

ROCK TEXTURES OBSERVED BY THE MARS HAND LENS IMAGER (MAHLI) IN THE GLEN TORRIDON REGION (GALE CRATER, MARS). M.E. Minitti,¹ D.M. Fey,² K.A. Bennett³ and K.S. Edgett²
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Introduction: The Mars Science Laboratory (MSL) *Curiosity* rover began exploration of the “Glen Torridon” region of Gale crater on Sol 2299. The Glen Torridon region largely coincides with a trough exhibiting the spectral signature of smectite clays detected by CRISM [1,2]. On the ~1.6 km traverse through Glen Torridon (as of Sol 2611), *Curiosity* has encountered a mixture of coherent bedrock and granule- to very coarse-sized (~2-50 mm) pebbles, often in close proximity. The Mars Hand Lens Imager (MAHLI) has observed 109 targets along the traverse at scales ranging from 20-40 $\mu\text{m}/\text{pixel}$ to assess texture and grain size, and ~50-150 $\mu\text{m}/\text{pixel}$ to assess bedrock structure. Where possible, dust was removed from targets using the Dust Removal Tool (DRT) or by laser shots from ChemCam to better reveal the color and texture of the targets. Targets were most commonly imaged from ~7 cm working distance (~30 $\mu\text{m}/\text{pixel}$) to support APXS analyses [e.g., 3]. This collection of images provides a consistent scale to compare and contrast rock textures, and investigate relationships between texture and units/facies throughout Glen Torridon.

MAHLI rock textures: Rock textures from 109 targets can be generally divided into seven classes, with some classes overlapping with others. Most classes have red or gray examples, but many targets exhibit a combination of red and gray color.

Laminated pebbles. Laminated pebbles exist in a range of sizes (~2-50 mm), exhibit very thin (~200-400 μm), regular laminations, and are pitted (Fig. 1). Some clasts are tabular in form with internal laminations paralleling the face on which the clast rests on the surface, while other clasts are rounded to sub-angular with internal laminations cutting through the clast with no relationship to the clast orientation on the surface.

Laminated bedrock. Bedrock of this class has regular laminations on the same scale as the laminated pebbles (~150-450 μm). This class largely lacks pits, but a few examples have elongated, lamination-parallel pits (Fig. 2). In some of the examples of this class, laminations are so fine that horizons containing them appear smooth and massive from a distance.

Laminated/layered bedrock. Some outcrop expressions of laminated bedrock are found intercalated with horizons that have generally thicker (~500 μm – 1 mm) layers. In many of these outcrops, the horizons with thin laminations repeatedly alternate with the horizons of thicker layers (Fig. 3). Other outcrop examples are dominated by thicker layers. Thicker layer horizons

have rougher surfaces that collect windblown sand. The layers are thick enough that they retain their layered character when viewed from a distance. Higher resolution imaging (<30 $\mu\text{m}/\text{pixel}$) of the thicker layers, however, reveals that some of them contain laminations of similar scales to the laminated horizons. Thus, it is possible that the whole outcrop is laminated uniformly throughout, but differences in cementing/diagenesis between the horizons lead to differences in erosional expression. Laminated/layered bedrock is associated with the Flodigarry facies identified at the same elevations in Glen Torridon and Vera Rubin ridge (VRR) [4].

Polygonally-fractured bedrock. This class is characterized by layered bedrock with fractures dividing each layer into ~0.5-2 cm angular segments (Fig. 4). Individual layers have smooth (mm to sub-mm scale surface roughness) texture and sometimes are also laminated. Measuring lamination or layer thickness in this class is challenged by the fact that most targets were viewed normal to layering.

Lumpy bedrock. This class exhibits rough (multi-mm scale surface roughness) texture caused by fine, shallow fractures dividing the surface into semi-rounded segments ~3-7 mm across (Fig. 5). The smaller, rounder segments and shallower surface fractures distinguish targets of this class from those in the polygonally-fractured class. Layers or laminations are difficult to discern because of the rough surface texture of these targets.

Nodular bedrock. Layered and/or laminated targets in this class are distinguished by the presence of small (sub-mm to multiple mm in diameter) resistant features (here referred to as nodules) embedded in the bedrock (Fig. 6). The nodules, where exposed by either dust removal or wind erosion, are gray and range from rounded to subangular. The spatial distribution of the nodules is not controlled by bedding. The nodules resemble the small resistant features, interpreted as concretions, observed throughout the Murray formation [e.g., 5,6].

Rock Hall-like. This class is characterized by knobby, pitted outcrops with greasy luster. Outcrops of this class also tend to be small, on the order of tens of cm across. Laminations are observed in some areas of the targets, but cannot be traced for more than ~1 cm due to the rough, knobby nature of the targets. These outcrops resemble the red Jura member of the VRR, in particular the drill target Rock Hall [e.g., 7].

Distribution along the traverse: Future work will focus on assessing the distribution of the MAHLI texture classes spatially with respect to the traverse and facies and units identified within Glen Torridon and by elevation.

References: [1] Milliken, R.E. et al. (2010) GRL, <https://doi.org/10.1029/2009GL041870>. [2] Fox, V.K. et al. (2019) LPSC 50, Abstract #2826. [3] Thompson, L.M. et al. (2019) 9th Mars, Abstract #6304. [4] Fedo, C.M. et al. (2020) this conference. [5] Sun, V.Z. et al. (2019) *Icarus*, 321, 866-890. [6] Minitti, M.E. et al. (2019) *Icarus*, 328, 194-209. [7] Horgan, B. et al. (2019) LPSC 50. Abstract #1424.

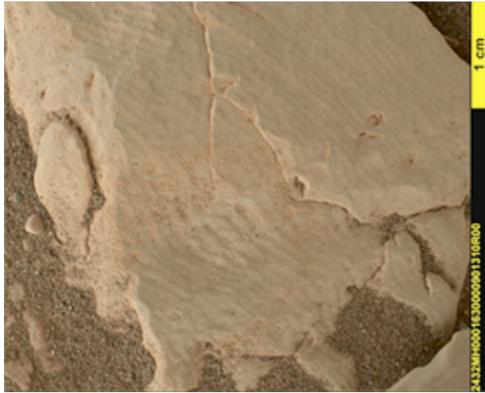


Fig. 1: Laminated pebble (Gullane). This image (and all images) by D.M. Fey.

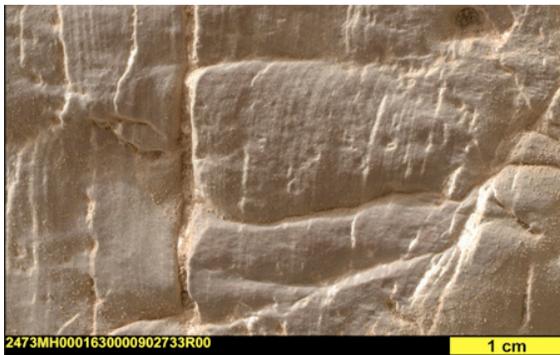


Fig. 2: Laminated bedrock (East Shetland).



Fig. 3: Laminated/layered bedrock (Mons Graupius). Scale the same as the other figures.



Fig. 4: Polygonally fractured bedrock (Crieff).



Fig. 5: Lumpy bedrock (Blawhorn).



Fig. 6: Nodular bedrock (Glenmard Wood).