STATISTICAL ANALYSIS OF LUNAR SWIRLS' SPECTRAL PARAMETERS RELEVANT TO SPACE WEATHERING. Kateřina Chrbolková[1,2], Josef Ďurech[1] and Tomáš Kohout[2,3], [1]Astronomical Institute of Charles University, V Holešovičkách 2, 18000 Prague 8, Czech Republic (katerina.chrbolkova@helsinki.fi), [2]Department of Geosciences and Geography, University of Helsinki, Gustaf Hällströmin katu 2, 00560 Helsinki, Finland, [3]Institute of Geology, The Czech Academy of Sciences, Rozvojová 269, 16500 Prague 6, Czech Republic.

Introduction: Slow gradual changes of surface properties of small airless planetary bodies in our Solar system due to influence of solar wind, galaxy radiation, and microimpacts are usually represented by term *space weathering* [1,2]. Space weathering results in mitigation of spectral mineral absorption bands, spectral slope reddening, and surface darkening. Therefore, the most important spectral parameters for space weathering studies are the albedo, spectral slope, and depth of the mineral absorption bands.

High albedo areas on the Moon, known as *lunar swirls,* usually lie in places of amplified magnetic field [3], which makes them a natural laboratory for the space weathering studies. The Magnetic field stand-off theory proposed by [3,4] says that charged particles of solar wind and galactic radiation cannot reach the surface of the swirls and thus only microimpacts influence the surface properties. We can hence study what is the difference between the changes to the spectra caused by the complete space weathering mechanism and those caused only by microimpacts. This can help us with understanding of the space weathering mechanism.

Methods: We used spectra from the Moon Mineralogy Mapper (M^3) on board Chandrayaan-1 spacecraft. For our analysis, we have chosen seven different swirls, four mare swirls: the Reiner Gamma, Mare Ingenii, Mare Marginis, and Rima Sirsalis swirl; and three highland swirls: Airy, Descartes, and Gerasimovich. In each swirl, four different regions were identified: fresh crater material outside the swirl, fresh crater material inside the swirl, swirl material from area far from the crater (mature), and mature material in the area adjacent to the swirl. We have chosen several tens to hundreds spectra for each of the regions.

We fitted the spectra using the Modified Gaussian Model (MGM) by [5,6]. This is how we got statistical sets of spectral parameters from the different regions, which we further evaluated using histogram plots, Principal Component Analysis (PCA), and we also used spectral stacking.

Histograms. A histogram is a plot showing number of occurrences of a value (or certain interval of values) of the given variable in the statistical set, with respect to that value.

Principal Component Analysis. PCA is an mathematical approach that transforms the original variables (spectral parameters in our case) into new variables called *principal components.* This is enabled by a rotation of the axes in space. The first principal component (PC1) is set to explain the maximum variance in the statistical sample. The second principal component (PC2) is then perpendicular to it and lies in the direction of the second largest variance in the data, etc. The higher is the number of the principal component, the more probable it explains rather small changes in the data than the overall trends. Last few principal components are usually caused by noise in the data.

Spectral stacking. By summing all the spectra from one region of the swirl, we got a representative spectrum of higher quality, which was easier to fit. We then compared the four representative spectra (for four regions) from one swirl to make further conclusions.

Results: All our results (from histograms, spectral stacking, and PCA) show, that the maria and highland swirls are distinct. In PCA plots, different regions of maria swirls are dependent on both, PC1 and PC2, whereas highland swirls' regions vary only with PC1, see Figure 1. Conclusions about spectral parameters made based on histogram plots agree with those of spectral stacking in most cases. Different spectral parameters show distinct behavior with respect to maria and highlands.

PCA plots also highlight that mature swirl material is distinct from the weathered and fresh materials (no matter if inside or outside the swirl). The intermediate position between the fresh and mature material can be viewed as a supporting argument to the Magnetic field stand-off theory.

Conclusions: Our work revealed that there is a difference between weathering trends in maria and highlands on the Moon. We also showed that lunar swirl areas do not exhibit the same spectral parameters as the fresh or mature material, this can point to the slow influence of the micrometeorites in these areas, as proposed by other authors.

References: [1] Cassidy W. and Hapke B. (1975) *Icarus, 25,* 371–383. [2] Hapke B. (2001) *JGR, 106,* 10039–10074. [3] Hood L. L. and Williams C. R. (1989) *LPSC Proceedings, 19,* 99–113. [4] Hood L. L. and Schubert G. (1980) *Science, 208,* 49–51. [5] Sunshine J. M. et al. (1990) *JGR, 95,* 6955–6966. [6] Sunshine J. M. et al. (1999) *LPSC, XXX,* abstract # 1306.

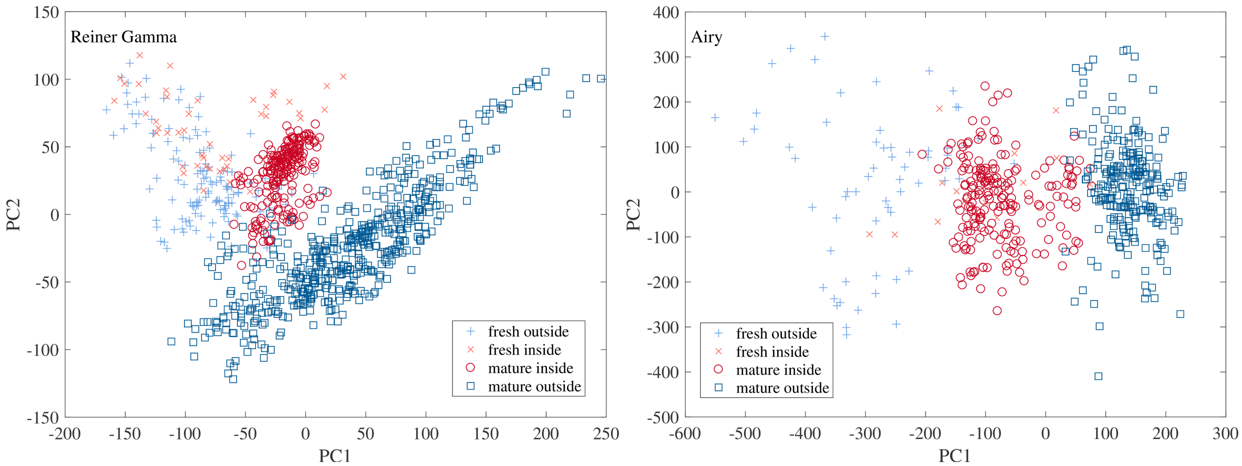

Figure 1: An illustration of the difference between maria (Reiner Gamma) and highlands (Airy) swirls. Outside/Inside describe if the spectra come from a region outside the swirl or inside it.