A SILICA-PRODUCING HYDROTHERMAL SYSTEM ON MARS AND ITS MICROBIALLY INHABITED ANALOG AT EL TATIO, CHILE. S. W. Ruff[1] and J. D. Farmer[1], [1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, 85287-6305, steve.ruff@asu.edu.

Introduction: An ancient volcanic hydrothermal system in the Columbia Hills of Gusev crater produced exposures of opaline silica (amorphous $SiO_2 \bullet nH_2O$) that were discovered in 2007 by the Spirit rover adjacent to the "Home Plate" feature, an eroded plateau of volcanic ash [1; 2]. An origin for the silica by fumarole-related acid-sulfate leaching of basaltic materials was favored initially. However, this hypothesis does not explain the stratiform expression of the silica outcrops or their characteristic nodular masses, some with mm-scale digitate structures. Recently published work based on comparisons with a hydrothermal system at El Tatio, Chile strengthens the case that Home Plate silica outcrops are hot spring/geyser sinter deposits, and may include potential biosignatures [3].

El Tatio: The active volcanic hydrothermal system at El Tatio forms the basis for scale-integrated comparisons to silica features at Home Plate, including geologic context, mesoscale structures in outcrops, mm-scale textures, and spectral signatures. The physical environment of El Tatio offers a rare combination of high elevation (~4300 m), low precipitation (<100 mm/yr), high mean annual evaporation rate (132 mm), common diurnal freeze-thaw [4], and extremely high UV irradiance [5]. Such conditions provide a better environmental analog for Mars than those of Yellowstone National Park (USA) and other well-known geothermal sites on Earth. The more Mars-like conditions at El Tatio produce unique deposits with features that compare favorably to Home Plate silica outcrops [3].

Analogous Features: Hot spring and geyser discharge channels at El Tatio commonly contain nodular masses of opaline silica sinter with mm-scale digitate structures that are strikingly similar in overall form to those at Home Plate (Fig. 1). Based on textural and microbial features apparent in thin sections and SEM images, El Tatio digitate silica structures are complex sedimentary structures produced by a combination of biotic and abiotic processes. Textural elements of El Tatio sinter, like breccia clasts and coated grains, also have counterparts among Home Plate silica [3].

Thermal infrared spectra (~340 – 2000 cm^{-1}) of Home Plate silica from Spirit's Mini-TES commonly display a strong absorption feature near 1260 cm^{-1} that typically is weak or absent in terrestrial opaline silica. However, sinter samples from El Tatio display this feature due to the presence of thin halite (NaCl) crusts produced in the extremely arid conditions, providing the best match yet to Mini-TES spectra [3].

Conclusions: Based on analogy with El Tatio, the Home Plate nodular and digitate silica structures and textures, combined with evidence for halite crusts, substantially bolster the case for an origin as sinter deposits in a hot spring/geyser environment with precipitation from silica- and chloride-bearing waters. A plausible hypothesis for the Home Plate digitate structures is that they are microstromatolites formed in discharge channels like those of El Tatio. However, the relative contribution of biotic and abiotic influences cannot be determined from available observations.

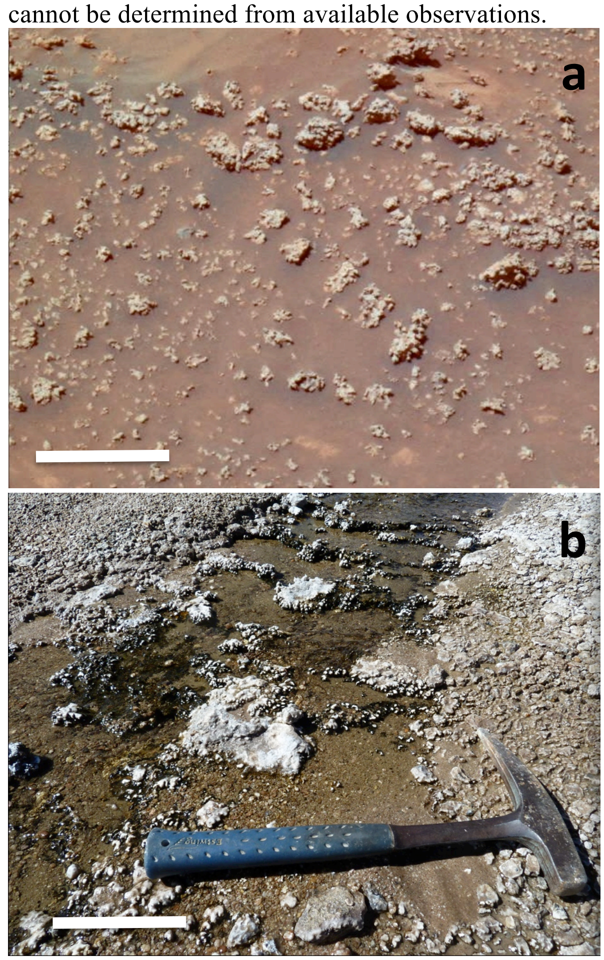

Figure 1. Nodular and digitate silica structures at (a) Home Plate (Pancam sol 778, p2388) and (b) in a hot spring discharge channel at El Tatio. Scale bar =10 cm.

References: [1] Squyres, S. W., et al. (2007), Science, 316, 738-742. [2] Squyres, S. W., et al. (2008), Science, 320, 1063-1067. [3] Ruff, S. W., and J. D. Farmer (2016), Nat. Commun., 7. [4] Nicolau, C., et al. (2014), J. Volc. Geotherm. Res., 282, 60-76. [5] Cabrol, N. A., et al. (2014), Frontiers Env. Sci., 2, 19.