Mars Science Laboratory Dynamic Albedo of Neutrons Passive Mode Data and Results from sols 753 to 1292: Pahrump Hills to Naukluft Plateau.

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Introduction: The Dynamic Albedo of Neutrons (DAN) instrument onboard the Mars Science Laboratory rover *Curiosity*, is capable of detecting neutrons escaping from the shallow Martian subsurface for the purpose of estimating the amount of water equivalent hydrogen (WEH) present in the Martian regolith [1,2]. Here, we present the most recent DAN passive WEH estimates and results, extending from sol 753 to 1292 of the mission,which includes measurements over the lower sediments of Mt. Sharp (Aeolis Mons). We also describe a new method of spatial binning of the traverse segment data that leverages the inherent extended nature of the footprint of the instrument to provide improved uncertainties relative to previous DAN passive data analyses.The DAN instrument itself and the relevant neutron physics are described fully in previous work [1,2,3,4,5].

Methods: Numerical simulations are necessary to analyze DAN passive mode data. We use the Monte Carlo radiation transport code MCNPX [6] to simulate the Martian neutron leakage flux relevant to MSL DAN passive mode and the instrument's response to it [7]. In large scale, this involves simulating GCR transport through the Martian atmosphere by keeping track of the relevant GCR and secondary particles and their energy and angular distributions. The results from this step are used as input for a rover-scale simulation that includes the Martian regolith, the rover, and the DAN detectors. In a separate simulation, the MMRTG source is also simulated within in the same rover-scale geometry. The composition of the Martian regolith within these simulations contains varying amounts of WEH and absorption equivalent chlorine (AEC). The results from both of these rover-scale simulations are in neutron counts per source particle and thus must be scaled by source strength and combined to produce the estimated DAN count rates for a given composition of the Martian regolith. The MMRTG source simulations are scaled by a factor derived in [3]. The GCR-source simulations are scaled using a factor derived from calibration of DAN passive data in combination with DAN active results and MSL Radiation Assessment Detector (RAD) data [7], the latter of which measures the high energy particle environment at the surface of Mars [8]. DAN passive data are compared to these simulation results in order to determine the composition that best models the data [7].

New to this work is the inclusion of a method of leveraging the inherent oversampling of the DAN passive measurements within the instrument's own footprint. Typically, when the rover is moving, ~15-20 DAN passive measurements are contained within the ~2-m diameter of the instrument's sensing footprint from any given position. Thus, determination of the WEH content for a single position along the traverse may make use of many individual DAN passive measurements. We include this effect by spatial binning of the traverse segment data using a Gaussian smoothing filter (to approximate the shape of the sensitivity within the footprint) applied to the thermal neutron count rates. The full width half maximum of the filter is 1 m. An example of the effect of this spatial binning can be seen in Figure 1. As shown, the uncertainties in the neutron count rates associated with all positions along the traverse decrease when this method is applied.

Results: The average WEH estimate derived from DAN passive measurements acquired during sols 753 to 1292 of the mission is 1.6 wt. % with a standard deviation of 1.1 wt. % [9]. WEH estimates from traverse waypoints are shown in Figure 2. Fully tabulated results are presented in [9]. Statistical analysis of DAN passive WEH estimates from both the Murray formation and the Stimson formation indicate that these sediments are compositionally distinct from the sediments of Aeolis Palus.

DAN passive WEH estimates are consistent with results from other instruments in this region of the traverse, notably, CheMin [10] and SAM [11]. For the locations known as Confidence Hills, Mojave 2, Telegraph Peak, Buckskin, Big Sky, and Greenhorn, where sediments were sampled and ingested by rover isntruments, [10] shows that phyllosilicate abundance decreases as elevation increases. DAN passive WEH estimates for these locations are in agreement with this as the WEH estimates decrease with decreasing phyllosilicate abundance, as expected. Additionally, [11] reports SAM evolved gas analysis (EGA) H_2O abundances for these locations. SAM H_2O values are consistent with

DAN passive WEH estimates from these locations (Figure 3).

