SPECTROSCOPIC REMOTE SENSING OF SOLAR SYSTEM ICES: LABORATORY RESEARCH AND APPLICATIONS FOR MAPPING COMPOUNDS. Roger N. Clark, U. S. Geological Survey, Mail Stop 964, Box 25046 Federal Center, Denver, CO, 80225, USA, rclark@usgs.gov.

Introduction: Spectroscopic remote sensing is the dominant method for studying surface composition of solid surfaces in the solar system, from Earth-based telescopes, spacecraft, and from landers. Chemical composition is a key component to understanding the origin and evolution of planetary surfaces.

Many spectrometers and imaging spectrometers have flown, are currently flying/orbiting and will soon be encountering solar system bodies. We currently have huge data banks of imaging spectroscopy data for the Earth, Mars, Jupiter and Saturn systems, as well as some asteroids, comets, and soon Pluto.

Spectroscopy: Imaging spectrometers acquire data with enough spectral range, resolution and sampling at every pixel in a raster image so that individual absorption features can be identified and spatially mapped. Further, with such sampling, the information in the spectral data are inherently self-verifying in many cases using known information in the remote scene [1]. This verification allows refinement and monitoring of spectral wavelength calibration (e.g., using known absorptions) as well as surface reflectance (e.g., spikes and offsets are "non-physical"). Imaging spectrometers are being used to map many minerals, amorphous materials, man-made materials (on the Earth), and sample solids, liquids and gases.

However, interpretation of solar system of solid surfaces spectroscopic data remains a challenge. Presently, we have no theoretical models that can generate spectra of molecular solids, and the radiative transfer models currently in use have deficiencies. While modeling is important for understanding compositional details, those models must employ basic spectroscopic data derived from laboratory measurements. With tens of thousands of compounds, plus complexities of elemental substitutions into lattices causing shifting of absorption band positions, combined with temperature and pressure effects, radiation damage/modification, and grain size effects, decades of laboratory research has only scratched the surface of what is needed to rapidly interpret exotic planetary surfaces. In some cases, even basic compounds have yet to be measured with spectroscopy. In other cases, measurements have only been made of thin films in transmittance whereas remote observations are made in reflectance or emittance. Sometimes measurements have been made at room temperature and applied to outer solar surfaces without knowing that temperature radically changes the spectrum of the material. Limited a wavelength ranges or poor spectral resolution in either the observed or laboratory data can lead to identifications of compounds not supported by other wavelength ranges/resolutions. New absorption features are discovered in planetary data for which there are currently no known compounds that match, thus driving the need for expanding current spectral databases. Some laboratory data only exists in one wavelength region (e.g. mid-infrared transmittance), when the preponderance of remotely-sensed spectra of solar system ices is from the UV to near infrared (reflected solar radiation wavelength range, ~0.1 to ~5 microns).

Discussion: This talk will review some of the applications that have already been accomplished, current problems, topics that might be addressed in the near future, and it will discuss some of the difficulties in advancing the science of mapping chemistry of solar system ices. Historical examples will be shown as well as recent results from current missions such as Cassini.

References:

[1] Clark, R. N., G. A. Swayze, K. E. Livo, R. F. Kokaly, S. J. Sutley, J. B. Dalton, R. R. McDougal, and C. A. Gent, Imaging spectroscopy: Earth and planetary remote sensing with the USGS Tetracorder and expert systems, *J. Geophys. Res.*, 108(E12), 5131, doi:10.1029/2002JE001847, pages 5-1 to 5-44, December, 2003.