## Shapes of Small Satellites. P. Thomas, Cornell University

The accurate measurement of limb coordinates on small satellites is the major technique for evaluating their sizes and shapes in the absence of good stereoscopic image coverage. The shapes of satellites may be clues to their internal structure if they are relaxed into ellipsoids (Dermott and Thomas, 1986). Small satellites appear not to be relaxed and hence their shapes may not help in estimating density or moments of inertia. The distinction between irregular and ellipsoidal satellites can now be made quantitatively with the availability of many accurate limb profiles of satellites. The limb profiles are found to subpixel accuracy (Dermott and Thomas, 1986) and can be fit by ellipses to approximate an average size and shape. The residuals from these fit ellipses provide a convenient and quantitative measure of the topography on the satellites. The standard deviation of the residuals as a fraction of the satellite's radius gives a measure of the departure from a smooth form. Departures from gravitational (and tidal) equipotentials would be greater, but on the average this is a good measure of the relaxed or non-relaxed nature of the shape of the object. Figure 1 plots the standard deviation of residuals of limbs for many small satellites, some of which are averages of several different views; there are many more data to be included for Phobos and Deimos. Mimas, a thoroughly studied equilibrium triaxial ellipsoid, is included, as are preliminary data from the Uranian satellites (Thomas et al., 1986).

The outstanding feature of this plot is the random distribution of shapes for objects smaller than Mimas, and the very smooth forms of larger satellites. The abrupt transition is probably due to a combination of the effects of the ratio of gravitational binding energy (varies as $r^5$) to the strength binding (varies as $r^3$) as well as greater relaxation of forms on larger objects due both to higher gravity as well as slight thermal gradients within the objects.

The limb topography is also related to specific forms on the objects, and a systematic survey of these forms on small and larger objects is underway.

## Reference:

Dermott, S. F., and Thomas, P. (1986). The shape and internal structure of Mimas. For submission to Icarus.

Thomas, P., J. Veverka, T. V. Johnson, and R. Hamilton Brown (1986). Voyager observations of 1985U1. For submission to Icarus.
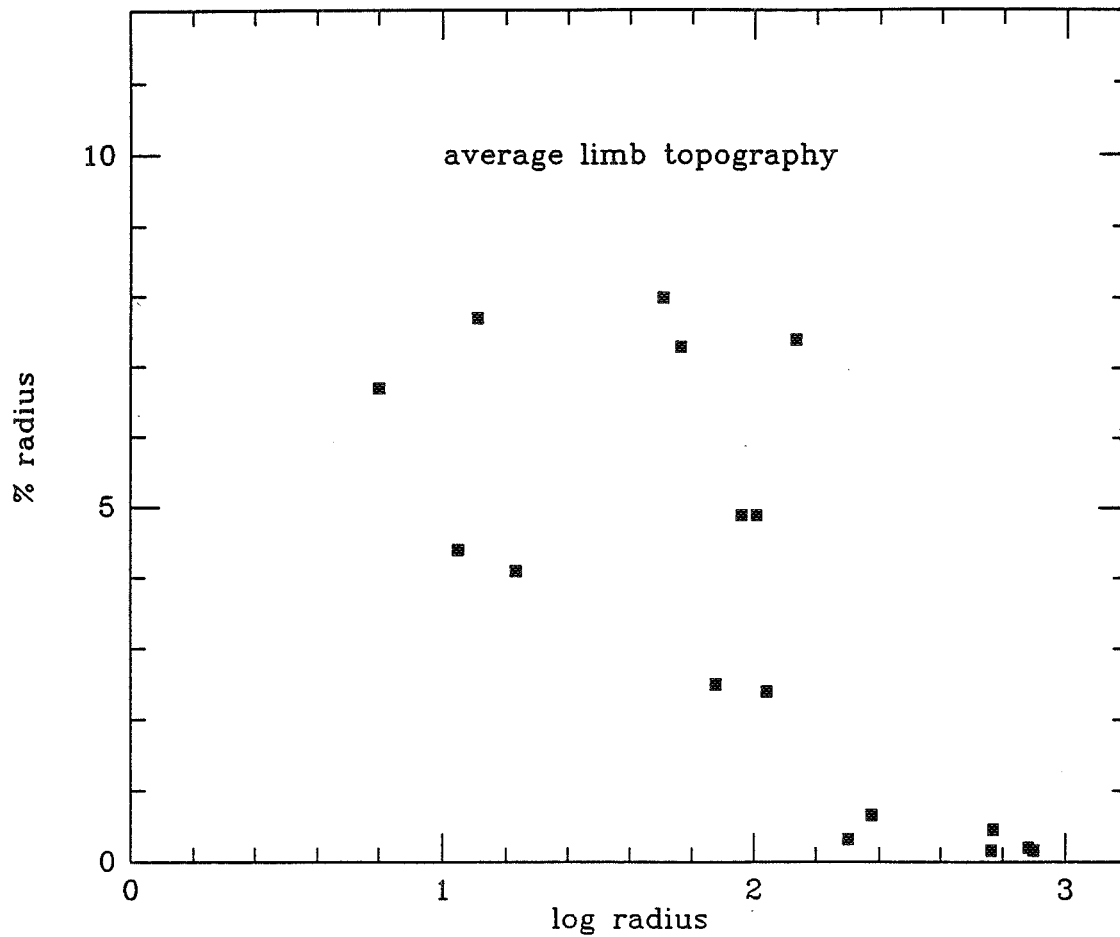
**Figure.** Standard deviations of limb profiles from fit ellipses. Deviations from equipotential surfaces would be slightly greater. Some data points are averages from several pictures as different perspectives of the same satellite can give very different results. The satellites are Phobos, Deimos, Calypso, 1980S6, Amalthea, Phoebe, Hyperion, Janus, Epimetheus, Mimas, and the major Uranian satellites (Uranian satellite data from Thomas et al., 1986). Other large satellites would plot even closer to the X axis than Mimas and Uranian satellites.