RECONSTRUCTION OF AN ANCIENT EOLIAN DUNE FIELD AT GALE CRATER, MARS: SEDIMENTARY ANALYSIS OF THE STIMSON FORMATION. S.G. Banham[1*], S. Gupta[1], D.M. Rubin[2], J.A. Watkins[3], D.Y. Sumner[4], J.P. Grotzinger[3], K.W. Lewis.[5], K.S. Edgett[6], L.A. Edgar[7], and K.M Stack[8] [1]Imperial College, London, *s.banham@imperial.ac.uk, [2]University of California, Santa Cruz. [3]California Institute of Technology, Pasadena, CA, [4]UC Davis Earth and Planetary Sciences, CA. [5]Earth and Planetary Sciences, Johns Hopkins University, MD. [6]Malin Space Science Systems, San Diego, CA. [7]USGS Flagstaff Science Center, AZ, [8]JPL, Pasadena, CA.

Introduction: The Stimson formation is observed from orbit as a draping unit, which overlies the Mount Sharp group in the foothills of Aeolis Mons (Fig. 1). The sedimentology and the relationship with units underlying this formation were uncertain, however recently, the Mars Science Laboratory (MSL) rover *Curiosity* has documented sedimentary characteristics of the Stimson formation directly. We use data collected between sols 995 and 1151 (Fig. 2) to define characteristic sedimentary facies and architectural elements preserved within the Stimson formation, and to determine the depositional history and regional relationships with the underlying Mount Sharp group. This work is key to understanding the later history of the infilling of the Gale crater, and the potential for habitable environments in Gale crater's lower stratigraphy.

Methods & Background: For this study, we utilized data collected by *Curiosity's* two fixed-focal length cameras (Mastcams) [1], to observe outcrop-scale features; and images from the Mars Hand Lens Imager (MAHLI), to resolve grain-scale textures [2]. The Stimson formation is discernible from the underlying Mt. Sharp group by distinctive NE-SW trending ridges with wavelengths of ~40 m [3]. From the surface, Stimson formation sandstones are typically gray-toned with a blocky erosional expression and exhibit abundant crossbedding. The underlying Murray formation is a mudstone that is characterized by mm-scale horizontal laminations and commonly fractured with fractures infilled by white mineral veins (likely calcium sulphate). The exposed upper surface of the Murray formation forms an undulating paleotopographic surface, with several meters of relief [4] onto which the Stimson formation was deposited.

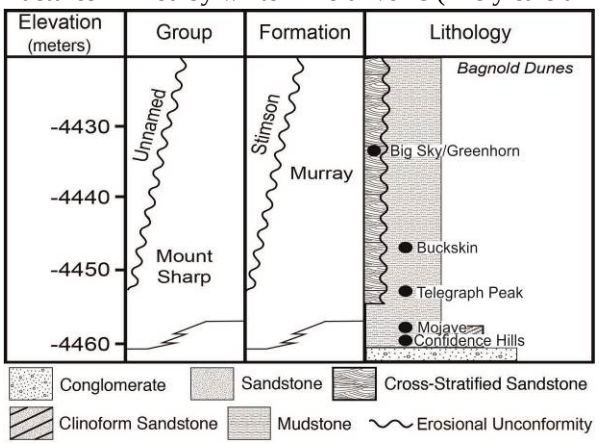

Figure 1: Stratigraphic Column with drill sites.

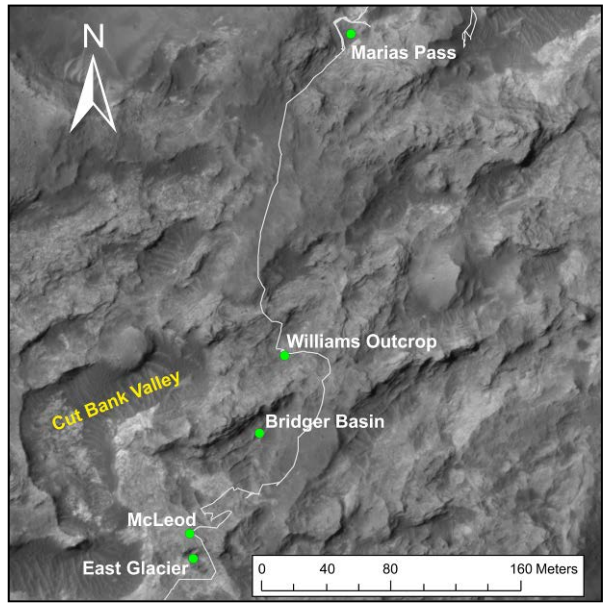

Figure 2: Outcrops in Study (NASA/JPL/Uni. Arizona)

Key Facies: *Meter-scale trough crossbedding* is the main facies forming the Stimson formation, which occurs in sets between 0.5 and 0.75 m thick, and cosets thicker than 1.0 m (Fig. 3). Laminations forming the cross sets contact the basal truncation surface with an asymptotic base. Where measured, laminations are 1-2 mm thick. Because of thickness of these basal dune sections, these crossbedded sandstones are interpreted to be the preserved expression of migrating eolian dunes. Lack of preserved grainflow strata within crossbeds is interpreted to be due to wind reworking of lee face grain flows to form wind ripple strata.

