MAPPING OF SEASONAL BOUND WATER CONTENT VARIATIONS ON THE MARTIAN SURFACE BASED ON THE TES DATA. R. O. Kuzmin[1], P. R. Christensen[2], M. Yu. Zolotov[2] and S. Anwar[2]. [1]Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, 19 Kosygin str., Moscow 119991, Russia, e-mail: rok@geokhi.ru, [2]Department of Geological Sciences, Arizona State University, Tempe, AZ 85287.

Introduction: Earth-based spectral observations of Mars [1-3,4,8] and results from orbital and landing missions [5-7,9,10] indicate the abundant presence H_2O, OH-bearing minerals (ferric hydroxides and oxyhydroxides, sulfates, chlorides and phyllosilicates). The salts content in the Martian regolith may vary within 8-25 vol. % [9] and the dominant salts are likely to be presented by Mg and Ca sulfates and chlorides. Last discovery from MER-A and B missions have shown that sulfates content in the Martian rocks varies in the range 15-40 wt.% [11,12]. The mid-IR spectral region of the most hydrated minerals includes distinctive emission peak (near 6.1 µm) attributed to the H-O-H bending fundamental vibration of bound water [13]. The bound water (BW) emission peak is notably observed in ground-based thermal emission spectrum of Mars [4], in TES (on Mars Global Surveyor) spectra [14,15] and in Mini-TES spectra at the landing sites of the MER rovers [16]. This peak serves as a direct indicator for the hydrated minerals in the Martian regolith. Preliminary mapping results of the 6.1 µm emission peak (based on the one Martian year TES dataset) have shown the bound water (BW) content in surface material varies seasonally at the time scale of the half Martian year (spring-summer, fall-winter) and character of its distribution in the northern and southern hemispheres is a notably different [17]. Here we report much more detailed results of the seasonal BW content distribution on Mars, based on the complete dataset of the TES observations accumulated during three martian years at two spectral resolutions (10 cm^{-1} and 5 cm^{-1}).

Seasonal variations of the BW content: In addition to our earlier mapping of the BW index we have conducted global mapping of the parameter with more frequent Ls time steps (from 30° to 90°), that allow studying the seasonal variations of the BW content in more details. To eliminate possible influence of the atmospheric water bend (~ 6.3 µm), which is located at lower frequency than the BW emission peak, we made a little modification of the from high latitudes to latitudes of 20°-30°N, being mostly disappearing in the period of Ls=130°-230°. At that, during the North spring and summer BW values within low-middle latitudes are four times higher than during the same season in the southern hemisphere. It is notably that the BW index distribution during the North summer is characterized by distinct latitudinal asymmetry (see Fig .2) while during the South summer the asymmetry is much less visible. BW index: it has been created using a ratio of the emission maximum near 6.1 µm (averaged value from TES channels 140-142) to averaged value of the emission minimums points (channels 135, 134 and 145, 139) located on each sides from the emission maximums of both the atmospheric water vapor and BW. The examples of the global BW content maps for the different seasons (with Ls time step 60°) and the zonally averaged meridional distribution of the BW content for each of the Martian seasons are shown on the Fig. 1 and 2 respectively.
During each seasons, the BW index has strong latitudinal distribution. The highest BW values are located mostly within the peripheral zones of the perennial and seasonal polar caps (cooler areas), while

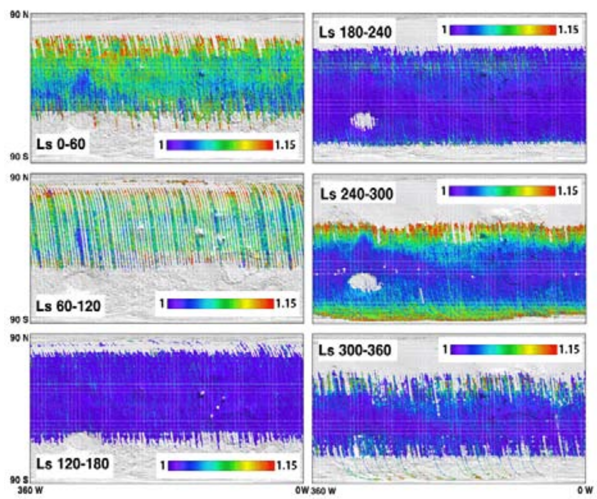

Fig. 1. The maps of the bound water index distribution for the different seasons (over the Ls time step 60°). Color bar shows values range of the BW index (see text).

lower BW values are observed at low latitudes (relatively warmer areas). At transition from the North spring (Ls=0°-90°) to the North winter (Ls=270°-360°) the northern maximum of BW values is shifting from high latitudes to latitudes of 20°-30°N, being mostly disappearing in the period of Ls=130°-230°. At that, during the North spring and summer BW values within low-middle latitudes are four times higher than during the same season in the southern hemisphere. It is notably that the BW index distribution during the North summer is characterized by distinct latitudinal asymmetry (see Fig .2) while during the South summer the asymmetry is much less visible.

