IMPACT MODIFICATION OF BASALT, GABBRO, SERPENTINE – EFFECTS ON SPECTRAL PROPERTIES. C. Own[1], D. L. Domingue[1], M. J. Cintala[2], C. J. Cline II[3], N. Pearson[1]. [1]Planetary Science Institute, 1700 E. Fort Lowell, Tucson AZ 85719, domingue@psi.edu, [2]NASA Johnson Space Center, Astromaterials Research and Exploration Science, Mail code XI3, [3]NASA Johnson Space Center, Astromaterials Research and Exploration Science, Mail code XI5.

Introduction: Powdered samples of Sheep Canyon basalt (Alpine, TX), Bushveldt gabbro, and serpentine (provenance unknown) were impacted at different speeds to explore spectral changes induced by the impact process. Understanding these changes enables identification and interpretation of remotely sampled rocky body surfaces. Post-impact materials were examined in the ultraviolet to visible (UV-Vis) to search for changes in spectral characteristics. Table 1 summarizes the samples and impact speeds examined.

Table 1. Sample Summary.

Target	Shot #	Velocity (km/s)	Sample Characteristics
Basalt	2357	6.2	< 63µm
			104 – 481 µm
			> 481 µm
	2359	6.0	< 63µm
			104 – 481 µm
			> 481 µm
	2361	6.3	< 63µm
			104 – 481 µm
			> 481 µm
Gabbro	2510	6.035	>250 µm
			<250 µm
			melt
	2607	4.048	>250 µm
			<250 µm
			Target holder
Serpentine	2364	6.312	<63 µm
			63 – 104 µm
			104 – 481 µm
			> 481 µm
	2365	3.844	104 – 481 µm
			> 481 µm
	2366	5.983	63 – 104 µm
			104 – 481 µm
			> 481 µm

Impact Experiment: Granular samples of basalt, gabbro, and serpentine were impacted the Johnson Space Center's (JSC) Astromaterials Research and Exploration Science (ARES) Experimental Impact Laboratory (EIL) with the 5-mm light-gas gun. The samples were shot with Al_2O_3 ceramic spheres, 3.18-mm (1/8") in diameter at varying speeds (see Table 1). The debris was collected and separated into grain-size fractions. UV-Vis reflectance measurements (0.2-0.9 µm) were collected using the Ocean Optics spectrometer at the Planetary Science Institute's spectral laboratory. In the case of the gabbro sample #2510, sufficient melt was collected to be measurable in the Ocean Optics system.

Spectral Analysis: All samples examined exhibited characteristic spectral features, including (1) changes in the slope from the UV to the visible and across the visible, and (2) variations in three band properties: depth, area, and position. Slopes were determined by fitting lines to sections of the spectra and using 5th-order polynomial regression curves to model the bands and calculate their properties (Fig. 1).

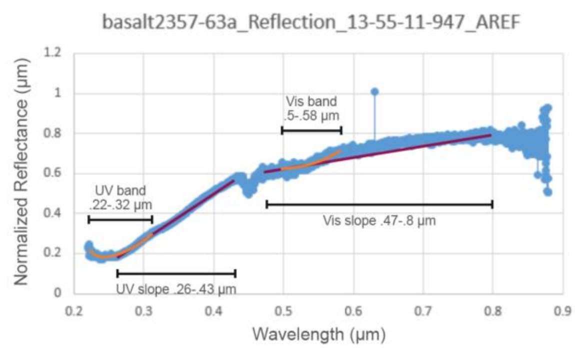

Figure 1: Full spectrum from the <63 µm size fraction of basalt sample #2357. Purple lines show slope locations and orange lines show band locations. The dip at 0.45 is an artifact from the handover between the UV and vis.

For each sample, a linear slope was approximated across both the UV and visible ranges, depending on the absorption features present in the spectra. The approximated ranges for the slopes were 0.26 – 0.43 µm and 0.47 – 0.80 µm for the basalt samples; 0.33 – 0.43 µm and 0.6 – 0.8 µm for the gabbro; and 0.27 – 0.32 µm and 0.58 – 0.75 µm for the serpentine (Table 2.1).

Table 2.1 Example Slope Measurements

	Basalt #2357 <63 µm	Gabbro #2510 >250 µm	Serpentine #2364 63-401 µm
UV Slope	2.3460	0.4340	4.2476
Vis Slope	0.6075	0.3498	0.0045

Bands were normalized by removing the continuum prior to measuring band properties. A line c, and the spectrum across the band was ratioed to the linear fit, thus normalizing the spectrum. A 5th order polynomial was then fit to the normalized band to approximate its shape (Fig. 2).

