HYPOTHETICAL SAMPLE SUITES AT GALE CRATER: A PROOF OF CONCEPT FOR COMPLETING MARS 2020 ROVER SCIENCE WITHIN ONE MARS YEAR.

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Introduction: The Mars 2020 Science Definition Team [1] envisioned a rover mission that would conduct rigourous *in situ* science that would investigate geologic context and history of an ancient habitable environment, assess its potential for preservation of evidence of past life, and seek such evidence. The mission would also enable future exploration by collecting a set of rock and soil samples in a "cache" that could be returned to Earth some time in the future. The dual objectives of the mission demand attention to the feasibility of filling the cache with the 31 samples the SDT envisioned within the one Mars year prime mission. We believe we can roughly demonstrate such feasibility, using the Mars Science Laboratory (MSL) mission's progress through Gale Crater as an illustration. Although MSL had a different set of objectives than 2020, much of the exploration process will be similar, and some of the instruments may be much the same. However, it is critical to avoid the assumption that the rocks MSL has chosen for drilling have direct correspondence to the rocks M2020 would drill given the different science objectives of the two missions.

Sample Suites: While each collected sample has intrinsic value on its own, the information content of the collection is enhanced when related samples are collected to better inform geologic origin, history, or process. This concept of a "sample suite" is at the core of the sample selection strategy for M2020 [1] and is distinctly different from MSL's process for selection of drill targets. We present here several different sample suites that M2020 could have collected had it followed MSL's first ~500 sols through Gale Crater.

*Hypothetical Suite 1: Modern Surficial Materials***.** These materials include mineral fragments of the most distally available landscapes; some may even represent mixtures processed across the global scale of the planet. In such materials every grain may carry unique information from landscapes never visited. Furthermore, surficial materials are a key archive for assessing recent environmental conditions. We can envision collecting two samples from varying depths at a location like Curiosity encountered on Sol 53 at the deposit nicknamed "Rocknest" (Figure 1), plus one additional sample from the distinctive, active, black dunes encircling Mount Sharp.

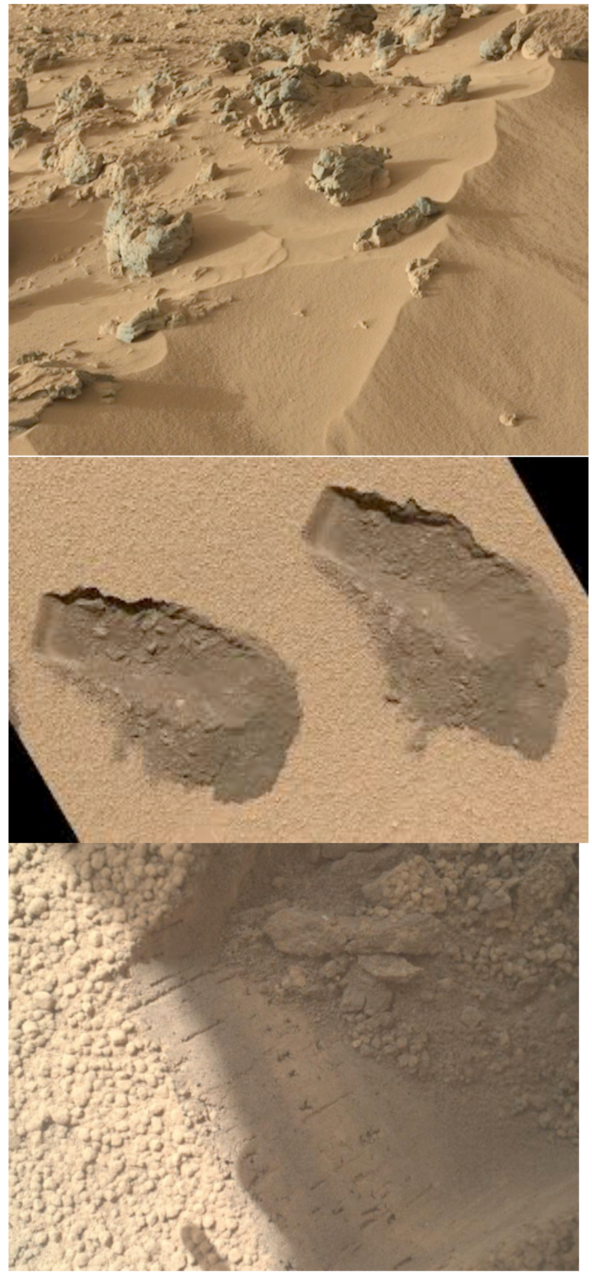

Figure 1. Mastcam and MAHLI images of the sandy deposit nicknamed "Rocknest," including disturbance from scooping activities. (Credit: NASA/MSSS)

*Hypothetical Suite 2: Igneous Rocks***.** Igneous rocks are critical for reading a planet's internal chemical and physical development through time, as illustrated by the multitude of studies of Martian meteorites [e.g., 2].

