Space weathering simulations through controlled growth of iron nanoparticles on olivine

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Airless planetary bodies are directly exposed to space weathering. The main spectral effects of space weathering are darkening, reduction in intensity of silicate mineral absorption bands, and an increase in the spectral slope towards longer wavelengths (reddening). Production of nanophase metallic iron ($npFe^0$) during space weathering plays a major role in these spectral changes. A laboratory procedure for the controlled production of $npFe^0$ in silicate mineral powders has been developed. The method is based on a two-step thermal treatment of low-iron olivine, first in ambient air and then in a hydrogen atmosphere. Through this process, a series of olivine powder samples was prepared with varying amounts of npFe0 in the 7–20-nm size range. A logarithmic trend is observed between the amount of $npFe^0$ and darkening, reduction of 1-µm olivine absorption band, reddening, and the 1-µm band width. Olivine with a population of physically larger $npFe^0$ particles follows spectral trends similar to other samples, except for the reddening trend. This is interpreted as follows: the larger, ∼40–50-nm sized $npFe^0$ particles do not contribute to the spectral slope change as efficiently as the smaller npFe0 fraction. A linear trend is observed between the amount of $npFe^0$ and the 1-µm band center position, most likely caused by the Fe^{2+} disassociation from the olivine structure into $npFe^0$ particles.

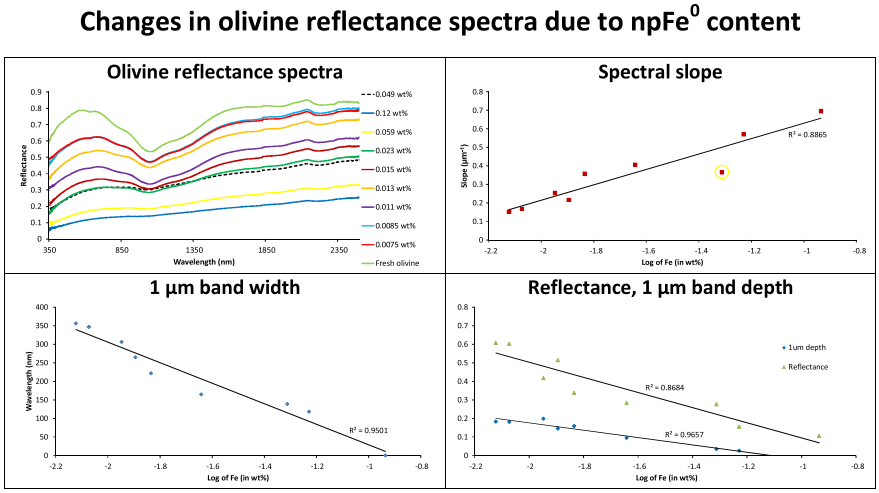

Figure: Changes in olivine spectra due to the presence of nanophase iron.

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References: Kohout T., Čuda J., Filip J., Britt D., Bradley T., Tuček J., Skála R., Kletetschka G., Kašlík J., Malina O., Šišková K, and Zbořil R. (2014): Space weathering simulations through controlled growth of iron nanoparticles on olivine. Icarus, in press.