

FIELD TEST OF THE WATER-WHEEL IR (WIR) SPECTROMETER ON EVAPORATIVE SALT DEPOSITS AT TIBETAN PLATEAU. P. Sobron, J. J. Freeman, Alian Wang, Dept Earth and Planetary Sciences and McDonnell Center for Space Sciences, Washington University, St. Louis, MO, 63130, USA (psobron@levee.wustl.edu).

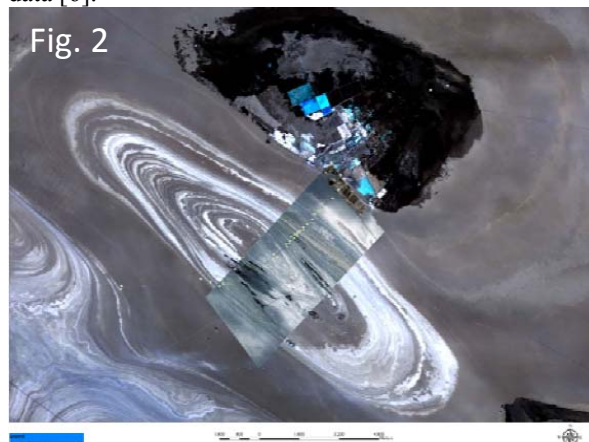
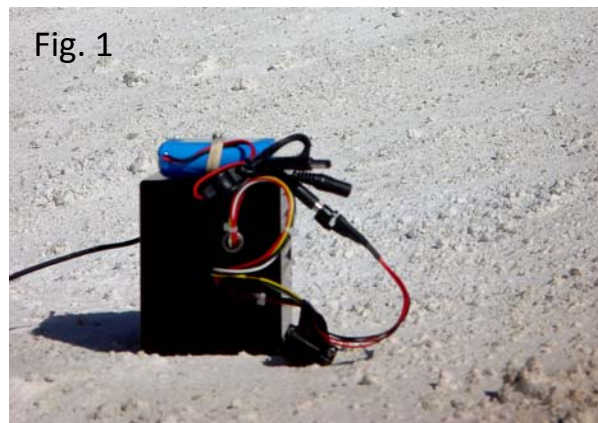
The WIR: The Water-Wheel IR instrument is a NIR (1-5 μm) reflectance spectrometer using active sources. The WIR experiment [1] is designed to detect directly water in different forms (liquid, ice, or clathrates, structural H_2O and OH, and water adsorbed on mineral surfaces), carbonates, sulfates, and C-H & N-H bonds in organic species on planetary surfaces. Technically, there are two ways to deploy a WIR unit. One we called “contact survey”, i.e., to install a WIR unit inside of a well set into the middle wheel of a planetary rover, to take fast measurement without interfering the normal operation of the rover. Thousands patches of disturbed soils can be examined during a rover travel to provide the information on the spatial distribution of the above-mentioned phases. The S/N of the spectra will be high because the measurements will be made at short distance ($\sim \text{cm}$). Another way is to deploy a WIR unit onto any desired surface (rock or soil without sample prep) by a robotic arm of a planetary rover or lander.

The phase-II version of WIR has a size of $10 \times 7.5 \times 6.5 \text{cm}$, mass of 450 grams, power consumption of 4W, and output data through a USB cable [2]. It covers a spectral range from 1.25 to 2.5 μm in 128 spectral channels. By putting a rugged frame that provides protection against dust and humidity in harsh environments, it has been transformed into a rugged, field portable NIR reflectance spectrometer that is able to operate in tough field conditions, including dusty and cold environments.

The field sites in 2008 campaign on Tibetan Plateau: The WIR (Fig. 1) was tested during a field campaign in Da Qaidam Lake, Xiao Qaidam Lake, and Da

Langtan playa (Fig. 2), on Tibetan Plateau (China) in the fall 2008. The climatic conditions and salt mineralogy within the lacustrine deposits of the Qaidam basin on Tibetan Plateau indicate that this area can be an excellent analog site for studying the precipitation sequence and subsequent dehydration/degeneration of Martian salts. Related abstracts [3, 4] in this volume provide detailed information on these field sites.

