Is the reddening of asteroids still a dilemma?

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The association of the most abundant population of meteorites (the ordinary chondrites) and their parent bodies, through the comparison of their reflected spectra, has been a long debate. In fact, many of the asteroids show reddened spectra when observed in the visible and near-infrared range (Gaffey 1976, Cloutis et al. 1990). This reddening, first observed in lunar mature soils, has been demonstrated to be caused by the presence of metallic nano-particles (Pieters et al. 2000, Noble et al. 2004). Though laboratory experiments reproduced the formation of such npFe as due to the vaporization of Fe-bearing silicates caused by the bombardment of micro meteoroids (Sasaki et al. 2001), the close-up observations of S-type asteroids obtained by the NEAR mission proposed a new mystery to be solved. In fact, if the continuous exposition to the space conditions should in principle darken and redden the surface of asteroids, the slopes of the Psyche crater on Eros shows redder but brighter spectra when compared to the proposed associated meteorites (Clark et al. 2001). This result asked for a mechanism capable to redden much more than darken. Very recently, an alternative process has been suggested for surface alteration of airless bodies. In fact, metallic nano-particles have been demonstrated to be formed in Fe-Ni regions of ordinary chondrites where shock-induced transformation occurred (Moretti et al. 2005). Even if this last mechanism is capable to redden almost instantaneously localized regions on asteroids surfaces, the distribution of the spectral slopes of asteroids families is still difficult to be fully interpreted. In fact, the recently obtained age-colour relationship for main-belt S-complex asteroids, suggests cooperativity within processes altering the surfaces (Jedicke et al. 2004). We will show other possible mechanisms capable to redden reflected spectra in the VIS-NIR range.

We will present in detail the effects of 1) the contribution from metallic specular reflectance (Hiroi et al. 1993) in a simulation of cratering on ordinary chondrites, 2) the presence of troilite (see also Britt et al. 1992), 3) the phase transformation in Fe-Ni alloys, 4) the presence of impact melts (see also Folco et al. 2005). On the basis of the showed results, we suggest that models used to reproduce the spectra should take into account different size distributions between the constituents of the regolith and that cratering and gardening of the regolith plays a fundamental role in the understanding the reddening of asteroid surfaces.