**MINERALOGICAL ANALYSES OF SURFACE SEDIMENTS IN THE ANTARCTIC DRY VALLEYS.**

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**Introduction:** Reflectance spectra of bulk particulate samples and Raman spectra of individual grains are coordinated in this analysis of the mineralogy of sediments from the Antarctic Dry Valleys (ADV) region. The samples in this study were collected from the Taylor and Wright valleys near Lakes Fryxell, Vanda and Brownworth. Sediments were sampled from regions surrounding the lakes and from the ice cover on top of the lakes. Major elements were also measured for these samples and are compared with the spectral data in order to asses trends in alteration of the sediments in these cold and dry environments. Differences are observed for the surface sediments in this study compared with lake bottom sediments [1] and samples from soil pits [2,3]. Characterizing the mineralogic variations in these samples provides insights into the alteration processes occurring in the ADV and supports understanding alteration in the cold and dry environment on Mars.

**Methods:** Reflectance spectra were measured from 0.3 to 50 µm of crushed samples dry sieved to <125 µm as in past studies [e.g. 1]. The spectra are a composite of bidirectional spectra collected under ambient conditions at 5 nm spectral resolution from 0.3-1.3 µm relative to Halon and biconical FTIR spectra collected under a dehydrated environment at 4 $cm^{-1}$ spectral resolution from 1-50 µm relative to a rough gold surface. Raman spectra were collected under ambient air of a spot ~1.5 µm in diameter using a confocal microscope as in [4]. The excitation wavelength was 532 nm and the spectral resolution is 4-5 $cm^{-1}$ across the range 100-1400 $cm^{-1}$. Elemental analyses were performed on these surface sediments compared to data from Martian meteorites and Mars as in prior studies [3].

**Results:** Reflectance spectra of these sediments are dominated by quartz, pyroxene and feldspar (Figure 2). Weak features due to aluminosilicates and carbonates are observed in selected samples. Previous studies of lake bottom sediments found high levels of carbonate

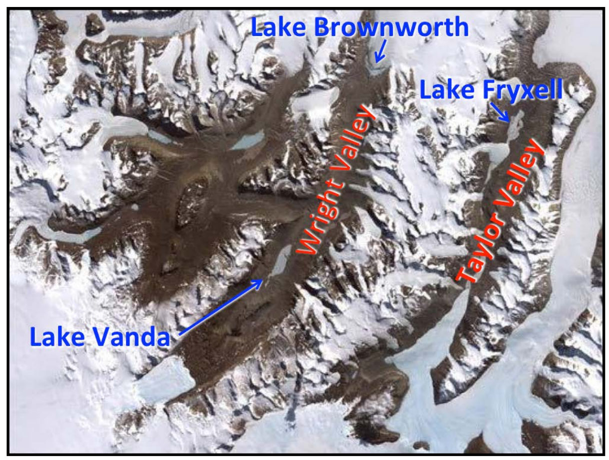


*Figure 1.* View of ADV region showing locations of lakes Brownworth, Fryxell, and Vanda.

