SEDIMENTS AND SOIL PROFILES OF UPPER WRIGHT VALLEY, ANTARCTICA. P. Englert[1], J. L. Bishop[2,3], S. Patel[4], E. K. Gibson[5], C. Koeberl[6,7], D. Tirsch[8], U. Böttger[8], and R. Jaumann[8]. [1]University of Hawaii at Mānoa, HI, penglert@hawaii.edu. [2]SETI Institute, Mountain View, CA. [3]NASA Ames Research Center, Moffet Field, CA. [4]San Jose State University, CA. [5]Johnson Space Center, Houston TX. [6]Natural History Museum, Vienna, Austria. [7]Department of Lithospheric Research, University of Vienna, Vienna, Austria. [8]German Aerospace Center (DLR), Berlin, Germany.

Introduction: The Antarctic Dry Valleys (ADVs) are extremely cold and dry desert environments. They represent a unique analog for Martian surface development conditions. Chemistry and mineralogy of soils and sediments from Taylor and Wright Valleys were analyzed [1-4]. Samples from selected lakes, ponds and nearby surface areas were collected in 1979/1980, from sediments below Lake Hoare in 1994/95, and from lake surfaces in 2005/06. Surface samples are from Lakes Brownworth, Vanda and Fryxell; sediment cores from Lake Hoare, Don Juan and Don Quixote ponds. Systematic analysis by INAA, XRD, VNIR and mid-infrared spectroscopy, Raman Spectroscopy, and other methods is underway for all samples.

Element ratios: In our study classical major element weathering/pedogenesis ratios and major element weathering indices are applied to ADV as well as MER and MSL rocks and soils. Chemical Index of Alteration (CIA) values were used to characterize weathering conditions in Antarctic soils of Barton Peninsula [5] and for sediment layers in Antarctic drill cores [6]. The CIAs of sediment layers in drill cores are largely explained by the CIAs of source materials and reflect little or isochemical weathering. At Barton Peninsula with a less arid environment than the ADVs, CIAs of soils generally exceed those of source rocks. In Figure 1, two of several ADV soil source rocks and three sets of ADV soil and sediment CIAs are compared to molar Al_2O_3/TiO_2 ratios. ADV CIA data are clustered and, as expected, lower than those of Barton Peninsula, indicating a lesser degree of weathering. Very low ADV soil CIAs indicate sulfur rich samples. Full geochemical analysis will provide good indicators of weathering where historical to contemporary alteration conditions are liquid water based [7]. Investigating elemental relationships for analogs that can be applied to Mars elemental abundance data bases is therefore important to assist in evaluating the extent of water based alteration derived from indicators in the Martian surface.

Minerals: Raman spectra of grains from Lakes Fryxell, Brownworth and Vanda characterize the feldspar, quartz and pyroxene grains and complement the VNIR spectral identification of carbonates, sulfates and clays in these sediments. Raman analyses also identified amorphous carbon in some samples.

Trace elements: Trace element abundances measured by INAA show pattern and abundance ranges compatible with the expected provenance of soils. While general Taylor and Wright Valley Rare Earth Element (REE) abundance ranges show a wide spread based on soil compositions of two or more major components, Don Juan Pond REE abundances analyzed so far cover a narrower concentration range and provide a provide a coherent set of abundance patterns. This may be due to the limited range of sources for Don Juan Basin soils supporting arguments of the model character that this ADV region may have for the study of Martian surface processes, see Figure 2.

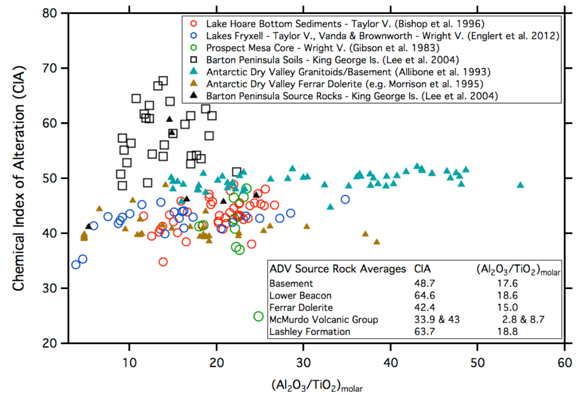

Figure 1. CIA vs. molar Al_2O_3/TiO_2 ratio for ADV soils and sediments (circles) compared to Barton Peninsula soils (squares). Source rock data (triangles) are given for comparison. Source rock geochemistry adapted from [8] Roser & Pyne (1989); see also [6], and [1-5], [9, 10]

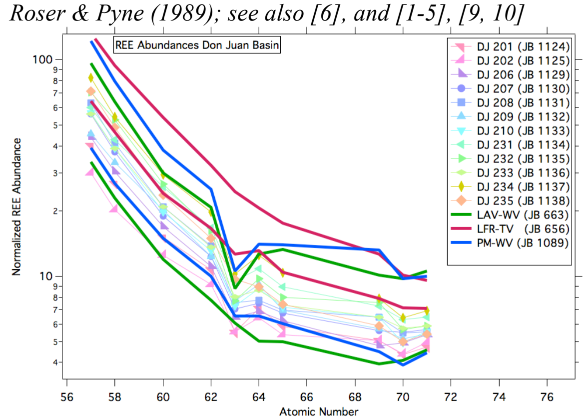

Figure 2. Normalized Rare Earth Element abundance pattern for Wright and Taylor Valley locations. DJ locations are in Don Juan Basin, LAV and PM locations are from Lake Vanda and Prospect Mesa, Wright Valley, respectively, and LFR represents Lake Fryxell in Taylor Valley. Don Juan Basin REE pattern show regularity and a narrow concentration range.

