LINEAR UNMIXING OF FINE PARTICULATE MATERIALS: IMPLICATIONS FOR COMPOSITIONAL ANALYSES OF PRIMITIVE ASTEROIDS. V. C. Lowry[1], K. L. Donaldson Hanna[1], H. Campins[1], N. E. Bowles[2], and V. E. Hamilton[3], [1]University of Central Florida, Orlando, FL, USA, [2]University of Oxford, Oxford, UK, and [3]Southwest Research Institute, Boulder, CO, USA.

Introduction: Linear least squares unmixing of infrared spectra is a fast and effective way to spectrally estimate the modal mineral abundances of laboratory samples and remotely sensed surfaces to within 5% on average [e.g., 1]. This technique has been applied to spectra of whole rocks, coarse particulates, meteorites, and the Martian surface to successfully determine modal abundances [e.g., 1-3]. With the recent arrival of NASA's OSIRIS-REx spacecraft to asteroid 101955 Bennu, the OSIRIS-REx Thermal Emission Spectrometer (OTES) has been providing a wealth of data to interpret using spectral unmixing techniques [e.g., 4].

We investigate the effectiveness of a weighted linear least squares (WLS) unmixing approach to estimate mineral abundances for samples dominated by fine particulates (< 38 μm). The WLS algorithm is based on previous linear least squares algorithms [e.g., 1-3]. By implementing a WLS unmixing algorithm, one is able to deconvolve these mixed spectra into areal percentages of each endmember that corresponds to the volume percentages [e.g., 1-3]. Results from this investigation have implications for the interpretation of spectral observations of primitive asteroids that have some amount of fine particulate regolith that can be remotely sensed.

Data and Methods: Here we used TIR laboratory spectra of a suite of physical mixtures and meteorites obtained under ambient (Earth-like) and simulated asteroid environment (SAE) conditions collected as a part of the OSIRIS-REx blind test [5]. We will use the WLS algorithm to unmix these blind test spectra to determine their end member abundances. Our spectral library includes spectra of fine particulate end members San Carlos olivine, Kakanui augite, Johnstown enstatite, calcite, saponite, magnetite, troilite, spinel, pyrrhotite, cronstedtite, and albite [5]. In addition, a blackbody end member was added to the spectral library [6]. We also applied modified versions of the WLS algorithm, including a sum-to-one (STO) constraint based on a model by Heinz and Chang [7], and a prior knowledge of abundances (PKA) algorithm based on the work by Rodgers [8], to the spectral data. The prior knowledge of abundances information was obtained from Table 1 of the OSIRIS-REx blind study data [5].

Results and Discussion: The WLS algorithm used in this investigation underestimated the modal abundances of the dominant mineral phases in all of the physical mixture and meteorite spectra. Minor phases in the mixtures and meteorites (abundances ≤ 5%) were typically not modeled, which is not surprising given the uncertainties in the technique shown previously [1-3]. Additionally, phases not present in the mixtures were commonly selected to account for spectral slopes and small spectral features, and to reduce the albedo and the spectral contrast of features of the mineral phases in order to get the best mathematical fit.

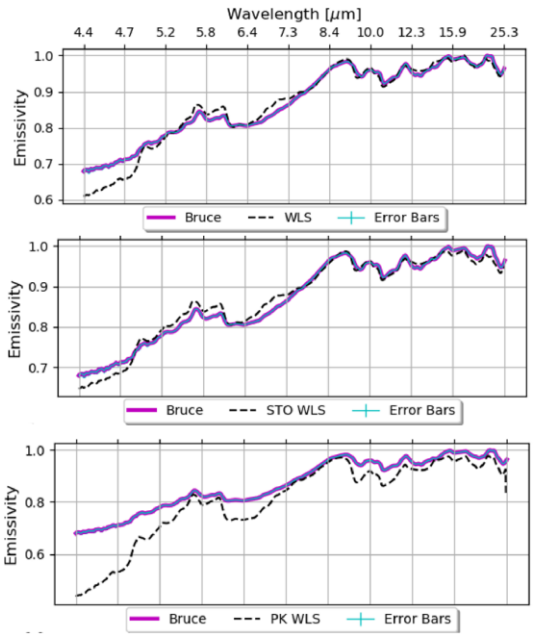

Figure 1. The model fits: WLS (top panel), STO (middle panel), PKA (bottom panel) to the anhydrous ambient Bruce spectrum from [5].

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