STATUS OF THE SMALL BODY MAPPING PROGRAM, Philip J. Stooke, Department of Geography, University of Western Ontario, London, Ontario, Canada N6A 5C2 (stooke@vaxr.sscl.uwo.ca).

INTRODUCTION. I have developed shape modelling methods and map projections for non-spherical bodies (**1,2,3,4**). The shape modelling method, which duplicates limbs and terminators using interactive modification of a digital radius model, is a precursor of the greatly extended SPUD software developed by the Galileo imaging team (**5,6,7**). In the **Small Body Mapping Program** I am applying these techniques consistently to all bodies for which data are acquired. Sources include NASA planetary images (e.g. Voyager), ESA and russian spacecraft (e.g. Giotto, VeGa), Earth-based radar (**8**), star occultations (**9**) and HST images. Shapes derived by the SPUD team and others can be imported for mapping. Results for the nucleus of Comet Halley, Amalthea, Prometheus, Pandora, Janus and Epimetheus have been published. Work is in progress on Larissa, Proteus, Puck, Phoebe and Hyperion.

RESULTS TO DATE. These techniques were used to map the nucleus of Comet Halley (**10**) and Amalthea (**11**). The Halley model was based on a rotation state now known to be incorrect. It will be repeated when the rotation is better understood, as now seems to be within reach. The Amalthea map (**11**) was drawn using earlier versions of the software, and has been improved (paper submitted). The new shape is being used to model the gravitational field (**12**).

Since then, models and maps have been derived for the F Ring shepherd and co-orbital satellites of Saturn (**13,14,15**) and for Larissa and Proteus, the inner satellites of Neptune (submitted for publication). Experience indicates that global maps greatly facilitate the interpretation of geology. The process of shape modelling gives a far greater familiarity with the object than can be obtained from simple inspection of images. Thus I was able to describe grooves and a major trough on Epimetheus, find parallel ridges and a large but poorly imaged crater on Prometheus, and note that Prometheus appears smoother than the other three nearby satellites (**16**). For Proteus, lower resolution image pairs were merged to improve SNR, revealing new details including a massive apparent valley on the leading side, and strongly confirming prograde synchronous rotation. Many lineaments are seen, apparently grooves (Figure 1).

WORK IN PROGRESS. Models and maps of Phoebe, Hyperion and Puck are in progress. For Phoebe many images were taken over nearly three rotations at low resolution (10 to 11 pixels across the disk). Despite low resolution and noise, features can be recognised in successive views and in images taken at intervals of one or two rotations. The limb shape varies systematically (Figure 2) and a simple shape model is possible. Preliminary indications are that several large (40 km diameter) craters can be reliably distinguished, and that bright markings are located on ridges rather than around craters.

For Hyperion, two indicators of rotation are found in resolved images: (A) features are seen to cross the terminator in the last few views (arrows, Figure 3), giving a rough indication of the pole position (40° to 80° beyond the centre of the terminator in Figure 3). (B) Images 43883.11 to 43883.31 show small but real brightness variations indicating the position of a large crater well seen in later images. Motion of the crater shows the sense of rotation about the pole described above (counterclockwise in Figure 3). The images show grooves or valleys near the terminator, and many more craters than have been described previously. Hyperion is not lacking in craters as suggested in ref. **17**. Preliminary indications are that the rotation state at the time of the Voyager 2 flyby was as described in ref. **17** (13 day period, axis near the orbit plane) and that the rotation axis was significantly inclined to the short body axis.

Puck was resolved in a single small image. Two dark 'lanes' have been mapped (**18**), but I find only one convincing. It is surrounded by two bright bands and is most likely a single large groove or trough, comparable to that seen on Epimetheus. The bright bands are its walls, the dark lane is its floor (Figure 4). The trough was probably caused by a large impact, at the formation of Puck by fragmentation or later.

FUTURE WORK. These techniques will be applied to all bodies for which data are obtained. The shape modelling method will be modified to work with delay-doppler images of NEAs. The Phoebe experience is directly applicable to HST images of main belt asteroids. Shapes modelled by other researchers will be analyzed independently to help assess duplicability of such models, and maps in a consistent style will be prepared for all suitable worlds.

