CORRELATION OF AEOLIAN STRATIGRAPHY ACROSS THE GREENHEUGH PEDIMENT, GALE CRATER: YEAH, IT'S MORE STIMSON FORMATION. S.G. Banham[1]*, C.C. Bedford[2], S. Gupta[1], A.L. Roberts[1] W.E Dietrich[3], A.B Bryk[3], D.M. Rubin[4] J.P. Grotzinger[5], A. Weintraub[6], C.H. House[7], G. Caravaca[8] R.M.E. Williams[9], L.C. Kah[10], and A.R. Vasavada[11], [1]Imperial College London (*s.banham@imperial.ac.uk), [2]LPI, URSA, [3]University of California Berkeley, [4]University of California Santa-Cruz, [5]California Institute of Technology, Pasadena, CA, [6]Northern Arizona University, [7] Pennsylvania State University, University Park, PA. [8]IRAP, Univ. Paul Sabatier Toulouse, France, [9]PSI, Tucson, AZ, USA, [10]University of Tennessee Knoxville, Knoxville, TN, USA [11]Jet Propulsion Laboratory, Caltech, Pasadena, CA.

Introduction: The Stimson formation (Siccar Point group) is recognized to represent a major change in depositional style and climate within Gale crater during the Hesperian period [1,2,3,4]. Deposition in Gale was dominated by aqueous processes in what is interpreted to be a relatively humid climate prior to Stimson formation accumulation [5]. A depositional hiatus and some duration of erosion encapsulated by the base Siccar Point Group unconformity followed [6]. The deposition of the Stimson formation (currently the lowermost unit of the Siccar Point group) commenced in conditions apparently dominated by aeolian processes in an arid environment [1], subsequently the Stimson sandstones were lithified by an episode involving the flow of water within the subsurface [1,2,5,8].

Internally, the Stimson formation records temporal changes of aeolian dune morphologies associated with changing dune size and sediment availability common across an evolving dune field, and changes of sediment transport directions, associated with fluctuating wind strength and direction at multiple temporal scales [3].

Since Sol 2600, the Curiosity rover has been circumnavigating the Greenheugh pediment capping unit. This is a distinctive body of rock that covers an area of ~2.6 km^2 (Fig.1) and occurs at the mouth of Gediz Vallis, a prominent canyon eroded into the lower slopes of Mt. Sharp. The capping unit is formed of Stimson formation strata [4]. The base of the capping unit is interpreted to form part of the base Siccar Point Group unconformity, which separates the strata from the underlying Mount Sharp group and the overlying Siccar Point group.

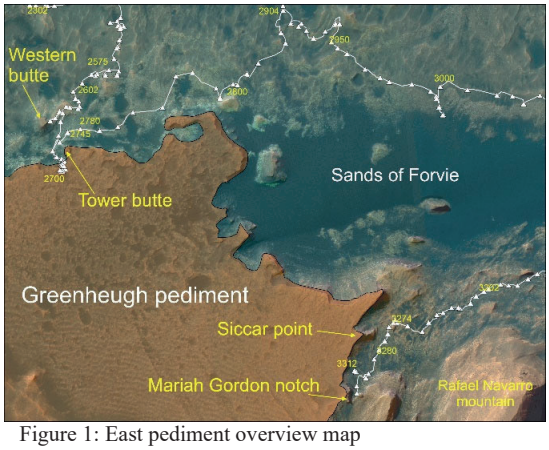

Figure 1: East pediment overview map

Here we document changes in the stratigraphy and internal architecture of Stimson formation between the northern and southeastern flanks of the pediment capping unit to characterize variability in sedimentary geometries, facies, and sediment transport directions. Our observations provide constraints on the geologic and paleoclimate history of Gale crater.

Pediment overview: Where the pediment has been investigated by the Mars Science Laboratory rover, observed sedimentary textures, facies, and architecture, plus geochemistry have been consistent with those observed elsewhere in the Stimson formation [1,2,3]. As of Sol 3350 (January 2022), the pediment has been investigated in detail near Tower butte (Fig.1), at distance along the Northeast margin, and along the eastern margin on the climb toward the Mariah Gordon notch (Fig.1). Isopach maps generated using orbital data indicate that the pediment ranges between 2 and 5 m thickness along the margin of the Pediment Capping unit.

Tower butte area (Sols 2616-2780): Investigation here revealed a more complex stratigraphy compared to other parts of the Stimson formation. Texturally, the mean grainsize was 486 µm (n=1950), with a bimodal sorting, and well-rounded grains [4]. The strata are subdivided into three intervals, based on cross-set architecture, and cross-set dip-azimuth. The lower Gleann Beag interval is characterised by compound cross-sets, with foreset dip-azimuths oriented northeast. This interval was deposited by compound dunes migrating northward, similar to those observed at the Murray buttes [1,3]. The basal section contained Murray formation detritus, which are identified visually as mudstone rip-up clasts, and a hybrid geochemical signature observed by ChemCam [2]. The middle Ladder interval is characterised by planar cross-sets with dip-azimuths oriented south. These represent the migration of simple straight-crested dunes toward the south and formed under a fluctuating wind regime. The upper Edinburgh interval is characterised by trough cross-sets with dip-azimuths

oriented west. These were deposited by simple sinuous crested dunes migrating west.

