MINERALOGY OF VESTA AND HOWARDITE, EUCRITE, AND DIOGENITE (HED) METEORITES DETERMINED BY SPECTRAL DECONVOLUTION. K. L. Donaldson Hanna[1] and A. L. Sprague[1], [1]Lunar and Planetary Laboratory, Tucson, AZ 85721, khanna@lpl.arizona.edu.

Introduction: We use an established spectral deconvolution algorithm [1] with mid-infrared spectral libraries of mineral separates of varying grain sizes to determine minerals and their abundances of Vesta and HED meteorites [2]. Mid-infrared spectra of Vesta were measured by Infrared Space Observatory (ISO) on 1997 June 13 at 221°W longitude [3] and Cornell's Mid-Infrared Asteroid Spectroscopy (MIDAS) Survey on 2001 October 2 at 73 – 96°W longitudes [4]. Mid-infrared spectra of a sample of HED meteorites [5] were measured in the laboratory.

Spectral Deconvolution: Inputs into Ramsey and Christiansen's spectral deconvolution algorithm [1], a linear unmixing algorithm, include a data spectrum to be unmixed and a spectral library of minerals measured at the same wavelengths as the data spectrum. A reflectance spectral library of known HED constituents was built from JHU, JPL, RELAB, USGS, BED, and Hamilton [6] spectral libraries.

Table 1. Deconvolution Result Compositions

Meteorite	Mineral	Abundance
Johnstown (D)	hypersthene	66 – 76%
	diopside	21 – 31 %
	anorthite	5 – 15%
	olivine (Fo_{61})	3 – 13%
	chromite	0 – 10%
Bholghati (H)	pigeonite	20 – 30%
	augite	20 – 30%
	anorthite	15 – 25%
	hypersthene	15 – 25%
	chromite	2 – 12%
	olivine (Fo_{89})	0 – 10%
Haraiya (E)	pigeonite	35 – 45%
	augite	25 – 35%
	anorthite	25 – 35%

Johnstown (Diogenite). Floran et al. [7] determined that the Johnstown meteorite is dominated by orthopyroxene with minor and accessory phases of anorthite, diopside, olivine (Fo_{71-72}), silica, troilite, Ni-Fe metal and chromite. Minerals and their abundances determined by the spectral deconvolution algorithm are in Table 1. The correct pyroxene and plagioclase compositions were fit; however the amount of pyroxene in the fit is approximately 75% of that found by Floran et al. [7]. The olivine (Fo_{61}) fit to the meteorite spectrum is less magnesium rich than the olivine (Fo_{71-72}) Floran et al. found. These differences are likely because of deficiencies in our spectral library. The meteorite spectrum and the spectral deconvolution fit are plotted in Fig. 1. The overall spectral shapes of the Johnstown and unmix fit spectra are similar and absorption band positions are nearly the same.

Bholghati (Howardite). Fuhrman and Papike [8] determined that the bulk composition of Bholghati contained 60 – 70% pyroxene (varying in composition between pigeonite to augite to hypserthene), 18-23% anorthite, and trace amounts of ilmenite, chromite, olivine (Fo_{90-80}), silica and Ni-Fe metal. Minerals and their abundances determined by the spectral deconvolution algorithm are in Table 1. The correct pyroxene, plagioclase and olivine compositions as well as their approximate abundances were fit (see Fig. 1). Differences in grain size of minerals between the meteorite and the fit are seen as amplitude differences in the spectral features at 9 and 11.8 μm. Differences in mineral composition between the meteorite and fit are seen as differences in band minimum from 9.8 – 10.1, 10.2 – 10.4 μm, and a mismatch of the reflectance peak at 12.2 – 12.4 μm.

Eucrite. Kitts and Lodders [9] determined that the bulk composition of Haraiya contained 53.9% pyroxene (varying in composition from pigeonite to augite), 41.9% anorthite, 0.7% ilmenite, 0.3% chromite, 0.2% apatite, and 2.9% quartz. Minerals and their abundances determined by the spectral deconvolution algorithm are in Table 1. Black arrows indicate obvious differences between the Haraiya spectrum and the spectral deconvolution fit, in particular from 8.75 – 9.2, 10.4 – 11.0, and 12.0 – 14.0 μm owing to grain size differences. Salisbury et al. [10] demonstrated that as grain sizes of minerals change, spectral features can be exaggerated or diminished, how ever the wavelength location of the features do not change. We are encouraged that the correct mineral compositions have been correctly determined as the spectral maxima and minima are at the same wavelength in each spectrum.

