the FREND investigation will be mapping of epithermal neutron emission from the martian surface with high spatial resolution about 40 km. It is significantly better than neutron observations onboard Mars Odyssey and is comparable with the size of Gale crater, which opens possibility to improve comparsion between orbital and surface observations of water distrubtuon at MSL landing site.

Another ExoMars mission planned for launch in 2018 will consist of landing platform and rover and will be focused on a detailed surface studies including search for subsurface water distribution. These measurements will be based on the stationary active neutron and gamma methods (analog of DAN instrument onboard of Landing platform) and mobile passive neutron spectroscopy and ground penetration radar observations (ADRON and WISDOM instruments onboard rover). It will provide another set of ground truth data acquired at the equatorial lattitudes and new area of comparison with orbital Odyssey and TGO water mapping, monitoring of seasonal changes of atmosphere thickness and seasonal cycle.

References:

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