LINEAR STRUCTURES ON THE SMALL INNER SATELLITES OF SATURN, Philip J. Stooke, Department of Geography, University of Western Ontario, London, Ontario, Canada N6A 5C2 (stooke@vaxr.sscl.uwo.ca).

Shape modelling methods developed for non-spherical worlds were applied to four satellites of Saturn, Prometheus, Pandora, Janus and Epimetheus, resulting in the first detailed shaded relief maps of their surfaces. Ridges and valleys are described with their implications for satellite history and asteroid 951 Gaspra. They probably result from fracturing during break-up of parent bodies and/or later large impacts. Prometheus and perhaps Gaspra may be coated with debris from parent body fragmentation as well as more recent regolith.

These four satellites are covered by relatively few useful images (3 or 4 views each), so the shapes are imperfectly known and positions of features on maps may be wrong by up to a few tens of degrees in some areas (worst where a feature is seen only near a limb). Nevertheless, these shape models (refs **1-5**) are more useful than the previous triaxial ellipsoid models (e.g. **6**). The maps reproduced in refs **3**,**4** and **5** are the only detailed maps yet published, and despite remaining shortcomings they offer the best chance yet to examine global structures.

Prometheus (Fig. 1) is very elongated and appears unexpectedly smooth in the one high resolution image. It resembles Gaspra in having a few small sharp craters and subdued depressions suggestive of a mantled appearance. Three parallel ridges run across its north polar region, the largest (middle) one 100 km long (70% of the length of the satellite). A possible faint depression crosses the leading side at about 90° longitude, and may continue as a groove or chain of depressions where it meets the set of parallel ridges near the north pole. Two large depressions, possibly craters, occur at either end of the leading side (longitudes 12° and 160°).

Pandora is heavily cratered, with several large craters and others down to the limit of resolution. The surface must be old. No linear features are visible in the 25% of the satellite clearly imaged.

Janus (Fig. 2) is the largest (diameter 200 km) and roundest of the four satellites. A complex of bright linear markings near longitude 30° may be artifacts of the smeared image covering this area, or rims of large craters. The only obvious linear ridge runs from 20° north, 350° west to 10° north, 290° west, separating two major facets. It may be a relic of the original shape of Janus as its parent body broke up. The surface is heavily cratered so any such break-up must have been ancient. The other linear features are large crater chains. Several occur in the Voyager 2 image where their linear walls might be interpreted as faults. The component craters are large and shallow, more like the lunar Vallis Rheita than Catena Davy. More are seen in the Voyager 1 transit image. The chains (or parts of them) might be artifacts of smearing (**7**), but other craters appear relatively unsmeared and a groove-like chain seen at high sun in the transit image is clearly visible as a chain of depressions near the terminator in the Voyager 2 frame. These two groups of crater chains are seen in different images and appear unconnected until mapped globally, when they appear to radiate from an otherwise unremarkable region near 30° south, 260° west.

Epimetheus (Fig. 3) has the highest resolution coverage among these satellites, 1.6 km/pixel on parts of the trailing side. It has a unique topographic data set, six images of the shadow of the F Ring crossing its surface. The portion of the ring casting the shadow was assumed linear and the shape model was adjusted until the ring shadows appeared linear from the direction of the sun. The shape of the trailing side of Epimetheus is better known than any other part of the inner satellite system. The surface is heavily cratered. Several linear markings, some certainly grooves or valleys, are visible in Voyager 1 images, another in a Voyager 2 image. Some appear on an unpublished map by P. Thomas (personal communication), but a prominent valley in the high-sun region of the best images has never been described previously. The F Ring shadows are roughly parallel to it and may have hindered its identification. The valley is 100 km long, 20 km wide through most of its length, widening at its eastern end. The depth is not usefully constrained, though photometry may help. It runs from 30° south, 30° west across the prime meridian to 30° south, 290° west. A prominent ridge of about the same scale runs along 10° north over a similar range of longitudes.

Prometheus, Epimetheus and Janus have more linear features than have been acknowledged before. The most plausible mechanism for their formation is impact damage, possibly enhanced by tidal effects as orbits evolve. Damage may be caused by impacts creating craters large in relation to the size of the satellite (e.g. Stickney on Phobos) - e.g. depressions on the leading side of Prometheus or craters like Pollux or that at 20° south, 50° west on Epimetheus. No suitable crater has been found on Janus, but a limb depression at 40° north, 25° west is a possibility. Damage may also result from the fragmentation event which ejects a satellite from a parent body - the pristine 'new' satellite may be heavily fractured. If subsequent cratering does not entirely obliterate the old fractures or tidal effects reactivate old fractures, a 'cratered graben' may result, looking like some of the apparent crater chains on Janus.