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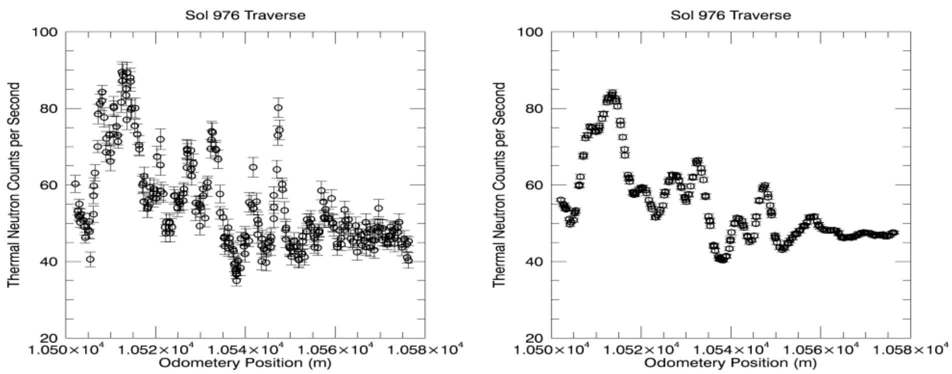

Figure 1. Thermal neutron count rates versus odometry position for an example traverse segment from sol 976 are shown. Left: No spatial binning applied. Right: Spatial binning applied.

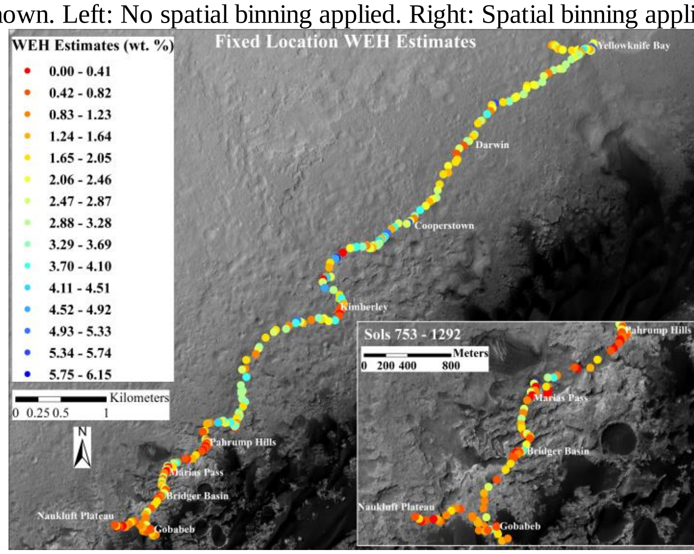

Figure 2. DAN passive WEH estimates at fixed locations along *Curiosity's* traverse are shown.

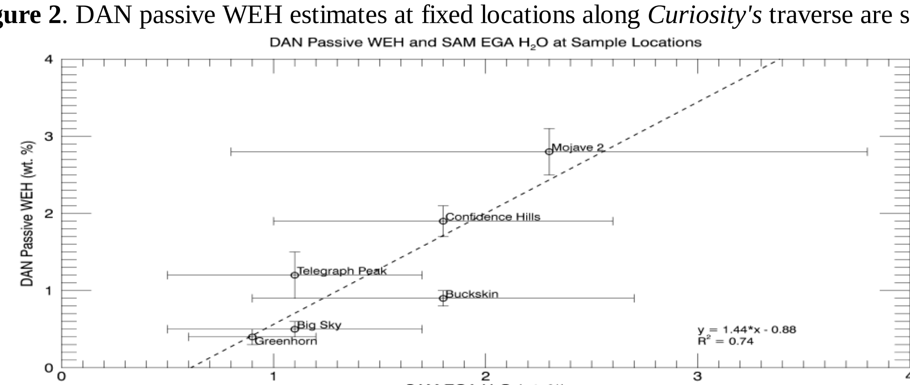

Figure 3. Correlation plot between DAN passive WEH estimates and SAM EGA H_2O estimates for sampled locations within the Murray and Stimson formations. The R^2 value is 0.74.