ARE STROMATOLITES RELIABLE BIOSIGNATURES?. F.A. Corsetti[1], W.M. Berelson[1], J.R. Spear[2], C. Pepe-Raney [2], C. Marshall[3], A. Olcott-Marshall[3]; [1] Department of Geological Sciences, University of Southern California, Los Angeles, CA 90089-0740 (corresponding author e-mail: fcorsett@usc.edu); [2] Division of Environmental Science and Engineering, Colorado School of Mines, Golden, CO 80401; [3] Department of Geology, University of Kansas, Lawrence, KS 66045-7613

Introduction: Stromatolites are usually interpreted as a macroscopic manifestation of microbial processes, and as such constitute a key structure in the astrobiologist's search image for off-world exploration—large enough to be imaged remotely, but ultimately built by organisms too small to easily locate [e.g., 1, 2]. On the one hand, there is no doubt that some (perhaps most) stromatolites on Earth were formed with biologic influence. On the other, recent work has suggested that stromatolite-like structures have formed without biologic input [3, 4]. When faced with determining the presence of life elsewhere in our solar system, "extraordinary claims require extraordinary evidence"—do stromatolites pass this test?

Observation/Discussion: Here, we contrast two different stromatolites as a cautionary tale for exobiologic studies. The stromatolites are similar at the hand sample scale, the scale most easily imaged by a rover. The first stromatolite in question was collected from a hot spring in Yellowstone National Park (fig. 1, top). An active microbial biofilm was present on the top of the structure. The other was collected from a hydrothermal vein that crosscuts local bedding at a high angle from the Tempaiute Range in central Nevada and formed deep within the earth in the absence of light (fig 2., bottom). Both are small (~15 cm tall) branching columnar structures that display finely laminated "light-dark" lamination on the order of ~100 microns thick. The laminae tend to thicken over the tops of the columns and thin towards the sides.

Microscopic examination reveals that the laminae of the Yellowstone stromatolite are composed entirely of silicified microbial filaments—a classic biogenic stromatolite. In contrast, the laminae in the Tempaiute vein stromatolite are composed of interlocking bladed calcite crystals—a classic abiotic precipitated fabric. However, darker, finer grained material of undetermined origin drapes the tops of some crystal layers, suggestive of a microbial origin. Raman spectroscopy reveals that the layers are composed of calcite with varying degrees of disseminated hematite. Notably, Raman bands, indicative of sp^2 carbonaceous material, was absent in these samples, corroborating the abiotic interpretation suggested by the crystalline structure.

Conclusion: While the geologic context provides some hint to their potential biogenicity (hot spring/active mat versus subsurface vein), the context may not always be apparent (e.g., a Mars boulder field). At the hand sample scale, stromatolites may fail the "extraordinary evidence" test—if possible, such structures should be examined *in-situ* microscopically to help guide our decision, and other techniques (e.g., Raman spectroscopy) should be employed.

References: [1] Walter ME (1976) Developments in Sedimentology 20. Elsevier, pp. 790.; [2] Allwood AC, Walter MR, Kamber BS, Marshall CP, Burch IW (2006) Stromatolite reef from the Early Archaean era of Australia. Nature, 114, 714-718.; [3] Grotzinger JP, Knoll AH (1999) Stromatolites in Precambrian carbonates; evolutionary mileposts or environmental dipsticks? Annual Review of Earth and Planetary Sciences, 27, 313-358.[4] Grotzinger JP, Rothman DH (1996) An abiotic model for stromatolite morphogenesis. Nature, 383, 423-425.

Fig. 1 (top): Yellowstone hotspring stromatolite (large divisions on scale = cm); (bottom) Tempaiute vein stromatolite (scale as above)