Prometheus appears oddly smooth in the best image. It may be young, formed by a recent (ring-forming?)

fragmentation event, but Pandora has an older surface and cannot be its sibling. On the other hand, Prometheus has many depressions which might be heavily mantled craters, in which case it could be as old as Pandora but mantled by ejecta, perhaps from the largest leading side depression (30° north, 160° west) or from a ringlet like the F Ring which collapsed onto the surface of the satellite as orbits evolved. These explanations would not work for Gaspra which looks similar (much Prometheus ejecta could be re-accreted from Saturn orbit) , but a third could accomodate both bodies: most of the debris is from the fragmentation event which presumably formed each body, the equivalent of late low velocity ejecta which forms a crater rim or falls back into the crater on a larger body but could be accreted onto the larger fragments during parent-body breakup. The premise that fragmented bodies are initially dust-free and only acquire a regolith by subsequent cratering may need to be re-examined.

REFERENCES: **(1)** Stooke, P.J., 1986. Proc. 2nd Int. Symp. Spatial Data Handling, pp. 523-536. **(2)** Stooke, P.J. and Keller, C.P., 1990. Cartographica **27**: 82-100. **(3)** Stooke, P.J., 1992. "The topography of Epimetheus", Earth, Moon, Planets (submitted). **(4)** Stooke, P.J., 1992. "The shapes and surface features of Prometheus and Pandora", Earth, Moon, Planets (submitted). **(5)** Stooke, P.J. and Lumsdon, M.P., 1992. "The topography of Janus", Earth, Moon, Planets (submitted). **(6)** Yoder, C.F., Synnot, S.P. and Salo, H., 1989. Astron. Journ. **98**: 1875-1889. **(7)** Thomas et al., 1983. J. Geophys. Res. **88**: 8743-8754.

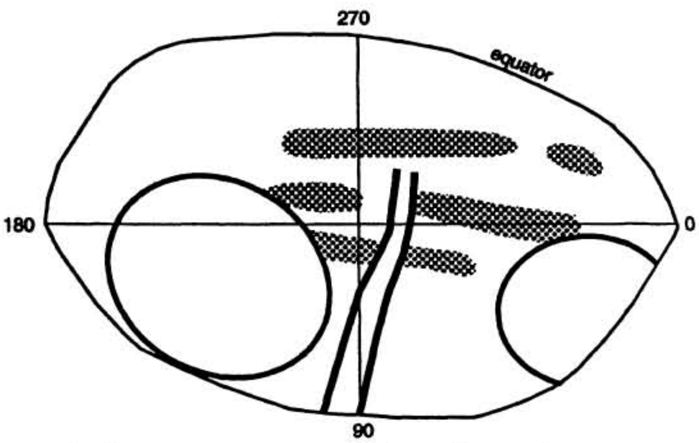

Figure 1. Major features, north side of Prometheus. Pattern: ridges; double line: valley; loops: depressions. Base is an equal area projection (ref. 4). Outline is convex hull of equator.

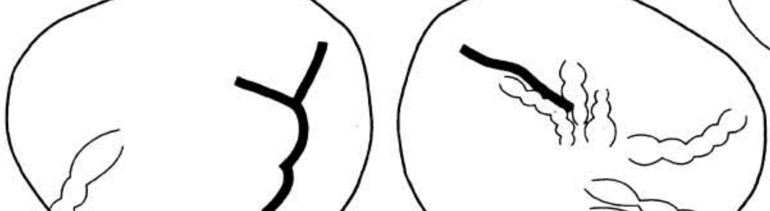

Figure 2. Non-crater features of Janus. Heavy lines: ridges (Y shape is very uncertain); scalloped lines: crater chains. Conformal projections centred on equator (ref. 5), trailing side at right. Outline is convex hull.

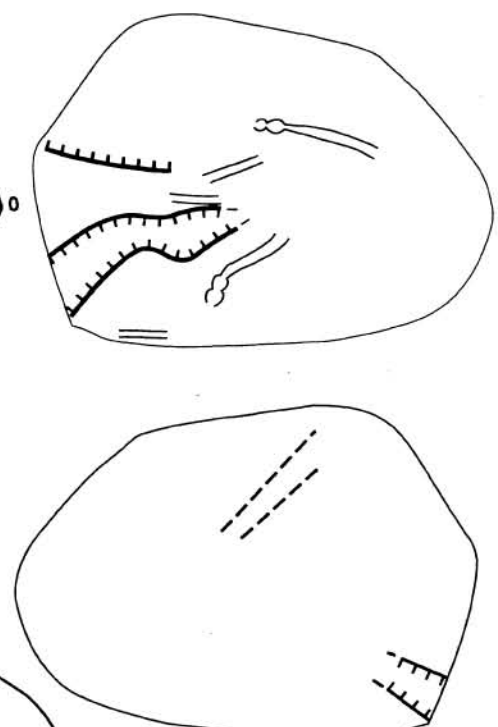

Figure 3. Non-crater features of Epimetheus. Heavy lines - scarps (ticks downslope); light lines - grooves (scalloped where they resemble crater chains); dashes - possible grooves. Conformal projections (ref. 3), trailing side at top. Outline is convex hull.