

Evidence for alkaline composition source rocks along Curiosity's >26 km traverse. L. M. Thompson¹, J. A. Berger², N. Boyd³, R. Gellert³, M. A. McCraig³, C. O'Connell-Cooper¹, J. G. Spray¹, S. J. VanBommel⁴ and A. Yen⁵, ¹PASSC, University of New Brunswick, Canada, ²NASA Johnson Space Center, USA, ³Dept. of Physics, University of Guelph, Canada, ⁴Dept. of Earth and Planetary Sciences, Washington University in St. Louis, USA, ⁵Jet Propulsion Laboratory, California Institute of Technology, USA

Introduction: At the outset of its exploration of Gale crater, the Mars Science Laboratory (MSL) *Curiosity* rover discovered a number of alkaline composition rocks [1-8]. These rocks were unexpected owing to the generally accepted paradigm that Mars is a basaltic planet [9, 10]. The more alkaline rocks are concentrated within the Bradbury grp as sandstone outcrops, clasts within breccio-conglomerates, and as float rocks. They have also been encountered intermittently as float blocks over Curiosity's more than 26 km traverse (Fig. 1) and have been interpreted to represent primary igneous and volcanoclastic derived rocks [1-8].

Recently, *Curiosity*'s Alpha Particle X-ray Spectrometer (APXS) has identified alkaline composition sandstone bedrock and float rocks associated with a prominent, crater-retaining unit referred to as the "Greenheugh pediment" capping unit (Fig. 1). This provides further evidence that Na- and K-rich, as well as basaltic material, contribute a significant sediment source in Gale crater.

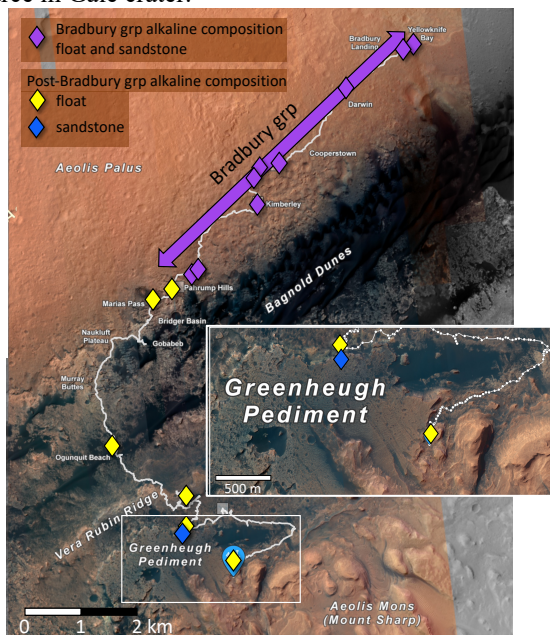


Figure 1: HiRISE imagery showing *Curiosity*'s traverse to Sol 3340 with location of alkaline composition targets highlighted. Purple arrow shows the extent of the Bradbury grp. Inset – zoomed in to the Greenheugh pediment.

Greenheugh pediment context: Rocks that cap the Greenheugh pediment comprise part of a more extensive, resistant, crater-retaining capping unit originally identified from orbit [11]. The unit was interpreted to lie unconformably on the underlying strata. Initial investigation of the Greenheugh pediment capping rocks (sols

2695–2733) revealed eolian sandstones interpreted to belong to the Stimson fm, Siccar Point grp [12]. Stimson fm sandstones were originally encountered at the Emerson and Naukluft plateaus, where they rest unconformably on the underlying lacustrine Mount Sharp grp [13]. The Greenheugh pediment cap rocks also exhibit an unconformable relationship with underlying Mount Sharp grp rocks [14]. The Mount Sharp grp strata is itself considered to overlay the fluvio-lacustrine Bradbury grp. The Bradbury grp was encountered from landing to Pahrump Hills (Fig. 1)

