Cryogenic Infrared Reflectance Spectroscopy of Acetylene and Cyanoacetylene. John M. Curchin[1], Clark, R.N[1]., Shaffer, C.[2], Mc Mahon, R.J.[2], and Hoefen, T.M.[1], [1]U.S. Geological Survey, Mail Stop 964, Box 25046 Federal Center, Denver, CO, 80225, USA, jcurchin@usgs.gov, [2]Deptartment of Chemistry, University of Wisconsin, Madison, Wisconsin, 53706, USA

Introduction: As part of the USGS Spectroscopy Lab's continuing efforts to integrate organic compounds into its spectral database, the primary alkyne, acetylene (C_2H_2), and the first of the cyano-polyyne series ($HC_{2n+1}N$), cyanoacetylene, HC_3N have now been characterized in the visible and near to mid-infrared. Each compound was investigated in reflectance, over the wavelength range from 0.35 microns to 15.5 microns (Fig. 1). Measurements were taken at approximately 80 Kelvins for the pure substance, and in each case the sample was a white ice that was ground to a fine powder. Additionally, both compounds were mixed with a dark spectrally neutral compound and measured again in order to unsaturate the deep C-H stretch absorptions near 3 microns.

Results: In doing so, we explore the nature of the C-H stretch when associated with a carbon-carbon triple-bond skeleton, and find that the absorption moves from approximately 3.36+ microns in the singly carbon-bonded alkanes, to 3.24+ microns in the doubly-bonded alkenes, and to 3.05 microns in the alkynes [1], in response to the increasing strength of the multiply-bonded carbon backbone. As such, acetylene ice can be mistaken for water ice on a planetary surface when imaged by relatively low resolution spectrometers. We caution investigators not to mistake acetylene ice for water ice when interpreting spectra of icy satellite surfaces based on a 3 micron feature.

Numerous other fundamental, overtone and combination absorption bands are identified and compared, particularly absorptions due to the C≡C and C≡N bonds. This has allowed a current discrepancy in the organic spectroscopic literature regarding these triply-bonded band assignments to be resolved, as well as shed light on the nature of cyanide compounds in the mysterious 'dark component' of the icy surfaces of numerous Saturnian satellites. Finally, reflectance spectra of cyanoacetylene frost, a possible component in the haze aerosols and on the surface of Titan, will be presented publicly for the first time.

References:

[1] Clark, R.N., Curchin, J.M., Hoefen, T.M., and Swayze, G.A. (2008), Reflectance Spectroscopy of Organic Compounds I: Alkanes, J. Geophysical Research (in review).

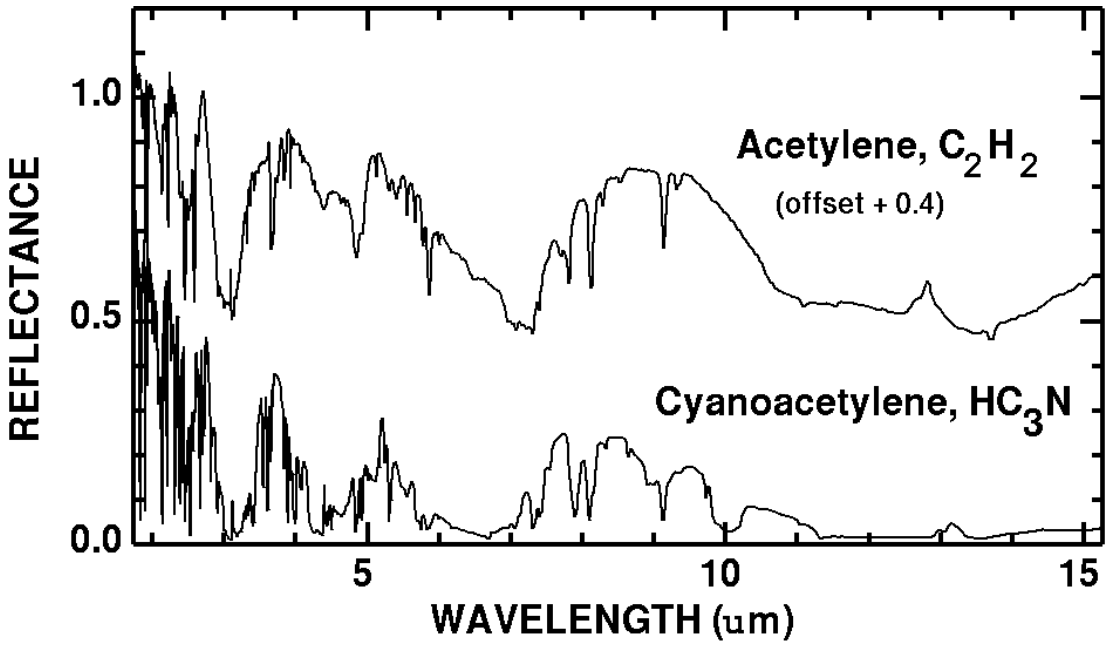

Figure 1. Reflectance spectra of pure acetylene and cyanoacetylene powders.