

Astrobiogeochemistry, Habitability, and Returned Sample Science

PI: Kenneth Williford (3225) Co-I: Michael Tuite (3227)
Program: Strategic Initiative

Project Objectives:

The objectives of this initiative are fourfold:

- 1. Method Development:** Develop novel sample preparation and analysis techniques to address key questions in returned sample science.
- 2. Mars Analogs:** Seek signs of life in modern and ancient Mars-analog environments.
- 3. Planetary System Science:** Investigate major events in the co-evolution of the Earth/life system to better understand planetary habitability.
- 4. Communication & Leadership:** Engage with the public and broader scientific community through publication, mentorship, participation, and leadership as well as online presence and media visibility.

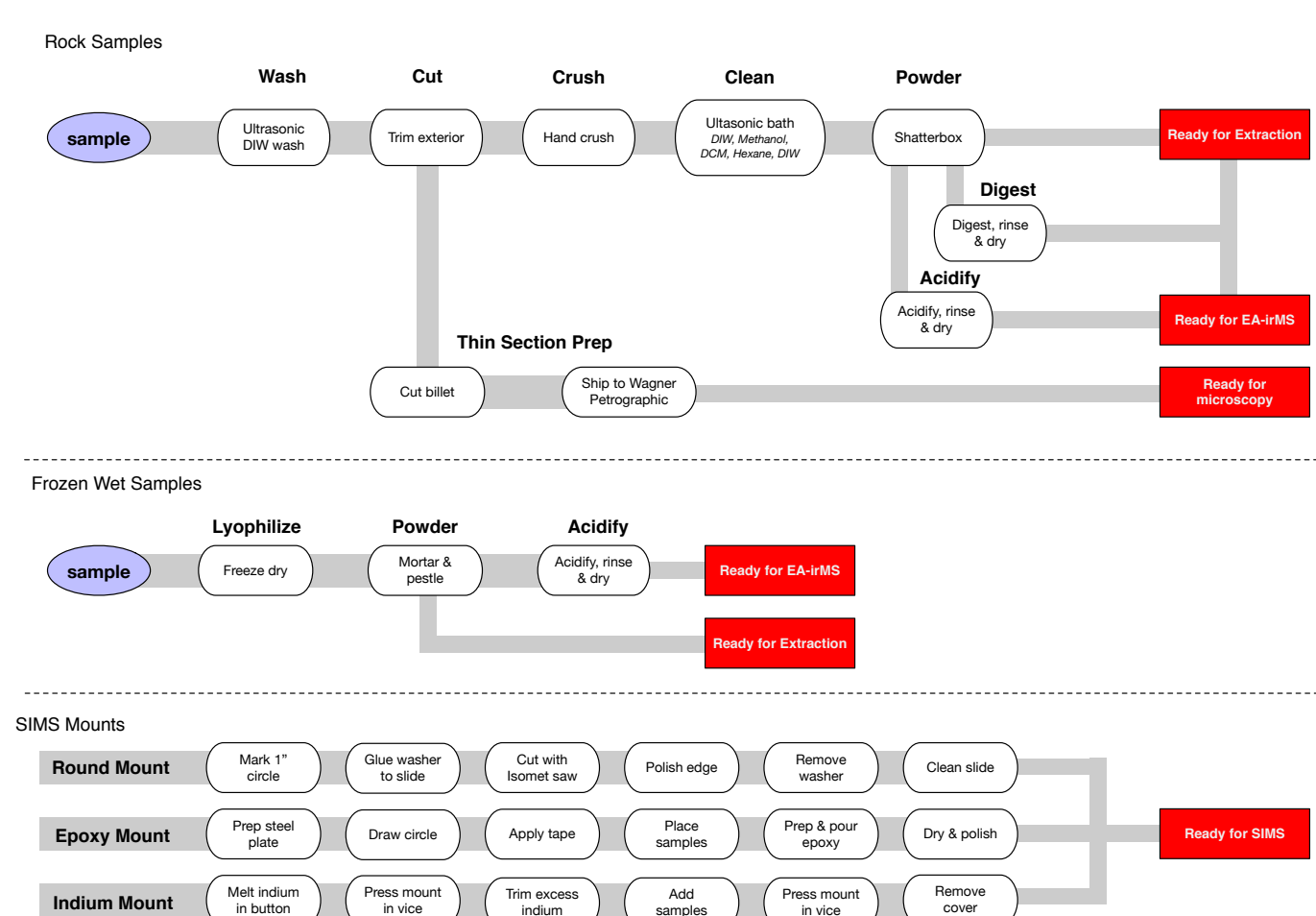
Benefits to NASA and JPL:

