INTRACRATER EVAPORITE DEPOSITS OF THE LAKE ST. MARTIN IMPACT STRUCTURE: IMPLICATIONS FOR MARS J. Stromberg[1], G. Berard[1], P. Mann[1], E. Cloutis[1]. [1]Department of Geography, 515 Portage Avenue, University of Winnipeg, Winnipeg, MB, Canada R3B 2E9. jessica.m.stromberg@gmail.com

Introduction: The Lake St. Martin impact structure is the result of a hypervelocity meteorite impact during the Early Triassic into what is now the northwest Interlake region of Manitoba. It is circular in shape and ~40km in diameter and has an abundance of shocked carbonates and intracrater evaporite deposits dominated largely by gypsum ($CaSO_4 \cdot 2H_2O$) that have been open pit mined throughout the last 100 years [1]. It is these gypsum-rich intracrater evaporites, the presence of endolithic microbial communities within the gypsum deposits, and the presence of intracrater gypsum deposits on Mars [2], which make the Lake St. Martin impact structure a relevant analogue site for understanding the origin of what appear to be similar deposits on Mars.

Gypsum deposits on Mars have previously been detected from orbit in the northern circumpolar dunes, but evidence for intracrater evaporite deposits has recently been found. Hydrated sulfate minerals have been detected in the Columbus, Gale and Gusev craters [2,3,4]. Such intracrater evaporite deposits are important to the understanding of early Mars as they may be indicative of hydrothermal activity or paleolakes.

Recent CRISM data from the ~119km diameter Columbus crater (29ºS, 166ºW) has indicated the presence of polyhydrated sulfates and a kaolin group phyllosilicate [2]. One of the polyhydrated sulfates detected was gypsum which occurs as a deposit ringing the lower crater walls. Interbedding of the gypsum and clays was also detected [2,5]. Similar gypsum deposits are what make the Lake St. Martin impact structure a unique intracrater evaporite deposit on earth (Figure 1).

Figure 1. Gypsum deposit at “White Elephant” in the Lake St. Martin impact structure (Sept./10)

Intracrater gypsum and endoliths: Endoliths are organisms whose habitat is within or below the surface of rocks. As gypsum is a relatively transparent and porous rock, gypsum deposits can provide a microenvironment for endolithic microbial communities that retains more moisture than the surface environment and provides protection from temperature fluctuations and solar ultraviolet irradiation. These conditions allow for this microenvironment to remain habitable even under unfavorable external conditions. Such evaporite deposits are host to extremophilic species, specifically halophiles or osmophiles which can tolerate high osmotic pressures. This makes endolithic communities of particular interest to astrobiology as they may provide clues to possible last refuges of habitable environments on Mars.

The primary intent of this research was to compare the evaporite deposits of the Lake St. Martin impact structure with those found on Mars and to determine whether its endolithic communities are detectable by reflectance spectroscopy.

Experimental Procedure: Samples were collected from gypsum deposits within the Lake St. Martin impact structure in May 2010 and transported to the University of Winnipeg for analysis. The gypsum endolith samples were stored in an environmental chamber with alternating light/dark cycles to maintain *in situ* conditions until spectral analysis. Reflectance spectra of six gypsum endoliths were taken from the naturally exposed gypsum surface as well as interior surfaces where the endoliths were exposed by sample collection (Figure 2). Larger samples such as GYP612 were broken into smaller pieces in the laboratory to expose fresh endolith surfaces. All reflectance spectra were measured at the University of Winnipeg’s Planetary Spectrophotometer Facility (PSF). Reflectance spectra were acquired with an ASD Field Spec Pro HR spectrometer (0.35-2.5 µm) with a 50 watt QTH light source with a viewing geometry of i=30º and e= 0º; 1000 spectra were collected and averaged to improve SNR.

Results: The spectra of the endolith samples are dominated by spectral features characteristic of gypsum regardless from which sample and part of the sample the data was taken (Figure 3). Spectra of both the external gypsum surface and the colored interior endolithic communities were nearly identical. The only significant change in spectral signatures was found below 0.8µm. In this range, the spectra of the endolithic communities visible in the interior of the samples show a sharp decrease in absolute reflectance and an absorption feature at 0.67 µm (Figure 3). This feature did not vary with the color of the endolithic community, it was observed in the spectra of green, blue and brownish spots in the gypsum. We attribute this feature to absorption by chlorophyll.