In-situ spectra collection by WIR: IR reflectance spectra were acquired at various sites of interest during the field campaign. Fig. 3 shows some of the collected spectra (offset for clarity), recorded at temperatures ranging 8 to 16 $^\circ\text{C}$ from exposed sediment, soil samples, and evaporites without any sample preparation. The spectra were recorded in 30 s and show very good signal-to-noise ratios. The red lines and red shaded area represent water absorption bands. Sulfate bands (combinational modes) are found within the blue shaded areas. The strong water combination modes in the XQ-02-01-01, DL-02-01-02 and DQ-01-02-14 spectra near 1.45 and 1.95 μm are highly consistent with gypsum as well as the small shoulder near 1.76 μm [5]. There is a shift in the position of the water bands in the XQ-02-01-05 spectrum, likely due to the presence of other hydrated sulfates, as for instance thenardite or kieserite. Also the presence of Na and K chlorides, abundant in the sampling sites, may introduce additional bands. More WIR spectra were taken in laboratory from the salt samples collected from the field sites. The two sets of NIR spectra provided the ground truth for a remote sensing spectral analysis of Da Langtan salt distribution based on ASTER satellite data [6].



A low temperature test of WIR: In order to evaluate the performance of the WIR at lower temperature than those found in 2008 field campaign, and to move forward in the development of electronic and mechanical components that will allow WIR to operate under Mars-like conditions, a series of samples were analyzed at two different temperatures in laboratory: 20 °C and 4 °C. First, reflectance spectra of selected samples were recorded at 20 °C. These spectra are shown as solid lines in Fig. 4. Then, the entire WIR unit, a Panasonic Toughbook laptop computer, and the set of samples were placed into a cold chamber for 45 minutes where they reached a temperature of 4 °C. Once the thermal stability was achieved, reflectance spectra of the same set of samples were recorded using the same acquisition parameters as the spectra collected at 20 °C. “Cold” spectra are overlaid in Fig. 4 as dashed lines. Spectra have been offset for clarity and comparison purposes. The pairs of spectra recorded at 20 and 4 °C match perfectly and do not show differences in signal-to-noise ratio and bands relative intensity. The only exception is that the reflectance spectrum DL-02-03-02 at 4 °C appears to be less intense than that taken at 20°C. A possible explanation is that the measuring geometry (sample position relative to light source and collection optics) was less favorable in the case of 4 °C, thus reduce the spectral contrast.

Conclusion and future work: The development of the phase-II version of WIR unit has yielded a rugged and portable NIR spectrometer that has been field-tested for the first time. The selected field sites were on Tibetan Plateau, whose environmental conditions and salt mineralogy provide an excellent playground for the WIR to be tested and further improved. *In-situ* reflectance spectra collected during the field trip revealed the presence of hydrated sulfates, mainly gypsum and possibly thenardite and kieserite.

Although the current phase II-WIR covers only 1.25-2.5 μm spectral range, the phase-III WIR unit is now under development and the prototype will be ready for test in the Spring of 2009. Among other features, it will provide both the 1.25 to 2.5 μm and the 2.5 to 5.0 μm spectral coverage on one detector. Therefore a full spectral coverage from 1.25 to 5.0 μm, equivalent to OMEGA and CRISM spectral ranges, will be obtained in one exposure. This is of critical importance as the 1-5 μm spectral range contains the strongest bands for the fundamental vibrations of free water, adsorbed water, structural H₂O and OH in minerals (2.7-3 μm), also includes the bands (~2.2-2.3 μm) frequently used for the detection of phyllosilicates. Carbonates have two strong overtone and combination bands in ~3.4 and ~3.9 μm. Sulfates have a combination band occurs near 4.5 μm. The funda-

mental modes of C-H and N-H bonds occur at 3.1-3.5 μm and 4.1-5.0 μm respectively. Therefore, a NIR reflectance spectrometer as small and simple as WIR will have broad applications for the missions to Mars (secondary mineralogy), the Moon (form of H-host), Titan (C-H compounds), and Europa (ice related mineralogy).

The current version of the WIR instrument has proven to perform at a temperature of 4 °C without any loss of detection sensitivity and resolution. Further work to improve the working capabilities in colder environments (high altitude regions in Tibet Plateau and Arctic or Anctartic Mars analog sites) is foreseen.

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References: [1] Wang A. (2004) *LPS XXXV*, abs#1510. [2] Freeman J. J. et al. (2008) *LPS XXXIX* abs#2190. [3] Zheng et al. (2009), this volume. [4] Wang A. et al. (2009), this volume. [5] Bishop J. L. et al. (2004) *Icarus*, 169, 323-331. [6] Mayer et al. (2009), this volume.