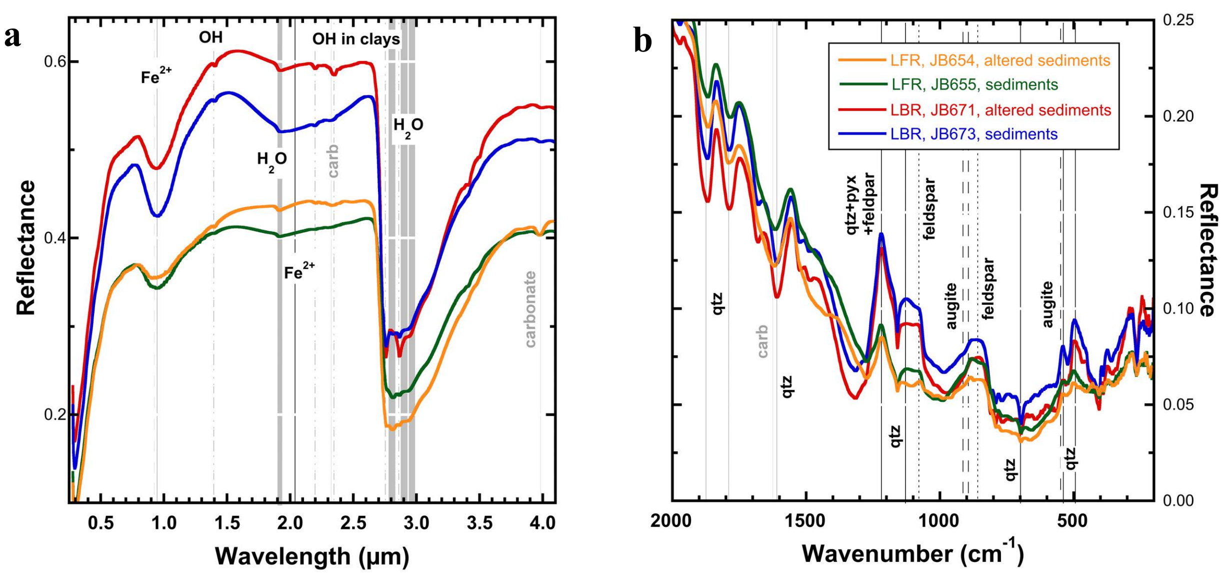


*Figure 2.* Reflectance spectra of selected sediments from the regions surrounding lakes Brownworth and Fryxell: a) VNIR spectra showing bands due to Fe, OH, $H_2O$ and carbonate, and b) mid-IR spectra showing features due to pyroxene, feldspar and quartz.

[1,5,6], which are not observed in these sediments. The aluminosilicates found in the surface sediments and lake bottom sediments are similar in abundance and mineral type. No smectite clays were detected that would indicate alteration in a warm liquid water environment. Instead, allophane was found in both the lake bottom sediments [6] and the surface sediments, which is a good indicator of immature volcanic soils. The amphibole tremolite is also likely present in the sediments but is not attributed to alteration. Reflectance and Mössbauer spectroscopy were coordinated previously [5] to characterize the Fe-bearing mineralogy and determine the relative abundances of pyrite, pyroxene and ferric oxides.

Raman spectra of selected grains in this study are consistent with feldspar, pyroxene and quartz (Figure 3), as observed in an earlier study of lake bottom sediments [7]. Raman spectra of the lake bottom sediments also found evidence for biogenic sulfide being deposited on quartz grains [7].

The Chemical Index of Alteration (CIA) [8,9] is based on mobility of the elements Al, Ca, Na, and K, and was used to assess weathering processes in ADV samples by comparing source rock material CIAs with those of surface sediments [10]. A CIA of ~30-45 is characteristic of fresh basalt, while completely weathered kaolinite has a CIA of 100. CIAs for ADV surface sediments are low, indicating that physical weathering is dominating their formation [10]. K/Th ratios also provide information about provenance and weathering [11]. ADV lake surface sediments exhibit similar trends to potential source rocks [12,13] and data from Mars (Figure 4).

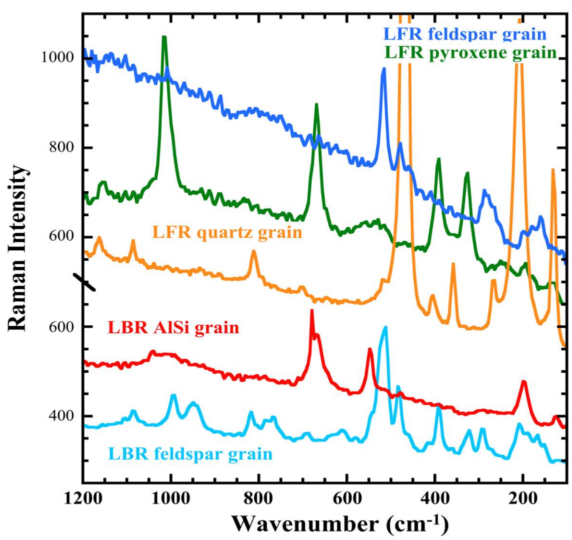


*Figure 3.* Raman spectra of several grains dominated by feldspar, pyroxene, and quartz from the regions surrounding Lake Fryxell (LFR) and Lake Brownworth (LBR). One aluminosilicate grain was also observed that is likely due to tremolite.

