VISIBLE NEAR-INFRARED REFLECTANCE SPECTRA OF HYDROTHERMAL SILICA SINTER DEPOSITS AND EXTREMOPHILES. J. B. Plescia[1] and J. R. Johnson[1], [1]Applied Physics Laboratory, The Johns Hopkins University, Laurel, MD 20723 (jeffrey.plescia@jhuapl.edu; jeffrey.r.johnson@jhuapl.edu).

Introduction: Silica has been recognized in reflectance spectra of Mars [1,2] and hydrothermal activity would be expected on the surface given the close spatial and temporal association of volcanism and water. Martian hydrothermal sites have also been suggested to be areas where life may existed (or exist). We present visible near-infrared (VNIR) reflectance data on hydrothermal sinter deposits and on hyperthermophile organism.

We collected data from a variety of sites including Yellowstone National Park WY and Beowawe, Steamboat Springs and Fish Lake NV. The silica ranges in age from modern (i.e., being actively deposited) to Pleistocene. In addition, we collected reflectance spectra of extremophile organisms from a number of springs in Yellowstone.

Data Source: Reflectance spectra (0.35 to 2.5 µm) were acquired using an ASD Field Spectrometer with both artificial and natural light. *In-situ* sinter samples were not prepared and thus have variable grain size, porosity, alteration and coatings. When possible, data were collected of dry sinter. Spectra for the hypertherophiles were collected *in situ* (under water) and from samples where the surface water was not present.

Results: Figure 1 illustrates example VNIR data for sinter deposits at several sites. The major absorptions are related to the presence of H_2O and OH in the sample including 1.4 and 1.46 µm (overtone -OH stretch), 1.9 and 1.96 µm (-OH stretch and H-O-H bending) and 2.21 and 2.26 µm (-OH stretch and Si-OH bending). The crystalline phase (micro- and nanocrystalline opal) will influence the location of the 1.4 µm absorption.

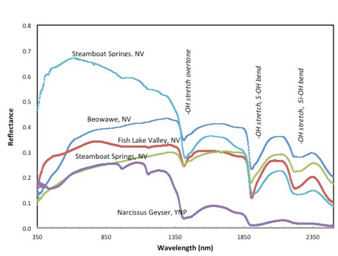

Figure 1. VNIR reflectance spectra of sinter deposits.

In addition to H_2O and OH features, a variety of absorptions occur due to the presence of coatings, particularly at Beowawe. Many of the coatings are due to post deposition alteration. The degree of alteration varies considerably and thus the spectra vary (Figure 2). The most common alteration species is iron-bearing (Fe^{2+}, Fe^{3+}), as well as clay minerals [3,4]. These produce a drop off <0.6 µm and broad absorptions near 0.8-0.9 µm. The positions of the features are a function of the degree of hydration. The absorptions associated with bound water become more complicated due to interaction with absorptions due to phyllosilicates and other species.

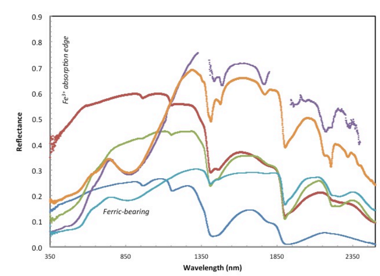

Figure 2. Altered sinter, primarily Fe-based species.

Spectra were collected on silica associated with the hyperthermophiles deposited along the course of the outflow channel. As soon the organism die due to changes in the outflow, silica rapidly looses it coloring and become dry and friable.

Spectra were collected of the various hyperthermophiles and acidophiles found in the springs. The principal species have similar spectra among different springs and can be separated from other major species. Figure 3 illustrates the VNIR spectra for *Synechococcus* and *Chloroflexus* from Octopus Spring at Yellowstone National Park.

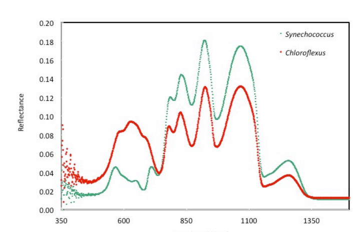

Figure 3. VNIR spectra of *Synechococcus* and *Chloroflexus in situ.*

Conclusions: VNIR spectra of hydrothermal sinter shows a range of absorptions due to H_2O and OH as well as due to alteration and secondary minerals. Spectra of extremophiles shows that species can be differentiated base on the absorption wavelength. Even though the same pigments are present in different species, the manner in which they are hosted in the cell changes the absorption wavelength.

References: [1] Milliken, R. E., et al. (2008) *Geology, 36*, 847-850. [2] Bandfield, J. et al. (2008) *Geophys. Res., Lett. 35*. [3] Squyres S. et al. (2008) *Science, 320*, 1063-1067. [4] Bishop, J., L., et al. (1995) *Icarus, 117,* 101-119. [5] Bishop, J. L., et al. (2004) *Icarus, 169*, 311-323.