

REFLECTANCE SPECTRA OF GREAT SALT LAKE DESERT SEDIMENTS AS ANALOGUE MATERIALS FOR MARTIAN PALEOLAKE BASINS. K. L. Lynch¹, J. Munakata Marr¹, B. H. Horgan², K. A. Rey³, R. J. Schneider¹, S. M. Ritter³, J. R. Spear¹. ¹Colorado School of Mines, 1500 Illinois Street, Golden, CO 80305, USA, (klynch@mines.edu), ²School of Earth & Space Exploration, Arizona State University, Tempe, Arizona, USA. ³Dept. of Geosciences, Brigham Young University, Provo, Utah 84602, USA.

Introduction: Martian paleolake basins are prime habitability targets for future missions. The majority of terrestrial paleolakes transition to modern day evaporite basins with clay, sulfate and chloride compositions similar to the mineralogy identified by orbital observations in inferred martian lacustrine systems such as Columbus crater [1]. Terrestrial basins are known to harbor a diverse array of microbial life, enhance the preservation of organic matter & fossils and serve as reservoirs for authigenic carbonate deposition [2, 3]. Also, life on Earth most likely originated in deep-water systems such as oceans or deep lakes where redox energy from chemical gradients would have been available. Hence, developing a comprehensive understanding of the characteristics of terrestrial basin systems will prove useful for future astrobiology-driven investigations of martian paleolake basins.

Mineral observations and identifications by near infrared spectrometers such as OMEGA or MRO CRISM are based on spectral libraries composed primarily of pure, individual minerals whereas terrestrial lacustrine systems tend to generate mixed-sediments with varying grain sizes and mineral compositions, thus creating a potential difference in spectral quality and identification capability [4]. In this study, we compare mineralogical identification of lacustrine sediments from the Pilot Valley sub-basin of the Great Salt Lake Desert (a terrestrial paleolake basin) by visible/near infrared spectra (VNIR) to *in-situ* methods such as XRD and automated scanning electron microscopy (QEMSCAN).

Methods: Fieldwork. Sediment core samples, down to a depth of 30 cm, were collected along a defined Pilot Valley basin transect in May of 2012. Surface samples for spectroscopy were taken using 2-inch diameter PVC collectors. The collectors were driven into the playa surface and then dug out with a shovel to preserve the surface for spectral analysis as shown in figure 1.

QEMSCAN. The clay (≤ 3 micron) fraction was extracted from the sediment cores and analyzed using QEMSCAN at the Colorado School of Mines to determine phyllosilicate composition. EDX spectra was acquired from each sample using approximate beam size of 1 μm , a beam stepping interval of 5 μm , an accelerating voltage of 25 keV, and a beam current of 5 nA. The beam-surface interactions were modeled using Monte Carlo simulation and the mineral phases

were assigned based on a local database within the QEMSCAN software.

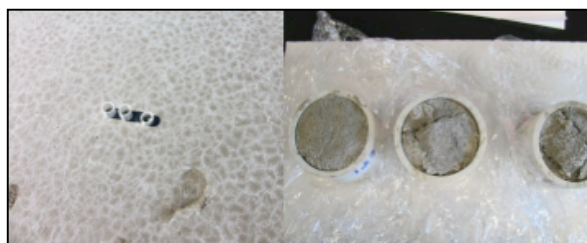


Figure 1. Surface sample collection in Pilot Valley,

X-Ray Diffraction. XRD measurements were made on the sediment cores using a Scintag XDS 2000 theta/theta goniometer with 2.2 kW sealed copper X-ray source. Measurements were made over a 2θ range of 2° to 70° at a continuous scan rate equated to 2° per minute. XRD patterns were collected and analyzed using the DMSNT software provided by Scintag. Mineralogical fits were identified using the ICDD database imbedded in DMSNT.

VNIR Spectroscopy. Reflectance spectra, in the range of 0.5 to 2.5 μm , were collected from each surface sample using an ASD Fieldspec-3 Portable Spectroradiometer at Arizona State University (*Note: the ASD field spectrometer was mounted for in-lab use and was not available for field work*).

Results: Mineralogy. The primary phyllosilicate groups identified in the basin by QEMSCAN are Al-bearing kaolinite, chlorite and illite/muscovite. The data also indicate the presence of small traces of an illite-smectite-montmorillonite mixed layer clay. Calcite and aragonite (authigenic carbonates in Pilot Valley) and dolomite (a clastic carbonate from the surrounding mountain ranges) were also detected, in addition to small amounts of expected ancillary minerals such as quartz, K-feldspar, pyrite and pyroxene. Salts were removed during sample preparation and therefore were not detected by QEMSCAN.

