CHARACTERIZATION OF VOLCANIC MATERIAL FROM FUERTAVENTURA AS A POTENTIAL MARS ANALOG SITE. J. M. Danielsen[1,2], J. L. Bishop[2] and L. Gruendler[2], [1]San Jose State University (San Jose, CA; jacob.danielsen@sjsu.edu), [2]SETI Institute (Mountain View, CA).

Introduction: Surface rocks and tephra were investigated on the volcanic island of Fuertaventura, which lies approximately 95 km northwest of Morocco. Fuertaventura provides a possible analog for the Martian surface because of its igneous origin and the abundant clays and aqueous minerals present in the altered volcanic material. This island receives little rainfall, has high winds, and is sparsely vegetated, which makes it more similar to Mars than other volcanic islands. Samples were analyzed using visible/near infrared (VNIR) spectroscopy to determine mineralogical and chemical changes in the rock and altered tephra. This study also provides VNIR spectral data of phyllosilicate and sulfate-bearing volcanic material for comparison with orbital CRISM data of Mars.

Methods: Rock and tephra samples were collected near Gairia Caldera on Fuertaventura (Figure 1). Samples were collected in several locations including along the rim of the caldera and at a dry streambed nearby. Samples were labeled in the field using “FV” (Fuertaventura) followed by a sample number.

Figure 1. *Island of Fuertaventua and location of sample collection sites near Gairia Caldera.*

Samples. The altered tephra samples were dry sieved and/or ground into multiple size fractions. This study focuses on the 125-250 μm size fraction. One soil/tephra sample (FV-14) consisted of a variety of differently colored grains. These grains were sorted and separated visually by hand (Figure 2). Whole rock samples were measured at various positions on the rock surface; then portions of the rocks were crushed and dry sieved into several different size fractions.

Spectral Measurements. VNIR spectra of the samples were measured under ambient conditions in the lab from 0.35 – 2.5 μm relative to Halon using an ASD spectrometer. Each sample was measured at least twice and the data were averaged.

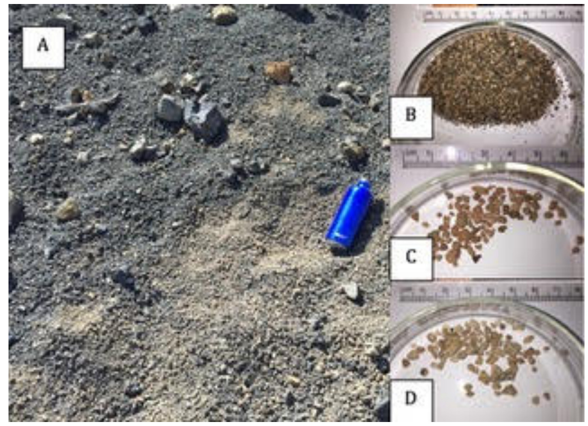

Figure 2. *FV-14 sample. (A) view of sampling site with water bottle for scale, (B) homogenized sample grains, (C) FV-14 Orange grains, and (D) FV-14 Tan grains.*

Results: All samples are of volcanic origin with many samples showing evidence of chemical alteration to phyllosilicates and sulfates.

VNIR spectra of six samples are shown in Figure 3. These spectra contain bands near 1.41 – 1.45 and 1.91 – 1.92 μm due to overtones and combinations of H_2O bending and stretching vibrations. This includes H_2O in the mineral structure and adsorbed on the grain surfaces. These spectra also exhibit bands near 1.4 and 2.1 – 2.4 μm that are consistent with vibrations of OH groups in the mineral structure.

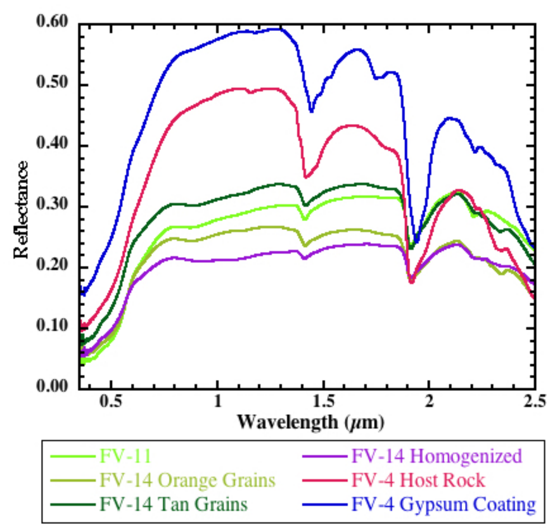

Figure 3. *VNIR spectra showing six samples collected near Gairia Caldera, Fuertaventura.*

OH vibrations in the range 2.1 – 2.4 μm allow for identification of specific phyllosilicate minerals. The spectra of selected FV samples are shown compared to phyllosilicate spectra in Figure 4.

