# THE EFFECT OF VERY FINE PARTICLE SIZES ON PLAGIOCLASE-MAFIC MINERAL MIXTURES.

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**Introduction:** The lunar surface consists of a regolith layer that covers the underlying bedrocks, with the exception of steep-sided crater walls, central peaks and lava channels [1]. The lunar regolith is the result of different processes, e.g., impact of meteoroids and bombardments from the sun and the stars. Lunar regolith size is <250 µm; lunar soils refer to the finer fractions and are generally between 60 and 80 µm [1]. However, sizes <10 µm have been recognized and petrologically classified [2,3].

For this reason, here we analyzed mixtures with mineralogical composition analogue to lunar regolith, at different particle sizes, in order to evaluate the effects of particle sizes on reflectance spectra and spectral parameters.

**Mineral mixtures and reflectance measurements:** 2 mafic end-members, E1: 44 vol.% Cpx ($En_{45}$-$Wo_{46}$) + 56 vol.% Opx ($En_{77}$); E3: 28 vol.% Opx ($En_{82}$) + 4 vol.% Cpx ($En_{45}$-$Wo_{46}$) + 68 vol.% Ol ($Fo_{84}$), and 2 plagioclases (PL), An80 with 0.36 (PL2) and 0.5 (PL3) wt.% FeO, respectively, were used to prepare a set of mixtures at 63-125 µm and 125-250 µm, see [4]. Starting from these mixtures, very fine particle size (<10 µm) have been produced, using a micronizer at the Department of Geosciences, Padova. Reflectance spectra (0.35-2.5µm; $i=30°$, $e=0°$) have been acquired on mixtures at the S.LAB., IAPS-Inaf, Roma, and quantitatively analyzed applying the MGM algorithm [5]. Then, we compared spectral parameters of very fine mixtures with coarse mixtures, 63-125 µm and 125-250 µm.

**Analytical approach:** The applied MGM algortihm modeled the continuum as a function of the wavenumber, with two parameters, the intercept c0 and the offset c1. Each Gaussian is described by three parameters: the band depth (expressed in log of the reflectance), the band center and the band width (in nanometers).

The end-members have been individually deconvolved. Considering that band center and width of mafic minerals depend only on the iron content and not on the modal abundance [6,7], the spectral parameters have been kept fixed for the Gaussians assigned to the mafic absorption bands in the mixtures. The mafic band depth (that varies with the modal abundance), as well as the 1250 nm band, were left free.

Here, only the spectral parameters variations of the ~1250 nm band are discussed.

**Results:** end-members. Fig. 1 shows that, generally, reducing the particle size produces spectra with high reflectance, reduced spectral contrast and, in particular for the PL (fig. 1c,d), a blue slope in the NIR and almost featureless spectra. Furthermore, E1 band I at ~900 nm becomes V-shaped (fig. 1 a); E3 shows a different behavior in the 1800-2500 nm spectral range (fig. 1b).

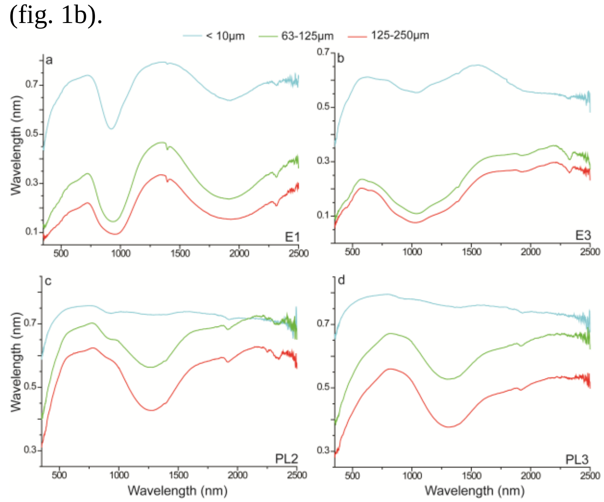


Fig. 1 Figure shows the reflectance spectra of mafic and PL end-members at different particle sizes. Light blue: <10 µm; green: 63-125 µm; red: 125-250 µm.

