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The Texture of Mars: Observations of Rock and Outcrop Targets Over 360 Martian Sols at the Gale Field Site

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Lithology (typically features 0.5-5 mm in scale, including sedimentary structure, texture, sorting, grain and crystal morphology) is a fundamental identifier for the field geologist, as it serves as a key indicator of rock-forming environments. Over the first 360 sols on the martian surface, the Mars Science Laboratory Curiosity rover interrogated geologic targets at this grain-size scale to identify and interpret the lithologic and textural clues to processes that formed and modified the geologic record. Its primary tool in this task was the Mars Hand Lens Imager (MAHLI). MAHLI is a 2-megapixel focusable macro lens color camera on the turret on Curiosity's robotic arm. MAHLI acquires focused images at working distances of 2.1 cm to infinity; at 2.1 cm the scale is 14 μm/pixel; at 6.9 cm it is 31 μm/pixel, like the Spirit and Opportunity Microscopic Imagers (MI). The Remote Microscopic Imager (RMI) also acquired non-color images at sub-mm scales; these images were also examined for clues to rock texture. Although because of dust and sand obscuration, the observables can sometimes be unclear, fine-grained rock textures are still informative and can be used to assess paleoenvironment.

Rock targets observed up to sol 360 can be classified very broadly by texture as: (1) rocks or outcrop composed of poorly-sorted sand-sized grains with larger grains (0.5-1.0 μm) of varying morphology making up 2-5% of the rock by volume (e.g., the target informally named Gillespie Lake); (2) very fine-grained (below MAHLI resolution) dark rocks or outcrop, some of which have larger (0.5-1.5 μm across) round or rounded grains entrained (e.g. the target Wernecke); (3) dark gray fine- to coarse-grained rocks mantled with dust and fine/very fine sand, currently interpreted as igneous (e.g., targets Jake Matijevic, Matthew, and Bathurst Inlet); (4) porphyritic rocks; and (5) rocks abraded by windborne particles (ventifacts), with sub-mm to cm-scale abrasion textures. This last class overlaps other classes and accounts for half the float and outcrop. However, texture can vary greatly within these groupings, and these variations contain important clues to rock provenance. For example, no grains within the Wernecke target at the Sheepbed unit are larger than 60μm (silt-sized); this implies that Sheepbed is a mudstone. Mudstones form through suspension deposition in a fluvio-lacustrine system. By comparison, Gillespie Lake's coarser grained facies may have formed through fluvial and/or debris flows; the variation in individual grain morphologies within this rock may also indicate variable source lithologies.