Terrestrial Evaporite Environments: Potential Analogs for Mars Penny A. Morris[1], Susan J. Wentworth[2], Monica Byrne[3], Robin Brigmon[4], Carlton C. Allen[5], David S. McKay[5]. [1]Dept. Nat. Sci., University of Houston Downtown, 1 Main St., Houston Tx 77002, smithp@zeus.dt.uh.edu; [2]Lockheed Martin C23, Houston, Tx 77058; [3]Wellesley College, Wellesley, Mass 02481-8266; [4]Savannah River Company, Aiken, So. Carolina 29808; [5]NASA/JSC, Houston, Tx 77058

Introduction: Terrestrial evaporite biota can help us understand microbial fossilization processes in extreme environments. The biota, and their fossilized remains, are potential analogs for interpreting some Mars meteorites and Mars sample return rocks [1,2,3,4,5]. Rocks containing evaporites may not represent equivalent environments, as evaporites from different terrestrial environments are not identical. We can assume that the same is true for meteorites. For instance, the origins of terrestrial evaporates can be marine or nonmarine, and depending on the source waters, their signatures or chemistry may be different [6]. The chemistry will subsequently affect the biota inhabiting saline waters. Two examples of evaporites with different signatures are Storrs Lake, San Salvador Island, Bahamas, and the Dead Sea, Israel. Storr's Lake is located at sea level and receives its waters from conduits within the bedrock and seepage through Holocene sand that allows limited exchange with the ocean. The elevated salinity (~50 to over ~ 100‰) is maintained with evaporation that exceeds the annual rainfall [7,8]. The Dead Sea is 400 m below sea level and receives its waters from the Jordan River system and a series of springs. Evaporation results in an elevated salinity of ~250‰ [9]. . We will briefly discuss the differences in the biota, the potential fossils and the differences in fossilization that appear to occur.

Methods: The Storr's Lake samples were collected from .5-1 m depth and kept at ~3.0^{0}C until they were processed in the laboratory. Samples to be used for analysis with a scanning electron microscope were preserved in 10% formaldehyde on the same day as they were collected. Dead Sea samples were collected from ~.5 to 1.5 m depth and immediately preserved with 3% formaldehyde. Halite samples dissolve in formaldehyde. To preserve the relationship of the microbes to their substrates the samples were kept moist in sterile plastic bags. Both Storr's Lake and Dead Sea material represent benthic samples. Larger samples were fractured while smaller samples (sand-sized and smaller) were critical point dried and coated with platinum before analysis with either a JEOL 6340F field emission scanning electron microscope (FE-SEM) or Philips XL30 environmental electron microscope (ESEM). A Scintag X-ray power difractometer (XRD) was used for Dead Sea benthic mineral identification.

Discussion: The benthic biota of Storr's Lake is incorporated into stromatolitic structures composed of biofilm, rods, filaments, cocci and diatoms. With the exception of the diatoms, the partially to completely fossilized organic remains are composed of calcium carbonate enriched with magnesium. The biofilms vary in thickness, with some microscopic and others thick and macroscopic. Within the biofilms are abiotically precipitated small, coccoid forms (.13 μm). Other coccoid forms are within normal cell range (.5-2.0 μm) and are clearly biotic . The filaments are probably representative of both fungal hyphae and filamentous bacteria (Fig. 1), while the ovoid to rod-shaped images observed with an ESEM may be representative of the sulfate-reducing bacteria identified by R. Brigmon by 16S rRNA (pers. comm.). Detrital components are minimal and not readily identifiable microscopically or macroscopically.

The Dead Sea benthic biota is far less diverse than Storr's Lake. Our samples contain minimal deposits of biofilm; the bacteria are rod-shaped (Fig. 2) and there is a single species of coccolith, *Coccolithus pelagica*. Other researchers have identified fungi and a one celled green alga *Dunaliella* [9,10,11]. EDS analysis indicates that calcium is the dominant cation characterizing fossil microbes.

Detrital components are abundant both microscopically and macroscopically. XRD analysis indicates the presence of orthoclase quartz, halite, gypsum, and unidentified silts and clays.

