EPSC Abstracts
Vol. 10, EPSC2015-36, 2015
European Planetary Science Congress 2015


# UV bluing after Space Weathering of silicates and meteorites

Z. Kanuchova (1,2), R. Brunetto (3), D. Fulvio (4), G. Strazzulla (2)
(1) Astronomical Institute of Slovak Academy of Sciences, SK-05960 T. Lomnica, Slovakia
(2) INAF-Osservatorio Astrofisico di Catania, Via S. Sofia 78, I-95123 Catania, Italy
(3) Institut d'Astrophysique Spatiale (IAS), Université Paris-Sud, UMR 8617 - CNRS INSU, Bât 121, F-91405 Orsay, France
(4) Departamento de Física, Pontifícia Universidade Católica do Rio de Janeiro, Rua Marquês de São Vicente 225, 22451-900, Rio de Janeiro, RJ, Brazil

## Abstract

Asteroid surface space weathering has been investigated both observationally and experimentally, mostly focusing on the effects on the visible-near infrared (VNIR, 0.4-2.5 μm) spectral range. Here we present laboratory near-UV (NUV, 200-400 nm) reflectance spectra of ion irradiated (30-400 keV) silicates and meteorites as a simulation of solar wind ion irradiation. These results show that the induced alteration can reproduce the spread observed in the VNIR vs. NUV slope diagram for S-type asteroids. We expect the evidence of weathering processes in the NUV part of spectra before these effects becomes observable at the longer wavelengths [1].

## 1. Introduction

Asteroid surfaces are continuously altered by solar and cosmic ion irradiation, and micrometeorites. These processes are known as "space weathering". As a consequence of the chemical-physical alterations induced by space weathering, optical properties of asteroid surfaces may change, thus affecting the interpretation of their spectral properties and the efforts to establishing a solid meteorites-asteroids link (e.g., [2], [3]). Direct evidence of the effect of space weathering has been recently provided by the laboratory analyses of particles returned from asteroid 25143 Itokawa by the Hayabusa mission [4].

A number of experimental studies have focused on the spectral alteration induced by irradiating OC meteorites and terrestrial silicates. The results of ion and laser irradiation experiments are, besides other applications, used to estimate timescale for which spectral alterations observed in laboratory may occur in the space environment. As UV bluing occurs with a lower amount of weathering than the VIS-NIR reddening [5], [6], the study of space weathering processes in this spectral region is very actual.

## 2. Experiments

Samples of different materials – meteorites and terrestrial silicates – have been irradiated with different ions at room temperature, inside a stainless steel vacuum chamber ($P<10^{-7}$mbar) faced to different spectrometers (see e.g., [7], [8]). Spectra of samples were obtained in- and ex-situ after irradiation. We also consider the results obtained after pulsed laser irradiation of silicate samples [9], and meteorites published in the RELAB database [10].

## 3. Results and discussion

Following the procedure described in [5] we have measured two spectral indexes - the spectral slopes, per nm and computed for the spectra normalized to 0.55 μm - that well represent the colour variations for our samples, before and after irradiation. Results for meteorites are shown in Fig. 1 and compared with those of S-type asteroids and OC meteorites [5]. Also enclosed in Fig. 1 are the data obtained after ns pulsed laser irradiation (from [9] and RELAB [10]).

For some samples we can look at the rate of spectral changes with the increasing of ion fluence or cumulative laser energy. We calculated the first derivative of the NUV and VNIR slopes as functions of ion fluence or laser energy accumulation (Fig.2). We have estimated the astronomical time-scale on an asteroidal surface at a distance of 2.7 AU and exposed to space weathering (Fig.2).

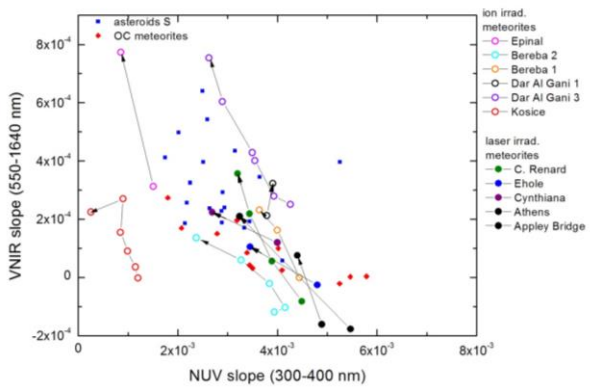


Fig.1: The VNIR spectral index is vs the NUV one.

