
The NEAR Shoemaker Multispectral Imager (MSI) has mapped the entire surface of 433 Eros at better than 5 m/pixel, covered much of the equatorial regions at 0.5 to 2.0 m/pixel, and returned images down to a resolution of 1.2 cm/pixel during the final descent. From these data it is clear that Eros has a wonderfully complex, loose, fragmental surface layer (regolith). The particle sizes of the regolith range over greater than 5 orders of magnitude, from blocks greater than 100 m in diameter to particles forming ponded sedimentary deposits smooth at a resolution of ~1.2 cm/pixel.

We have mapped the distribution of blocks over the entire asteroid (1125 km²) and found 6760 larger than 15 m. Nearly half the volume of all blocks larger than 15 m, is within a 7.6 km wide crater (proposed name of Shoemaker). We have modeled trajectories of materials launched from the Shoemaker area as well as from other sites on Eros. Simulations involve launching particles at chosen velocities and orientations from selected areas, and following them until impact. From these models we find that the mapped distribution of blocks on Eros approximates the predicted location of blocks from Shoemaker crater. This discovery has two critical implications for understanding the geology of the asteroid: 1) Shoemaker ejecta overlies Psyche crater completing the relative stratigraphy of major features on the asteroid, 2) ejecta blocks have a finite lifetime on Eros through degradation or burial. Either erosion or burial of blocks is indicative of significant regolith depths on the asteroid. Erosion of blocks creates fine materials that contribute to the regolith, and burial of large blocks requires a regolith at least as deep as the smallest dimension of a boulder.

In certain regions of Eros unusually smooth and flat deposits infill bottoms of craters and other depressions. Margins of these deposits sharply embay the pre-existing topography, and their surfaces are perpendicular to the local gravity gradient. Such morphology is consistent with emplacement with little to no shear strength, allowing the material to “pond” to an equipotential surface. This depositional process requires a mechanism for temporarily eliminating cohesive forces between particles. Ponded deposits currently support steep walled grooves, impact craters, and superposed blocks showing that subsequent to emplacement, some compaction has occurred giving the deposits a finite shear strength. Ponds can occur at all latitudes, however of the 255 ponds ≥30 m diameter 91% are located within 30° of the equator, and there are zones within a few degrees of the equator and asymmetrically around the long ends of the asteroid that have distinctively more and larger ponded deposits. Regions of pond occurrence coincide with projected Shoemaker ejecta areas, low gravity areas, and long terminator crossings due to Eros’s 88° obliquity.

The long terminator exposure is the perfect environment for the creation of photoelectric charge differentials between illuminated and shadowed terrain. In this setting fine particles (tens of µm) may be levitated from the surface and redistributed. The combination of relatively low gravity and enhanced terminator crossings in the areas of the ponds argues for serious consideration of electrostatic sedimentation processes to explain the ponds. In support, color imaging shows that many of the ponds have color properties unambiguously distinct from the surrounding terrain; in the visible range the ponds are relatively blue (550/760 nm) and have a deeper infrared band (950/760 nm): properties consistent with the pond material enjoying little alteration from the space environment (weathering) relative to their surroundings. This weathering produces glass from micrometeorite impact that forms relatively large clumps of glass and crystalline material. Electrostatic levitation may be lifting the finest component (crystalline material) and preferentially collecting it in the ponds.