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Compositional Variations of Rocknest Sand, Gale Crater, Mars

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The Curiosity rover spent over 40 sols at an aeolian deposit (termed Rocknest sand shadow deposit) that is several meters long (oriented north-south), 15-20 cm high (at crest) and about 50 cm wide. Material was scooped up from the subsurface to a depth of about 40 mm at five different locations on the deposit. Part of the sampled material was delivered to the analytical laboratories CheMin (x-ray diffraction) and SAM (pyrolysis, evolved gas analysis, gas chromatography, mass spectrometry, tunable laser spectroscopy) in the rover body. Scoop troughs and walls were imaged extensively by cameras onboard the rover (Mastcam, Mars Hand Lens Imager (MAHLI), Remote Microscopic Imager (RMI)) and probed by Laser Induced Breakdown Spectroscopy (LIBS) as provided by the ChemCam instrument.

Images show that the top surface of the deposit is armored by a layer 1–3 grains thick of mm-sized, subrounded, dust-mantled grains. The bulk of the deposit is composed of particles smaller than 150 microns (fine and very fine sand and likely silt and dust). Furthermore, there are bright bands in the subsurface, a narrow one and a broad one at depths 2-4 mm and 20-30 mm, respectively. The images also provide evidence for crust formation and cementation as the scoop trough floors are littered by platy angular fragments and cemented clods. Many of the clods contain numerous sub-mm sized bright (sulfate rich?) inclusions.

Chemical profiles (as provided by ChemCam data) do not clearly support the type of subsurface layering inferred from the images. However, chemical abundances (Li, Na, K, Mn, Fe, Ca, Mg, and Si) significantly deviating from average values are found at two different depths (respectively 15 and 25 mm).

It is unclear when (and over which time scale) the Rocknest sand deposit in Gale Crater formed. In any case, mm-sized particles cannot be moved efficiently in the current aeolian regime. If the deposit has been immobile for an extended period of time, it is conceivable that Martian obliquity cycles (up to the near geologic past) caused ice deposition and partial melting of subsurface water ice which in turn may have sustained slow alteration of the uppermost part of the deposit (Arvidson et al., J. Geophys. Res., 115, E00F03, 2010); this hypothesis is consistent with the observed crust formation as well as the chemical variations in the near subsurface.