The project objectives map directly to JPL's strategic goals to capture the MSR Flagship mission (6X) and the lunar, asteroid, and comet sample return New Frontiers missions (4X) by enhancing JPL's expertise in the key area of returned sample science. This work is particularly timely and urgent, with strong potential to inform key decisions about Mars 2020/MSR to be made over the next several years.



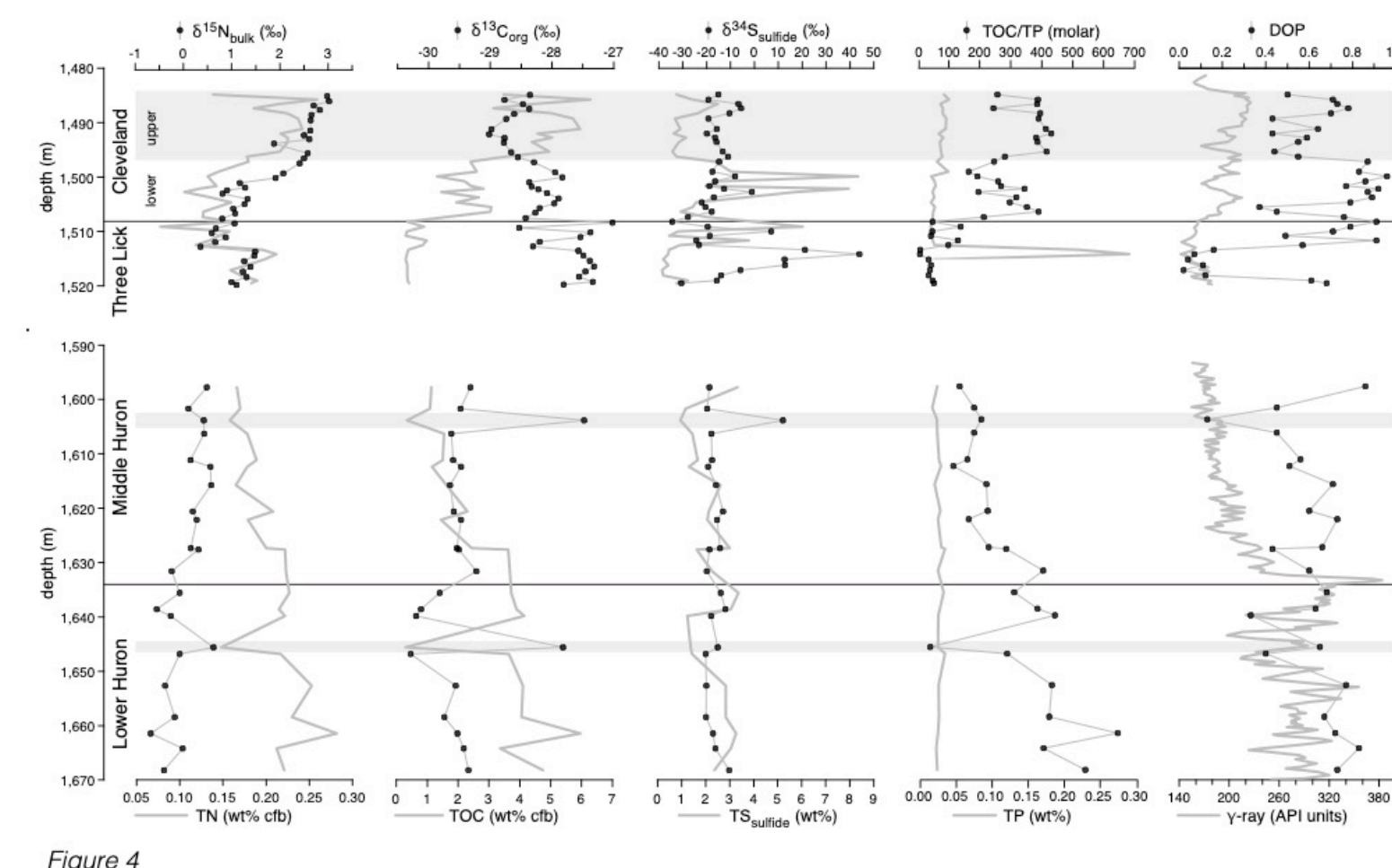
FY18/19 Research Highlights:

