SPECTRAL CALIBRATION OF ORTHOPYROXENE-TYPE A CLINOPYROXENE MIXTURES: IMPLICATIONS FOR INTERPRETING ASTEROID SPECTRA. V. Reddy[1], E. A. Cloutis[2], M. A. Craig[1,3], and M. J. Gaffey[3]. [1]Department of ESSP, University of North Dakota, Grand Forks, USA. [2]Department of Geography, University of Winnipeg, Manitoba, Canada. [3]Department of Space Studies, University of North Dakota, Grand Forks, USA. E-mail: Vishnu.kanupuru@und.nodak.edu

Introduction: Spectral calibration of pyroxenes has important implications for interpreting asteroid spectra. Pyroxenes have been spectrally detected on surfaces of terrestrial planets, the moon, and asteroids. Depending on their petrogenesis, pyroxenes can substitute a wide range of cations in their crystal structure [1]. Accurate quantification and identification of the abundances and chemistries of these cations from telescopic spectral data can help constrain the conditions under which the target object formed [2].

[3] performed mixing experiments of ortho (OPX) and low-Fe Type B clinopyroxenes (CPX) and suggested that low-Fe Type B CPX has only a weak band II at 2-μm and behaves like olivine (which has only Band I) spectrally in a mixture. To further verify and quantify these findings, we conducted new mixing experiments with OPX and Type A CPX mixtures (which also have only Band I). The relationship between chemical composition of high-Ca pyroxenes and their spectral type (A or B) depends on the sum of M2 preferring cations [4; 5 and 6]. Fe-rich calcic pyroxenes that have low Fe^{2+} in the M2 site tend to Type A and low-Fe high-Ca pyroxenes tend to be Type B [1]. The results presented here will help spectrally identify Type A CPX in a mixture. The intent of this calibration study is to help interpret asteroid spectra.

Methodology: Absolute reflectance spectra (0.35-2.5 μm) of OPX (PYX042-$Fs_{12.8}$ $Wo_{0.4}$) and Type A CPX (PYX150-$Fs_{4.0}$ $Wo_{51.1}$) (See Figure 1) in two particle size ranges (<45 μm and 45-90 μm) at approximately 10 wt% intervals were measured at University of Winnipeg Planetary Spectrometer Facility. Spectral parameters (band centers and Band Area Ratio (BAR)) were measured using SpecPR.

Results: Spectral parameters of the mixture were plotted to identify any trends either as a function of mineral abundance or particle size. Figure 2 shows change in Band I center as a function of % of OPX content in an OPX+Type A CPX mixture. Band I center moves rapidly to longer wavelength as % of OPX decreases below 30%. The trend is the same for both particle sizes. Pure Type A CPX has a Band I center ~0.98-μm, whereas pure OPX is at ~0.91 μm.

The lack of Band II feature in clinopyroxenes is a function of relative occupancies of the M1 and M2 sites and is related to abundances of M2-preferring cations, Ca normally being the most abundant [7]. Figure 3 shows Band I center vs. BAR for OPX+Type A CPX mixture. The boxes indicate the location of Gaffey S-asteroid subtypes (left-right) S-I, S-IV and S-VII, respectively. The data plots close to the trend line of olivine + OPX mixture from [8] for mixtures with ≥50% Type A CPX. Above 50% the Band I center does not shift to longer wavelength like olivine. This has implications for interpreting asteroid spectra and care should be taken to distinguish between olivine and Type A CPX in a mixture as it would lead to entirely different petrologic interpretations. While Type A CPX-rich assemblages in meteorites are not common, [9] has identified several angrite meteorites rich in Type A CPX. [10] recently suggested the presence of Type A CPX on the surface of asteroid 3628 Boznemcova.

For example, Figure 4 shows Band-Band plot from [4, 11] with OPX + Type A CPX mixture data. Band centers of samples with more than 30% OPX closely follow the OPX trend line but deviate from the trend as the Type A CPX content increases (>70%). Band centers of mixtures with > 70% Type A CPX plot close to H- and L-Chondrites on the Band-Band plot. This could lead to the misinterpretation of the asteroid's mineralogy, petrology and meteorite analogue as Type A CPX could be mistaken for olivine. Hence proper identification of Type A CPX in an asteroid spectrum is critical for its interpretation.

Identification of Type A CPX. Spectral identification of Type A CPX in a mixture is challenging at best. Type A CPX spectra displays a 0.8-μm feature due to Fe^{2+}>Fe^{3+} intervalance change transfer transition and two bands near 0.95- and 1.15-μm due to Fe^{2+} crystal field transitions located in the M1 site and [1] (Figure 1). In an OPX + Type A CPX mixture, an inflection at 1.15 μm appears when the CPX content is ≥40% (Figure 5 B). Other minerals that show this feature include olivine in olivine + OPX mixture (Figure 5A), high Fe OPX (Figure 5 C) and plagioclase in Lunar basalts [4]. However, the longer wavelength side lobe of pure olivine has band centers between 1.20-1.30 μm (Figure 5 A) [12]. Using the 1.15- μm feature one can potentially identify Type A CPX in an asteroid spectrum. [1] suggested the use of 1.15- μm feature to estimate Fe content in calcic pyroxenes.

