Chemically active horizon in a soil pit from an intermittent pond site in the Dry Valleys region, Antarctica and implications for soil processes on Mars

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\textbf{Introduction}

The cold and extremely xeric conditions in the Antarctic Dry Valleys (ADV) region provide an excellent analogue for conditions expected on Mars. The ice-free ADV region receives annual precipitation of 5-10 cm in the form of snow [1], but possible annual sublimation is over 50 cm [2]. This, combined with mean annual air temperatures of -18°C and lows of -55°C [1,3], means that persistence of liquid water is rare. Nonetheless, unfrozen waters do occur, mostly within closed basins without effluent streams. These bodies of water are most commonly sourced from glacial meltwater [2], though deep groundwater charging also occurs [4]. This study explores the mineralogy and geochemistry of a soil pit from the center of an intermittent pond site, referred to as the VXE-6 pond pit [2], in Wright Valley in the ADV region (Fig. 1). The pond is fed by shallow groundwater, potentially similar in nature to the Recurring Slope Lineae (RSI) observed on the Martian surface [5,6].

\textbf{Results: Spectroscopy}

\textbf{Results: Chemistry}

Abundances of the elements K, U, Cs, Fe, Th, Co, Zn, Rb, Zr, Ba, and Sr, are notably higher for the 4-7 cm depth sample (Fig. 4).

This likely indicates the transition zone from surficial salt to gypsum at depth, and may be a site of active alteration.

\textbf{Methods}

We examined sediment samples from six depth intervals from a soil pit dug within the dried up VXE-6 pond site. We characterized mineralogical and geochemical changes with depth via visible/near infrared (VNIR) and mid-IR reflectance spectroscopy and Instrumental Neutron Activation Analysis (INAA). VNIR spectra of sediment grains were measured using an ASD spectrometer at the SETI Institute. The RELAB facility at Brown University was used to obtain bidirectional reflectance spectra from 0.3-2.55 μm and FTIR reflectance spectra from 1-25 μm for particulate samples, as in previous work, e.g., [7]. Instrumental Neutron Activation Analysis (INAA) of samples was conducted at the University of Vienna as in [7].

\textbf{Conclusions and Implications for Mars}

Spectral results suggest:
- Allophane, anhydrite, and hydrated NaCl are present at shallowest depths
- Gypsum at intermediate depths
- Anhydrite at deepest depths

A chemically active zone occurs at the transition from shallow to intermediate depths. This zone has higher reflectance, lower H₂O absorption, and high concentrations of many major and trace elements, as well as REEs. These results suggest a salt layer where active alteration is occurring.

The changing spectral features seen in this salt pond could be applied to remote sensing data from Mars, and could aid in the search for paleosalt ponds on the Martian surface.

We may also be able to use chemistry and mineralogy of the salt pond samples with depth in order to monitor changes in the Antarctic climate.

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\textbf{References}