**Results:** mixtures. In E1-mixtures, PL produces an absorption band in the 1250 nm spectral region, while in E3-mixtures, PL and OL band 3, absorbing in the samespectral region, produces a composite (COMP) band in the 1250 nm region.

MGM shows that, adding PL content, the very fine mixtures vary as 63-125 and 125-250 µm mixtures (pink and fuchsia symbols in Fig. 2 and 3). In fact, increasing the vol. FeO content in PL: a) in E1-mixtures, the 1250 nm PL band deepens, widens and shifts towards longer wavelengths (fig. 2a-c); and b) in E3-mixtures, the COMP band becomes less intense, wider and is shifted towards the NIR spectral region (fig. 3a-c).

However, spectral parameters of the same mixtures (with the same PL/mafic content) vary with different particle sizes (fig. 2 and 3).

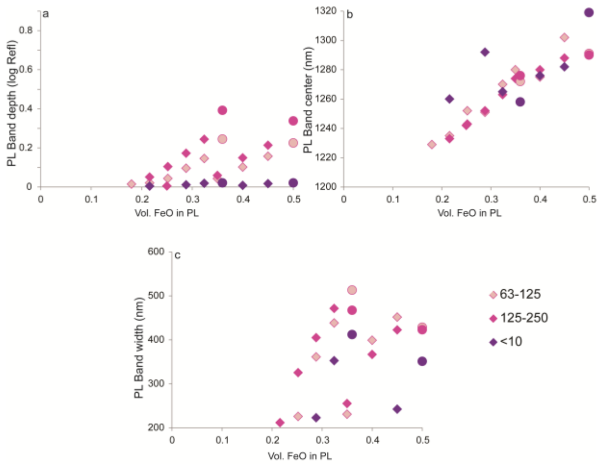


Fig.2 Figure shows the PL spectral parameter variations for E1+PLs mixtures at different particle sizes.

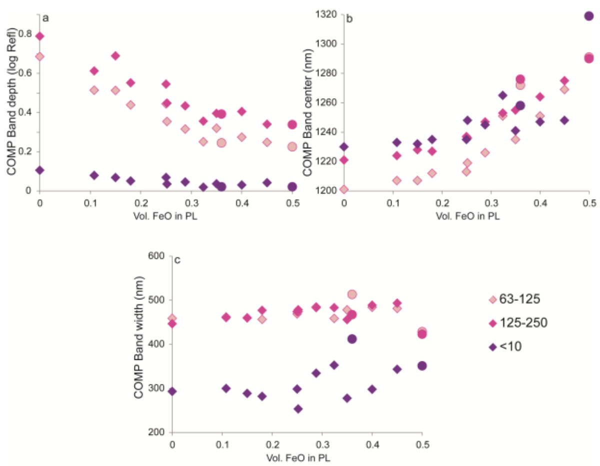


Fig.3 Figure shows the COMP band spectral parameter variations for E3+PLs mixtures at different particle sizes.

Fig. 2 shows that in E1-mixtures, the PL band depth in <10 µm mixtures is very reduced even for high PL content, almost close to 0, and narrower compared to the coarse sizes.

In E3-mixtures, the COMP band depth in <10 µm mixtures is reduced (fig. 3) and, with increasing vol. FeO content in PL tend to values close to 0. COMP band center displays a particular behavior: for vol. FeO in PL < 0.25, the center is shifted towards longer wavelengths, while for higher vol. FeO content is at shorter wavelength than the coarse sizes.

The spectral parameter (depth and width) differences due to the size are emphasized in E3-mixtures, ol-bearing mixtures.

**Discussions and implication for the plantes:** Particle sizes <10 µm have been recognized on the Moon, and their mineralogy differs from the coarse fractions: [2,3] showed how very fine samples are more enriched in PL compared to the coarse, probably due to simple comminution processes and the easy of fracturing of PL with respect to mafic minerals. Here we have analyzed mixtures composed with PL and mafic minerals at very fine particle size and we have shown how PL band depth is very close to 0 in mixtures with high PL content. Consequently, PL is underestimated, very difficult to recognize and mixture spectra composed with high PL content are almost featureless.

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