Conclusions: The similarity in temperatures at the collecting sites and the elevated salinity, although very different, are the only common denominators between the two localities. Storr's Lake possesses thick stromatolitic deposits dominated by mat forming cyanobacteria containing identifiable biotic structures [12]. In addition to the mat forming cyanobacteria, the structures contain filamentous and nonfilamentous microbes, diatoms, diverse and abundant biofilms, and .13 μm sized spheres that are presumably abiotically precipitated. Filamentous microbes include bacteria and fungi. The carbonate deposits are thick. The lowest or oldest parts of the stromatolites are approximately 2000 years old. The Dead Sea initially appears to be devoid of life as it does not possess stromatolites or any other obviously biotic structures that are visible

to the naked eye. The evidence for life requires microscopic and genetic analysis. Readily identifiable fossilized bacterial remains are sparse. Both Storr's Lake and the Dead Sea represent important terrestrial analogs and rich resources for understanding the types of adaptations required for organisms to survive in these environments. If life occurred early in Mars history, survival depended on genetic selection that may have allowed some groups to live and reproduce in high salinity environments. The evaporites, depending on their geographical position and the source of the waters may have varied in temperature and chemistry. The microbial halophiles may have formed unique associations and food webs.

References: [1]Wentworth, S. J., et al. (2001) *GSA Ann. Mtg., Boston, 2001,* A403. [2] Moersch, J. E., et al (2001) *GSA Ann. Mtg., Boston, 2001,* A403. [3]Baldridge, A. M., et al (2001) *GSA Ann. Mtg. Boston, 2001,* A404. [4]Byrne, M. et al. (2001) *GSA Ann. Mtg. Boston, 2001,* A405. [5]Morris, P. A. et al (2001) *GSA Ann. Mtg., Boston, 2001,* A 452. [6]Hardie, L. A. (1984) *American J. Sci. 284,* 193-240. [7]Neumann, A. C. et al (1988) *Proc. 4th Symp. Geol. Bahamas* 1-26. [8]Paull, C. K. et al (1992) *Paleogeogr. Paleoeclim. Paleoecol. 95* 335-344. [9]Kis-Papo, T. et al (2001) *Mycol. Res. 105* 749-756. [10]Buchalo, A. S. et al (1998) *Proc. Roy. Soc. Biol. Sci. 265* 1404. [11]Oren, A. et al (1995) *Hydrobiologia 315* 149-158. [12]Mann, C. J. et al (1984) *Proc. 2nd Symp. Geol. Bahamas* 41-51.

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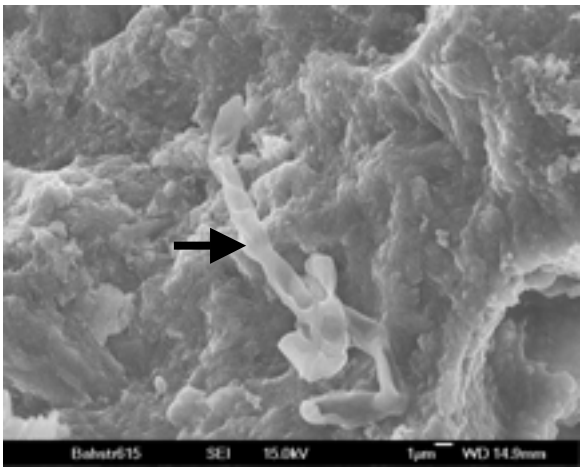

Figure 1. San Salvador Island, Bahamas. Arrow indicates filament.

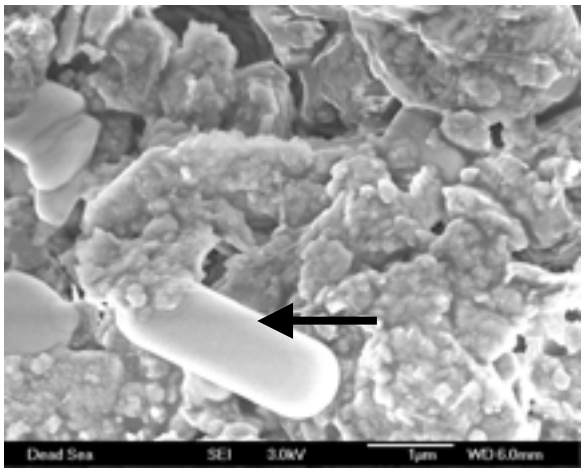

Figure 2. Dead Sea, Israel. Arrow indicates rod or bacillus shaped bacteria.