CRATERING OF THE C-TYPE ASTEROID MATHILDE. Clark R. Chapman[1], William Merline[1], Peter Thomas[2], and the NEAR MSI-NIS Team, [1]Southwest Research Inst., #426, 1050 Walnut St., Boulder CO 80302, USA (cchapman@boulder.swri.edu), [2]CRSR, Cornell Univ., Ithaca, NY 14853, USA.

The 53 km diameter C-type main-belt asteroid 253 Mathilde was imaged by the Near Earth Asteroid Rendezvous (NEAR) spacecraft on 27 June 1997 [1]. Not only is Mathilde's surface covered with craters, but several giant craters (4 with diameters larger than the radius of Mathilde itself) dominate the shape of the asteroid. Nearly 300 smaller craters were identified on the portions of Mathilde studied (regions totalling 1155 sq. km. with good lighting and viewing geometry, avoiding the often-shadowed interiors of the giant craters). Craters 0.5 to 5 km diameter approach saturation equilibrium spatial densities, with a differential power-law slope of -3; they exhibit a range of degradation states, similar to crater populations on Ida. They probably represent a population in quasi-equilibrium between creation and destruction of craters caused by saturation cratering of Mathilde.

The giant craters are a major surprise. It had been thought that an object's radius was roughly the limit for size of crater that could be produced on it without substantially disrupting the body, at least to the point of "resetting" the surface topography. Yet one crater is 30% larger than Mathilde's radius and three others exceed a radius. The large craters alone (on the 58% of Mathilde that is represented) exceed the usual definition of geometric saturation. Since only one of these craters can have resulted from the latest large impact, the fact that the others exist -- generally with fairly pristine morphology -- means that these impacts were unexpectedly ineffective in destroying pre-existing topography.

The composition and internal structure of Mathilde may contribute to the unusual retention of giant craters. The bulk density of Mathilde [1,2] is very low, about 1.3 gm/cm^3. Even assuming that Mathilde is made of the least dense known meteoritical materials (carbonaceous chondritic, which seems likely from its C-type reflectance spectrum), there must be additional porosity. One possibility is that Mathilde is a rubble pile, with large internal voids. Another is that Mathilde is composed of material even more porous (on a fine scale) and less dense than carbonaceous chondrites. We must remember that the Earth's atmosphere biases meteorite collections toward unusually strong examples of carbonaceous meteorites. Whatever the nature of Mathilde's porosity, it must damp the propagation of shock waves through the interior of the body and may also dramatically reduce ejecta velocities, thereby confining and limiting the damage done exterior to a crater's periphery. This style of cratering has never been recorded on any other solar system body, but it could be typical for primitive asteroids and comets, of which Mathilde is the first to be closely studied.

Calculation of an "age" for Mathilde is highly model-dependent, but it is plausible that Mathilde is billions of years old. There is no reason to require, however, that the giant craters are due to some ancient, now vanished, population of projectiles. Allowing for statistics of small numbers, they are compatible with the size distribution of modern-day projectiles in the inner solar system. We will speculate on possible implications from this first reconnaissance of a C-type asteroid for the derivation of C-type meteorites from the asteroid belt.

References: [1] Veverka J. et al. (1997) *Science, 278*, 2109-2114. [2] Yeomans D. et al. (1997) *Science, 278*, 2106-2109.