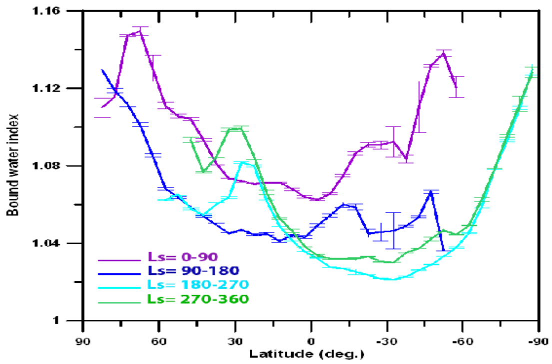

Fig. 2. Zonally averaged meridional distribution of the BW index values for the different seasons. Vertical bar represent the mean error.

Maps of BW can be interpreted in terns of the hydration-dehydration. The maximum of hydration on Mars is taking place in the period of the Northern spring and the first half of summer, while maximum of dehydration is taking place in the period of second half of the Northern summer and fall. Two maximums of the hydration are observed during the Southern summer: one is located at the high latitudes of Southern hemisphere and other is located in the Northern hemisphere within the latitude belt 20°-30°N. The mapping results show that the time scale of the observing transition from hydrated to dehydrated states of surface materials (depending on seasons) corresponds to the Ls range from 10° to 40° (from ~1 to 3 months).

Discussion: Conducted analysis of the seasonal dynamics of the BW content distribution (Fig.3) shows that seasonal regime of the BW index has strong sensitivity to the seasonal course of surface temperature and humidity in the boundary atmospheric layer. For example, the mapped seasonal maximums of the BW content on Mars are correlated with the seasonal maximums of the atmospheric water vapor abundance observed with TES [18] at relatively low temperature. In addition, the process of minerals hydration on Mars reveals much actively during the aphelion period. Later the atmosphere is warming quite quickly at very abrupt decreasing of the atmospheric water vapor abundance. This decreases relative humidity within boundary layer of the atmosphere. In that time minerals dehydration on the Martian surface is dominant (see fig.3). In the season of the Southern spring-summer (Ls=240°-330°), new activation of minerals hydration arise at the Southern high latitudes and at the Northern low-middle latitudes due to appearance of two atmospheric water vapor maximums. One of them is associated with sublimation of the perennial southern polar cap and other is related to the active south-north transfer of the

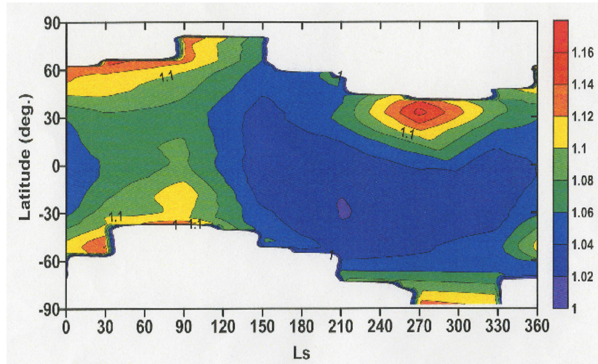

Fig. 3. Dynamics of the BW content distribution versus of the Ls and the latitude during the Martian year (results have been zonally averaged into bins that are 5° wide in the latitude and 60° wide in the Ls).

atmospheric water to the latitudes via the Hadley cell circulation [19]. Therefore, in the season the relative humidity may become higher due to both increased abundance of the atmospheric water vapor and moderately low surface temperatures resulted in higher dust opacity of the atmosphere, which is typical for the season [18].

Our mapping indicates that seasonal regime of the BW content distribution may serve as qualitative spectral indicator of degree and rates of mineral hydration/dehydration processes on Mars. Since the rates of hydration/dehydration processes strongly vary for different minerals, the observing features of the BW seasonal regime can be used to constrain surface hydrated minerals.

References: [1] Moroz V. I. (1964) *Sov. Atron*., 8, 273-281; [2] Singer R. B. (1982) *JGR*, 87, 10159-10168; [3] Soderblom L.A. In “Mars”(1992),557-593 ; [4] Pollack J. B. et al. (1990) *JGR*, 14595; [5] Pimentel G. C. et al. (1974) *JGR*, 79, 1623-1634; [6] Clark R.N. et al. (1982), *JGR*, 87,367-370; [7] Calvin W. M. (1997) *JGR*, 102, 9097-9107; [8] Bell J. F., D. Crisp (1993) *Icarus*, 104, 2-19; [9] Clark R.N. and Hart D.C. (1981), *Icarus*,45,370-378; [10] Murchie S. et al. (1993) *Icarus*, 105,454-468; [11] Rieder, R. et al., (2004) *Science*, 306, 1746-1749; [12] Squyres, S.W. et al., (2004) *Science*, 306, 1709-1714; [13] Salisbury,J.W. et al., (1991),The Johns Hopkins Univ. Press; [14] Bandfield, J.L. and Smith, M.D (2003) *Icarus*, 161, 47-65; [15] Ruff S. W. (2004) *Icarus*, 168, 131-143; [16] Christensen, P.R.et al., (2004) *Science*, 305, 837-842; [17] Kuzmin, R.O. et al., (2004) *LPSC* XXXV, abstr. 1810; [18] Smith M. D. (2002) *JGR*, 107, 25,1-25,19; [19] Haberle R.M. et al., (1993), *JGR*, 98,3093-3129;