Laboratory results here presented demonstrate that space weathering of meteorites and terrestrial silicates can reproduce the slope spread shown by S-type asteroids in the VNIR vs NUV slope diagram. This represents a not obvious confirmation of the suggestion by Hendrix and Vilas [5] that was only based on the comparison between the results of observations of asteroids and the laboratory spectra of lunar materials, and indicates the space weathering as the mechanism responsible for the observed spread of slopes.

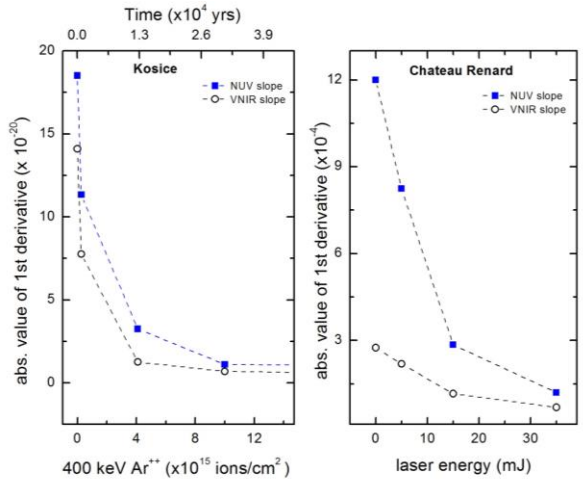


Fig.2: Absolute values of the first derivative of spectral slopes as functions of increasing ion fluence for meteorite Kosice and cumulative laser energy for meteorite Chateau Renard (from RELAB).

For two studied meteorite samples we found the higher rate of changes of NUV spectral slope with respect to the VNIR slopes as the derivative of the NUV spectral slope is always greater than that of the derivative of the VNIR slopes.

We attribute the NUV bluing, analogously to the VNIR reddening, to the formation of iron nanoparticles accompanied by structural modifications (amorphization) of surface silicates.

We expect the evidence of weathering processes in the NUV part of spectra before these effects become observable at longer wavelengths [1], thus searching for the SW effects in the UV range would allow establishing the grade of space weathering for very young asteroidal families.

## Acknowledgements

The research of Z.K. has been supported by VEGA - The Slovak Agency for Science, Grant No. 2/0032/14.

## References

[1] Kanuchova et al. 2015, Icarus, submitted

[2] Brunetto, R., et al. 2015, Asteroid Surface Alteration by Space Weathering Processes. Asteroids IV, in press.

[3] Hapke, B. 2001. Space weathering from Mercury to the asteroid belt. J. Geoph. Res. 106, 10039 – 10073

[4] Noguchi, T., et al. 2014. Space weathered rims found on the surfaces of the Itokawa dust particles. Meteoritics and Planetary Science 49, 188-214

[5] Hendrix, A.R., Vilas, F., 2006. The effects of space weathering at UV wavelengths: S-class asteroids. Astron. J. 132, 1396 – 1404

[6] Vilas, F., et al. 2015, Searching for the onset of space weathering in S-complex asteroids in the UV. In: 46th Lunar and Planetary Science Conference (2015), Abstact no. 2935

[7] Strazzulla, G. et al. 2005, Spectral alteration of the Meteorite Epinal (H5) induced by heavy ion irradiation. Icarus 174, 31-35

[8] Kanuchova, Z., et al. 2010. Space weathering of asteroidal surfaces. Astron. Astrophys. 517, A60.

[9] Brunetto, R., et al. 2006, Space weathering of silicates simulated by nanosecond pulse UV excimer laser. Icarus 180, 546-554

[10] Pieters, C. M., Hiroi, T. 2004, RELAB (Reflectance Experiment Laboratory): A NASA Multiuser Spectroscopy Facility. In: 35th Lunar and Planetary Science Conference, March 15-19, 2004, League City, Texas, abstract no.1720