# EFFECTS OF GRAIN SIZES ON THE SPECTRAL REFRECTANCE OF MINERAL MIXTURES -TOWARDS AN INVERSION PROBLEM FOR THREE COMPONENTS MIXTURES-

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Visible-infrared reflectance spectra are used to determine mineralogical compositions and classification of surface material of minor planets and Lunar near-side surface (1,2). Some models have been proposed to relate the diffuse reflectance spectra of mixtures from knowing those of end members (3). Major controlling factors governing the reflectance spectra of mineral mixtures are intensity of crystal field absorptions, grain sizes, and minor opaque minerals. Although effects of each factor on two-components mixtures have been studied (1,4), few measurements were systematically made for three-components mixtures with variety of grain sizes (5,6).

We report results of reflectance spectra for powdered mixtures of olivine (Ol), orthopyroxene (Opx), and clinopyroxene (Cpx), for four different grain sizes. Fig.1 shows values of mixing ratios and grain sizes used in this measurement from 0.35 to 2.5 $\mu$m with an integrating sphere (4). Powders of Ol, Opx and Cpx are separated from a block of spinel lherzolite (Kilborn hole, New Mexico), in which values of Fe/(Fe+Mg) are about 0.17 for three minerals. Absolute values of reflectance increase and absorption peak widths become narrow as grain size decreases (Fig.2). Presence of small amount of $Cr^{3+}$ and $Ti^{4+}$ in pyroxenes causes small absorption peaks in the visible range and makes reflectance spectra complex (6).

Because relative reflectance spectra are more reliable in the actual remote sensing observations, measured spectral reflectance is normalized to that at 1.5 $\mu$m (Fig.3). To test the predictability of the mixing ratios from the reflectance spectra of mixtures (an inverse problem), relative reflectances are used. In case of Ol, Opx and Cpx mixtures, relative reflectance at 1.0, 1.3, 2.0 and 2.3 $\mu$m can be good indicators to identify the mixing ratio (Fig.4). Contour lines indicate 10 % difference of relative reflectances.

Fig.5 indicates variations of relative reflectance at 1.0 $\mu$m as a function of grain size, in which open squares are the mean of averaged value and measured one. Solid symbols indicates those of Ol, Opx and Cpx end members. All measured value of mixtures fall between Opx and Cpx curves.

By using error analysis, the probability of error in the estimation of mixing ratio can be calculated for each grain size. Fig.6 shows the error probability for Ol:Opx:Cpx=1:1:2 mixtures for two different grain sizes, in which "true" relative reflectance spectra of the measured mixture are compared with the calculated spectra from three end members. Contour lines indicate 5% interval and shaded area is a region of 95 % confidence, so that the errors are larger in smaller grain size in the mixing ratio estimate procedure.

References: (1)Adams J.B., J.Geophys.Res. 79, 4829-2836, 1974. (2)McCord, T.B. et al., J.Geophys.Res. 86, 10883-10892, 1981. (3)Hapke,B., J. Geophys. Res., 86, 3039-3054, 1981; Kinoshita,M. et al., Mem. NIPR, Spec. Issue, 30, 93-96, 1983; Hiroi,T. et al., Lunar Planet. Sci. XVI, 356-357, 1985. (4) Miyamoto,M. et al., Mem. NIPR. Spec. Issue, 20, 345-361, 1981; Miyamoto,M. et al., Mem. NIPR, Spec. Issue, 30, 367-377,1983. (5) Nash, D.B. & J.E. Conel, J. Geophys. Res., 79, 1615-1621, 1974. (6) Fujii,N. et al., Proc. 18th ISAS Lunar & Planet. Symp., ISAS, 50-51, 1985.