This standardized the calculation of the band properties. The band position is the wavelength at the minimum point in the band. The band depth is the difference between unity and the reflectance value at the band position. The band area is the difference between the integral across the continuum over the wavelengths between the shoulders and the integral of the polynomial fit to the band shape across the same wavelength interval. See Tables 2.2 and 2.3, and Fig. 2.

Table 2.2 Example Band Properties (Basalt & Gabbro)

Sample	Band measurement	UV band	Visible band
Basalt #2357 <63 µm	Area	0.0145	N/A
	Position	0.2592	
	Depth	0.2500	
Gabbro #2510 >250 µm	Area	0.0105	0.0076
	Position	0.2625	0.5325
	Depth	0.1665	0.1407

The UV band was centered at ~0.27 µm, the visible band was centered at ~0.52 µm. This particular basalt sample does not exhibit a band in the visible range, but is present in other basalt samples.

Table 2.3 Example Band Properties (Serpentine)

Sample	Band measu-rement	UV band	Visible band 1	Visible band 2
Serpentine #2364 63-401 µm	Area	0.0164	0.0002	0.0032
	Position	0.2684	0.5366	0.7468
	Depth	0.3344	0.0059	0.0329

The bands studied were centered at ~0.28 µm in the UV and ~0.54 µm and ~0.74 µm in the visible.

Conclusions: Analysis shows no significant correlations between grain size and spectral features. The smallest size fraction in the basalt and serpentine data sets tend to exhibit consistent behavior, however, no overarching correlations were observed. Occasionally, patterns emerge within one sample set but are not replicated in others. Future study may include applying these same spectral analysis methods to FTIR data and studying the relationship between these same spectral properties and velocity of impact. Spectral modifications in the UV-Vis show no diagnostic trends, but may need to be coupled to spectral properties at longer wavelengths.

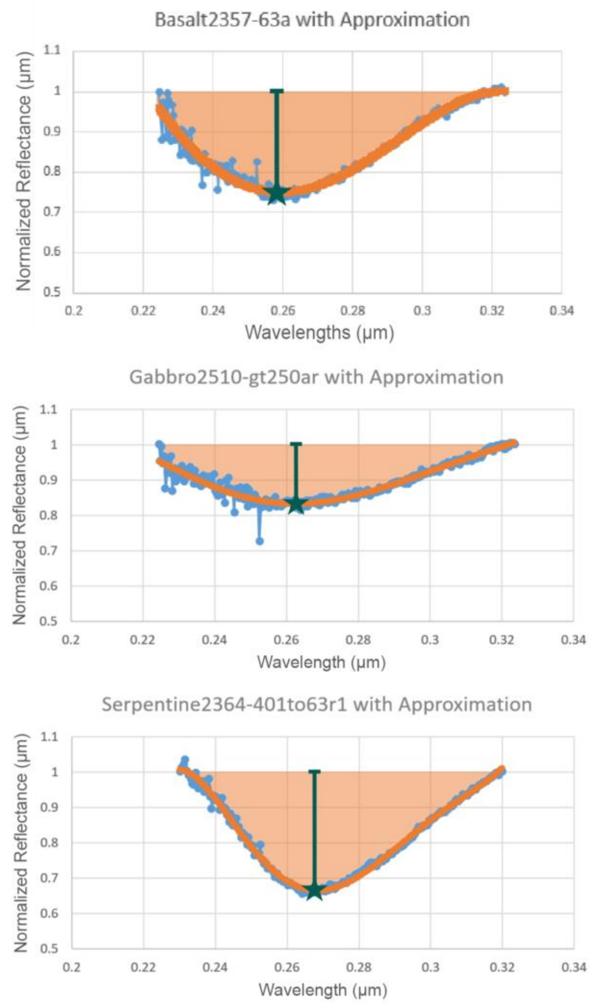

Figure 2: Example normalized UV band spectra. The blue curves show the data and the orange curves shows the 5th-order regression to those data. The orange fill represents the band area, the green line the band depth, and the star's x-value the band location. (Top) basalt #2357 <63 µm sample, (center) gabbro #2510 >250 µm sample, (bottom) from serpentine #2364 63-401 µm sample.

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