Eros Spectral Properties and Geologic Processes from Combined NEAR NIS and MSI Data Sets. N. R. Izenberg[1], S. L. Murchie[1], J. F. Bell III[2], L. A. McFadden[3], D. D. Wellnitz[3], B. E. Clark[4], and M. J. Gaffey[5], [1]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, Maryland 20723, USA, noam.Izenberg@jhuapl.edu, [2]Cornell University, Center for Radiophysics and Space Research, [3]University of Maryland, Astronomy Department, [4]Ithaca College, Physics Department, [5]University of North Dakota.

Introduction: We improve and extend the effective spectroscopic dataset for Eros acquired by the Near Earth Asteroid Rendezvous (NEAR) Shoemaker spacecraft to better understand the properties and geologic processes of the asteroid. We improve the Near Infrared Spectrometer (NIS) calibration by remediation of internally scattered light and extend its effective spectral range from a shortest wavelength of 812 nm to 754 nm by deriving a "pseudo channel" for NIS at 754 nm using Multispectral Imager (MSI) Eros approach color maps. We synthesize a 3127-spectrum high-resolution (footprint sizes from 213x427 m to 394x788 m) northern hemisphere dataset (Fig. 1) with the improved calibration and expanded wavelength coverage to investigate global and localized spectral variation with respect to mineralogy, composition, and space weathering of Eros.

Scattered Light Removal: The NIS instrument experiences some internal scatter of light from the spectrometer's grating not accounted for in earlier calibrations [1]. This results in higher measured light levels, especially in longer wavelength channels (adding to apparent spectral "redness"), and slightly different shape to the 1- and 2-micron absorption features. We generate an empirical correction for NIS by going back to ground calibrations and deriving am out-of-band light removal "filter" for each NIS channel. We apply the filter to ground data to re-derive the radiance calibration and again to the average calibrated spectrum to create a scalar correction for all calibrated spectra. Scattered light removal reduces the "red" slope of Eros spectra, though not to the level seen by telescopic observations [2] (Fig. 1).

Extension of NIS Spectrum to 754 nm. In order to extend the effective NIS spectrum to 754 nm, we generate a "pseudo channel" for NIS using MSI global approach color data. We co-register MSI global color maps [3], with high resolution NIS spectra of similar and smaller footprint size. We generate a value for NIS at 754 nm by multiplying NIS channel 7 (745.9 nm) by the MSI 754/951 nm color ratio (MSI filters 3 and 4, respectively). The pseudo channel completes sampling of Eros' 1-micron (Band I) absorption feature, enabling direct comparison of NIS data with other asteroid and meteorite spectra without additional scaling or correction. Following scattered light

