VISIBLE AND NEAR-IR REFLECTANCE SPECTRA OF MARS ANALOGUE MATERIALS UNDER ARID CONDITIONS FOR INTERPRETATION OF MARTIAN SURFACE MINERALOGY. R. V. Morris1, T. G. Graff2, C. N. Achilles3, D. G. Agresti1, D. W. Ming1, and D. C. Golden2. 1ARES NASA Johnson Space Center, Houston TX 77058 (richard.v.morris@nasa.gov), 2Jacobs Technology ESCG, Houston, TX 77058, 3University of Alabama at Birmingham, Birmingham AL 35294.

Introduction: Visible and near-IR (VNIR) spectra from the hyper-spectral imagers MRO-CRISM and Mars Express OMEGA in martian orbit have signatures from Fe-bearing phases (e.g., olivine, pyroxene, and jarosite), H2O/OH-bearing phases (e.g., smectites and other phyllosilicates, sulfates, and high-SiO2 phases), and carbonate [e.g., 1-5]. Mineralogical assignments of martian spectral features are made on the basis of VNIR spectra acquired in the laboratory under appropriate environmental conditions on samples whose mineralogical composition is known. We report here additional results for our ongoing project [6] to acquire VNIR spectra under arid conditions.

Samples and Methods:

Our focus here is 14 H2O/OH bearing phases. Samples containing primarily OH are KGA-1 (kaolinite; Georgia), SRPSSLO1 (serpentine, CA), CHLCLV1 (chlorite, CA), and IMT-1 (illite, MT). Samples containing both OH and H2O are CBZAZ1 (chabasite, AZ), HWMK919 (palagonite, HI), API-33A (nontronite, WA), PHY07 (nontronite, PA), NAU-1 (nontronite, Australia), SWA-1 (ferruginous smectite, WA), SWY-1 (montmorillonite, WY), STX-1 (montmorillonite, TX), BSDMNT1 (bentonite, SD), and SAPCA-1 (saponite, CA). All samples were fine powders (<150 µm) except HWMK919 (<5 µm) and PHY07 (<38 µm).

VNIR spectra were acquired at ~25°C with an Analytical Spectral Devices (ASD) FieldSpec3 spectrometer that was located inside a one-atmosphere glove box that was purged with dry N2 gas (from liquid N2). A hot plate (ambient to 400°C), a dewpoint meter to measure the H2O content of the gas atmosphere (Vaisala DRYCAP DM70), and an IR thermometer (Fluke Model 66) were also in the glove box.

A typical experiment sequence was to: (1) load samples into a Al-metal sample cup (painted with optical black paint) and acquire spectra in the glove box under ambient lab conditions (blue); (2) acquire spectra at ~25°C after a known time of N2 purge with the sample at ~25°C (green); (3) acquire spectra at 25°C after a known time of purging with the sample at ~110°C (brown); (4) acquire spectra at 25°C after a known time of N2 purge with the sample at ~210°C (red); and (5) acquire a spectrum at 25°C after a known time in laboratory air with the sample at 25°C (dark blue). The post-heating measurements were done as soon as the sample cooled to 25°C. Typically, the H2O content of the glove box was ~80 to ~140 ppmv at the end of steps (2), (3), and (4). We estimate an ~20 ppmv O2 content from measurements in a separate chamber that was N2-purged in the same way. The time intervals for each step are summarized in Table 1.

Backscatter Mössbauer (MB) spectra were acquired at room temperature using MER-like MIMOS-II spectrometers from SPESI [c.f., 7]. MB measurements were made on bulk sample inside air-tight plastic containers that were filled with sample inside the glove box.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Typea</th>
<th>N2, 25°C</th>
<th>N2, 110°C</th>
<th>N2, 210°C</th>
<th>Air, 25°C</th>
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<td>1206</td>
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</table>

a nont = nontronite, mont= montmorillonite, bent = bentonite, kaol = kaolinite, sapn = saponite, chlr = chlorite, serp = serpentine, zeol = zeolite, palg = palagonite.

b N2 gas atmosphere with 80 – 140 ppmv H2O and ~15 ppmv O2 at ~25°C at the end of each step.
c Lab air atmosphere with 8000 – 13000 ppmv H2O.
d Sample temperature in N2 or air atmosphere.

Results and Discussion: The OH spectral features of the OH-only samples (KGA-1, SRPSSLO1, CHLCLV1, and IMT-1) do not significantly change in an arid environment, as expected (Fig. 1a - 1d). The zeolite (CBZAZ1) does appear to loose some H2O, as can be seen by comparison the red and dark blue spectra at ~1.92 μm (Fig. 1e). The palagonite lost all detectable H2O (no 1.91 μm band; red spectrum; Fig. 1f).

The samples in Fig. 2 are all smectites, and thus have both M-OH and interlayer H2O. With increasing loss of H2O (decreasing intensity of the ~1.91 μm band), the position of the 1.40 μm band shifts in accordance with a higher contribution of OH from M-OH than from H2O (e.g., Fig. 2g). Note that all smec-
tites re-acquire their interlayer H₂O upon exposure to lab air (step 5). Powder X-ray diffraction data show that the interlayer is fully collapsed for the nontronites (step 4) [7].

All spectra show to varying degrees a decrease in albedo in the region between ~0.4 and 1.7 μm by the end of step 4. The change is especially evident for the zeolite (Fig. 1e) and the smectites (Fig. 2). Furthermore, this decrease is still present after prolonged exposures to humid lab air (step 5). A possible explanation is precipitation of ferric oxide particles during the thermal treatments. However, MB evidence (not shown) for this explanation is not compelling.

The spectra that result from thermal treatments at 25°C, 110°C, and 210°C (Fig. 1 and Fig. 2) in arid atmospheres for laboratory timescales are reasonable surrogate spectra for geologic timescales on Mars at lower temperatures.
