WATER DISTRIBUTION IN VERA RUBIN RIDGE AND GLEN TORRIDON BASED ON THE DAN/MSL MEASUREMENTS COMPARED TO CRISM/MRO HYDRATED MINERALS ABUNDANCE IN GALE CRATER.
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Introduction: The Dynamic Albedo of Neutrons (DAN) instrument designed to detect neutrons in order to determine hydrogen abundance in the Martian subsurface (down to 1 m deep) [1,2] is successfully working onboard Mars Science Laboratory (MSL) rover Curiosity for more than 7 years. We investigate the possible correlation between Water Equivalent Hydrogen (WEH) value as measured by DAN instrument along the Curiosity traverse and the presence of hydrated/hydroxylated minerals as seen by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) instrument onboard Mars Reconnaissance Orbiter (MRO) in order to connect geochemical features of the surface to the subsurface WEH measurements.

The Curiosity rover covered more than 20 km on the Martian surface and crossed a range of terrain types and geological structures of different mineralogical composition. For the last 2 years Curiosity is driving across the regions discovered from the orbit by their spectral features: Vera Rubin ridge, rich in hematite, and Glen Torridon, containing clay minerals, according to CRISM data. We present the results of the comparison between CRISM data and DAN measurements acquired for these two regions.

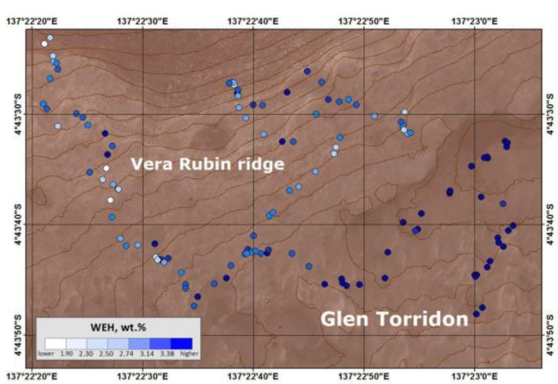

Fig. 1. DAN active measurements for Vera Rubin ridge and Glen Torridon. Data from sol 1800 up to sol 2470.

Instrumentation: DAN instrument operates in two modes: active and passive. In active mode, DAN detects neutrons from the pulsing neutron generator (PNG). In passive mode, the instrument detects low energy neutrons produced by the rover's Multi-Mission Radioisotope Thermoelectric Generator and by galactic cosmic rays as they propagate through Martian atmosphere and penetrate Martian subsurface. These neutrons interact with the soil nuclei through both elastic and inelastic scattering, slow down, and escape from the surface to be measured by DAN instrument. The energy spectrum of these neutrons is dependent on the amount of hydrogen in the Martian subsurface.

CRISM instrument onboard MRO is an imaging spectrometer that can cover wavelengths from 362 to 3920 nanometers at 6.55 nanometers per channel, observing Mars in both visible range and wavelengths within the infrared range [3]. Imaging the Martian surface in these wavelength ranges CRISM can identify a range of minerals by their spectral signatures.

Data Analysis: WEH value obtained through the analysis of DAN active measurements (see Fig. 1) increases from the mean value of 2.7 wt.% for Vera Rubin ridge up to 3.7 wt.% for Glen Torridon. Similarly, WEH value derived from the passive measurements (see Fig. 2) increases from 3.0 wt.% to 3.8 wt.%, respectively [4].

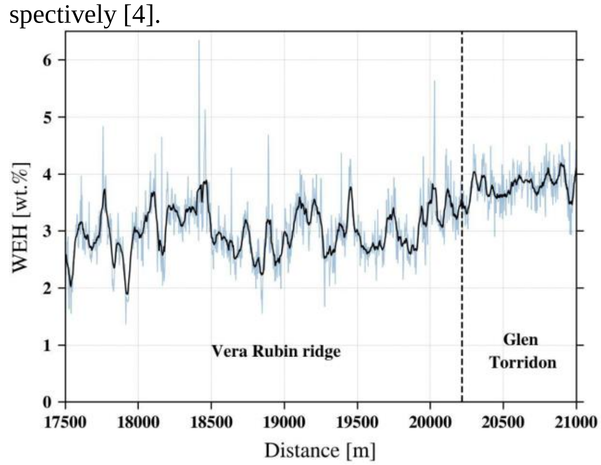

Fig. 2. DAN passive measurements for Vera Rubin ridge and Glen Torridon [4].