Method Development



A series of Analog Mars Sample Return workflows will permit consistent state-of-the-art analysis of analog samples.

Planetary System Science



An elemental and isotope record of the transition from a greenhouse to an icehouse climate in the Paleozoic reveals fundamental changes in nitrogen biogeochemistry that are relevant to modern oceans.

Mars Analogs



PI Williford acquires a sample of Jezero-analog Kunwarara magnesite (QLD, Australia) using a Mars 2020 drill bit.

Communication & Leadership

- Convened multi-day session at Goldschmidt geochemistry conference in Barcelona: "Planetary Chemistry in the Age of Space Exploration."
- Conducted a workshop at Goldschmidt conference on geosample data management.
- Convened a session at AbSciCon 2019 in Seattle on the analysis of returned Mars samples.
- Hosted post-doc and Raman spectroscopist Julene Aramendia from the University of the Basque Country
- Sponsored SURP student initiative with MIT grad student Kelsey Moore.
- Continued collaboration with JVSREP grad students: Adam Hoffmann and Maria Figueroa (UC Riverside), Jeff Osterhout (UCLA), and Jon Zaloumis (ASU)
- Boundaries of Life post-doc Matt Koehler
- Hosted eight graduate and undergraduate interns during the year.
- Published a variety of manuscripts in the relevant literature (see below).
- Tuite gave invited talk at UCR-Palm Desert in their annual "Are We Alone?" lecture series



Publications:

Tuite, M.L., Williford, K.H., Macko, S.A. (2019) From Hothouse to Icehouse: Nitrogen Biogeochemistry and the Oxygenation of the Late Devonian Ocean/Atmosphere System. *Palaeogeography, Palaeoclimatology, Palaeoecology*

Caudill, Christy, Gordon Osinski, Eric Pilles, Haley Sapers, Alexandra Pontefract, Shamus Duff, Joshua Laughton, Jonathan O'Callaghan, Racel Sopoco, Gavin Tolometti, Michael Tuite, Kenneth Williford, Tianqi Xie (2019). Field and laboratory validation of remote rover operations Science Team findings: The CanMars Mars Sample Return Analogue Deployment (MSRAD), *Planetary and Space Science*, vol 176.

Stamenković, V., et al., 2019. The Next Frontier for Planetary and Human Exploration, *Nature Astronomy*, 3(2) 116-20.

Diloreto, Z.A., Bontognali, T.R., Disi, Z.A., Al-kuwari, H.A., Williford, K.H., Strohmenger, C.J., Sadooni, F.N., Palermo, C., Rivers, J.M., McKenzie, J., Tuite, M.P., & Dittrich, M. (2018). Microbial community composition and dolomite formation in the hypersaline microbial mats of the Khor Al-Adaid sabkhas, Qatar. *Extremophiles*, 23, 201-218.

D. Flannery, A. Allwood, R. Hodyss, R. Summons, M. Tuite and M. Walter. 2018. Microbially-influenced formation of Neoproterozoic ooids. *Geobiology*.

PI/Task Mgr. Contact Information:

Kenneth Williford

Kenneth.h.Williford@jpl.nasa.gov