OPALINE SILICA OCCURRENCES IN THE COLUMBIA HILLS OF MARS: A CASE STUDY IN THE HUNT FOR BIOSIGNATURES. S. W. Ruff[1] and J. D. Farmer[1], [1]Arizona State University, School of Earth and Space Exploration, Tempe, AZ 85287-6305, steve.ruff@asu.edu.

Introduction: Occurrences of opaline silica (amorphous SiO_2•H_2O) have been recognized on Mars with orbiter and rover assets [e.g., 1; 2; 3]. The Spirit rover encountered opaline silica rocks and soil adjacent to Home Plate in the Columbia Hills of Gusev crater that were interpreted to be the products of a volcanic hydrothermal system [2]. The silica rocks commonly occur in nodular masses that have a rubbly appearance but are considered outcrops because of their stratiform expression and resistance to deformation by the rover wheels. Their origin via acid-sulfate leaching of basaltic precursor materials by fumarolic steam condensates was the favored hypothesis in the initial analysis, based largely on geochemical arguments [2]. An origin as hot spring siliceous sinter deposits produced from alkali-chloride waters also was considered in that work. A subsequent analysis presented salient observations of the silica outcrops that support a hot spring and/or geyser origin [4]. We now find remarkable similarities in the silica at Home Plate and El Tatio, a geothermal field at ~4300 m elevation in Chile's Atacama Desert.

Spectral Features: Spectra of Home Plate silica outcrops obtained by Spirit's Miniature Thermal Emission Spectrometer (~340 – 2000 cm^{-1}) commonly display a strong absorption near 1260 cm^{-1} that typically is weak or absent in terrestrial opaline silica [4]. Based on silica sinter samples from El Tatio, we can now attribute this feature to a thin (10s of micrometers) patchy crust of halite that accentuates a feature of opal-A. The inferred halite crust on Home Plate silica implies chloride-bearing solutions rather than fumarolic gases, consistent with a hot spring/geyser origin.

Morphologic Features: The nodular appearance of the Home Plate silica outcrops and their common digitate structures (Fig. 1A) were interpreted to be the result of aeolian erosion of a formerly more extensive rock unit [4]. However, El Tatio hot spring/geyser discharge channels produce silica sinter with characteristics comparable to the Martian silica outcrops (Fig. 1B). The digitate structures typically are found within channels of shallow (<5 cm depth) flowing water that support microbial mats of diatoms and filamentous bacteria, where water temperature is <40°C. Water pH is circum-neutral (~6.5-7.5) throughout El Tatio [5].

Scanning electron microscopy supported by energy dispersive spectroscopy of El Tatio digitate silica structures reveals: internal microlaminations with fenestral porosity; silica encrusted microbial features on both internal and external surfaces; and C enrichment consistent with organic matter. Petrographic thin sections of these structures reveal laterally persistent, lenticular to wavy laminations dominated by distinctive palisade microtextures oriented roughly perpendicular to laminations, with local populations of heavily ensheathed fossil cyanobacteria resembling *Calothrix* (family Rivulariaceae). Based on the suite of textural and microbial features, supported by spectroscopy, we infer that El Tatio digitate silica structures are microbially mediated microstromatolites and that the Martian structures are thus potential biosignatures.

Fig. 1. Nodular silica with digitate structures adjacent to Home Plate, Mars (A) and in El Tatio, Chile (B) at the same scale. The latter are biomediated.

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