DIFFUSE REFLECTANCES 0.25 TO 25 μm OF AN ENSTATITE CHONDRITE AND IMPLICATIONS FOR SURFACE MINERALS OF M-TYPE ASTEROIDS

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We measured diffuse reflectances of the Y-691 enstatite chondrite (E3) in the UV-VIS-NIR region (0.25-2.55 μm) and the middle infrared (MIR) region (2.53-25 μm), to better understand the surface mineral assemblage of M-type asteroids. We also measured reflectances of an olivine and an iron meteorite for comparison. The UV-VIS-NIR spectra of enstatite chondrites and iron meteorites are similar, and this causes difficulty in interpreting the mineral assemblage of M-type asteroids (1). We measured reflectances of polished surfaces (plate samples) and powder samples. Small fragments were ground and sieved by 46 μm and 149 μm mesh cloths to obtain <46 μm and <149 μm samples, respectively. Details of measurements are described in (2).

UV-VIS-NIR spectra: Salient differences between the spectra of the powder and plate samples of Y-691 and olivine (Figs. 1,2) are seen in the UV fall-off. The powder samples of Y-691 show relatively steep UV fall-off at wavelengths less than about 0.55 μm compared with the plate sample of Y-691. It should be noted that the plate sample of Y-691 shows weaker UV fall-off compared with that of the plate sample of the iron meteorite (Fig. 1)(2). For a silicate assemblage containing transition metal ions, charge transfer absorptions determine the spectral features in the UV region. The UV fall-off of metals is due to the effect of plasma oscillation. The UV fall-off of the powder samples of Y-691 may be due to multiple scattering. It should be also noted that the UV fall-off of the powder samples of Y-691 start at about 0.55 μm, whereas that of the iron meteorite starts at about 0.4 μm and that the UV fall-off of iron meteorite is steeper than that of Y-691 (Fig. 1). The spectral feature of the UV fall-off may enable us to distinguish enstatite-like materials from iron meteorite-like materials.

MIR spectra: The spectra of Y-691 show many absorption bands at wavelengths longer than about 9 μm mainly caused by enstatite, whereas the reflectance of the iron meteorite does not show any strong absorption bands up to 25 μm. The spectra of the plate samples are apparently different from those of the powder samples (Figs. 1,2). Relatively high reflectance around 10 and 20 μm is probably caused by contribution of the specular component to reflectance, because the absorption coefficient is probably large. This may not be a serious problem to identify the surface materials, because asteroidal surfaces are generally thought to be covered with regolith-like materials. These results suggest that we can distinguish the enstatite chondrite from the iron meteorite by the reflectance around 10 μm.

Speculation: Asteroid 16 Psyche is classified into M type based on the UV-VIS-NIR reflectance (1). Psyche appears to show the absorption around 10 μm and some contrasts in 8-13 μm (3), although the spectrum between 9 and 10 μm is not reliable because of the atmospheric ozone absorption. We speculate that the surface composition of Psyche is the enstatite chondrite-like assemblage, if the absorption features around 10 μm are real. The UV-VIS-NIR reflectance of 16 Psyche (1) shows no UV fall-off to 0.3 μm. The iron meteorite-like assemblage may be ruled out. Ostro et al.(1985)(4), however, suggested that the highest albedo estimate for Psyche is consistent with a surface having porosities typical of lunar soil and a composition nearly entirely metallic on the basis of radar observations. Infrared measurements of high enough quality of the asteroid are needed.

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REFLECTANCE OF AN ENSTATITE CHONDRITE

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Fig. 1. Diffuse reflectances of plate and powder samples of the Y-691 enstatite chondrite (E3) and Toluca iron meteorite (octahedrite). 1: plate (polished) sample of Y-691, 2: powder sample (grain size of less than 149 μm) of Y-691, 3: powder sample (grain size of less than 46 μm) of Y-691, 4: plate (polished) sample of Toluca.

