

The water bulk distribution along MSL Curiosity traverse measured by DAN instrument

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Abstract

In our analysis we have used active neutron spectroscopy measurements performed by the Dynamic Albedo of Neutrons (DAN) instrument onboard the MSL rover Curiosity at multiple stops along rover's traverse. The main objectives of the analysis is to monitor variation of neutron flux, to estimate average content of water, to detect its depth distribution, to understand effects of soil density variations and presence of neutron absorption elements (such as chlorine).

1. DAN Instrument

DAN instrument consists of pulse neutron generator (DAN/PNG) and neutron detectors of epithermal and thermal neutrons (DAN/DE). In active mode of measurements DAN/PNG emits very short (~2 microseconds) pulses of high energy neutrons (14MeV) which penetrate to a subsurface under the rover, losing their energy down to the epithermal and thermal range. This process strongly depends on the soil composition, especially from depth distribution of Hydrogen (which could exist in the soil in the hydrated minerals). The moderated neutrons can escape from the soil and be detected by DAN/DE within hundreds of microseconds after the neutron pulse. It is recorded as a time profile of die away curve and its shape brings to us information about the subsurface structure and hydrogen abundance.

2. Results

Neutron data from DAN show the water variations from 1.0 up to 3 wt% within 60 cm of subsurface. It is significantly less than the estimated content of water ~ 5% derived from the orbital neutron data (HEND/Odyssey).

Comparing different locations along MSL path one may conclude that in half of rover stops water in-depth distribution could be described with homogeneous model of subsurface (water is distributed homogeneously as a function of depth). Another half of considered cases requires non-homogeneous model and could be described with two layer model showing water increasing with depth or water decreasing with depth.

References

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