CLAY MINERALS OF THE CLAY-BEARING UNIT, MOUNT SHARP, GALE CRATER, MARS. T. F. Bristow[1], A. C. McAdam[2], V. K. Fox[3], K. A. Bennett[4], E. B. Rampe[5], A. S. Yen[6], A. R. Vasavada[6], D. T. Vaniman[7], V. Tu[5], A. H. Treiman[8], M. T. Thorpe[5], M. Salvatore[4], S. M. Morrison[9], R. V. Morris[5], D. W. Ming[5], C. A. Malespin[2], P. R. Mahaffy[2], R. M. Hazen[9], J. P. Grotzinger[3], R. T. Downs[10], G. W. Downs[10], D. J. Des Marais[1], J. A. Crisp[6], P. I. Craig[7], S. J. Chipera[11], N. Castle[8], D. F. Blake[1], and C. N. Achilles[2], [1]NASA Ames Research Center, Moffett Field, CA (thomas.f.bristow@nasa.gov), [2]Goddard Space Flight Center, Greenbelt, MD. [3]California Institute of Technology, Pasadena, CA, [4]Northern Arizona University, Flagstaff, AZ, [5]Johnson Space Center, Houston, TX, [6]JPL/Caltech, Pasadena, CA, [7]Planetary Science Institute, Tuscon, AZ, [8]Lunar and Planetary Institute, USRA, Houston, TX, [9]Carnegie Institute, Washington DC, [10]University of Arizona, Tuscon, AZ, [11]Chesapeake Energy, Oklahoma City, OK.

Introduction: Phyllosilicates are common components of Noachian and Early Hesperian age (>3.5 Ga) terrains on Mars, providing evidence of a larger water inventory earlier in the planet's history [1]. The end of phyllosilicate formation appears to coincide with planetary aridification, also signaled by an increasing abundance of sulfate and Fe-oxide minerals [2]. This mineralogical motif has been identified by orbital spectrometery in stratified deposits of Aeolis Mons (Mount Sharp), a 5 km tall mountain in the center of Gale crater, with distinct clay-bearing strata overlain by sulfate-bearing units [3]. The Mars Science Laboratory (MSL) Rover, Curiosity, was sent to study these units and examine the possibility that they record a global change in environmental conditions [4].

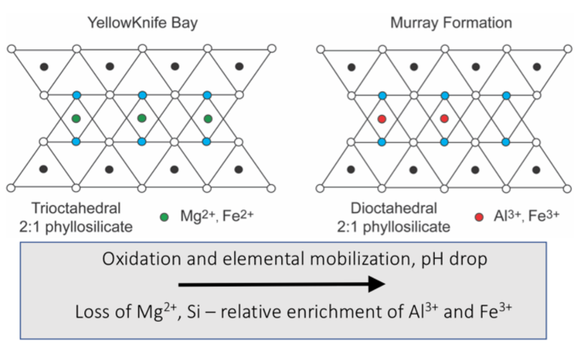

Fig. 1: Crystallographic structures of clay minerals documented during MSL's traverse. The presence of smectites supports other evidence that ancient Gale lakes were habitable [7,8,12].

Clay minerals in Gale crater: Since landing in 2012, MSL has documented almost 400 m of vertical stratigraphy consisting of fluvial-lacustrine sediments of the Bradbury and Mount Sharp Groups, deposited ~3.7 Ga [5,6]. Many of the drill samples collected by MSL, and analyzed by the CheMin x-ray diffraction (XRD) instrument and SAM evolved gas analysis mass spectrometry (EGA-MS), contain clay minerals comprising up to ~25 wt. % of the bulk rock [7-10]. Smectite clay minerals are dominant in all the clay-bearing samples analyzed so far. The smectites show variable chemistry indicating a variety of aqueous alteration conditions [10]. Detrital sources for the clays have been proposed [11], but coincidental changes in clay mineral chemistry with sedimentological, mineralogical and geochemical indicators of changing lacustrine conditions and processes support formation close to the time of deposition [8,10]. The clay minerals documented by MSL are important indicators of clement lake water chemistry and a key indicator that ancient Gale lakes were habitable environments [7,8,12].

The clay-bearing unit: At the time of writing, MSL is about to embark on a campaign to investigate the clay-bearing unit [13], originally identified from orbit [3]. An important part of this campaign will be to document the nature, abundance and origin of clay minerals in this unit, and determine if and how they are related to the clay-bearing lacustrine mudstones previously documented in the Murray formation of the Mount Sharp group. This will help constrain stratigraphic models of sedimentary deposits at Gale, improve our understanding of how environmental conditions changed in Gale crater, and allow ancient habitability and organic preservation potential to be assessed [13]. Combined with *in situ* examination of the terrain, mineralogical data will provide important ground-truth for orbital data and new information on the factors that influence the detectability of clay minerals from orbit. An important part of the characterization activities will be obtaining drill samples of the clay-bearing unit for analysis by MSL's onboard laboratory instruments. In this contribution, initial mineralogical findings, based on CheMin XRD analyses and SAM EGA-MS analyses, of clay-bearing unit drill samples obtained by the rover will be discussed.

References: [1] Carter J. et al. (2013) *JGR Planets, 118,* 831-851. [2] Bibring J-P et al. (2006) *Science, 312,* 400-404. [3] Milliken R. E. et al. (2010) *GRL, 37,* L04201. [4] Grotzinger J. P. et al., (2012) *Space Sci. Rev. 170,* 5-56. [5] Grotzinger J. P. et al. (2015) *Science, 350,* aac7575. [6] Fedo C. M. et al. (2018) *LPSC 49*. [7] Vaniman D. T. (2014) *Science, 343*, 1243480. [8] Bristow T. F. et al. (2015) *American Mineralogist, 100,* 824-836. [9] Rampe E. B. et al. (2017) *Earth Planet. Sci. Lett., 471,* 172-185. [10] Bristow T. F. et al. (2018) *Science Advances, 4,* eaar3330. [11] Schieber J. (2017) *Sedimentology, 64,* 311-358. [12] Grotzinger J. P. et al., (2014) *Science, 343,* 1242777. [13] Fox V. K. et al. (2019) *LPSC, 50.*