**ROCK MICROTEXTURES IN THE LOWER CAROLYN SHOEMAKER FORMATION, GALE CRATER, MARS, AS IMAGED BY THE MARS HAND LENS IMAGER (MAHLI).** J.C. Cowart[1, 2] and R.A. Yingst[2], [1] Stony Brook University, 255 Earth and Space Sciences Building, Stony Brook, NY. [2]Planetary Sciences Institute, Tuscon, AZ

**Introduction:** Orbiter spectral observations of the 5 km thick sedimentary sequence within Gale crater indicate a transition zone from clay-bearing to sulfate-bearing rocks. The clay-sulfate transition coincides with a major lithologic change. The Murray formation is a ~300 m thick package of predominantly phyllosilicate-bearing mudstones deposited in a lacustrine environment [1, 2]. During the traverse of the Glen Torridon valley, Curiosity encountered a large, laterally continuous sandstone unit truncating the Murray mudstones [3]. Long-distance ChemCam RMI observations of the sedimentary package above Glen Torridon also show a mixture of finely-layered tabular beds, large-scale crossbeds, and interbedded truncation surfaces [4], suggesting a stronger influence of aeolian processes. The change in lithology spurred the definition of a new stratigraphic unit, the Carolyn Shoemaker formation.

Proposed mechanisms for the geochemical transition include declining clay formation amid global aridification [e.g. 5] and overprinting by sulfate precipitation within shallow groundwater systems [e.g. 6]. The overlap of major lithologic and geochemical transitions poses a challenge to interpretation. If global aridification is the dominant factor, it suggests linked transitions, i.e., sulfates result from increasing salinity and persistent acid weathering of the available sedimentary mass. However, if groundwater is the dominant factor, the transitions may be independent, i.e., groundwater influence was controlled by increased porosity in aeolian deposits. In-situ, grain-scale observations of the Carolyn Shoemaker formation by the Mars Hand Lens Imager (MAHLI) instrument will contribute to a better understanding of the relative importance of these processes in forming the clay-sulfate transition.

**Data Set:** MAHLI observations of surface materials are typically performed at ~25 cm, ~7 cm, and ~4 cm working distances. At the 4 cm working distance, textural elements >60-80 µm in diameter (fine sand or larger) can be resolved [6]. Due to aeolian dust and other fines on rock surfaces, grain size and rock color analyses require the use of MSL's Dust Removal Tool (DRT). DRT damage also provides insight into bedrock mechanics. DRT targets have a maximum stratigraphic separation of 25 m, corresponding to drill sampling cadence. In practice, this is improved to ~5 m resolution by contact science activities between drill sites.

Our microtexture analysis uses DRT-brushed rocks encountered from Sol 2444 to present. As of this writing, 58 targets were available. We performed grain size measurements, observed bedrock mechanical properties (e.g. fracture density, DRT damage), and characterized diagenetic features (e.g. concretions, veins).

**Preliminary Results:** The MSL Science Team has currently defined four Carolyn Shoemaker formation members: Knockfarril Hill, Glasgow, Mercou, and Pontours.

*Knockfarril Hill:* The Knockfarril Hill mbr. consists of sandstones with several thin mudstone interbeds. The sandstone exhibits thin bedding which forms crossbeds at some sites. Grains are well-sorted, with a 60-180 µm size (very fine to fine sand). White veins (interpreted as calcium sulfate veins, common within the Mt. Sharp Group [7]) are uncommon relative to other formation members. Where observed, veins are planar and occur both along bedding planes and at steep angles to bedding. DRT damage to the sandstone unit is minimal.

Interbedded mudstones are thinly bedded and rubbly in outcrop expression. Grains were not observed, indicating coarse silt or finer. Stellate features with a 300-

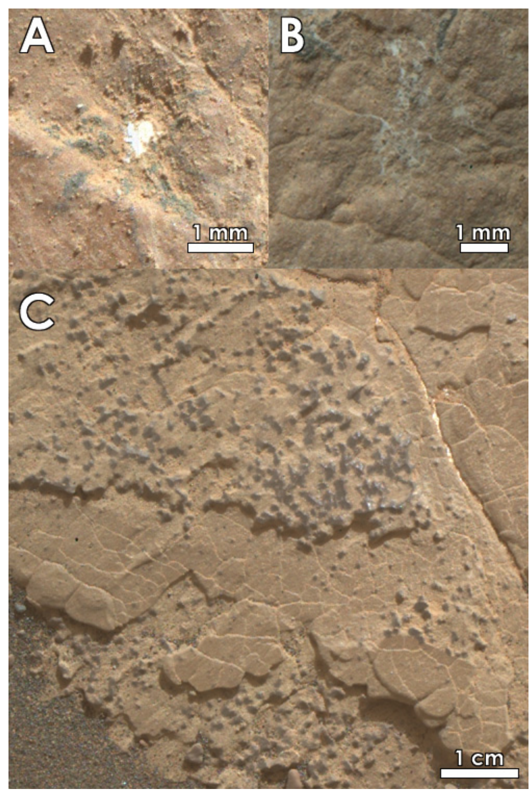


**Figure 1**. Knockfarril Hill member. A) Stellate structure (Everbay, Sol 2597). B) Cobweb-like light-toned vein (Inverurie, Sol 2601). C) Concretion-rich layers (Troy, Sol 2908).

