GEOCHEMISTRY OF THE BRADBURY AND SICCAR POINT LITHOSTRATIGRAPHIC GROUPS IN GALE CRATER AS SEEN BY CHEMCAM: IMPLICATIONS FOR REGIONAL PALEO-ENVIRONMENTAL EVOLUTION*. L. Le Deit[1], G. Caravaca[2], N. Mangold[1], O. Forni[2], K. Rammelkamp[3], C. C. Bedford[4], R. C. Wiens[4], J. R. Johnson[5], S. Le Mouélic[1], E. Dehouck[6], J. Frydenvang[7], K. M. Stack[8], L. Thompson[9], R. M. E. Williams[10], O. Gasnault[2], N. Lanza[11] and the ChemCam team, [1]LPG, Nantes Université, France (Laetitia.Ledeit@univ-nantes.fr), [2]IRAP, Toulouse, France, [3]DLR-Berlin, Germany, [4]Purdue University, USA, [5]Johns Hopkins University, Laurel, USA, [6]Univ. Lyon, LGL-TPE, Villeurbanne, France, [7]University of Copenhagen, Denmark, [8]JPL,Caltech, Pasadena, USA, [9]University of New Brunswick, Canada, [10]PSI, USA, [11]LANL, Los Alamos, USA. ******This work is dedicated to the memory of our dear colleague and friend, Horton Newsom.*

Introduction: Over the past eleven years, the Mars Science Laboratory (MSL) rover *Curiosity* has been investigating the plains of Aeolis Palus and the lower reaches of Aeolis Mons (informally known as Mount Sharp), a 5 km tall mound of sedimentary rocks in Gale crater (***Fig. 1***). After traversing 31 km and about 800 m of vertical stratigraphy, three lithostratigraphic groups have been identified: Bradbury, Mount Sharp (Mt. Sharp), and Siccar Point (SP) (***Fig. 1***). The Bradbury group primarily consists of fluvial and lacustrine sedimentary rocks (e.g., [1-4]). The basal Murray formation of the Mt. Sharp group mainly corresponds to laminated mudstones with minor fluvial sandstones, interpreted as evidence of a long-lived lacustrine environment (e.g., [3, 5, 6]). At several localities along the traverse, exposures of the Mt. Sharp group are unconformably overlain by coarser-grained, aeolian cross-bedded sandstones of the Stimson formation (SP group), interpreted to have deposited on an aeolian deflation surface (e.g., [7-9]). While these three groups show evidence of deposition in specific environmental and climatic conditions, knowledge of their stratigraphic relationships is a key information to understand the evolution of environmental conditions in Gale. No clear stratigraphic contact has been observed neither at the boundary between the Bradbury and the Mt. Sharp groups, nor between the Bradbury and the SP groups. Because the mean dip of the Bradbury group is approximately horizontal, the MSL team suggested that the Bradbury group might be stratigraphically lower than the Mt. Sharp group, and therefore lower than the SP group [2]. Since then, analyses of chemical data from the APXS and ChemCam instrument suites have shown that rocks of the SP group exposed on Emerson Plateau, Naukluft Plateau and the Greenheugh pediment have similar chemical compositions to many of those of the Bradbury group [10-12].

The objective of this study is to reappraise the chemical compositions of the Bradbury and SP groups encountered by *Curiosity* in major localities by integrating data recently collected in the Marker Band Valley (upper Gediz Vallis Ridge floats) using ChemCam data. This approach could shed new light on sediment provenance, weathering and alteration conditions, and possible chemostratigraphic relationships between the Bradbury and SP groups.

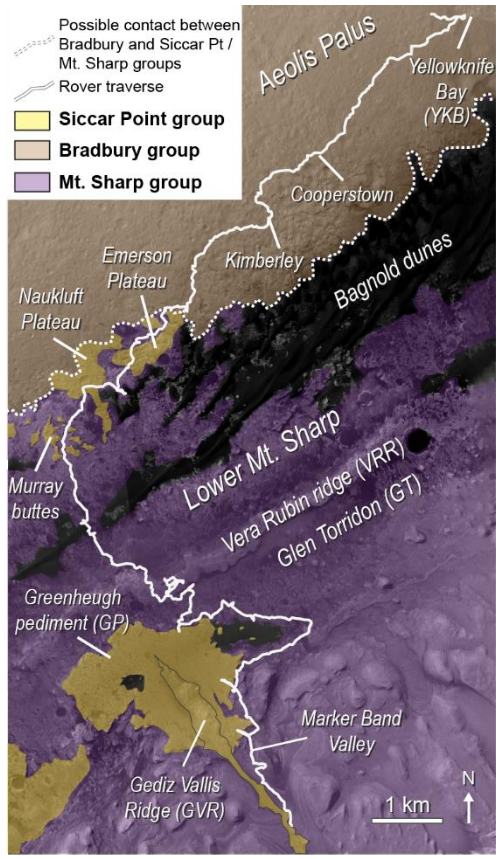

Fig. 1: *Location of the three lithostratigraphic groups exposed at Aeolis Palus and lower Mount Sharp and of the major localities of the study area.*

Results and interpretations: The average compositions of the rocks of the Bradbury and SP groups are overall quite similar, and clearly different from the rocks of the Mt. Sharp group (***Fig. 2***). By analyzing the rock compositions of Bradbury and SP groups, we sorted them into four major chemical groups, which are, in order of increasing average K_2O/Na_2O ratio and average K_2O content for groups 1

