DAWN OBSERVATIONS OF VESTA VERSUS LUNAR-TYPE SPACE WEATHERING

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Introduction

Airless planetary bodies are directly exposed to space weathering. Space weathering is caused by a combination of solar wind, micrometeorite bombardment, and cosmic radiation that can alter the physical and chemical properties of regoliths of airless planetary bodies. The main spectral effects of space weathering are darkening, reduction in intensity of silicate mineral absorption bands, and spectral slope increase towards longer wavelengths (reddening). This fact contributes to controversies over the interpretation of remotely sensed spectra of lunar and asteroid surfaces compared to the spectra of meteorites and minerals. Production of metallic iron nanoparticles (npFe^0) during space weathering plays major role in the observed spectral changes.

DAWN observations of Vesta

Observations of the asteroid Vesta recently visited by DAWN mission revealed a different pattern of spectral changes. The darkening and the absorption band attenuation occur in similar way as on the Moon. The reddening, however, is not apparent over the 1 µm pyroxene band as observed by DAWN.

Thus, is space weathering on Vesta distinct from that we see on the Moon? Or is another mechanism, such as the addition of carbonaceous darkening material responsible for spectral darkening of Vesta?

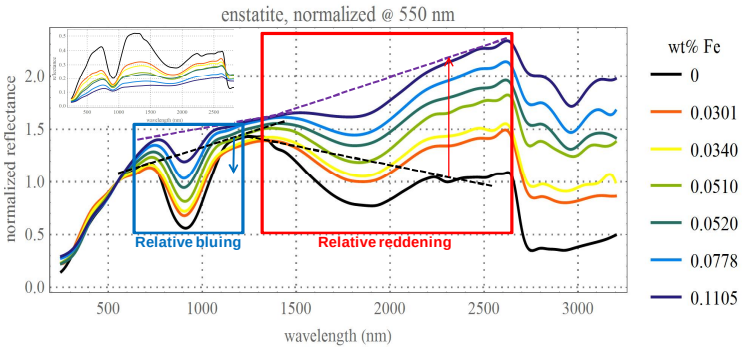
Space weathering experiments with pyroxene and howardite

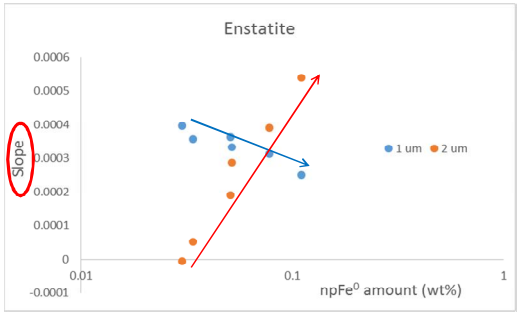
In order to study effects of npFe^0 on reflectance spectra a pyroxene (En 90) and howardite (NWA 1929) powder samples were subjected to the space weathering experiments using a double-heating method (see poster 213.13 by Malina et al.). Both pyroxene and howardite show progressive changes in their spectra with increasing npFe^0 amount. An interesting feature was observed in the comparison of the slope over the 1 and 2 µm bands. While the slope over 2 µm band show progressive reddening with increasing npFe^0 amount, the situation is reversed in the 1 µm band region. The relative reduction in slope (bluing) is observed in this region.

Interpretation

The different slope trend over the 1 (relative bluing) and 2 µm (relative reddening) bands in both pyroxene and howardite is due to the fact that the decrease in reflectance when adding npFe^0 is a nonlinear process where higher reflectance values will decrease more than lower values. If the original slope is positive, as the slope over the 1 µm band in pyroxene and howardite, the slope will decrease with increasing npFe^0, and vice versa. In addition, the npFe^0 has a small positive slope itself in the VIS-NIR range, and that will turn originally zero slopes in the host mineral into positive slopes when adding npFe^0. See poster 213.07 by Penttilä et al. for more details and modeling results. This finding can potentially explain some of the space weathering observations of Vesta. The majority of DAWN observations were done in the 1 µm region where lack of reddening is observed, similar to our results.

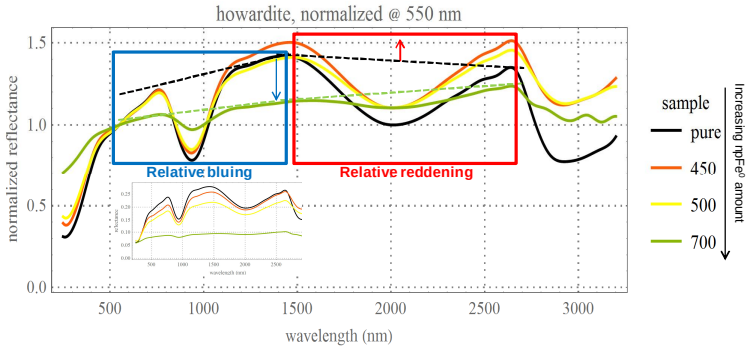
Enstatite

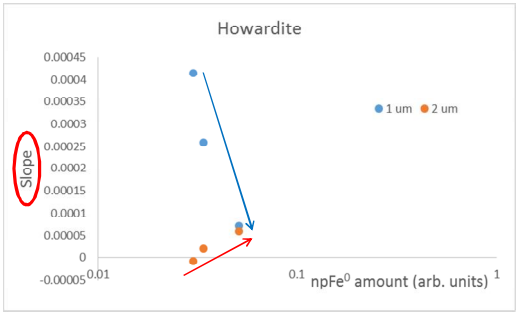




Relative bluing over 1 µm band and relative reddening over 2 µm band.

Howardite





Relative bluing over 1 µm band and relative reddening over 2 µm band.

Conclusions

Based on our space weathering laboratory results the lack of reddening over 1 µm region as observed on Vesta does not contradict the space weathering mechanism driven by the presence of npFe^0. In order to confirm this more NIR data from Vesta are needed over the 2 µm region where our experiments predict progressive reddening.

Acknowledgments

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