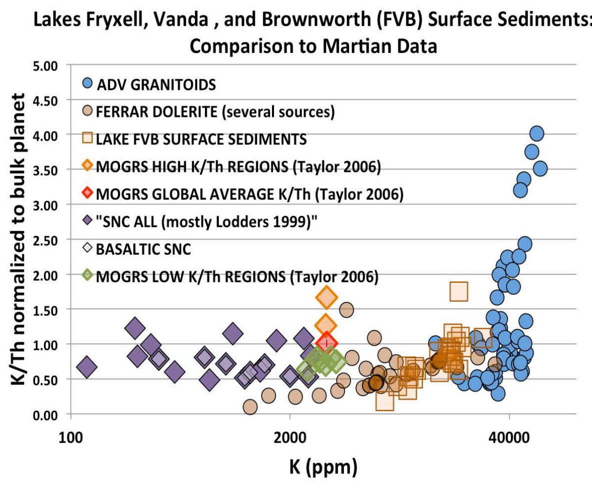


*Figure 4.* K/Th ratios for ADV samples compared with ADV source rocks [12,13], Martian meteorite [15,16] and Martian surface [14] data.

**Discussion and Applications to Mars:** The surface samples studied here are representative of immature volcanic sediments formed largely by physical weathering, while the lake bottom samples exhibit mineralogic and isotopic signatures of biologic processes [1,6], and subsurface sediments provide a history of chemical activity [2,3]. Analyses of sediments from soil pits near Lake Vanda in the Wright Valley found elevated abundances of salts a few cm below the surface [2]. Spectral analyses of these sediments with depth discovered an increase in allophane and the presence of gypsum from ~3-8 cm below the surface [3,10]. This suggests that although the surface sediments in the ADV may be largely unaltered, sediments only a few cm below the surface are experiencing chemical alteration. This study of ADV surface sediments compared to related investigations of lake bottom and subsurface samples suggests that surface regolith on Mars dominated by largely physical processes could be masking sediment or soil material a few cm below the surface that has been altered by current or former chemical activity.

**References:** [1] Bishop J.L. et al. (2003) *IJA*, 2, 273-287. [2] Gibson E.K. et al. (1983) *JGR*, 88, A912-A928. [3] Englert, P. et al. (2013) EPSC, Abstract #96. [4] Böttger, U. et al. (2012) *PSS*, 60, 356-362. [5] Bishop J.L. et al. (2001) GC*A*, 65, 2875-2897. [6] Bishop J.L. et al. (2013) *Icarus*, 224, 309-325. [7] Edwards, H. et al. (2003) JRS, 6, 458-462. [8] Nesbitt H.W. & Young G.M. (1982) *Nature, 229*, 715-717. [9] Fedo C.M. et al. (1995) *Geology, 23*, 921–924. [10] Englert P. et al. (2012) *LPS* XLIII Abstract #1743. [11] Taylor G. J. et al. (2006) *JGR, 111*, doi: 10.1029/2006-JE002676. [12] Allibone A.H. et al. (1993) *NZ J. Geol. Geophys., 36*, 299-316. [13] Elliot D.H. et al. (1999) *EPSL, 167*, 89-104. [14] Taylor G. J. et al. (2006) *JGR, 111*, E03S08, doi: 10.1029/2006JE002679. [15] Meyer, C., Jr. (2009) *Mars Meteorite Compendium JSC#27672*. [16] Lodders, K. (1998) *MAPS, 33*: A183–A190.