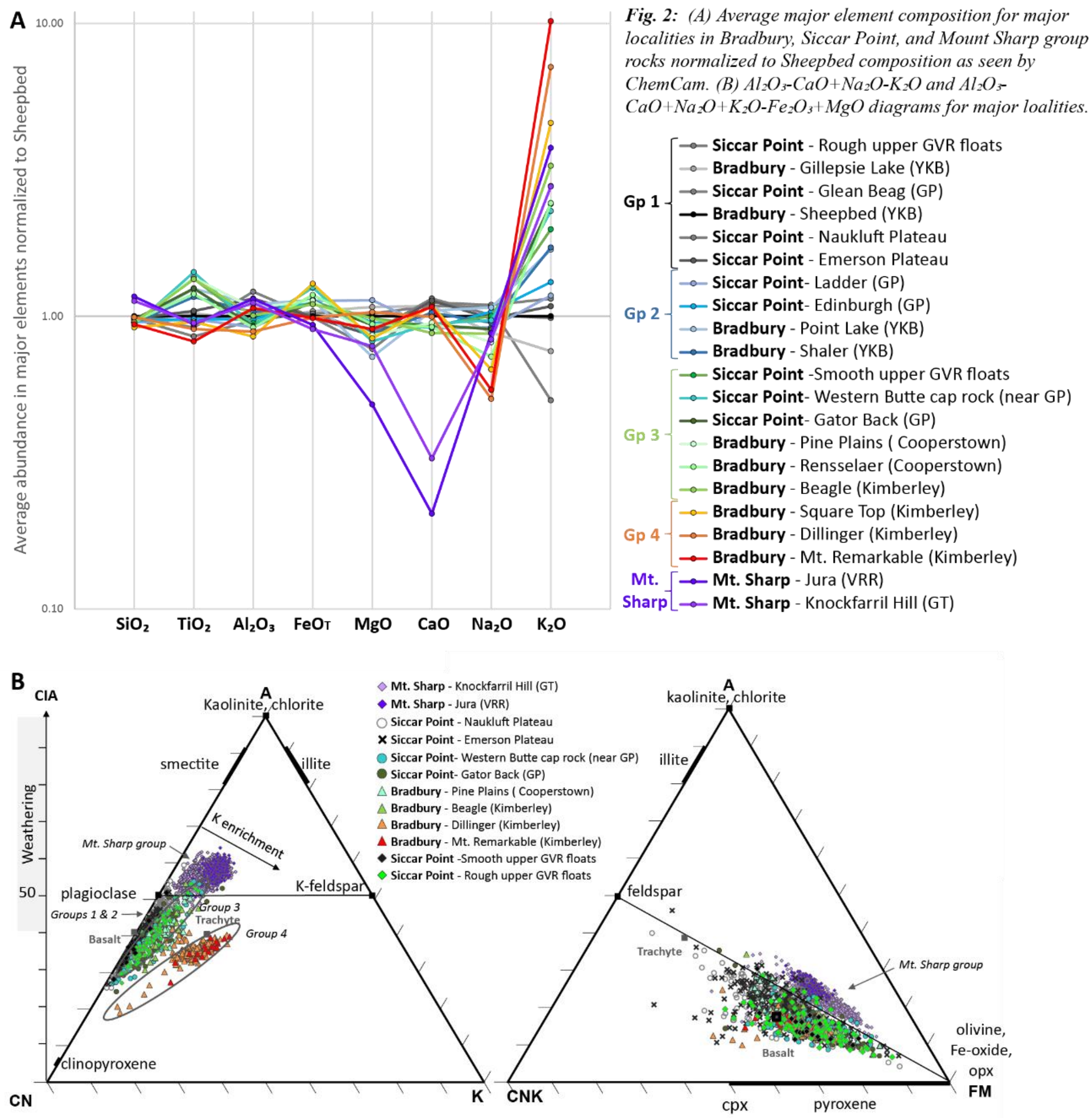

Fig. 2: (A) Average major element composition for major localities in Bradbury, Siccar Point, and Mount Sharp group rocks normalized to Sheepbed composition as seen by ChemCam. (B) Al_2O_3-$CaO+Na_2O$-K_2O and Al_2O_3-$CaO+Na_2O+K_2O$-Fe_2O_3+MgO diagrams for major loalities.

to 4: group 1 has a basaltic composition; group 2 has low SiO_2, intermediate TiO_2, high FeO_T and Na_2O contents; group 3 has low CaO, high TiO_2, FeO_T, and K_2O contents; and group 4 has low TiO_2, Na_2O and Al_2O_3, and very high K_2O contents (***Fig. 2A***). Overall, the MgO and Al_2O_3 contents are quite variable. The composition of these rocks suggests mixing between mafic minerals and feldspars, including alkali feldspars in various proportions (***Fig. 2B***). Interestingly, both Bradbury and SP rocks occur in the first three chemical groups, which suggests similar source rocks for both groups of at least two types: a relatively low-potassium basaltic rock and a potassic-rich rock. The relative abundance of potassic-rich source rock in the mixture is interpreted to increase from group 1 to group 4. Besides, in contrast to Mt. Sharp group rocks, Bradbury and SP group rocks have a low Chemical Index of Alteration (CIA), which is indicative of limited chemical weathering, before and after their formation (***Fig. 2B***).

Conclusion: These observations are consistent with a common origin for both Bradbury and Siccar Point as a single clastic group, as suggested by Stack et al. [13]. This would represent a temporal evolution from clement conditions during the deposition of Mount Sharp group to a colder and drier environment with still transient episodes of fluvial activity during the deposition of Bradbury and Siccar Point groups.

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