The correlation with mineralogical composition of the Martian surface was based on ALT and HYD Specialized Browse Product Mosaics, provided by the CRISM Team for the purpose of MSL landing site mapping [5]. The composite of the mosaics constructed from the IR spectral range show a combination of the indicators of hydrated/hydroxylated minerals believed to be present at Gale crater.

To find the correlation between DAN passive data and CRISM products we spatially overlayed the two datasets. Thus, the four samples of DAN passive data were obtained: passive measurements spatially corresponding to hydrated/hydroxylated minerals in CRISM products: phyllosilicates, mono- and polyhydrated sulfates, and passive measurements with no such correspondence. Then we compared three WEH distributions for each type of minerals with the reference one.

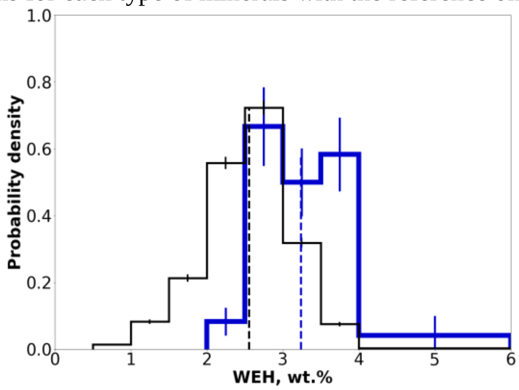

Fig. 3. WEH value distribution for: the group of DAN measurements with the spectral signature of polyhydrated sulfates – for Vera Rubin ridge and Glen Torridon (blue) and the reference group of the DAN measurements which do not have signatures of hydrated minerals – for the whole traverse (black) Dotted lines indicate mean values of the distributions: 3.24 wt.% and 2.56 wt.%, respectively.

Results. We present the results for Vera Rubin ridge and Glen Torridon parts of the Curiosity traverse. The analysis shows that not only polyhydrated sulfates (see Fig. 3) on the surface can lead to the WEH value increase, as it was stated in [6], but phyllosilicates (see Fig. 4) can provide the same effect, possibly if being presented not only on the surface and detected by CRISM, but in sufficient amounts in the subsurface to be detected by DAN. The shift of the WEH distribution, corresponding to the phyllosilicates on the surface, as well as the probability of their coincidence (according to the Pearson criterion – almost zero), allows us to presume a pronounced thickness of the phyllosilicates layer in the subsurface of Glen Torridon.

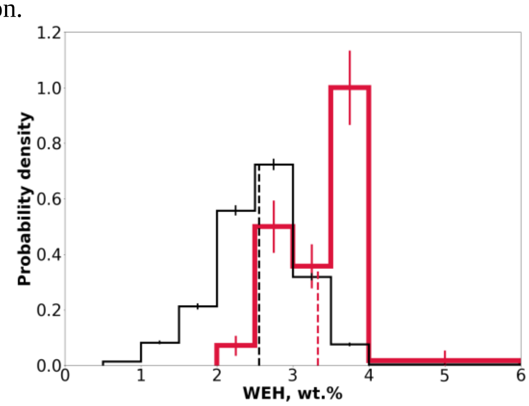

Fig. 4. WEH value distribution for: the group of DAN measurements with the spectral signature of phyllosilicates – for Vera Rubin ridge and Glen Torridon (red) and the reference group of the DAN measurements which do not have signatures of hydrated minerals – for the whole traverse (black). Dotted lines indicate mean values of the distributions: 3.33 wt.% and 2.56 wt.%, respectively.

References: [1] Mitrofanov I. G. et al. (2014) J. Geophys. Res., 119, 1579–1596. [2] Livak M. L. et al. (2014) J. Geophys. Res., 119, 1259–1275. [3] Pelkey, S. M., et al. (2007), , J. Geophys. Res., 112, E08S14. [4] Nikiforov S. Y. et al. (2020), *this conf*. [5] Viviano-Beck, C. E., et al. (2014), J. Geophys. Res., 119, 1403–1431, http://crism.jhuapl.edu/ [6] Djachkova M. V., et al. (2019), EGU2019, id.16622