Northern margin of the pediment on traverse east (Sols 2740-~3000): The rover traversed eastwards along the pediment, less than 500m from the pediment margin. Long distance observations of the pediment capping unit is laterally continuous, with no breaks in outcrop. At these distances, only bulk dimensions and geometries could be observed, however features consistent with general Stimson formation outcrops are identified: generally, the outcrop was erosion-resistant, grey-colored, and is cliff-forming in nature. In certain locations crude bedding (which would correspond to interdune surfaces) and cross-bedding could be identified at several locations.

Siccar Point area & Maria Gordon Notch (Sols 3200-): The rover Curiosity has closed to a distance where valid observations can be made of the eastern margin of the pediment capping unit. Initial observations (made up to January 2022) indicated a similar outcrop expression and stratigraphic architecture to the Tower butte area, and to the rest of the Stimson formation observed along the traverse. The outcrop has a "typical" Stimson expression: it is grey-colored, and forms blocky, erosion-resistant, cliff-forming, layered outcrops, overlying the slope-forming formations of the Mount Sharp group.

Architecturally, the outcrop is internally cross-stratified, with evidence of different cross-set morphologies (simple and compound) (Figure 2). At the outcrop north of Siccar point, the pediment capping unit is 4.5 m thick, and representative cross-sets are broadly between 0.5-1 m thick. In several locations at the base of the unit, diagenetic textures in the form of concretions can be observed. These are similar to those observed near Tower butte, and across other Stimson outcrops to the north [1,2,3]. While different types of cross-set can be identified, at present, there are no correlatable intervals discerned within the east side of the pediment that may relate to the intervals mapped in the Tower butte area. A distinct discontinuous basal unit has been identified at the base of the pediment: See Dietrich et al (LPSC 2022).

Textural and geochemical analysis of Pediment float rock: Float rocks derived from the capping unit were observed using MAHLI on sol 3324 (Helens Bay). Initial grainsize analysis show a mean grainsize of ~300 µm. This is ~200 µm smaller than Stimson observed in the Tower butte area, and is ~100 µm smaller than grains observed at Emerson plateau, suggesting that this single float rock may not be texturally representative of the Stimson at this location.

A geochemical analysis of the float rocks using ChemCam shows that they are compositionally equivalent to the Stimson formation analysed in the pediment mini-campaign, supporting that they are derived from the aeolian capping unit (Fig 3).

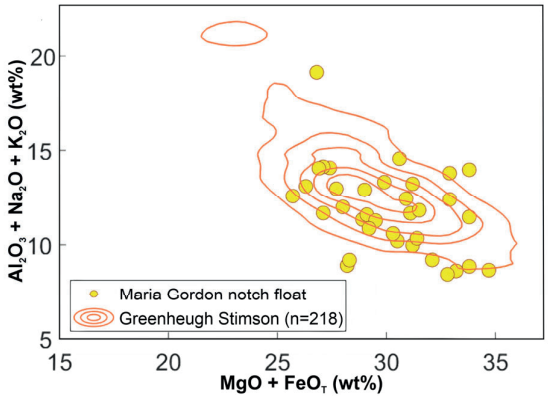

Figure 3: Comparison of float rock from Mariah Gordon notch and Greenheugh Stimson rock

References: [1] Banham, et al. (2018) Sedimentology. [2] Bedford et al (2022) JGR-P, [3] Banham et al. (2021) JGR-P. [4] Bedford et al (2020) Icarus. [5] Banham et al. (2021) NAM2021, Bath. [6] Grotzinger et al. (2015) Science. [7] Watkins, J.A. et al (2016) LPSC XLVII [8] Yen et al (2017).

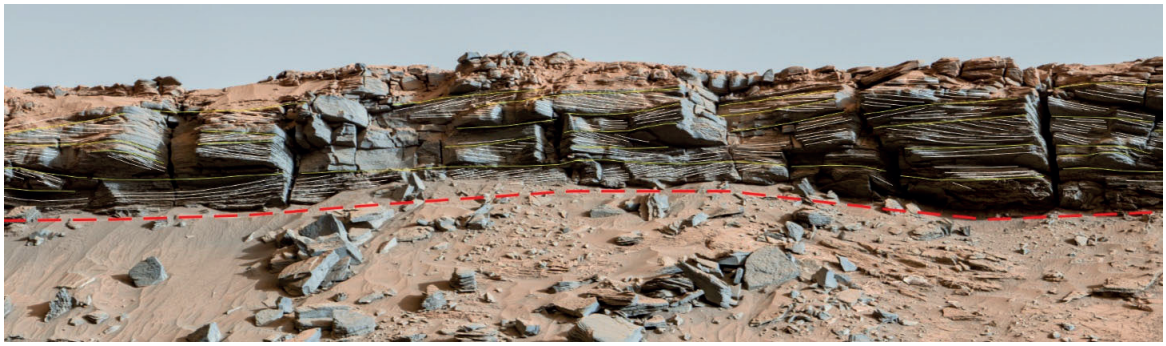

Figure 2: Representative outcrop of Stimson caprock near the Siccar Point outcrop (MR mcam100748, NASA-JPL/MSSS)