BOULDERS ON THE SURFACE OF VESTA – The Southern Hemisphere. U. Carsenty[1], R. Wagner[1], R. Jaumann[1], S.E. Schröder [1], C.A. Raymond[2], C.T. Russell[3]. [1]DLR, Berlin Germany (uri.carsenty@dlr.de), [2]JPL, California Institute of Technology, [3]UCLA, Institute of Geophysics.

Introduction: Images from the Dawn mission Low Altitude Mapping Orbit (LAMO) [1,2,3,4] enable us to study the surface of Vesta at a spatial resolution of 20m per pixel. We are using the imaging data to identify surface features down to the 30m size range, and also measure their sizes when above - 80m.

Boulders Studies:

Boulders are the product of impacts on planetary bodies. The rims of craters formed in hard bedrocks are littered with blocks of rocks [5]. The blocks are usually largest on the rim because the ejection velocity is lowest there. The block size should be affected by variables such as rock strength, preexisting cracks, and perhaps impact velocity. The boulders ascend along the crater inner wall from some distance below the original surface, in consonance with the inverted stratigraphy of the rim region. “These shattered fragments of the original subsurface rock layers are further reduced in size as they participate in the strongly sheared excavation flow and are thrown to their final resting places on the rim” [5]. Rocky boulders are frequently observed on the surfaces of planetary bodies and their residence times on the surface can reveal the nature and rates of small scale erosion and weathering processes. The destruction of lunar surface boulders [6] is largely accomplished by collisional disruption due to a small number of relatively energetic impact events that deliver the critical rupture energy. A few hundred boulders were identified on Lutetia [7]. Most are concentrated around the central crater in Baetica regio with a few more apparently associated with Patavium crater**.** The size range of boulders visible to the camera is about 60-300 m. The authors evaluated various destruction mechanisms for ejecta blocks and concluded that using current estimates of the number of small asteroids in the main belt, destruction by impacts of small (several meters diameter) projectiles limits the lifetime of the boulders to 300 million years. This might also apply to Vesta.

The Vesta Data Set: We conducted an exhaustive search for boulders and their corresponding craters in the southern hemisphere of Vesta. We identified 4644 boulders, associated with 72 craters. Some 1400 of these boulders are larger than 80m in diameter and we can derive their size distribution. For the smaller boulders we can only mark their position to study the spatial distribution. In a few cases the craters are in a double or even triple arrangement, so that we have only 62 distinct crater units associated with the boulders. The craters vary in size between 1 and 37km, with a higher abundance of craters with diameters around 8 and 22km. There are small craters surrounded by large number of boulders and large craters associated with only few boulders. The largest number of boulders, (803) surround the crater Cornelia (225.59E, 9.32S. 15km diameter) – see Fig. 1.

Discussion

Formation of boulders requires the presence of a *consolidated subsurface bedrock layer*. The *size* and *depth* of the crater is directly defined by the *impact energy*. The projectile penetrates the regolith and *shatters the bedrock, excavating* the crater cavity. The boulders are ejected in ballistic trajectories and their spatial distribution can be correlated to the geometry of the impact and the structure of the bedrock layer where they formed. The retention of boulders is a function of the gravity field, while their destruction is accomplished by collisions with small meteorite (flux of small meteorite at the main asteroid belt) and other small secondary projectiles from nearby impact craters (regolith gardening).

The Case of Vesta - various scenarios

All the parameter presented above - crater size, subsurface layers and relative age - and the interplay between them are essential in order to understand and explain the observations. We observe a large crater without boulders next to a small crater with boulders. Is the layer of competent material not globally present ? The thickness of the non-consolidated regolith must be included in this analysis. The erosion of boulders is a function of time. Is the presence of boulders a criteria for young age? and does it correlate with other methods to determine geological ages. It might be that all craters (above a threshold size) had boulders in the past, those that do not have them now might be significantly older. This study will add to the general understanding of the structure of the southern basins.

