TRACING HOT-SPRING FACIES AND THEIR GEOTHERMALLY SILICIFIED MICROBIAL TEXTURES INTO THE TERRESTRIAL GEOLOGIC RECORD: RELEVANCE FOR MARS BIOSIGNATURE RECOGNITION.

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Introduction: More than 125 years of study of siliceous hot-spring sedimentary facies since Weed's insightful observations on "algous vegetation" in sinter at Yellowstone National Park [1] has illuminated a variety of deposit geometries and macro- and micro-textures, most microbial in origin [2-5]. The microbial fabrics entombed in sinter are controlled by temperature, pH and physico-chemical parameters operating along environmental gradients in any given geothermal system [2,3]. Many of these textures can be recognized in the geologic record [5-8], in some cases as far back as 3.48 billion years to the earliest signs of life on Earth [9]. Early silicification is paramount for preserving high-quality biosignatures in ancient hydrothermal settings [10]. One recurring sinter facies resembles siliceous nodules at Columbia Hills on Mars [11], and thus warrants more detailed comparative study.

Sinter Preservation and Facies on Earth and Mars(?): Alkali chloride thermal waters of nearly neutral pH tend to precipitate the thickest stratiform deposits (dm's to 10's of m's). This geometry implies high fluid volumes and/or systems that were active over long durations [12]. Acid-sulfate-chloride springs precipitate thin sinters (few cm's to dm thick) [13] with distinctive fabric types [14]. Aridity may strongly dictate the amount and distribution of precipitated silica. Sinters are rare in rocks older than Cenozoic age, being best represented in subsiding basins during the waning stages of regional volcanism [5]. On Earth, all old and some young sinters have diagenetically transformed from amorphous opal to micro- or mesocrystalline quartz. In contrast, the inferred sinters at Columbia Hills remain opaline, indicating a lack of diagenesis [11]. Because of this history, Mars may be the best place in the Solar System to preserve ancient biosignatures, if ever they were present [15,16].

In New Zealand, sheet channel-flow areas bathed by warm (~40-60°C) discharge from acidic or neutral pH springs commonly form digitate knobby to spicular textures that are broadly similar in morphology at the macro-scale, and which may be compared to features in the Columbia Hills siliceous nodular deposits [11,19]. The terrestrial examples invariably develop by evaporative wicking and silicification of microbial communities situated at the air-water interface, growing thin (<3 cm) microstromatolites on pumiceous clasts or sediments that are slightly elevated above the steaming, sluggish (≤0.5m/sec), thin (mm's to 1-2 cm) water layer [14]. More detailed analysis of these features is needed to differentiate environmental controls on the range in style of their micro-digitate morphologies.

Sinter Biosignatures: Following the paragenesis and diagenesis of recurring microbial fabrics in sinters of different ages enables an understanding of the fate of biosignatures through time. Over >3 billion years of geologic history of geothermal settings suggests that the most robust biosignatures are preserved as silicified macro- and micro-textures, with laser micro-Raman analysis providing additional important characterization of carbonaceous material, its mineralogic replacement by iron or titanium oxide minerals, and fingerprinting of the enclosing hydrothermal minerals [10]. Lipid biomarkers, while preserved in some Quaternary sinters [17], thus far do not extend meaningfully into the deeper time record we have studied [18].

References: [1] Weed W. H. (1889) *AJS*, 37, 351–359. [2] Walter M. R. (1976) *Dev. Sed., #20*, 489–498. [3] Cady S. L. and Farmer J. D. (1996) *Proc. CIBA Symp*., *202*, 150–173. [4] B. Jones B. et al. (1998) *JSR*, *68*, 413–434. [5] Guido D. M. and Campbell K.A. (2011) *JVGR*, *203*, 35-47. [6] Rice C. M. and Trewin N. H. (1988) *Trans. IMM(B)*, *97*, B141– B144. [7] Cuneen R. and Sillitoe R.H. (1989) *Econ. Geol.*, *84*, 135–142. [8] Campbell K. A. et al. (2001) *JSR*, *71*, 727–746. [9] Van Kranendonk M. et al. (2008) *Precambr. Res.*, *167*, 93–124. [10] Westall F. et al. (2015) *Geology*, *43*, 615–618. [11] Ruff S. W. et al. (2011) *JGR*, *116*, E00F23. [12] Guido D. M. and Campbell K. A. (2014) *JVGR*, *275*, 61–70. [13] Mountain B. et al. (2003) *CJES*, *40*, 1643–1667. [14] Schinteie R. et al. (2007) *Palaeont. Electr*., 10.1.4A. [15] Walter M. R. and Des Marais D. J. (1993) *Icarus*, 101, 129–143. [16] Westall F. et al. (2015) *Astrobio*., *15*, 998–1029. [17] Kaur G. et al. (2011) *Astrobio.*, *11*, 259–274. [18] Parenteau M. N. et al. (2014) *Astrobio.*, *14*, 502–521. [19] Ruff S. W. and Farmer J. D. (2015) Abstract P24A-01 AGU Fall Meeting, 14-18 Dec.