Geophysical Research Abstracts
Vol. 16, EGU2014-5032, 2014
EGU General Assembly 2014

Link of local micro-morphology diversity with variability of the DAN active mode measurements along the rover Curiosity traverse in the Gale crater

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The rover Curiosity traverse from the Yellowknife Bay (YKB) up to the Darwin outcrop area (DOA) crossed mainly the Smooth Hummocky unit and in places – the Rugged unit spots. Whereas the Smooth Hummocky unit is characterized by low surface roughness and uniform tone, the Rugged unit is typically represented by outcrops with rougher surface texture. As it well seen based on Navcam and Mastcam images, the modern dominant micro-morphology of the landing site area is characteristic of surface shaped by strong aeolian deflation processes. Blowout shallow depressions and wind erosion remnants (in forms of mounds and ridges) are widespread along the rover traverse. As result, in most cases the surface texture of the regolith in the traverse area represents a desert pavement – a surface of tightly packed gravels and pebbles that armor lower more fine material below. Conglomerate outcrops are also exposed within both the Smooth Hummocky unit and the Rugged unit spots and aeolian accumulation features (aeolian drifts, small dunes and ripples) are relatively rare occurring mainly on local leeward slopes of mounds and ridges.

During the traverse from the YKB to DOA the Dynamic Albedo of Neutrons (DAN) instrument conducted 140 local active mode measurements of the thermal and epithermal neutrons counts in the top ~60 cm of the Martian subsurface with horizontal sensing "footprint" of about 3 m. Based on the active mode of the DAN measurements it was found that the thermal and epithermal neutron counts measured along the rover traverse show distinct variability from one rover location to another. It was found that a water equivalent of H (WEH) distribution in 60-cm subsurface layer along the rover traverse are fit by a two-layers model, where the top layer (with varied thickness) has less WEH ("dry") than the bottom layer ("wet"). It is distinct that spatial distribution of WEH within the top layer (1-2.5 wt. %) are chiefly homogeneous along the traverse, whereas the range of WEH values within the bottom layer are much wider (1-5.8 wt. %) and the spatial distribution of the water amount in the layer is quite inhomogeneous at the distance from first tens meters to 100 m. Based on the model results, the rover traverse can be divided into distinct DAN testing subsurface layer types. The parts of the traverse with little difference of WEH values between the top and bottom layers are alternated with the parts where the difference remarkably higher. It was found that the highest values of averaged bulk WEH are associated (in most cases) with a surface composed by fine-granular soil, while lower WEH values are associated with coarser, rocky soils and conglomerate outcrops. Analysis of the DAN active mode measurements along the rover traverse from the YKB to DOA show that two-layer model of the water distribution in the subsurface layer corresponds well to both outcrops spots and deflated surfaces with variable top layer thickness, that is composed of finely granulated and coarse, rocky soil. This suggests that the boundary between the top and bottom layer may not represent a lithological difference (while in some cases this is not excluded) but rather it is related with a level of surface regolith desiccation at the modern climatic conditions in the Gale crater area. In places where the surface regolith has been exposed for a longer period of time, the contrast in WEH between the top and bottom layers is essentially lower than in the cases of more recent surface regolith exposure by an aeolian erosion.