Vesta. Minerals and their abundances determined by the spectral deconvolution algorithm are in Table 2. The fit to the MIDAS spectrum seen in Fig. 2. suggests that the surface location at those longitudes is howardite-like with a composition of 55 - 65% pyroxene of varying composition from pigeonite to augite to hypersthene, 15 - 25% calcic plagioclase, and minor amounts of chromite and olivine (Fo_{89}). The fit to the ISO spectrum seen in Fig. 2 suggests a howardite or eucrite-like composition of 49 - 59% pyroxene of varying composition from pigeonite to augite to hypersthene, 13 – 23% calcic plagioclase, 15 – 25% olivine

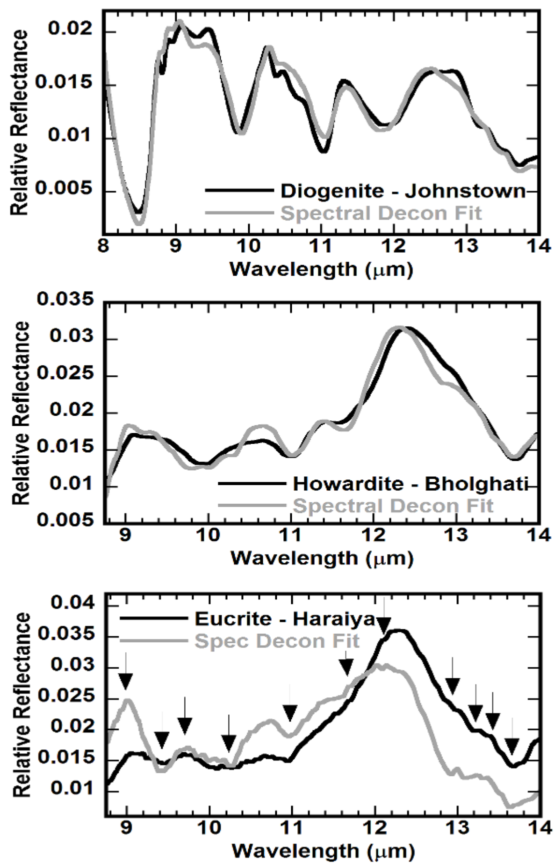

Fig. 1. (top) Johnstown (D) meteorite spectrum along with its spectral deconvolution fit (middle) Bholghati (H) meteorite spectrum along with its fit (bottom) Haraiya (E) meteorite spectrum along with its fit; HED spectra from [5].

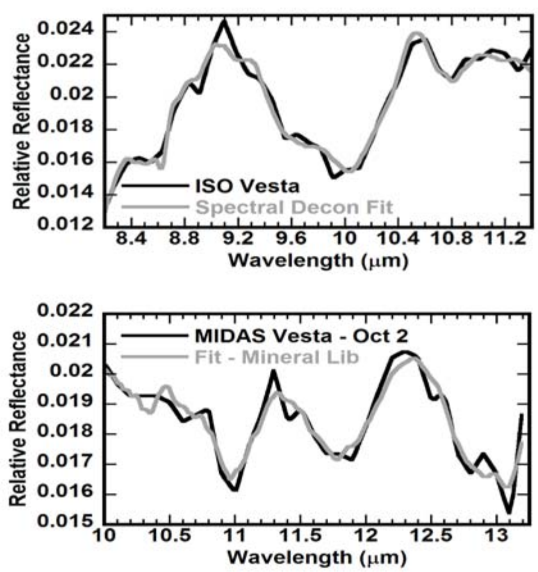

Fig. 2. (top) ISO Vesta spectrum along with its spectral deconvolution fit (bottom) MIDAS Vesta spectrum along with its fit.

(Fo_{89} and Fo_{61}) and minor amounts of diopside and quartz.

Table 2. Deconvolution Result Compositions

Vesta Observation	Mineral	Abundance
ISO	pigeonite	32 – 42%
2 Oct 2001	anorthite	10 – 20%
	hypersthene	5 – 15%
	olivine (Fo_{89})	5 – 15%
	orthoclase	3 – 13%
	augite	0 – 10%
	diopside	0 – 10%
	olivine (Fo_{61})	0 – 10%
	quartz	0 – 10%
MIDAS	hypersthene	35 – 45%
13 June 1997	pigeonite	20 – 30%
	augite	10 – 20%
	magnesiochromite	3 – 13%
	anorthite	0 – 10%
	olivine (Fo_{41})	0 – 10%
	olivine (Fo_{66})	0 – 10%
	chromite	0 – 10%

Conclusions: Although our end member mineral spectral library was missing key meteorite minerals such as troilite, kamacite and Ni-Fe metals, the fits to the HED and Vesta reflectance spectra indicate spectral deconvolution is a valid tool for interpreting remote observations and we had good, if limited, success. We will continue to add end member mineral spectra of varying grain size and compositions as they become available. We anticipate improvement in our ability to identify compositions and abundances as our spectral library improves.

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