MAPPING WATER AND WATER-BEARING MINERALS ON MARS WITH CRISM. R. N. Clark[1], G. A. Swayze[2], S. L. Murchie[3], F. P. Seelos[3], C. E. Viviano-Beck[3], and J. Bishop[4], [1]Planetary Science Institute, Tucson, AZ, [2]U.S. Geological Survey, Denver, CO, [3]Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, [4]SETI Institute, Mountain View, CA.

Introduction: Water is expressed in martian spectra mainly at two wavelengths in the near infrared: near 3-microns, the O-H stretching fundamental, and near 1.9 to 2.1 microns with an OH stretch + H-O-H bend combination (hereafter called the 2-micron absorption). A third location, the first overtone of the O-H stretch, near 1.4 microns may also appear. The 3-micron absorption shows strongly in every CRISM Mars spectrum we have examined except when fresh CO_2 frost covers the surface with sufficient depth. Where present, the 3-micron water absorption is saturated, indicating the presence of water in the percent range but shows little variability in band depth across the surface. The pervasive fine grained dust on Mars creates increasing scattering at shorter wavelengths, weakening or masking the apparent 1.4-micron water absorption in Mars reflectance spectra. That leaves the 2-micron water absorption often as the most diagnostic absorption for detecting larger amounts of water in the optical surface. Frequently the 2-micron absorption is stronger than the metal-OH combination bands in the 2.2- to 2.3-micron region.

Historically, the 2-micron water absorption has received little attention as a feature to diagnose mineralogy. However, with available spectral libraries, we can examine if this feature might be diagnostic of mineralogy. Different mineral groups have different hydrogen bonding, shifting the position and width of the water absorption (Figure 1). Analysis of available spectra obtained in dry environments [1] show that some minerals or mineral groups can be uniquely identified. Along with the wavelength position and width of the absorptions plotted in Figure 1, the shape, including asymmetry and shoulders from overlapping water absorptions further separate absorptions from different minerals, improving discrimination.

We use the new CRISM Map-projected Targeted Reduced Data Record (MTRDR) image cubes [2] to enable a new sophistication in detection and mapping of materials using the 1.9-micron water feature. We have developed a new version of Tetracorder [3] that expands capabilities and wavelength range allowing for more sophistication of the expert system for identification and mapping of materials in CRISM data. The new system includes automated curved continua to detect trace compounds whose spectral features are superimposed on other spectral features. For example, curvature of the 2-micron pyroxene absorption creates a false positive water absorption detection if straight line continua are used. Curved continua reduces the false positives, enabling weaker water spectral features to be detected.

Results: We have analyzed over 200 CRISM scenes, and find diverse signatures of water using the 2-micron absorption. We find water bearing zeolites and sulfates are most common in the scenes mapped so far. Also abundant are hydrated silica, and smectite clays. An example result is shown in Figure 2, where mixed zeolites and sulfates dominate. The results, like those shown in Figure 2, can be further sub-divied into the specific zeolites and specific sulfates indicated by the absorption positions and shapes.

We find water rich materials are commonly found wherever there are erosion slopes. The top surface layer appears desiccated, consistent with Feldman et al. (AGU 2015 abstract). We find diverse water-bearing mineralogy eroding from slopes, often in complex mixtures as shown in Figure 2, or mono-minerologies in other locations.

The latest mapping results will be presented at the meeting.

References: [1] Clark R. N., et al. (2007) USGS digital spectral library splib06a: *U.S. Geological Survey*, Data Series 231, http://speclab.cr.usgs.gov/spectral-lib.html. [2] Seelos, F. P., M. F. Morgan, H. W. Taylor, S. L. Murchie, D. C. Humm, K. D. Seelos, O. S. Barnouin, C. E. Viviano, and C. R. I. S. M. Team (2012), CRISM Map Projected Targeted Reduced Data Records (MTRDRs) – High level analysis and visualization data products, in Planetary Data: A Workshop for Users and Software Developers, U.S. Geological Survey, Reston, Va. [3] Clark, R.N., Swayze, G.A., Livo, K.E., Kokaly, R.F., Sutley, S.J., Dalton, J.B., McDougal, R.R., and Gent, C.A., 2003, Imaging spectroscopy: Earth and planetary remote sensing with the USGS Tetracorder and expert systems, Journal of Geophysical Research, Vol. 108(E12), 5131, doi:10.1029/2002JE001847, p. 5-1 to 5-44, December, 2003. http://speclab.cr.usgs.gov/PAPERS/tetracorder

