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An Aquatic Journey toward Aeolis Mons (Mount Sharp): Sedimentary Rock Evidence observed by Mars Science Laboratory

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Since leaving Yellowknife Bay (summer 2013), Mars Science Laboratory Curiosity has investigated a number of key outcrops as it traverses along the Rapid Transit Route toward the entry point to begin its investigations of the extensive rock outcrops at the base of Mount Sharp. Rover observations are characterizing the variability of lithologies and sedimentary facies along the traverse and establishing stratigraphic relationships with the aim of reconstructing depositional processes and palaeoenvironments. Here, we report on sedimentological and stratigraphic observations based on images from the Mastcam and MAHLI instruments at Shaler and the Darwin waypoint.

The informally named Shaler outcrop, which forms part of the Glenelg member of the Yellowknife Bay formation [1] is remarkable for the preservation of a rich suite of sedimentary structures and architecture, and was investigated on sols 120-121 and 309-324. The outcrop forms a pebbly sandstone body that is $\sim$0.7 m thick and extends for up to 20 m. Shaler is largely characterized by pebbly sandstone facies showing well-developed decimeter-scale trough cross-stratification. Bedding geometries indicate sub-critical angles of climb, resulting in preservation of only the lee slope deposits. The grain size, and the presence and scale of cross-stratification imply sediment transport and deposition by unidirectional currents in a fluvial sedimentary environment.

Curiosity investigated the informally named Darwin waypoint between sols 390 and 401, making detailed Mastcam and MAHLI observations at two separate locations. The Darwin outcrop comprises light-toned sandstone beds separated by darker pebbly sandstones. MAHLI observations permit differentiation of distinct sedimentary facies. The Altar Mountain facies is a poorly sorted pebbly sandstone that is rich in fine pebbles. Pebbles are sub-angular to sub-rounded in shape and show no preferred orientation or fabric. Pebbles and sand grains show clast-to-clast contacts. The clast-supported nature of the facies, the presence of coarse sand grains to fine pebbles, and the occurrence of some rounding of clasts indicates that these are sedimentary clasts that have been transported by aqueous flows. However, the absence of a well-sorted fabric, size grading of clast, and major rounding of grains suggests that these pebbly sandstones were rapidly deposited rather than built up from sustained fluvial reworking, implying that the deposits may be the result of more ephemeral river flows rather than sustained flow discharges. The Bardin Bluffs facies overlies the Altar Mountain facies and shows a more sand-dominated fabric with a smaller proportion of floating fine pebbles. This facies is also clast-supported but contains fewer pebbles and shows an overall fining-up trend. This facies is also interpreted to represent fluvial deposition albeit with a different grain size distribution than the Altar Mountains facies.

We will compare and contrast the varying sedimentary fabrics and facies to develop models for the variety of aqueous fluvial transport processes that have led to the deposition of sedimentary rocks en route to Mount Sharp. The origin of these sedimentary rocks with relation to fluvial fan processes in Gale Crater will be discussed.

References: [1] Grotzinger, J.P. et al Science 2013, doi: 10.1126/science.1242777.