WHAT DEPOSITIONAL PROCESSES AND PALEOENVIRONMENTS FORMED THE LAYERED SULFATE UNIT IN GALE CRATER, MARS?: INSIGHTS FROM MARKER BAND VALLEY. Amelie L. Roberts[1], Sanjeev Gupta[1], William E. Dietrich[2], Lauren Edgar[3], William Rapin[4], Steven Banham[1], Alex Bryk[2], Joel Davis[5], Edwin Kite[6], Aster Cowart[7], Tex Kubacki[8], Natalie Moore[8], Patrick Gasda[9], Jeff Johnson[10], Gwénaël Caravaca[4]. [1]Imperial College London (a.roberts21@ic.ac.uk), [2]UC Berkeley, [3]USGS, [4]IRAP-CNRS, [5]Birkbeck, U. London, [6]U. Chicago, [7]PSI, [8]MSSS, [9]LANL, [10]John Hopkins.

Introduction: The stratigraphy of Aeolis Mons, Gale crater, is considered to provide a record of the possible 'drying out' of Mars with a temporal evolution from clay-bearing mudstones, to sulfate-bearing rocks, to anhydrous minerals [1]. The Mars Science Laboratory *Curiosity* rover is investigating the depositional environments of the layered sulfate-bearing unit considered to be from a 'drier' period than the underlying clay-bearing strata [1, 2, 3]. On sol 3560, Curiosity commenced exploration of the informally named Marker Band Valley (Figure 1) where the sulfate-bearing strata are exposed in local buttes. One of the overarching questions is what depositional environments do the sulfate-bearing-units record. Here, we characterize the stratigraphic relations visible in these scarps and reconstruct processes of deposition of the sedimentary strata and their paleoenvironments.

Marker Band Valley: Marker Band Valley is located east of Gediz Vallis and is eroded into the sulfate-bearing strata of Aeolis Mons. This valley is surrounded by buttes named Orinoco, Chenapau, Kukenan, and Bolivar (Figure 1). The sulfate-bearing strata are exposed in the scarps of these buttes and along the valley floor. The stratigraphy of Marker Band Valley comprises the uppermost part of the Contigo member of the Mirador formation and is overlain by the Catrimani, Amapari, and as-of-yet un-named members.

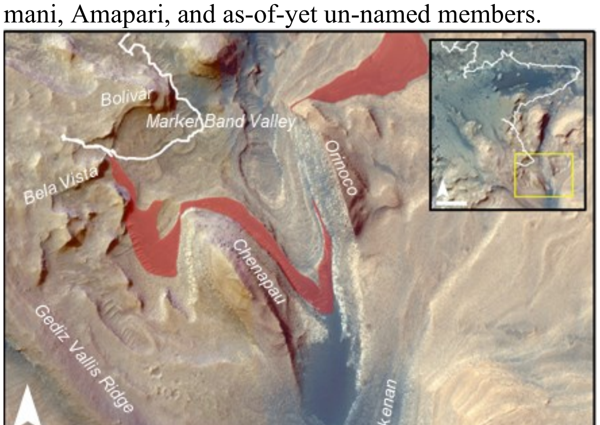

Figure 1: Marker Band Valley (marker band (red) [4])

Observations from Mastcam and LD_RMIs:

Orinoco: Orinoco stretches across ~300 m of the eastern margin of Marker Band Valley containing ~68 m of exposed vertical stratigraphy (Figure 1 and 2). The lowermost unit exposed in Orinoco and Marker Band Valley, Unit A (>8 m thick), forms the uppermost part of the Contigo member. This unit is light-toned, scarp-forming, and consists of low-angle (apparent angles of 5-6º) inclined strata which downlap onto bounding surfaces. Unit B (~4.5 m) overlies Unit A and is composed of distinctive planar stratification (Figure 3B); this unit can be traced over the entirety of Orinoco for up to 300 m. This unit contains multiple, laterally extensive (>300 m) tabular, dark, bands.

Unit C (~0.4 m thick) is a distinctly light-toned, mottled horizon in Orinoco displaying regular down-pointing cusp-shaped filled depressions that appear to penetrate the underlying strata. These are bounded by randomly orientated, south and north dipping fractures (Figure 3B). The Marker Band (Amapari member) is a distinct horizon that can be traced around Orinoco for up to 300 m forming a dark-toned resistant layer. This unit is ~0.2 m thick and internally layered (Figure 3B). The overlying and underlying contacts appear planar and are laterally consistent in thickness over Orinoco.

Immediately overlying the Marker Band, there is light-toned, tabular unit, Unit E (~3.6 m thick), which is laterally extensive for 300 m with pervasive planar stratification. This unit continues upwards into a dark-toned stratigraphic interval (Unit F; ~4.2 m thick) with a series of 30-40-mm thick bulbous-shaped nodules that form a horizon dipping to the north. These nodular horizons cross-cut laterally extensive planar strata. This unit is overlain by light-toned planar, laterally extensive laminae similar to Unit E (Unit G; 2.7 m thick). This stratigraphic interval gradually transitions vertically into a darker-toned unit comprising resistant and non-resistant strata with occasional sub-horizontal nodular horizons (Unit H; ~5.3 m thick). Unit H is truncated by an erosional surface with a distinctive shallow u-shape (~25 x 1.5 m).