500 µm light-toned center and radiating 500 µm – 2 mm long black needles occur in the interbedded mudstones (**Fig. 1A**). Veins form cobweb-like textures in some targets. (**Fig. 1B**). Rounded, dark, 500 µm – 3 mm concretions were also observed and appear to occur within less rubbly interbeds (**Fig.1c**).

*Glasgow:* The Glasgow mbr. consists of mudstones with sandstone interbeds in the interval's lower half. Layering is not observed with MAHLI. Parts of the Glasgow mbr. are overprinted by a diagenetic horizon underlying the Greenheugh pediment [8, 9, 10]. Within the diagenetic zone, the Glasgow has a bluish appearance (**Fig. 2A**), contrasting with a gray to reddish appearance for the bulk Glasgow (**Fig. 2B**). Grain size is coarse silt or finer. DRT damage is variable and is stronger in the diagenetic zone underlying the pediment.

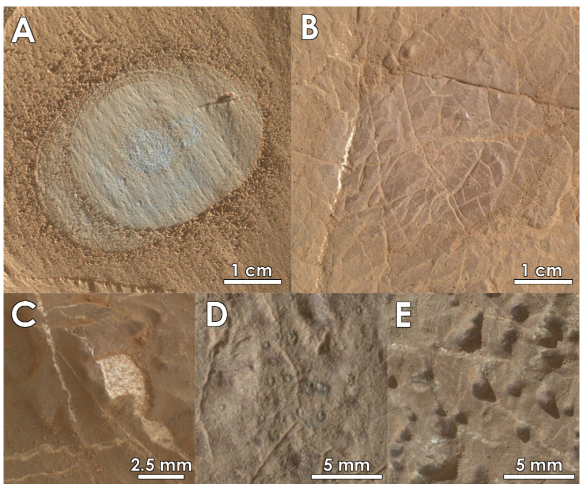


**Figure 2**. Glasgow member. A) Bluish diagenetic zone underlying Greenheugh pediment (Buchan Haven, Sol 2643). B) Typical red rock of the Glasgow member (Cod Baa, Sol 2974). C) Light-toned veins with inclusions (Ben Arnaboll, Sol 2631). D) Hollow concretions (Heather Island, Sol 2785). E) Solid concretions (Chalus, Sol 3037)

Light-toned veins are common in the Glasgow mbr. and form dense networks in some targets. Thick veins typically contain sand-sized inclusions with a similar tone to bedrock (**Fig. 2C**). Hollow dark-toned concretions 500-750 µm in diameter are observed in redder Glasgow targets. These are surrounded by gray rock, possibly reduction haloes (**Fig. 2D**). Dark, filled concretions 1-2 mm in size are also observed and are most prominent in the upper Glasgow (**Fig. 2E**).

*Mercou:* The Mercou mbr. is a ~5 m thick sandstone which was not well-observed by MAHLI. Grain size is between 60-100 µm, although pixel-scale variability in DRT gouges suggests the presence of additional coarse silt. Erosional surfaces have a wavy texture with scattered dark 600 µm – 1.2 mm concretions.

*Pontours:* The Pontours mbr. exhibits a strong diagenetic overprint, preventing easy identification of original depositional structure (e.g., laminae). The lower Pontours unit appears to be mudstone; no matrix grains were identified. Irregular, elongate concretions 4 – 15 mm in size are present (**Fig. 3A**). Their greenish color contrasts with the reddish surrounding rock.

The upper Pontours is sandstone with well-rounded grains. Some targets show alternating sand- and silt-rich layers (**Fig. 3B**). Grains are well-sorted, but vary in size between beds. The coarsest upper Pontours sandstones consist of grains 750 µm – 1.5 mm diameter grains (coarse to very coarse sand) embedded within a sub-resolution matrix; 200-400 µm (fine to medium sand) is more typical. Dark textural elements have a reddish rim, possibly a weathering/oxidation rind (**Fig. 3C**). Lighter textural elements appear heterogeneous and are possibly reworked evaporite aggregates (**Fig. 3D**).

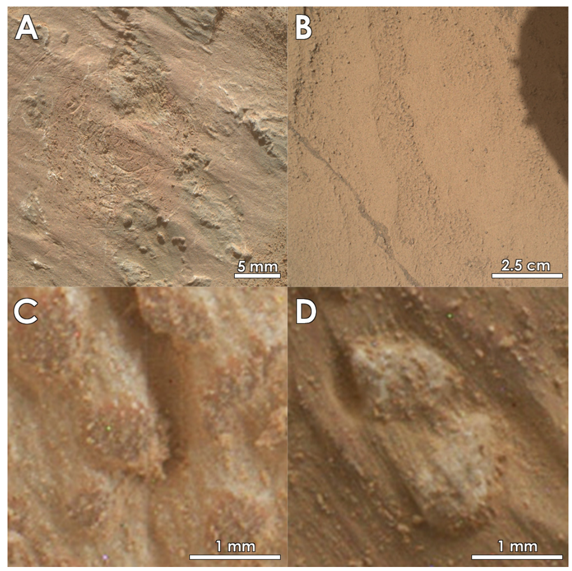


**Figure 3**. Pontours member. A) Irregular greenish concretions in the lower Pontours (Nadaillac, Sol 3202). B) Alternating sand and silt layers observed in upper Pontours (Camster Cairns, Sol 3212). C) Dark-toned textural elements with reddish rims (Cladh Hallan, Sol 3321). D) Heterogeneous light-toned textural elements (Joppa Salt, Sol 3276).

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