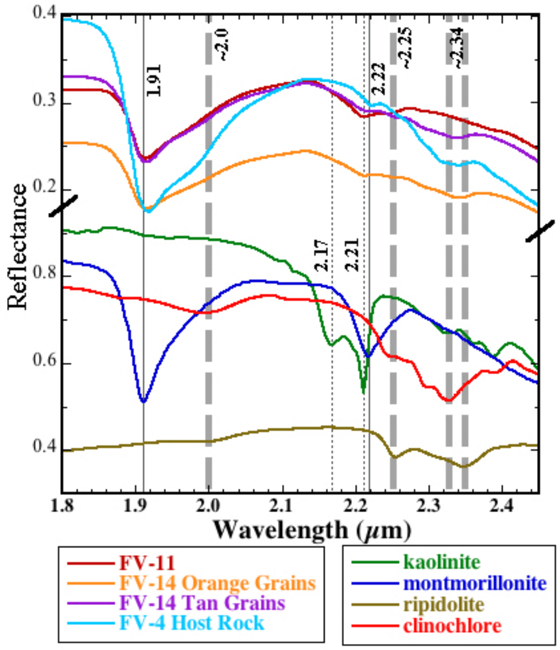

Figure 4. *VNIR spectra of FV samples and clay mineral standards. Lines mark key spectral features.*

The spectra of FV samples FV-11, FV-14 orange and tan grains in Figure 4 have predominant bands near 1.91 and 2.21 μm that are characteristic of the Al-rich phyllosilicate montmorillonite [1]. These spectra also have a shoulder feature from 2.17 – 2.21 μm that is consistent with the Al-rich phyllosilicate kaolinite. Bands near 2.33 – 2.35 μm are exhibited predominantly in spectra of FV-4 and in FV-14 (orange & tan grains), and are accompanied by weak features near 2.0 and 2.25 μm. All of these features are consistent with Mg-rich chlorites [2]. The FV-14 orange and tan grains have a higher Fe abundance than the FV-4 host rock because of the position of the bands near 2.25 and 2.35 μm exhibited in the FV-14 spectra.

Figure 5. *Image showing sample FV-4 rock with light-orange coating. Circle indicates location of visible gypsum crystals.*

Sample FV-4 contained a thin light-orange coating with visible crystals (Figure 5). Spectral analysis of this coating indicates bands near 1.45, 1.75, and 1.95 μm (Figure 6). These spectral features are consistent with gypsum [2]. The coating probably formed on top of this volcanic rock due to the close proximity of the ocean salts.

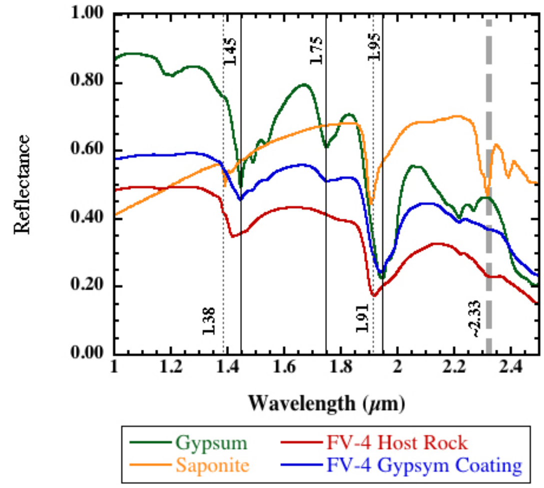

Figure 6. *VNIR spectra of FV-4 host rock, FV-14 gypsum coating, gypsum standard and saponite.*

The FV-4 host rock spectral signature includes bands near 1.38, 1.91, 2.31 and 2.33 μm that are consistent with saponite (Mg-rich smectite) and Mg-rich chlorite. The weak band at 2.22 μm and the shoulders near 1.45, 1.75 and 1.95 μm could be due to minor gypsum. No other collected samples exhibited bands at 1.75 μm consistent with sulfates.

Summary and Application to Mars: Spectral analysis of samples collected on Fuertaventura indicate that the montmorillonite and kaolinite are present in many samples and that the larger tephra pieces and the host rocks contain Fe/Mg-smectites and chlorites as well. Gypsum was only found in one sample in this study and it was concentrated in a coating on one side of the rock. Gypsum and all of these clay minerals have been observed in aqueous outcrops on Mars [3]. Thus, characterizing the volcanic alteration on Fuertaventura may provide insights on the formation of aqueous outcrops on Mars.

References: [1] Bishop J. L. et al. (2014) *American Mineralogist*, 99, 2105-2115. [2] Bishop J. L. et al. (2008) *Clay Minerals*, 43, 35-44. [3] Murchie S. L. et al. (2009) *J. Geophyscal Research, 114,* doi:10.1029/2009JE003342.