ASTEROID RUBBLE PILES: HOW BIG ARE THE PIECES? D. T. Britt[1] and G. J. Consolmagno SJ[2], [1]Department of Geological Sciences, U of Tennessee, Knoxville TN 37996, USA, [2]Vatican Observatory, V-00120, Vatican City State.

Introduction: Many lines of evidence lead to the conclusion that asteroids are strengthless bodies, piles of rubble held together only by their own self gravity. Among the indications leading to this conclusion are the observations that all asteroids spin slowly enough to be held together by their own self gravity [1]; that near-Earth asteroids have odd shapes matching those predicted for strengthless bodies undergoing tidal distortion [2]; and that the densities of asteroids are significantly lower than corresponding meteorite bulk densities [3].

This latter work allows one to put numerical estimates on the amount of macroporosity in asteroids. If S-type asteroids like Ida and Eros with a density on the order of 2.6 g/cm^3 are made up of material similar to that in ordinary chondrites, then they must be at least 30% empty space. Given the 10% porosity typical of ordinary chondrites, these asteroids must have void spaces on a scale comparable to the meteorites representing another 20% of the volume of the asteroid. For C type objects like Mathilde, Phobos, and Deimos, the observed low density (1.5 g/cm^3) implies a macroporosity of at least 20% if they are made of rocky material similar to low density hydrated carbonaceous chondrites. However, these dark asteroids are observed to be anhydrous; to make them out of water-free dark meteoritic material would require that they were 50% or more void space.

Observations: Is such a large amount of void space compatible with the way the surfaces appear in the imagery of asteroidal bodies obtained so far by spacecraft? We have re-examined archived images of Ida, Gaspra, Mathilde, Phobos, and Deimos returned by various spacecraft over the past ten years to try to find evidence of macroporosity, and to look for any indication of a typical size for the individual bits of "rubble" from which these asteroids must be made.

Along with the well known grooves on Phobos, the surfaces of both Phobos and Deimos show significant mass wasting. In some images, what appear to be coherent blocks on the order of tens of meters diameter can be seen sitting on the surface. Images of Mathilde, Ida, and Gaspra show evidence of possible fracturing and shifting of material.

These images and simple calculations suggest that asteroids may be primarily rubble whose size ranges from meters to tens of meters. The surfaces of asteroids are almost certain to have been significantly modified by impacts, leading to a regolith of smaller sized pieces, but the meteorites themselves show that the lithification of small fragments into larger rocks is a common occurrence. Gravity would cause smaller fragments to fill void spaces near the surface, but deep inside the asteroid it is possible that the filling of spaces between meter-sized bits of rubble may be less efficient.

References: [1] Harris A. W. (1996), *LPS XXVII* 493-494 [2] Bottke W. F. *et al.* (1997), *Bull A. A. S. 29,* 965; Bottke W. F. *et al.* (1999) *Astron. J.* in press. [3] Consolmagno G. J. and Britt D. T. (1998) *Meteorit. Planet. Sci.* **33**, 1230-1241.