References:

[1] Mest et al. (2013) JGR in Review.
[2] Russell, C.T.& Raymond, C.A. (2011) Space Sci. Rev. 163, 3-23.
[3] Jaumann, R. et al. (2012) Science 336, 687-690.
[4] Russell et al. (2012) Science 336, 684-686.
[5] Melosh H.J. (1988) Impact Cratering.
[6] Basilevsky A.T. et al. (2013) PSS3576.
[7] Kueppers M. et al. (2012) PSS 66, 71-78.

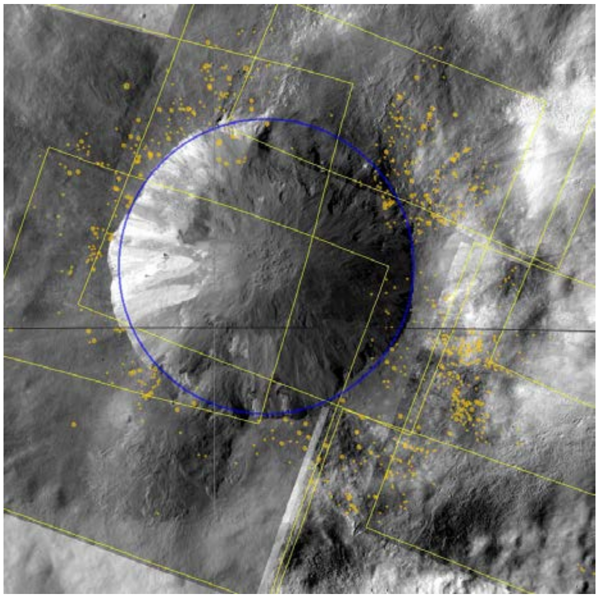

Fig 1a – Cornelia crater – 15km diameter.
The 803 boulders are marked in yellow.

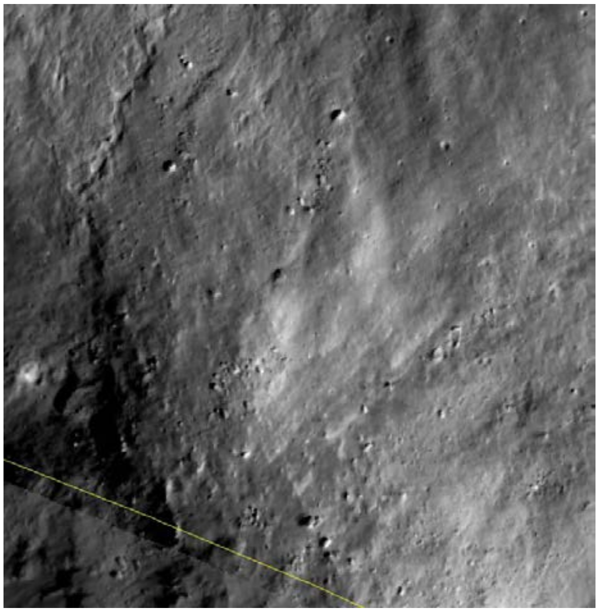

Fig. 1c - The NE corner of Cornelia crater with its extended field of boulders. The distance between the 2 large boulders (almost EW oriented) is 2km.
The size of large boulders is 200m.

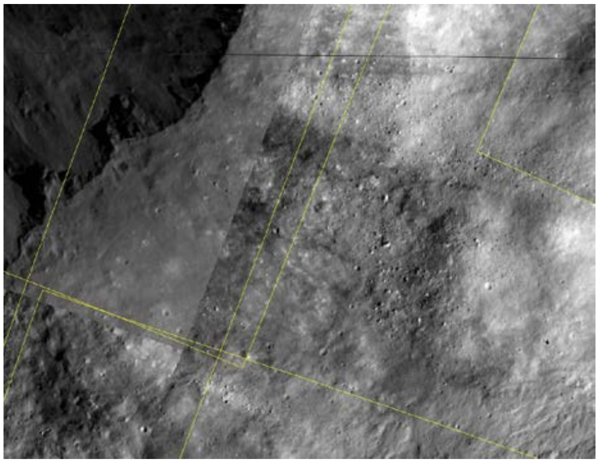

Fig. 1b - The SE corner of Cornelia crater with its extended boulder field. The distance between the 2 largest boulders (above each other near the center) is 900m.