Unit I (~4.9 m thick) is light-toned and downlaps, occasionally onlaps, to the erosional surface. This unit contains prominent bands near the erosional surface. The majority of this unit away from the erosional surface is light-toned with <10 mm thick layers. Unit I gradually transitions into Unit J (~7.3 m) which is darker-toned, with recessive and prominent interbedded layering, and occasional nodular horizons which follow the layers. Unit J also includes examples of embedded u-shaped scours (Figure 3C). Unit J gradationally transitions into the light-toned, slope forming Unit K (>7.8 m) the uppermost unit in Orinoco.

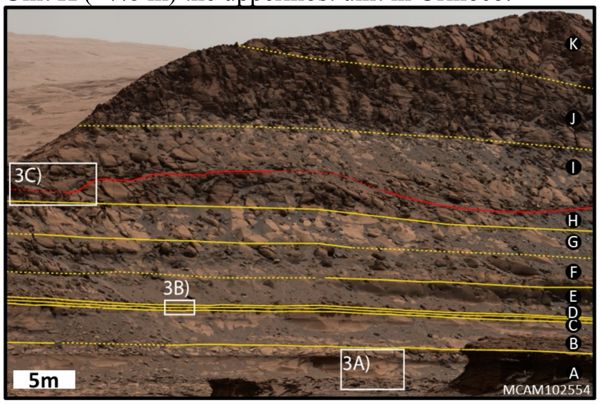

Figure 2: Mastcam mosaic of Orinoco's stratigraphy (NASA/JPL-Caltech/MSSS)

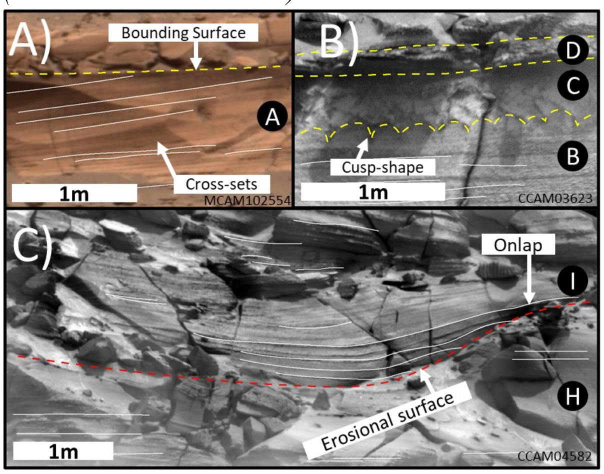

Figure 3: A) Unit A, B) LD RMI of Units B, C and D, C) LD RMI of Unit I (NASA/JPL-Caltech/MSSS)

Chenapau: Chenapau stretches for ~400 m along the western side of Marker Band Valley with ~75 m of exposed vertical stratigraphy (Figure 1) which the rover will approach. The unit succession from Orinoco is contained in Chenapau with similar thicknesses and expressions. The Marker Band at this location, Unit D, appears to undulate in places. Similar to Orinoco, Chenapau contains two shallow-u-shapes forming an erosional surface which marks the base of Unit I.

Nearfield observations in Marker Band Valley: The rover traversed across the north-western part of Marker Band Valley (Figure 1). Here, strata show abundant overprinting of primary sedimentary features by diagenetic features. However, locally the strata show well-developed persistent planar stratification near the drill site at Canaima. The Marker Band along the rover traverse exhibits distinctive undulating laminations identified as symmetrical wave ripples overlain by a rhythmically laminated unit [5, 6, 7] similar in appearance to Unit D and then E from afar. The rover also encountered inclined nodular horizons dipping to the north with consistent widths and elevation as Unit F. However, in this location, these inclined nodular horizons were associated with trough cross-stratification which may indicate a laterally differing environment. Bela Vista contains a unit similar in expression, from afar, to Unit H. Overlying this unit, on the eastern scarp, was a u-shaped erosional surface similar to ones underlying Unit I, reoccurring to the west on sol 3655.

Preliminary paleoenvironmental interpretation: The low-angle cross-stratification of Unit A is interpreted as cross-strata produced by dune migration and lee face accretion in aeolian dunes. The low angle dip of the cross-strata could be explained as the result of observing oblique cross-sections through more steeply dipping cross-strata or cross-sections through proto-dunes [e.g. 8] The extent, evenness in thickness, and planar expression of the overlying planar laminations of Unit B are characteristic of the development of wind-ripple strata in aeolian sand sheets [9]. The absence of dune cross-stratification may indicate prevention of dune development for example by a high water table creating damp surface conditions [9].

The morphology of the fractures in Unit C show similarity to syn-sedimentary fractures as they may indicate injection of material into the strata below (the cusp-shapes), and shallow fractures which originate from this unit's surface [10]. This may represent an alteration horizon below the Marker Band.

The symmetric ripples identified in the Marker Band are interpreted as evidence for a transient stable lake body interrupting aeolian deposition in the sulfate-bearing strata [5, 6, 7].

The overlying unit, Unit E, appears similar to Unit B, and likely indicates a return to an aeolian sand sheet environment. The truncation by shallow u-shaped erosional surfaces indicates a period of erosion and could represent either scour from aeolian dunes [e.g. 11], deflation [12], or fluvial channel erosion [13].

The stratigraphy of Marker Band Valley records a dynamic and complex sedimentary system and provides evidence for the presence of near-surface water when the sulfate-bearing strata was deposited.

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