Other associated facies include: *Decimeter-scale trough cross bedding, sandstones with Murray fm. clasts, and Massively bedded sandstones.*

Spatial and Temporal Variations: The base of the Stimson formation is observed to onlap the underlying Murray formation in the Bridger Basin area, Marias Pass and near the East Glacier Target (Fig 4), signifying that there was paleotopographic relief on the depositional surface onto which the Stimson dune field

Figure 3: Crossbedded sandstones at Williams Outcrop (NASA/JPL-Caltech/MSSS)

accumulated. The succession at Marias Pass, contains a large diversity of facies, including decimeter-scale crossbedded sandstones, massively bedded sandstones, and sandstones with Murray formation clasts, which are associated with the basal contact. With increasing stratigraphic height at Marias Pass, facies diversity decreases until only cross-bedded sandstones are observed. The highest concentration of Murray fm. clasts are observed just above the basal contact, suggesting that these clasts were derived directly from the underlying formation within the local area. At East Glacier, these exotic facies are not observed, and meter-scale crossbedded sandstones accumulated directly on the underlying Murray formation. In one case, these meter-scale crossbedded sandstones are observed to incise directly into the underlying Murray formation (Fig. 4). The large size of the preserved cross sets suggests that they are likely eolian in origin. The difference in facies observed at Marias Pass and East Glacier could be associated with paleotopography, as the Murray-Stimson contact is mapped to form a local high at the Marias Pass [4].

Larger cliff sections observed at the Bridger Basin outcrop, demonstrate sedimentary architecture within the Stimson formation. When viewed in strike section, horizontal surfaces with subordinate undulations are observed, which are linked by surfaces climbing between these horizontal surfaces toward the NE. The horizontal undulating surfaces are potentially interpreted to be deflationary supersurfaces, linked by subordinate dune climbing surfaces, which form when dune fields aggrade due to sediment accumulation.

Depositional Environment: Our observations lead us to interpret the Stimson formation as the preserved expression of eolian dunes which were migrating to the north-east, across an undulating north-west dipping paleoslope. Throughout the duration of the dune field's existence, the system experienced episodes of aggradation when sediment supply increased to allow migrating dunes to climb, preserving the basal parts of the dunes as the now-preserved stratigraphy.

References: [1]Bell III, J.F. *et al.* (2012) LPSC XLIII, Abstract #2541. [2]Edgett, K.S. *et al.* (2015) Technical Report: Curiosity's robotic arm-mounted Mars Hand Lens Imager (MAHLI): Characterization and calibration status. [3] Rubin, D.M et al. (2014) Search and Discovery Article #50991. [4] Watkins, J.A. et al (2016) LPSC XLVII.

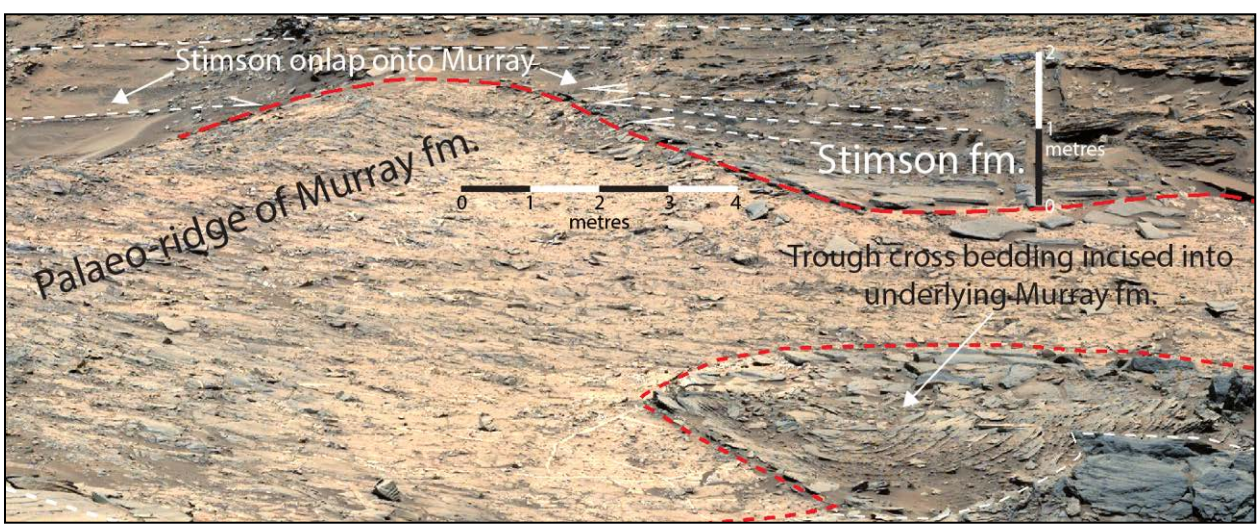

Figure 4: Basal contact with Stimson formation onlapping Murray formation at East Glacier