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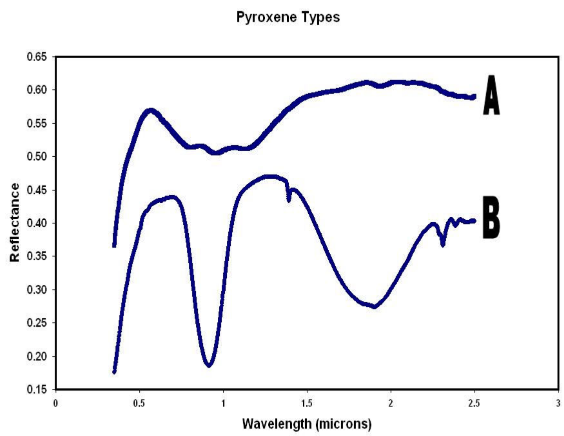

Figure 1. Spectra of PYX150 (A) Type A Clinopyroxene and PYX042 (B) Orthopyroxene (<45 µm).

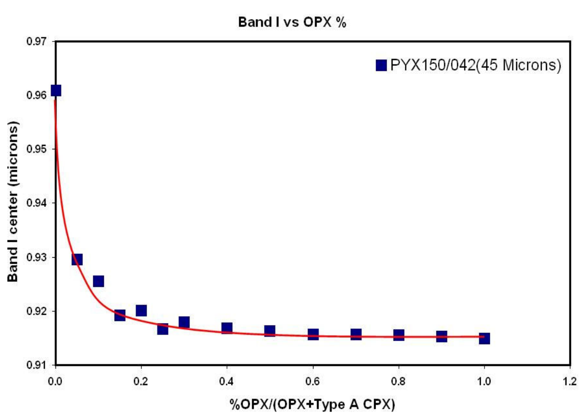

Figure 2. Change in Band I center as a function of OPX % in OPX + Type A CPX mixture (<45 microns particle size).

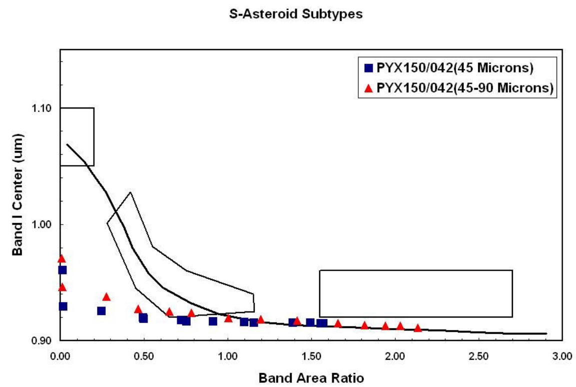

Figure 3. Band I center vs. BAR data for OPX + Type A CPX mixtures plotted on S-asteroid subtypes plot.

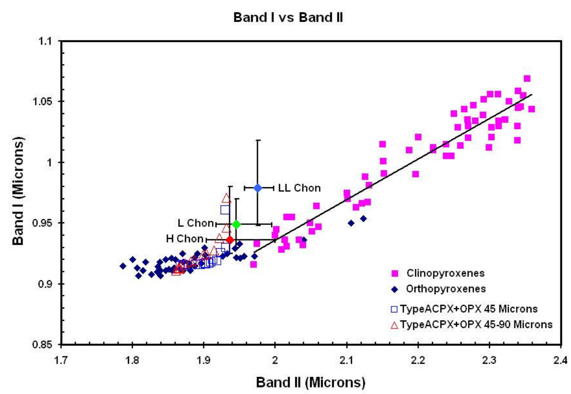

Figure 4. Band I vs. Band II center data for OPX + Type A CPX mixtures plotted on OPX+CPX Band-Band plot. Note how band I center for this mixture closely follows OPX trend line except for high Type A CPX (>70%) content in the mixture.

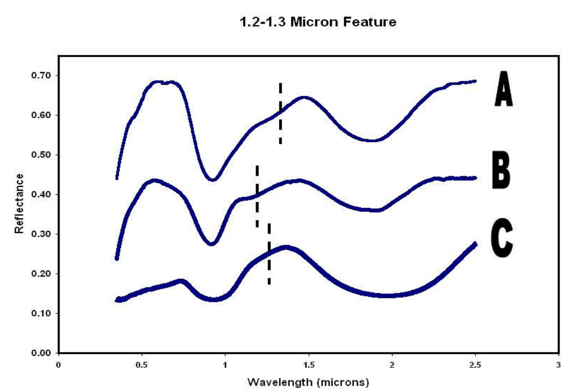

Figure 5. Plot showing the location of 1.2-1.3 micron inflection on spectra of olivine + OPX mixture (A) Type A CPX + OPX mixture (B) and high-Fe OPX (C).