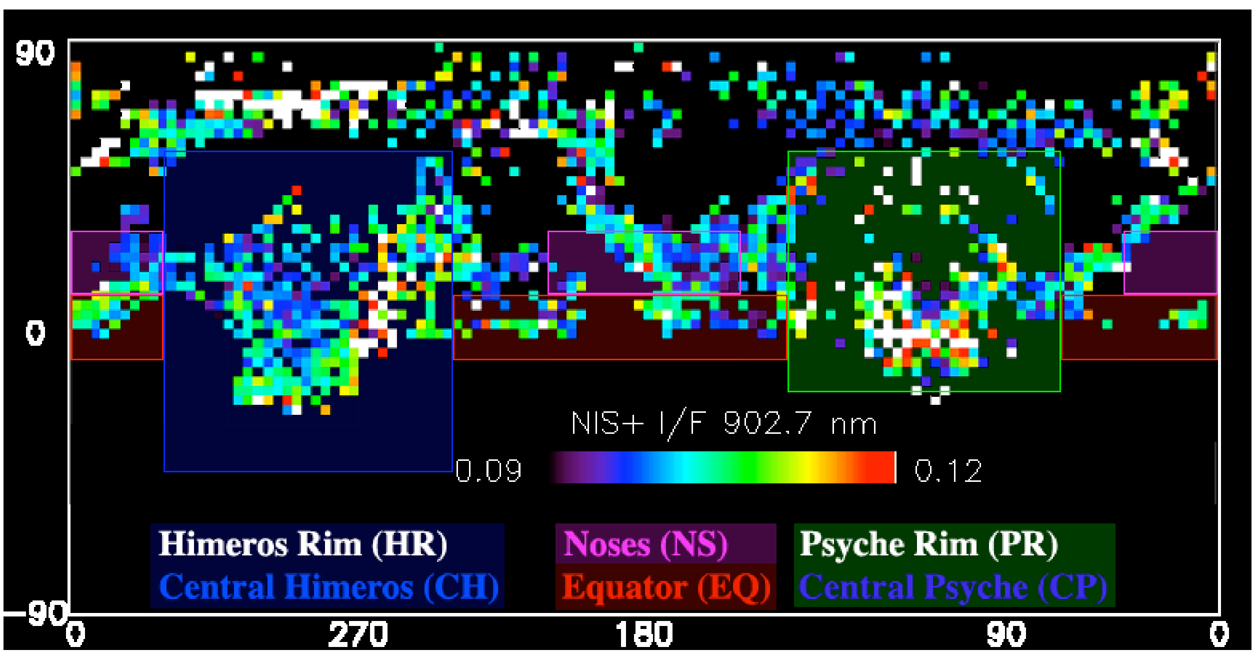

Fig 1. Coverage of NIS high resolution, scatter corrected, extended spectral data on Eros. Individual points are 3x3 degree area boxes indicating co-registration of NIS and MSI data, color coded by NIS reflectance at channel 5 (902.7 nm. Outlined boxed areas show geographic/geologic subsets of the 3127-spectrum dataset. CP and CH are the subset of darkest materials in the Psyche and Himeros regions (green and blue boxes respectively), while PR and HR are the brightest.

removal and wavelength range extension, NIS Eros spectra have lower band area ratios (BAR) and slightly shorter Band I absorption centers than previously published results. The spectral parameters of average Eros plot well inside the S(IV) asteroid taxonomic classification field [4], consistent with the L6 chondrite meteorite field [5] (Fig. 2).

Spectral Variation and Space Weathering. Although Eros shows no evidence of mineralogical heterogeneity, significant spectral variations correlate with geologically and geographically distinct areas of the asteroid. We cut the 3127 high-resolution, extended spectrum dataset to subsets based on geography and geology (Fig 1). Central Psyche and Himeros (CP and CH, respectively) comprise some of the darkest and most spectrally weathered-looking materials on Eros. Conversely, the rims and walls of Psyche and Himeros (PR, HR) contain some of the brightest and most pristine looking materials. The narrow ends of the asteroid (Noses, or NS), and the equator (EQ) comprise additional subsets.

We determine average spectra from all subsets and compare them to each other and average Eros with the following results: Eros bright-to-dark spectral ratios are consistent with laboratory "space weathering" experiment results and modeling of space weathering effects [6-8]. The brightest areas on Eros – steep crater walls - have lesser spectral slope deeper Band I, and smaller BAR, consistent with exposure of "fresher", less space weathered materials. The floors of the large craters Psyche and Himeros have lower albedo and contain the most degraded or altered looking materials.

The global average opx(opx+olv) for Eros is 0.31 ± 0.02 with variations for geology and geography. The freshest-appearing materials on Eros - the rims/walls of Himeros and other craters - have a ratio ranging from 0.24-0.29, and may be more representative of "fresh" Eros beneath a weathered surface "Average Eros" regolith layer. If the brightest materials on Eros are in fact representative of un-weathered, pristine materials of a uniform body, then derived spectral parameters for Eros are consistent with an S(IV) asteroid with a low iron, thermally metamorphosed, ordinary chondrite (L6 meteorite petrologic type) composition. The average surface materials, even if altered by space weathering, remain in the S(IV) and L6 classifications.

