Asteroid surface archaeology: Identification of eroded impact structures by spectral properties on (4) Vesta
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Introduction: Vesta's surface material is characterized as a deep regolith [1,2], mobilized by countless impacts. The almost catastrophic impact near Vesta's south pole, which has created the Rheasilvia basin, and the partly overlapping older impact of similar size, Veneneia, have not only reshaped the areas of their interior (roughly 50 % of the Vesta surface), but also emplaced each time a huge ejecta blanket of similar size, thus covering the whole remaining surface. In this context, pristine and even younger morphologic features have been erased. However, the spectral signatures of the early differentiation and alteration products by impacts have partially remained in situ. While near the north pole several large old eroded impact features are visible, the equatorial zone close to the basin rims seems to be void of those. Since it is unlikely, that this zone has been entirely avoided by large projectiles, in this area the results of such impacts may have left morphologically not detectable remnants: Individual distribution of particle sizes and altered photometric properties, excavated layers, shock metamorphism, melt generation inside particles and on macroscopic scales, and emplacement of exogenous projectile material. An analysis by color ratio images and spatial profiles of diagnostic spectral parameters reveals such features.

Results: Based on local spectroscopic evidence we have detected eroded impact features of three categories: 1) Small craters with diameters of a few kilometers, 2) Large craters or, if even larger, incipient impact basins, 3) Sub-global ejecta blankets. The eastern part of Feralia Planitia, diameter 140 km, has little evidence of a round outline in the shape model, but it features spectral gradients towards its center. A feature of similar size, centered north of Lucaria Tholus becomes only visible by a similar spectra gradient and a circular outline in specific spectral ratio mosaics. These features seem to be related to the excavation of deeper layers of Vesta's crust and gradients of space weathering, the latter showing up also at smaller highly eroded craters. As an example of the third type, a global mosaic demonstrates the relationship of reflectance level and band I depth. A non-uniform distribution appears, with an anomaly emerging from the large crater Albana in one of its sectors. This association seems to be caused by ejected material from this crater. Only the spectral signature has remained to identify the original pattern. The spectral properties appear to be related to an enhanced presence of shocked material [3] and impact glass [4].

Conclusions: Today's non-uniformity of impact structures, dominated by the Rheasilvia basin, reflects a singular event in a late stage of Vesta's surface evolution. Some earlier large impacts have left their footprints in specific remnants resembling the cases of lunar cryptomaria [5]. Vesta has escaped the fate of other differentiated protoplanets, which have been disrupted, but the crust has been shattered, which does not change the spatial distribution of the surface material entirely. This is associated with linear fragmentation features of various sizes (grabens, troughs, cracks, pit chains) which are correlated with some of the features described here.

References: References: [1] Denevi, B. W., et al., 2012, EPSC2012-813. [2] Jaumann, R., et al., 2012, Science 336, 687. [3] Keil, K., et al., 1992, Icarus 98, 43. [4] Tompkins, S. and Pieters,C. M., 2010, Meteoritics and Planetary Sci. 45, 1152. [5] Antonenko, I., et al., 1997, Lunar Planet Sci 28, 1670.