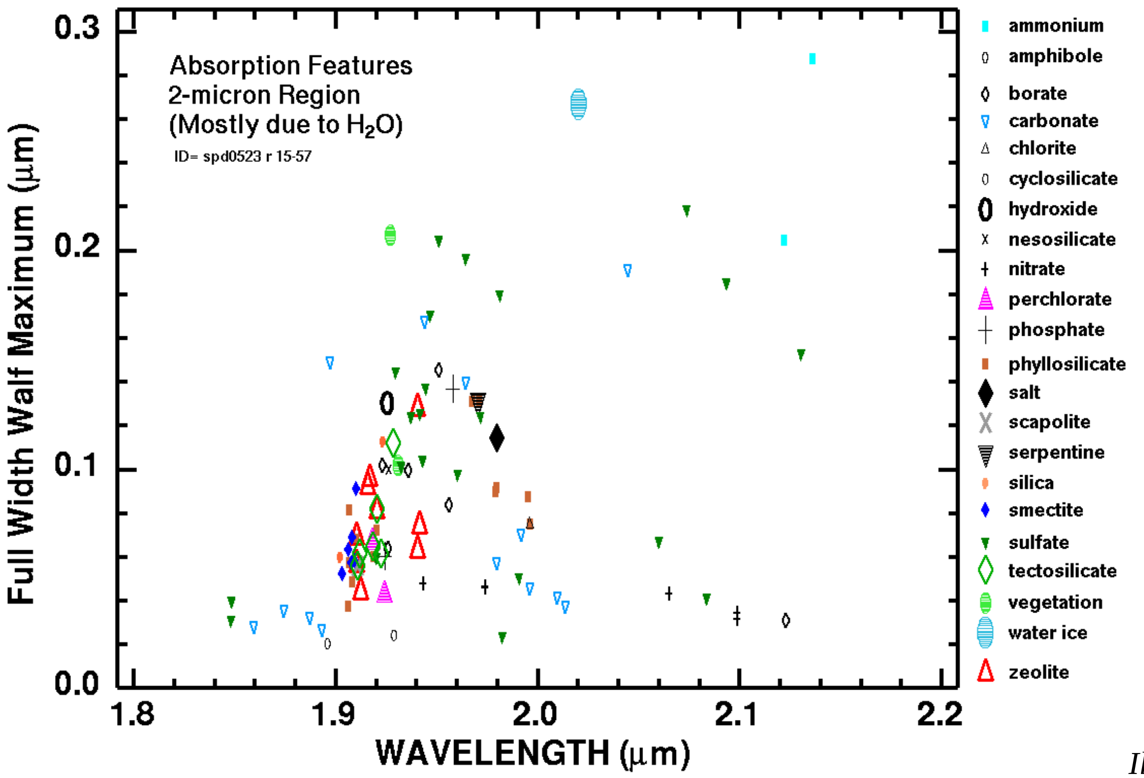

Illustration 1: Figure 1. Water absorption positions and widths derived from the USGS spectral library [1] for materials measured in a dry environment.

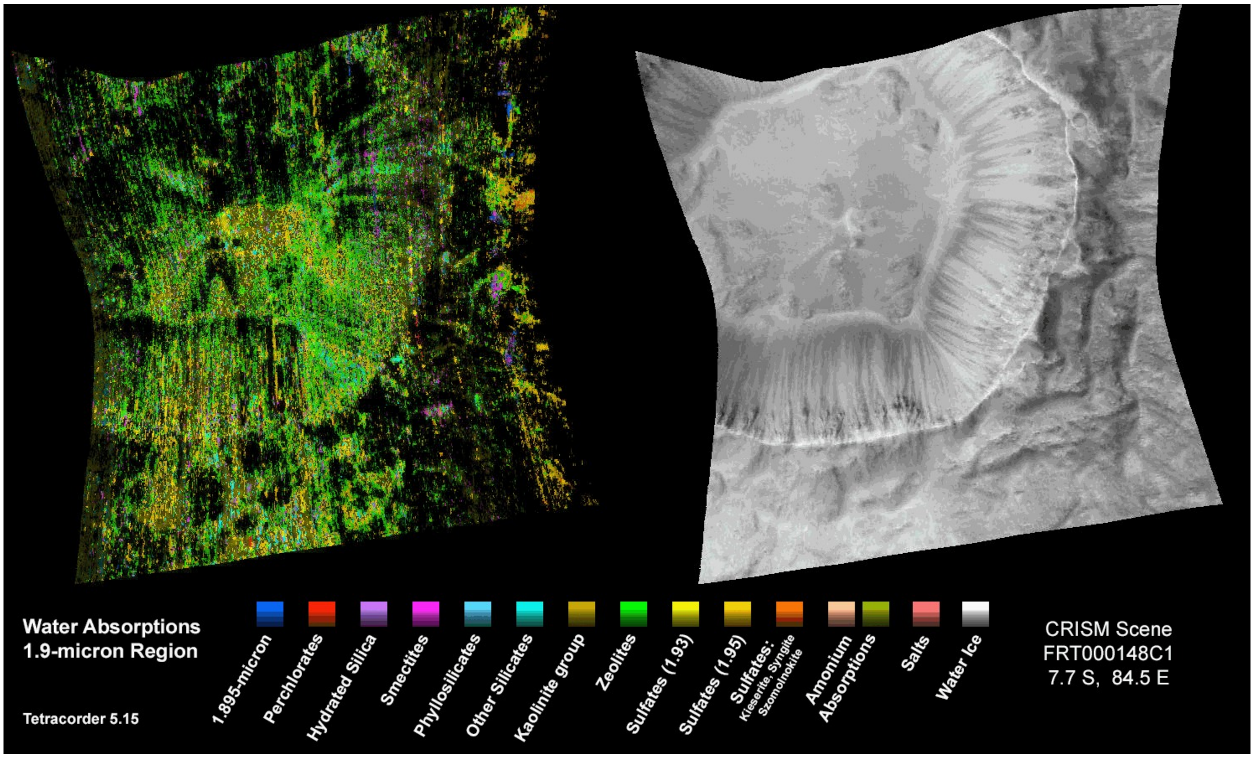

Illustration 2: Figure 2. CRISM Tetracorder water absorption map for 14 possible compounds, not all of which were found in this scene. Here zeolites and sulfates dominate.