Resurfacing processes on Vesta

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Planetary surfaces are steadily modified by endogenic processes. The most important resurfacing processes on dry airless bodies are: mass-wasting processes, volcanic activity, and tectonics due to impact cratering. Due to the absence of volcanic activity on Vesta [1], mass wasting and impact cratering are the most likely resurfacing processes on Vesta. The high elevation differences on Vesta [2] and the steady bombardment of Vesta's surface by impacts cause seismic shaking which promote material to move downwards.

We analyzed different types of mass-wasting features in the South Polar Region, such as slumping blocks at the steep scarp Matronalia Rupes, spur-and-gully morphologies, and landslides in craters [3]. Collapse processes, instability of slopes, and seismic-triggered events cause the landslides, rotational slumping blocks on scarps, as well as spur-and-gully morphologies on crater walls and scarps. Spur-and-gully morphology is known to form on Mars and the Earth normally supported by liquid flow but, on Vesta, these features formed under dry conditions. At Matronalia Rupes, rotational rock slumping blocks are clearly exposed as material slumped down the scarp wall in a stair-stepped pattern, which is interrupted by minor scarps and covers the underlying terrain. This rotational rock slumping is affected by slope instability and gravitationally triggered events, such as seismic shaking mostly produced by impacts elsewhere on Vesta [3].

The sloping surface of Vesta cause not only the formation of mass wasting features, but also the formation of craters on slopes. These craters are in turn influenced by mass wasting and show an asymmetric crater shape with a sharp uphill rim and a smooth downhill rim. The craters show a sharp crater rim uphill and a smooth one downhill as well as ejecta on the downhill rim and only thin ejecta over the uphill rim. Three-dimensional numerical simulations have been performed to study the formation process of the unusual craters [4,5]. The results showed that the slope prevents the deposition of ejected material in uphill direction and results in a larger accumulation of ejecta within the crater and beyond the downhill crater rim [4,5]. Downhill-directed crater collapse results in slumping of uphill- material and products the sharp uphill rim [4,5]. Thus, mass accumulation downhill is a mixture of ejected material and material of the initial slope [2].

References: [1] Russell et al. (2013) Meteoritics & Planetary Science, 1–14. [2] Jaumann et al. (2012) Science, 336, 687–690. [3] Krohn et al. (2014) Icarus, in press. [4] Krohn et al. (2013) PSS, submitted. [5] Elbeshausen et al. (2013) LPSC,1903.