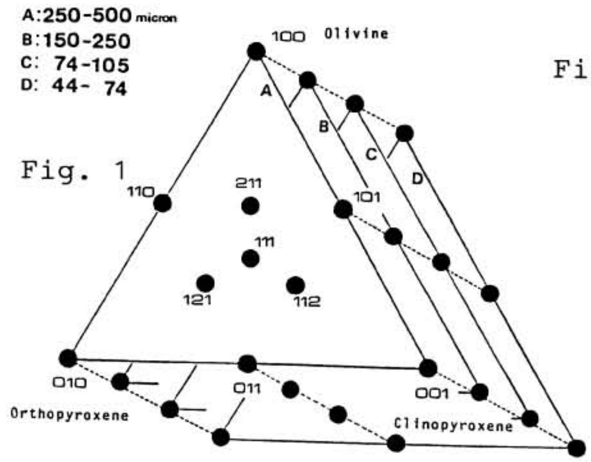
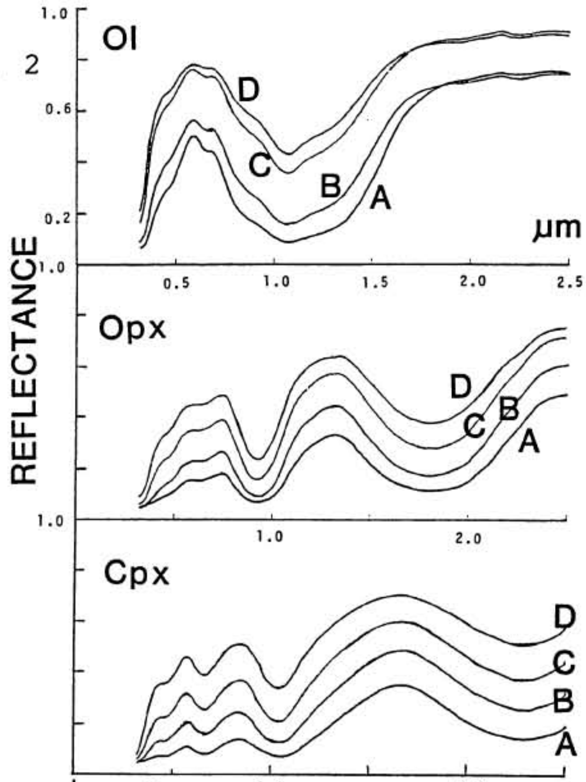
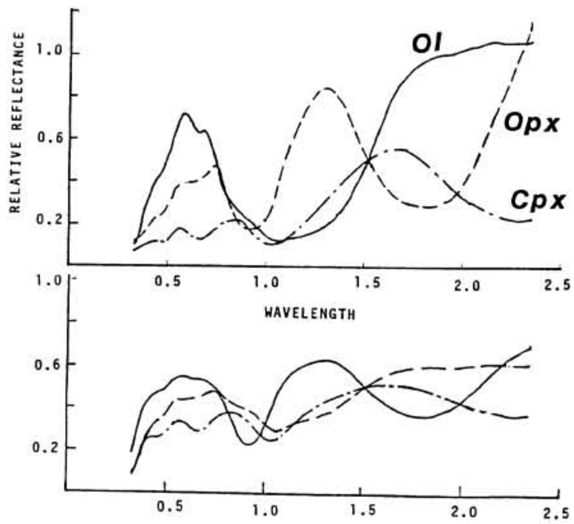



Fig. 1

Fig. 2



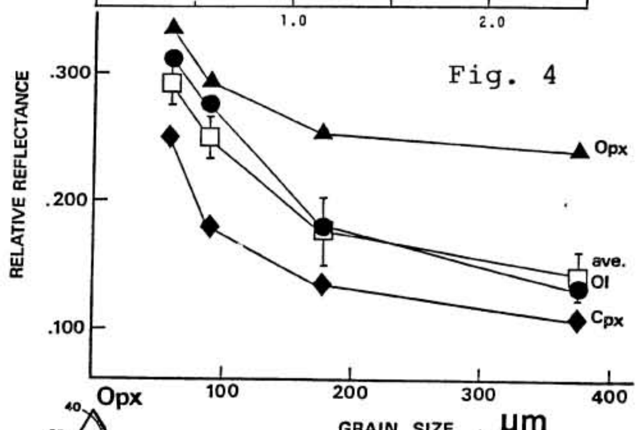




Fig. 4

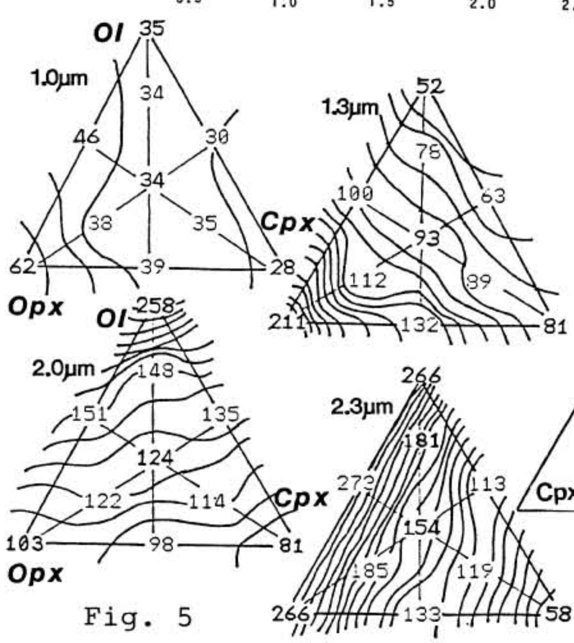



Fig. 5

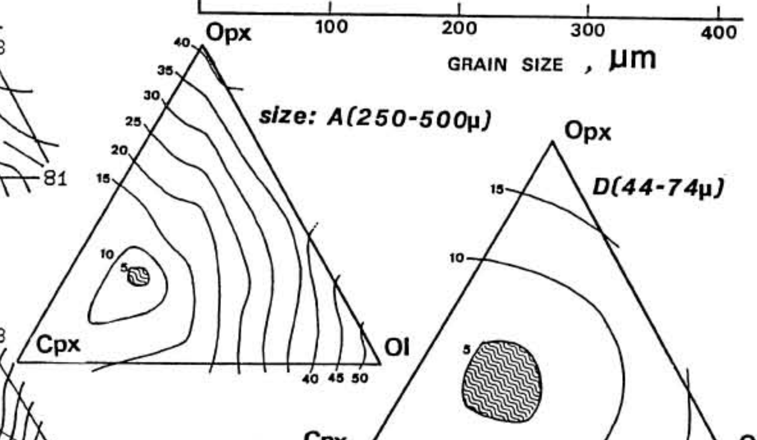



Fig. 6