References: [1] Izenberg N. R. et al. (2000) *Icarus, 148,* 550-571. [2] Murchie S. L. and Pieters C. M. (1996) *JGR, 101,* 2201-2214. [3] Murchie S.L. et al. (2002) *Icarus, 155,* 145-168. [4] Gaffey M. J. et al. (1993) *Icarus, 106*, 583-602. [5] Gaffey M. J. and Gilbert S. L. (1998) *Met. Planet. Sci., 33,* 1281-1295. [6] Moroz L. V. et al. (1996) *Icarus, 122,* 366-382. [7] Pieters 2000. [8] Hapke B. (2001) *JGR, 106,* 10039-10073. [9] Cloutis E. A. et al. (1986) *JGR, 91,* 11641-11653.

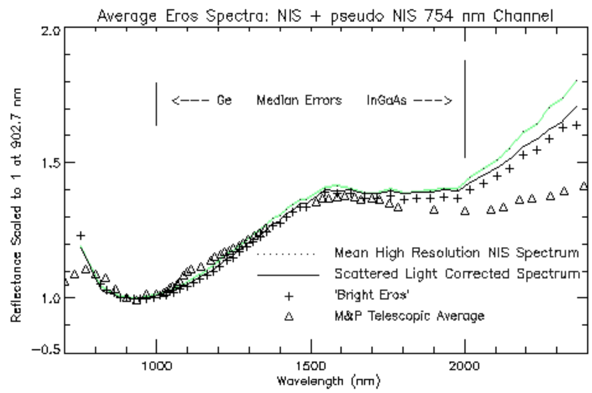

Fig. 2. Average NIS spectrum of Eros with (black) and without (green) scattered light correction, compared with telescopic average [2]. Average spectrum of brightest Eros materials (crater rims/walls) is also shown. Spectra are normalized to 1 at 900 nm.

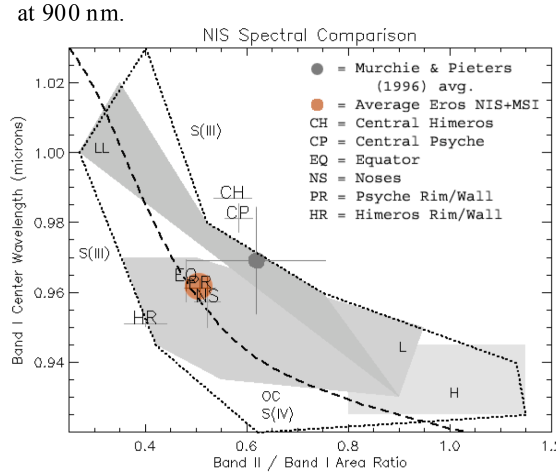

Fig. 3. BAR vs. Band I center wavelength for corrected and extended NIS dataset, including the average NIS spectrum (orange circle). We plot the parameters over the asteroid fields defined [4] and the ordinary chondrite meteorite fields [4]. The S(III) asteroid field lies to either side of the S(IV) field in the higher and lower BAR directions. Telescopic average data (grey circle) is from [2]. The dashed line shows the olivine pyroxene mixing line [9]. The average spectrum's error bars are on the order of the circle size. Bright rim/wall materials have shorter BAR and shorter wavelength Band I centers than dark central materials of Psyche and Himeros, possibly describing a trend of increasing weathering. The variation between the most pristine-appearing materials (HR and PR) and the most weathered-looking (CH and CP) follows a trend, consistent with space weathering, orthogonal to the olivine mixing line, crossing from the low-BAR side of the S(IV) envelope into the high-BAR S(III) field. Nose and equatorial materials (and Psyche rim materials) plot along the olivine mixing line, with the noses plotting slightly more olivine-poor.