CORRELATION BETWEEN SUBSURFACE WATER FROM THE PASSIVE MEASUREMENTS OF THE DAN INSTRUMENT (NASA/MSL) AND HYDRATED/HYDROXYLATED MINERALS FROM CRISM (NASA/MRO) DATA PRODUCTS 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 5 years.

The Curiosity rover covered more than 17 km on the Martian surface and crossed a range of terrain types and geological structures of different mineralogical composition.

Here, we investigate the possible correlation between water content value as measured by DAN instrument along the Curiosity traverse and the presence of hydrated 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 water measurements.

Instrumentation: DAN instrument can operate 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 galactic cosmic rays as they propagate through Martian atmosphere and penetrate Martian subsurface and by the rover's Multi-Mission Radioisotope Thermoelectric Generator are detected. These neutrons interact with the soil nuclei through both elastic and inelastic scattering, slow down, and escape from the surface to be measured by the DAN instrument. The energy spectrum of these neutrons is dependent on the amount of hydrogen in the Martian subsurface.

The 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 the visible range and shorter wavelengths within the infrared wavelength range [3]. Imaging the Martian surface in these wavelength ranges CRISM can identify a range of minerals.

Methods: Water Equivalent Hydrogen (WEH) parameter obtained through the analysis of DAN passive measurements [4] shows substantial variation along the rover's traverse (see Figure 1). Its correlation with mineralogical composition of the Martian surface was based on «ALT» Specialized Browse Product Mosaic, provided by the CRISM Team for the purpose of MSL landing site mapping [5]. ALT composite constructed from the IR spectral range is a combination of those indicators of hydrated and/or hydroxylated minerals believed to be present at Gale Crater.

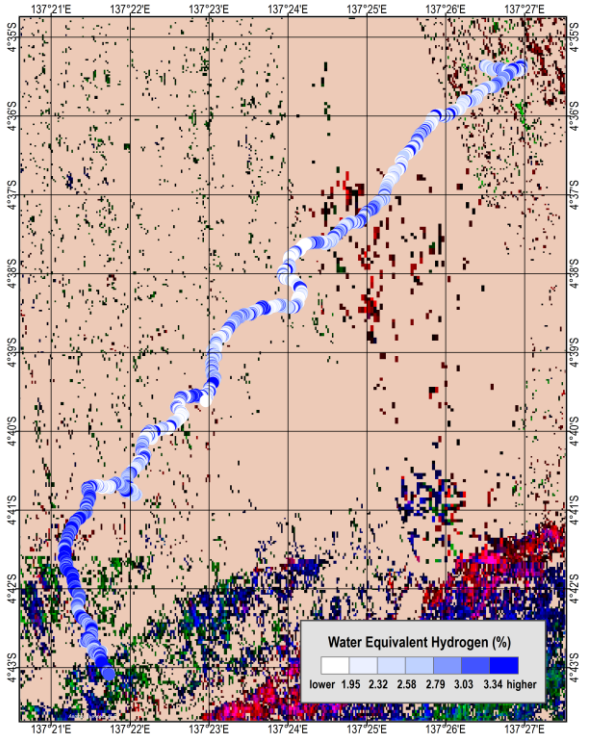

Figure 1. DAN passive mode measurements on CRISM ALT mosaic background. Hydrated sulfates are green or blue-green. Blue areas either have more hydrated sulfates or one or more additional hydrated phases. Red areas have Fe/Mg clays [5]. Orange means no hydrated/hydroxylated minerals.

To find any correlation of DAN passive data with CRISM ALT product we spatially overlayed the two datasets. Thus, the two samples of DAN passive data were obtained: passive measurements spatially corresponding to hydrated/hydroxylated minerals in ALT Product and passive measurements with no such correspondence. The visible difference in the WEH parameter frequency distributions of the two samples can be seen in Figure 2.

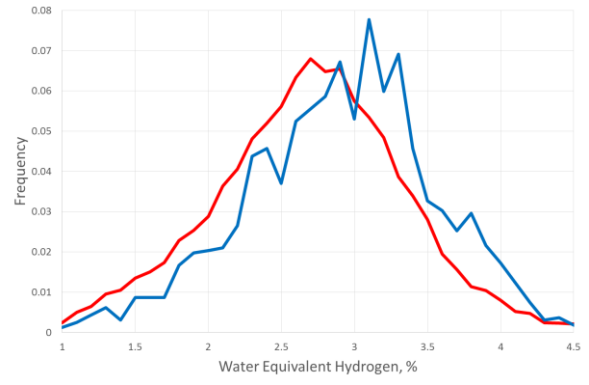

Figure 2. Frequency distribution of DAN passive data samples: blue line – corresponding to hydrated/hydroxylated minerals in CRISM ALT Product, red line – with no such correspondence.

Results: The cross analysis of DAN passive mode data with CRISM ALT Product showed a substantial correlation which means that DAN instrument feels the presence of hydrated/hydroxylated minerals in the Martian subsurface. As Curiosity rover is just arriving at the region with the subsurface rich in these minerals we are expecting the future confirmation of our conclusion.

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. (2018) 49th LPSC Abstract #2127 (This Conference). [5] Viviano-Beck, C. E., et al. (2014), J. Geophys. Res., 119, 1403–1431, http://crism.jhuapl.edu/