Discussion: The prevalence of gypsum deposits within the Lake St. Martin impact structure has implications for Mars analogue research given the recent detection of similar deposits within Columbus crater [2]. This is particularly true for the presence of endolithic communities within the gypsum where they are protected from the harsher external environment. If there were to be any microbial life present on Mars, it would need such protection from the harsh UV radiation, dry conditions and temperature fluctuations.

The spectral data from the endolith samples indicates that is possible to spectrally differentiate between pure gypsum and gypsum containing endolithic communities. This can be achieved by concentrating on the region below 0.8 µm where the spectra of the endolith-containing gypsum drops significantly. Above that range gypsum completely dominates the spectra and no differentiation can be made between external surface spectra and the internal endolith spectra. Below this 0.8µm threshold there is the distinct spectral feature at ~0.67µm that is seen in the endolith spectra and which we attribute to chlorophyll.

It is important to note that the endolith-associated feature at ~0.67µm is not seen in the spectra of the naturally occurring exposed gypsum directly above the endolithic community. In order to detect the endolithic spectral feature, the endolithic community must be exposed to view for the spectrometer. This also indicates that we would not be able to detect this feature from orbit by examining naturally occurring rock surfaces.

The present Mars Explorations Rovers (MER) Spirit and Opportunity are equipped with Panoramic Camera (Pancam) which is a multispectral, stereoscopic, panoramic imaging system consisting of two digital cameras. Each camera includes a small eight-position filter wheel to allow surface mineralogical studies in the 0.4-1.1 µm wavelength region of which six fall below 0.8µm. There is a possibility that the differentiation between pure gypsum and endolith-containing gypsum may be made using these filters. The 0.67µm endolith feature have the greatest likelihood of being visualized using the L3 filter which has a central wavelength of 0.673 µm (673 nm) and a band pass of 16 nm [6]. However, detectability would still be hampered by the fact that the 0.67µm feature is narrow; we are investigating whether this absorption feature can be distinguished in Pancam-type spectra.

References: [1] McCabe H. R. and Bannatyne B. B. (1970) *Geol Survey Manitoba, Geol. Paper 3/70*, 79. [2] Wray J. J. et al. (2009) *LPSC XXXX*, abstract #1896 [3] Milliken R. E. (2009) *LPSC XXXX*, abstract #1479. [4] Lane et al. (2004) *Geophys. Res. Lett*., 31 L19702. [5] Wray J. J. et al. (2010) *Geology, 37*, 1043-1046. [6] J. F. Bell III et al. (2003) J. *Geophys. Res.*, *108(E12)*, 8063.

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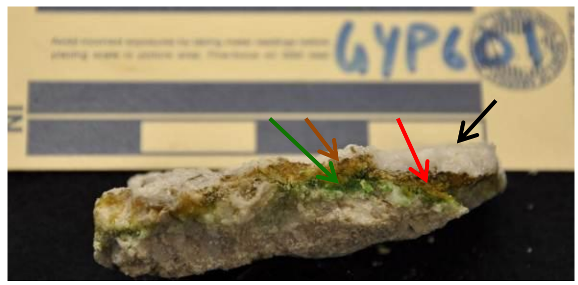

Figure 2. Sample GYP601: Endolithic community in gypsum (color of arrow corresponds to the same colored spectrum in Figure 3).

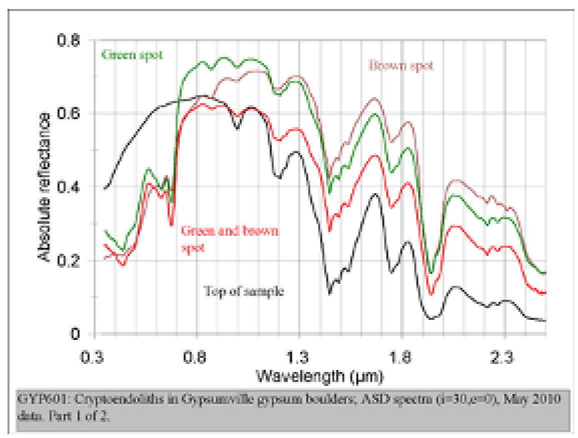

Figure 3. Reflectance spectra of sample GYP601 which contains visible endolithic communities. Color of spectra corresponds to color of arrows in Figure 2. Black arrow is spectrum of naturally occurring subaerial surface.