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REFERENCES. (**1**) Stooke, P.J., 1986. Proc. 2nd Int. Symp. Spatial Data Handling, 523-536. (**2**) Stooke, P.J., 1988. Ph.D. Diss., Univ. of Victoria, 169 pp. (**3**) Stooke, P.J. and Keller, C.P., 1990, Cartographica, 27: 82-100. (**4**) Stooke, P.J., 1992. Proc. ACM '91, LPI, Houston, 583-586. (**5**) Simonelli, D.P., et al., 1993. Icarus 103: 49-61. (**6**) Thomas, P.C., 1993, submitted to Icarus. (**7**) Thomas, P.C. et al., 1993, submitted to Icarus. (**8**) Ostro, S.J. et al., 1990. Science 248: 1523-1528. (**9**) Dunham, D.W., Sky & Tel. Jan. 1992, 71-77. (**10**) Stooke, P.J. and Abergel, A., 1991. Astron. Astrophys. 248: 656-668. (**11**) Stooke, P.J., 1992. Earth, Moon, Plan. 56: 123-139. (**12**) Gozdziewski, K. et al., in preparation. (**13**) Stooke, P.J., 1993a. Earth, Moon, Plan. 62: 199-221. (**14**) Stooke, P.J. and Lumsdon, M.P., 1993. Earth, Moon, Plan. 62: 223-237. (**15**) Stooke, P.J., 1993b. Earth, Moon, Plan. 63: 67-83. (**16**) Stooke, P.J., 1993c. LPSC XXIV (abstract), 1363-1364. (**17**) Thomas, P. and Veverka, J., 1985. Icarus 64: 414-424. (**18**) Croft, S.K. and Soderblom, L.A., 1991. in Uranus (Bergstralh et al., eds), U. Arizona Press, pp. 561-628.

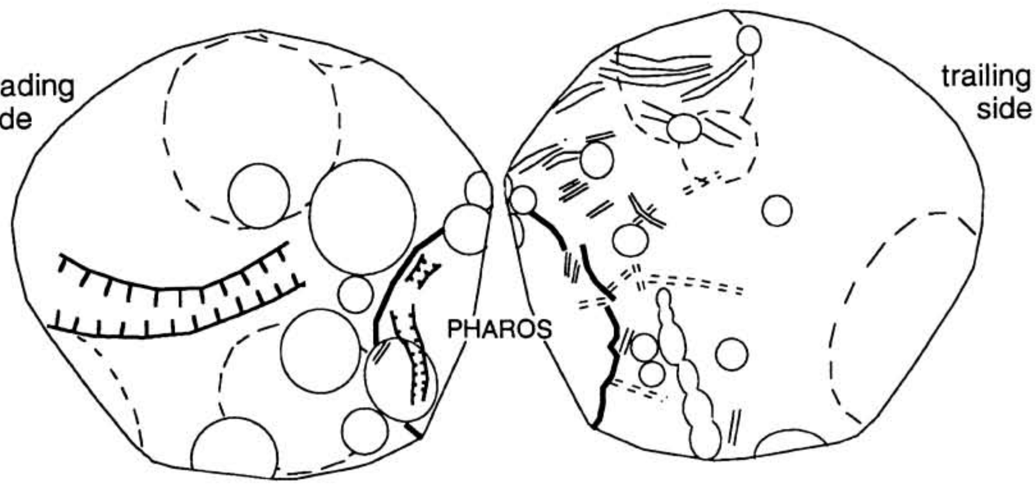

Figure 1. Map of major features of Proteus (morphographic conformal projection), showing grooves (double lines, dashed if uncertain), larger valleys (heavy double lines), large craters (solid loops), degraded craters or facets (dashed loops) and the large crater Pharos (thick arcs).

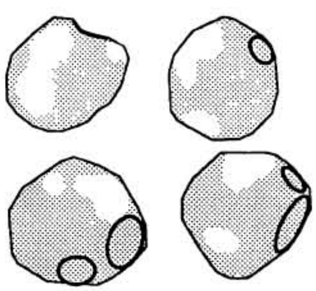

Figure 2. Sketches of Voyager images of Phoebe showing variations in limb shape, possible large craters and bright markings.

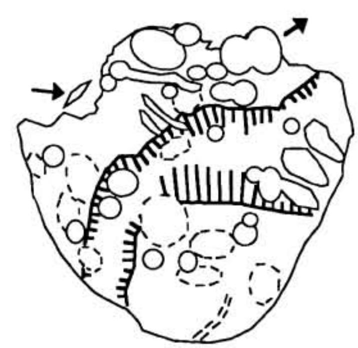

Figure 3. Sketch of Voyager image 43972.11 of Hyperion showing craters, grooves (top centre), motion of craters relative to the terminator (arrows), and major scarps (walls of a large trough).

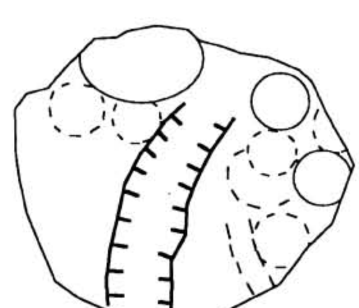

Figure 4. Sketch of Voyager image 26837.16 of Puck showing craters and the possible large trough (centre).

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