Content of Hydrogen and neutron absorbing elements at Gale crater measured by DAN instrument onboard the Curiosity Mars Rover.

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Introduction: The Dynamic Albedo of Neutrons (DAN) experiment on MSL [1,2] was designed to measure the hydrogen content of the regolith to a depth of approximately 60 cm. The instrument is located at the back of the rover together with the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG). DAN consists of two separate blocks integrated onto the two sides of the rover: a pulsed neutron generator (DAN/PNG) and a detector element (DAN/DE). DAN may be operated both in active and in passive modes of measurements. In active mode the DAN/PNG produces 2-μs pulses of high energy (14.1 MeV) neutrons (10^7 neutrons per pulse) emitted in 4π around the DAN/PNG. A significant fraction of these neutrons penetrate into the subsurface under the rover and interact with soil nuclei. The neutrons lose energy through inelastic scattering reactions with nuclei in the subsurface. Some of the moderated neutrons leak back out of the subsurface where they are counted by the DAN/DE subsystem as a function of time after the neutron pulse.

Figure 1. Two blocks of the DAN instrument onboard Curiosity: the DAN PNG block *(right)* for pulsing neutron generation and DAN DE block (left) for obtaining measurements of the die-away time profiles of thermal and epithermal neutrons.

Data analysis: The presence of water molecules in the soil of Gale Crater is thought to be direct evidence for the existence of a water reservoir in the crater a long time ago. Layered sediments over the Gale Crater floor are thought to have accumulated in past epochs, when episodes of water inflow and evaporation took place in the crater. The layers of water-bearing minerals contain the history of these episodes. In our analysis we have used DAN active measurements performed onboard Curiosity rover at ~ 300 individual points in Gale crater along more than 6000 meters of the traverse starting from the Bradbury landing site. It is found that a model of constant water content within subsurface should be rejected for practically all tested points, while a two-layer model, with different water contents in the subsurface layers, is supported by the data. So-called direct two-layer model (water content increasing with depth) works for majority of rover stops except a short intervals at the beginning of traverse The mean water abundances of the top and bottom layers are estimated as follows 1.15±0.04 wt% and 3.2±0.1wt%, respectively. The thickness of the top layer is equal 17.1±0.5 cm. At some tested spots the water content is estimated to be as high as about 5-7 wt% in the bottom layer. An inverse two-layer model (water content decreasing with depth) is supported by the data for the odometry range 455 – 638 meters, with an estimated mean water abundance of 2.1 ± 0.1 wt% and 1.4 ± 0.04 wt% in the top and bottom layers, respectively (see also [3,4]).

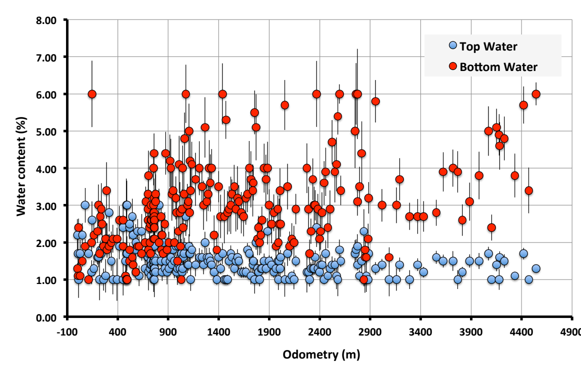

Figure 2. Variations of estimated content of water at top (blue) and bottom (red) layers along the Curiosity traverse.

References: [1] Mitrofanov I.G. *et al*. (2012), *Space Sci. Rev*., 170, 559-582. [2] Litvak M. *et al*., (2008), ASTROBIOLOGY, 8, 3, 605-612. [3] Mitrofanov *et al*., (2014), JGR submitted. [4] Litvak *et al*., (2014) , JGR submitted.