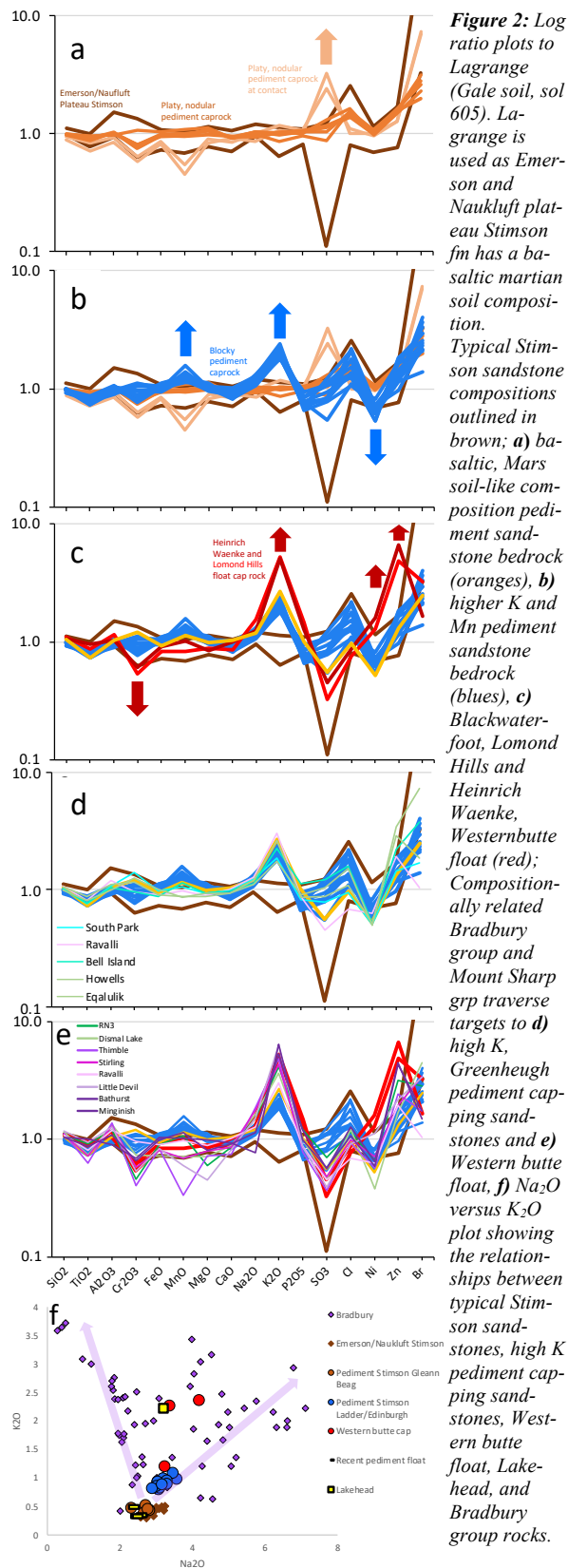
APXS investigation of Greenheugh pediment caprocks: APXS acquired 22 analyses on rock and drill fines (Edinburgh drill hole) associated with the Greenheugh pediment cap rock between sols 2631-2733. These included 3 float rocks from a butte (Western butte) encountered prior to *Curiosity*'s climb onto the pediment. *Curiosity* is again approaching the eastern extent of the pediment and APXS has analyzed a further 5 float blocks interpreted to be derived from the nearby pediment (i.e., similar colour and texture).

APXS compositions: During the initial investigation of the Greenheugh pediment, three distinct compositions were identified [15]: 1) basaltic, Mars soil-like, with elemental trends related to typical Stimson fm sandstones encountered earlier in the mission at Emerson and Naukluft plateaus (Fig. 3a), 2) high K and Mn sandstone outcrops (>2 x K of typical Stimson), which also trend to higher Na, Fe and Cr than typical Stimson sandstones (Fig. 3b), and 3) very high K (>5x typical Stimson), higher Na, Ni and Zn concentration float blocks (Lomond Hills and Heinrich Waenke float on Western butte) (Fig. 3c).

The majority of float cap rocks most recently analyzed by APXS fit with 1) above. However, the Lakehead target has a near identical composition to the float-blocks from Western butte.

The higher K and Na pediment rocks (than typical Stimson) reveal related elemental trends to Bradbury group sandstone bedrock and float rock targets, as well as float blocks analyzed along the Mount Sharp grp traverse (Fig. 1, 3d, e, f).

Implications: Consistent with a change in provenance and/or minor transport/sorting processes relative to typical Emerson/Naukluft plateau Stimson and basal pediment sandstones are contrasting, 1) sedimentology [12], 2) mineralogy [16], and 3) composition, of the higher-K sandstones.



The compositional relationship between the more alkaline pediment-capping rocks and the Bradbury grp lends further credence to the presence of a widespread, relatively alkaline igneous source rock within, and in the vicinity of Gale crater. This would have provided sediment input to both fluvial and eolian sandstones, which may have been deposited more or less contemporaneously, i.e., the Bradbury group and Siccar Point group are both younger than the Mount Sharp group (Fig. 5a). Alternatively, erosion and transport of an alkaline source rock by both wind and water may have occurred at different times during the evolution of Gale crater, separated by millions of years, i.e., the Bradbury group is older than both the Mount Sharp and Siccar Point groups (Fig. 5b).

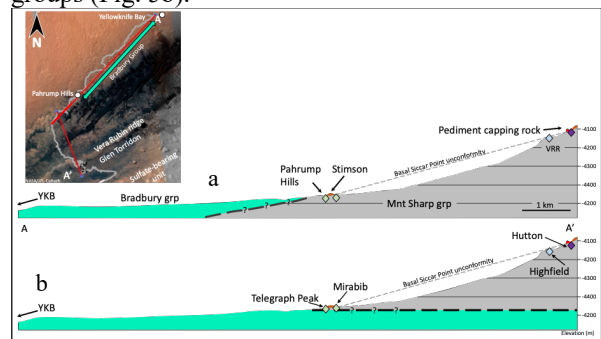


Figure 5: Schematic cross-sections drawn through A-A' shown top left; from the Yellowknife Bay area (left) to the pediment (right). **a)** Bradbury grp and Stimson fm are younger than, and deposited onto the erosional surface of the flat-lying Mount Sharp grp; **b)** the Bradbury grp is older than the Mount Sharp grp, and the Stimson fm is the youngest. Both show Basal Siccar Point grp unconformity extrapolated from Pahrump Hills up to the pediment. Diamonds depict altered Mount Sharp grp strata lying just below the unconformity.

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