# 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. Bowles[2], V.E. Hamilton[3]

[1] *University of Central Florida, Orlando, FL, USA*
[2]*University of Oxford, Oxford, UK*
[3]*Southwest Research Institute, Boulder, CO, USA*
vanessa_lowry@knights.ucf.edu

**Abstract**. 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].

The assumption of linear spectral unmixing allows for the deconvolution of a mixed spectrum if the individual spectra and particle sizes of the pure end members are present within a spectral library. By implementing a weighted linear least squares (WLS) unmixing algorithm, one is able to deconvolve these mixed spectra into areal percentages of each endmember with the underlying assumption that this then corresponds to the volume percentages [e.g., 1-3]. At thermal infrared (TIR) wavelengths, end member spectra of coarse particulates combine linearly due to high absorption coefficients and relatively small mean optical paths, which limits most of the volumetric scattering [e.g., 1-3]. Linearity in the TIR region continues as particle size decreases until the wavelength of light approaches the particle size, at this point particles become optically thin and non-linear behavior (e.g., volumetric scattering) is observed. However, Ramsey and Christensen [1] demonstrated that when unmixing fine particulates (10 – 20 μm) with a spectral library of end members at the same particle size linear unmixing can still be used to estimate modal mineral abundances.

In this study we investigate the effectiveness of a linear least squares unmixing approach to estimate mineral abundances for samples dominated by fine particulates (< 38 μm). We use a WLS algorithm and a spectral library of fine particulate pure minerals to unmix spectra of a suite of fine particulate, primitive asteroid analogs. Results from this investigation have implications for the interpretation of spectral observations of primitive asteroids that have a layer of fine particulate regolith.

[1]Ramsey M. S. and Christensen P. R. (1998) *JGR, 103,* 577-596. [2]Hamilton V. E. and Christensen P. R. (2000) *JGR, 105,* 9717-9733. [3]Rogers A. D. and Aharonson O. (2008) *JGR, 113,*EO6S14. [4]Hamilton V. E. et al. (2019) *Nature Astron., 3,* 332-340.