Qualitative XRD confirms the calcite and aragonite detection from QEMSCAN and also shows the presence of the expected salts halite and gypsum. XRD also confirms ancillary minerals detected by QEMSCAN. No phyllosilicates were detected with XRD. With the exception of the K-feldspar, all minerals found at Pilot Valley have been found at Mars. K-

feldspar has been tentatively detected by Dr. James Wray at Georgia Tech, but the results are still pending publication [5]

VNIR Spectra. Data analysis resulted in five major spectral groups that are represented by end-members as shown in figure 3. Groups 1 and 2 reflect spectra where gypsum is the dominant mineral detected with the key bands at 1.75 μm , the H_2O “triplet” at 1.45, 1.48, and 1.53 μm and the S-O overtone doublet at 2.21 and 2.28 μm [6]. There is also a strong absorption band around 1.16-1.17 μm in groups 1-3 that may indicate the presence of either (per)chlorate salt or a carbonate [7, 8]. Groups 4 and 5 may indicate a shift to phyllosilicates as the dominant mineral group with key bands around 2.21, 2.31, and 2.4 μm and the loss of the gypsum triplet and the (per)chlorate band absorption.

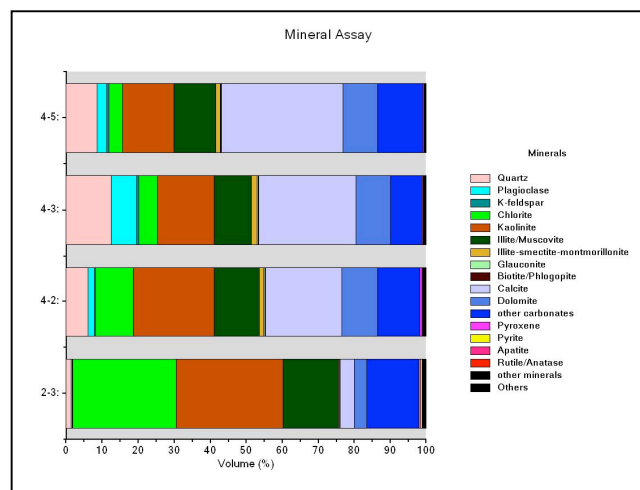


Figure 2. QESCAN Results along Pilot Valley transect. Sample 2-3 is the beginning of the transect and the rim of the basin. Sample 4-5 is the end of the transect and the topographic center of Pilot Valley.

Discussion: Analysis of the resulting spectra show that gypsum is the only mineral that can be unambiguously identified. Other sulfate salts and phyllosilicates are present, but clear identification is difficult as they share absorption bands around 2.2 and 2.4 μm with carbonates, (per)chlorate & chloride hydrates and each other. Perchlorate has been identified in the Pilot Valley sediments, hence consideration of (per)chlorate spectral features in this study is a valid exercise. The presence of chlorate and other chloride hydrates in Pilot Valley is unknown at this time.

Groups 2-4 may indicate a transition from a salt/evaporite-dominated material to a phyllosilicate dominated material as the gypsum triplet and the 1.16 μm (per)chlorate band feature disappear. Perhaps the most compelling finding from this work is that the

presence of the carbonates from Pilot Valley cannot be definitively identified by the VNIR spectra. Each of 7 diagnostic bands for carbonate in this region overlap other features or are swamped out by proximity to the hydration band at 1.9 μm .

Conclusions: These results show that current analysis techniques and library data sets for VNIR may lead to incorrect conclusions regarding mineral assemblages in martian paleolake basins.

Future work will include mid-IR spectra of Pilot Valley sediments and simulated mixed-sediment materials.

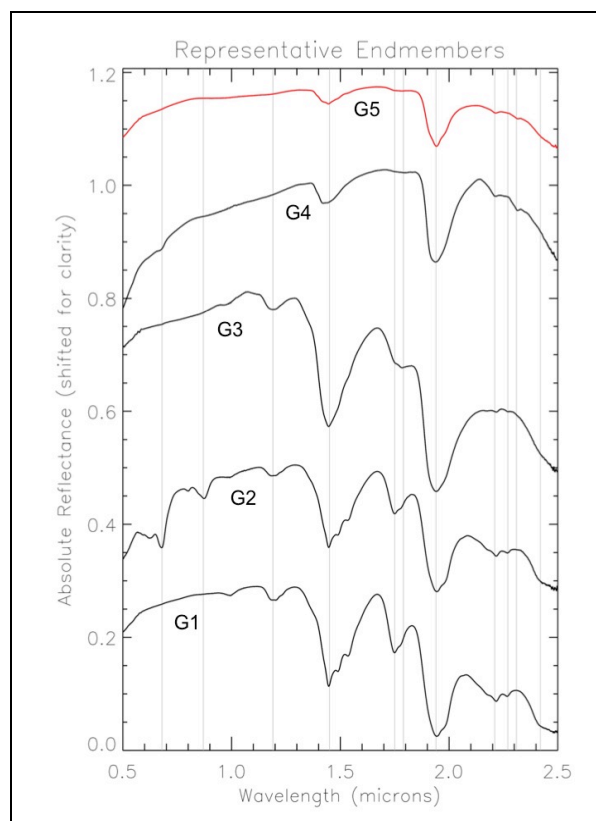


Figure 3. VNIR end member spectra of Pilot Valley surface samples

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