Don Juan Basin. Dickson et al. (2013) [11] provide extensive arguments for Don Juan Basin, Upper Wright Valley, Antarctica as a model environment for calcium and chlorine weathering and distribution on Mars. Their field observations, photographic and photometric time series analyses, are sophisticated and support new model assumptions on processes that formed Don Juan pond. Don Juan Pond and the basin contain an unprecedented amount of $CaCl_2$ salt [12]. However, Oberts (1973) [13] discovered mostly halite and some gypsum in soils on or near the rock glacier (Western Lobe).

Eight soil cores (211 samples) and twenty-two surface samples were collected from locations in San Juan Basin. Four of these cores have been studied to some degree: WV 42, DJ 21 and WV 38 are from evaporite ponds South and increasingly distant of Don Juan Pond, and DJ 39 in the West and close to the pond; all others are being investigated. Don Juan Basin cores indicate a high location and depth variability of soluble salt concentrations. Calcium and magnesium salt production indicate chemical weathering. However, soluble potassium, a major component of source rocks, is either low or below detection limits.

In the spectra of DJ 39 we found peaks characteristic of clays and sulfates. They have unique spectral signatures due to OH and H_2O bands that enable us to distinguish between these minerals. The high salt/water region was found to be a few cm below the surface (3-8 cm). The sulfate gypsum and aluminosilicate allophane are consistent with the spectra in this region (Figure 3).

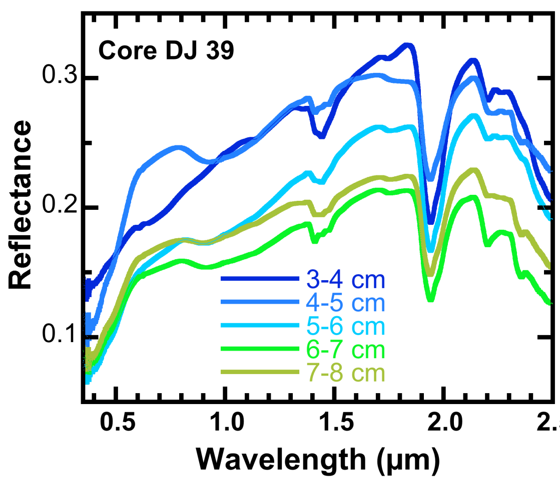

Figure 3. Salinity and water absoptivity in Don Juan Basin core DJ 39. Regions with higher water absorptivity also have higher salt concentration. These spectra indicate clays and sulfates suggesting a connection between hydration, salinty and sulfates.

Don Juan Pond related evaporation ponds #4 – WV 42, #3 – DJ 21 and #1 – WV 38 depth profiles have much higher Nitrate concentrations than DJ 39. Overall salinity is lower for evaporation ponds #3 and #1, the most distant ones from Don Juan Pond. Ionic concentrations for the pond soils further demonstrate the connection between NO_3/Cl increases and higher elevations (WV42; approx 0.20, DJ 21 approx. 0.26, WV approx. 0.50). Also common in these three cores is the apparent fractionation of calcium and chloride salts. Eugster and Hardie (1978) [14] describe similar patterns in desert brines. With repeated inundation of storm water runoff and desiccating winds, insoluble calcium sulfate and carbonate precipitate at the surface, while more soluble chlorides remain in solution and accumulate at the bottom of the basin.

The salt concentrations were significantly lower at these two pond sites, less than 200 micromoles/ gram. Lower salinities in the shallow ground waters might have contributed to this phenomenon. The more temperate climate at these sites may have affected less saline pond waters. Torii and Yamagata (1981) hypothesized that freezing temperatures are the dominant cause of concentration and precipitation of salts in the dry valleys. Ionic concentrations for the WV 38, DJ 21, and WV 42 pond soils decrease, while NO_3/CI increase with increasing elevation (WV42; approx 0.20, DJ 21 approx. 0.26, WV 38 approx. 0.50). Also common in these three cores is the apparent fractionation of calcium and chloride salts. Generally, NO_3 concentrations of DJ 39 are lower than those of the evaporite ponds.Don Juan Basin/ Wright Valley cores variability of soluble salt concentrations seems to be dependent on multiple factors including hydrology and sediment age. This observation supports that diverse local alteration processes were operating in proximity over long time periods.

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