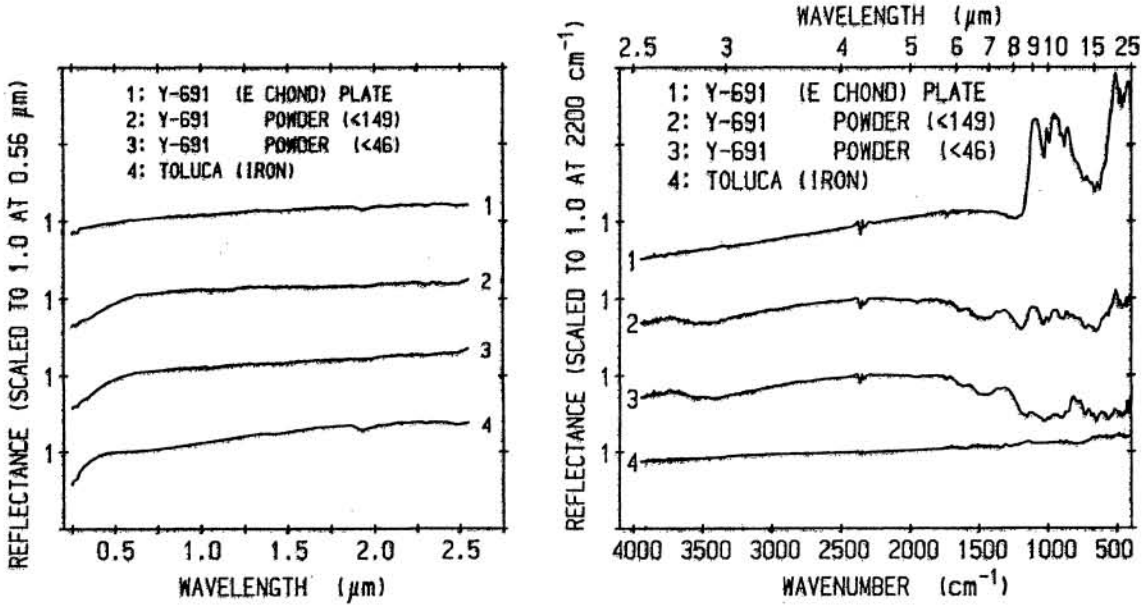
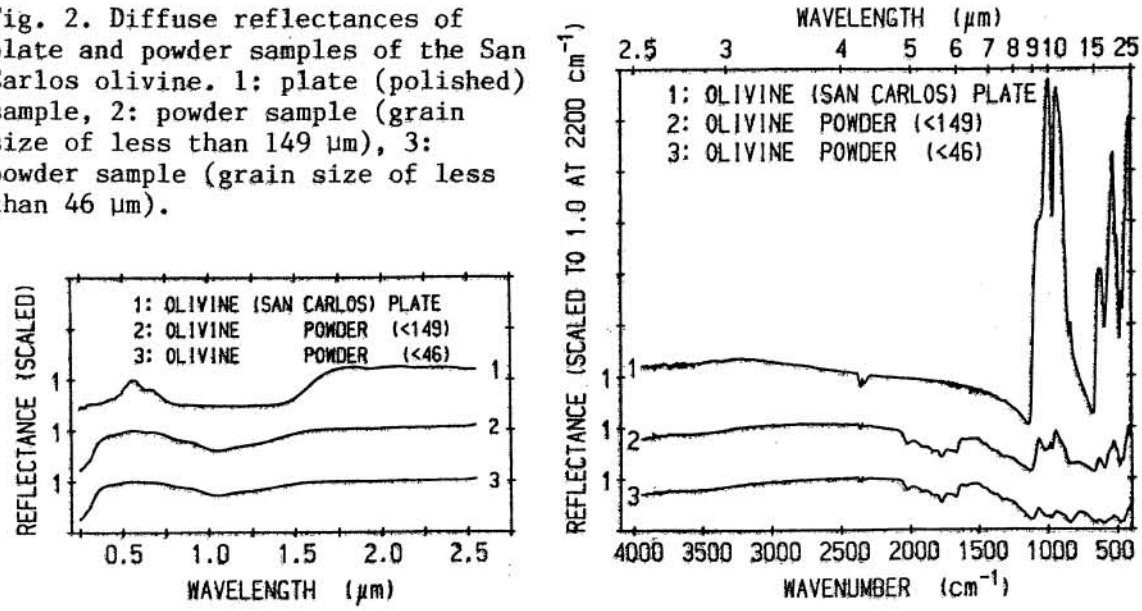


Fig. 2. Diffuse reflectances of plate and powder samples of the San Carlos olivine. 1: plate (polished) sample, 2: powder sample (grain size of less than 149 μm), 3: powder sample (grain size of less than 46 μm).



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