UBIQUITY AND DIVERSITY OF NODULAR AND DIGITATE MICRO-STROMATOLITES IN NEW ZEALAND'S SILICEOUS HOT SPRINGS: RELEVANCE FOR MARS BIOSIGNATURE EXPLORATION. K.A. Campbell[1,2], K.M. Handley[2,3], C. Sriaporn[3,4], S.W. Ruff[5], M.J. Van Kranendonk[6,7], D.M. Guido[8], T. Djokic[6], [1]School of Environment, Univ. of Auckland (UOA), Auckland 1142 New Zealand (ka.campbell@auckland.ac.nz), [2]Te Ao Mārama – Centre for Fundamental Inquiry, Faculty of Science, UOA, [3]School of Biological Sciences, UOA, [4]Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai Thailand, [5]School of Earth and Space Exploration, Arizona State Univ., Tempe, AZ 85287-6305 USA, [6]Australian Centre for Astrobiology, School of Biological, Earth and Environmental Sciences, Univ. New South Wales Australia, Kensington, NSW 2052 Australia, [7]ARC Centre of Excellence for Core to Crust Fluid Systems, [8]CONICET and Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Instituto de Recursos Minerales (INREMI), La Plata 1900 Argentina.

Introduction: On the horizon are prospects for eventual return to Earth of cached samples from a habitable Martian environment for high-resolution, multi-proxy analysis of potential biosignatures [1]. This will require comparative terrestrial analog studies to inform and contextualize site selection, and refine sample search strategies, as is underway for Columbia Hills (CH), a NASA Mars 2020 landing site candidate. Compelling similarities have been drawn between nodular, micro-digitate and opaline silica at CH and actively forming, siliceous hot spring deposits (sinter) entombing microbes at El Tatio, Chile [2]. This research investigates formation mechanism(s) of a broadly similar suite of sinter fabrics in the Taupo Volcanic Zone (TVZ), New Zealand (NZ) (Fig. 1).

Ubiquitous NZ analogs in diverse geothermal settings: One objective of this study is to characterize the physical and chemical conditions under which digitate silica textures are precipitating from thermal fluids at 5 geothermal fields in the TVZ. Spring waters vary from alkali chloride, to acid-sulfate-chloride, to acid sulfate in composition, with wide ranges in temperature and pH (Fig. 1). All are in shallow sheet discharge areas where evaporative wicking is likely the primary mechanism initiating and maintaining the digitate structures [cf. 3, 4]. Another objective is to determine the nature of associated microbial communities and organic matter being entombed in silica, and appraise their preservation potential. A pilot study from an alkali chloride spring-derived sinter amplified prokaryotic 16S rRNA gene fragments, while eukaryotic and fungal marker genes were very poorly amplified or not at all. In contrast, eukaryotic/fungal genes were successfully amplified from around half of sinter sub-sections collected from an acidic spring.

Future work: Confirming that mineral-microbe constructed micro-stromatolitic edifices, akin to the CH textures, are growing in NZ under varying conditions in the same position on numerous sinter discharge aprons could help narrow the hydrothermal site sampling targets on Mars. Future work will grow the textures over time, complete DNA/ultra-structural characterization, and measure molecular biomarkers to gauge preservation potential.

References: [1] http://mars.nasa.gov/mars2020/mission/overview. [2] Ruff S. W. and Farmer J. D. (2016) *Nature Comm.*, 7, 13544. [3] Handley K. M. et al. (2005) *Geobiology*, 3, 93-114. [4] Schinteie R. et al. (2007) *Palaeont. Electr.*, 10.1.4A. [5] Mountain B. et al. (2003) *Can. J. Earth Sci.*, 40, 1643-1667.

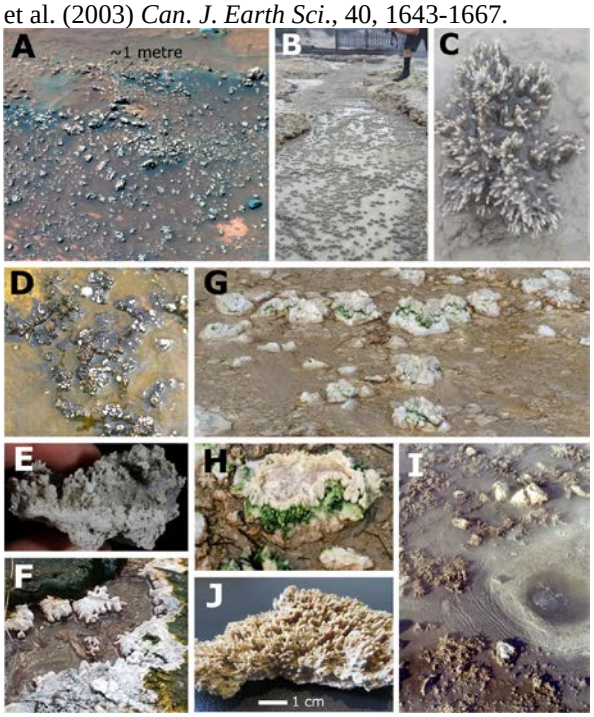

Fig. 1: Comparative textures of nodular to spicular, digitate hydrothermal silica deposits (few mm's-1 cm high) in Martian (A) and NZ sinter (B-J). (A) Putative sinter, CH, Mars (false color; NASA/JPL/Cornell). Alkali chloride springs (45-55 ^{0}C), neutral-8.5 pH at Tikitere (B,C), Atiamuri (D,E), Waimangu (F). (G,H) Acid-sulfate-chloride springs (30-85 ^{0}C, pH 2), Parariki Stream [4]. (I) Around sulfur-rimmed vent of acidic springs (60-85 ^{0}C, pH 3), Lake Rotokawa shoreline [5]. (J) Acidic spring (98 ^{0}C, pH 1.5), Te Kopia.