At Gale, Curiosity's analyses have shown that igneous rocks are chemically and petrologically far different from all known Martian meteorites [e.g., 3]. They are also likely much older than all but two such meteorites. If returned to Earth a suite of such rocks would undoubtedly rewrite our understanding of Martian planetary evolution, likely providing a unique window into the earliest differentiation of the planet. We suggest that four float samples (MSL has not encountered in place volcanics) could thus comprise a second suite for the M2020 Rover to collect (Fig 2,3).

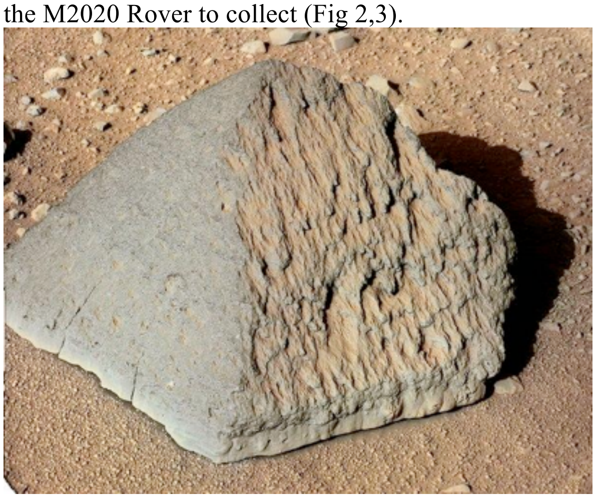

Figure 2. Mastcam image of rock nicknamed "Jake M." A mugearite acquired on sol 45 [3], a volcanic rock very different from all Martian meteorites. (Credit: NASA/MSSS)

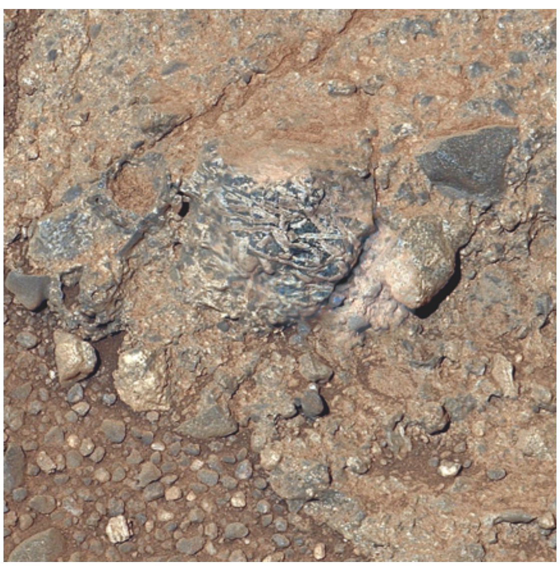

Figure 3. RMI-Mastcam composite image of target nicknamed "Harrison", a feldspar porphyritic volcanic rock contained in a fluvial conglomerate. (Credit: NASA, MSSS)

A third suite would be obtained from the Yellowknife Bay outcrop - a well exposed section of sandstones and mudstones likely representing fluvial, deltaic, and lacustrine environments. In our presentation we will discuss the unique importance of this suite relative to the specific objectives of the M2020 mission, and assess how many samples are required to adequately document it.

Collecting Sufficient Samples within One Mars Year: Could 31 samples like the above described sample suites be collected within one Martian year (669 sols)? This question may be evaluated with a model that partitions one Mars year into the time available for scientific exploration and the time required for activities that do not contribute directly toward meeting the mission science objectives (for example, the spacecraft commissioning and checkout period and solar conjunction).

Based on analysis of the usage of sols by the MSL team in Yellowknife Bay, coupled with the hypothetical sample suites posited here, the model extrapolates the measurements and science decision-making process necessary to identify and collect the full set of samples for the proposed Mars 2020 mission. Parallels are drawn where possible between broad types of investigations on MSL and corresponding expected investigations for M2020 using the straw payload suites detailed in [1]. Also the model accounts for communications patterns and operations scheduling, injecting additional realism into the estimate of activities that could fit within one Mars year. The remaining time available for exploration could be used for driving.

Conclusion: We will present the results of this proof of concept, detailing the expected sample suites from the first five hundered sols of the MSL mission, combined with the modeling results. These results would be incorporated in the operational concept for the Mars 2020 Rover mission as its planning proceeds.

References:

[1] Mustard J. F., et al. (2013) *154 pp., posted July, 2013, by the Mars Exploration Program Analysis Group (MEPAG) at* *http://mepag.jpl.nasa.gov/reports/MEP/Mars_2020_SDT_Report_Final.pdf.* [2] Basaltic Volcanism Study Project (1981) Basaltic Volcanism on the Terrestrial Planets. Pergamon Press, Inc., New York. 1286 pp.
[3] Stolper, E. M., et al. (2013) The Petrochemistry of Jake_M: A Martian Mugearite, *Science 341*, 6153, DOI 10.1126/science.1239463.