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The role of very fine sizes in reflectance spectroscopy: new understanding for the interpretation of the finest fractions of regolith. Applications to the lunar regolith.

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Very fine sizes dominate many planetary surfaces and their regolith, e.g., Moon, Mars and Mercury. Different particle size fractions in the regolith affect in different ways the optical properties of the surface and the mineral assemblages. For this reason, it is important to investigate deeply very fine sizes in order to retrieve correct information about the mineral's composition and the surface texture.

The lunar regolith, for example, is characterized by material <1 cm (McKay et al., 1970). The lunar soil is the fine fraction of the regolith, derives from mechanical disintegration of lunar rocks and is generally between 60 and 80 μm (McKay et al., 1970); the lunar dust describes even finer material than lunar soils (ca. <50 μm). Furthermore, sizes <10 μm, ca. 5-20% of the soil, have been recognized (Laul et al., 1978; 1979; 1980). While coarse sizes of the lunar regolith are chemically and mineralogically very similar, the <10 μm fractions are different and more feldspathic, probably due to an easier fracturing of plagioclase with respect to mafic minerals (Devine et al., 1982). According to the more feldspathic nature of the very fine lunar soils, we present results for a set of plagioclase-bearing mixtures analyzed at the <10 μm particle size, to investigate the effects of very fine sizes on the reflectance spectroscopy of lunar-likely mineralogies.

Two mafic end-members, E1 (56 vol.% orthopyroxene+44 vol.% clinopyroxene) and E3 (68 vol.% olivine+28 vol.% orthopyroxene+ 4 vol.% clinopyroxene), and 2 plagioclases, An80 with 0.36 (PL2) and 0.5 (PL3) wt.% FeO, respectively, were used to prepare mixtures and reflectance spectra (0.35-2.5μm; i=30°, e=0°) have been acquired. Quantitative analyses have been performed through the MGM algorithm (Sunshine et al., 1990).

We demonstrated how very reduced particle sizes imply higher albedo and decrease in the spectral contrast, particularly for the plagioclase, that becomes almost featureless and is always shallower than mafic bands even for very high plagioclase abundances (>80%). We also showed how in olivine-bearing mixtures the composite band center (due to the complex absorption of olivine and plagioclase) always shows the typical olivine value, differently from coarser mixtures (Serventi et al., 2015). Furthermore, E1 has a more V-shaped 1μm absorption, while E3 is characterized by a 2000 nm absorption not present at coarser sizes; generally, the 1μm mafic band centers are shifted of ca. 40 nm with respect to coarse sizes, reflecting different behaviors within the crystal field absorption of mafic component in very fine size.

These results can have several implications for the lunar regolith: spectra with a well-defined and deep 1250 nm absorption reflect not only the crystallinity of the plagioclase but also the size that cannot be too fine; featureless spectra can lead to an erroneous interpretation of the plagioclase chemistry and/or underestimation of abundance.