PHOBOS: SURFACE AND SOLID BODY PROPERTIES FROM DIGITAL SHAPE DATA. P. C. Thomas, Cornell University

The combination of irregular shape and significant tidal forces makes much of the scientific investigation of Phobos's surface conditions and solid body properties dependent on techniques more specialized than those used on ellipsoidal objects. Stereogrammetric and limb coordinate data have been used (from Viking and Phobos 2 images) to derive a digital shape model of Phobos at 2° grid spacing. Uncertainties in grid positions are mostly under 75 m, but some areas with only low resolution imaging have uncertainties of 300 m. One view is given in Fig. 1.

The effective gravitational topography has been calculated using the potential energy equations (1), and an average gravitational acceleration to derive a "pseudo topography." The points that are gravitationally low have the lowest potential energy and should accumulate debris if it is able to move over the surface of the satellite. The gravitational topography was calculated for several different orbital radii to test the effects of orbital evolution on slopes on Phobos.

There are several, often non-intuitive aspects to the gravitational topography on Phobos:

1. Points with the greatest radii are in fact gravitationally the lowest areas on Phobos at present. At greater orbital radii this tendency is much less pronounced, and regional slopes are much reduced or even reversed. Further orbital evolution toward Mars exaggerates the topography.

2. The magnitude of surface gravity does not correlate simply with body radius; as the satellite evolves inward the relation become progressively less direct. At 5.0 Mars radii, surface gravity ranges from 0.49 to 0.57 cm/s^2; at present it ranges from 0.35 to 0.57 cm/s^2.

Some of the consequences of the data are:

1. Equatorial areas at 270° and 90° longitude are the highest regions of the satellite; the area near 270° has several characteristics that suggest less regolith is present there, and the regions at 0° and 180° longitude have some features suggesting deep regolith. Thus it would appear that a significant fraction of regolith volume has been generated or subject to redistribution since tidal effects became important (since the orbit was at about 1.5 times the present distance; no absolute time scale is possible.)

2. The asymmetry of crater Stickney may suggest formation or modification in a strong tidal regime because the western part of the crater is subject to significant slumping to the center while the eastern side apparently is not. Fill inside some craters near Stickney confirms the general slope in this vicinity.

3. The shape gives a uniform density moment of inertia parameter (B-A/C) of 0.125; which would imply a forced libration of 1.02° (2); This is within the error bars of the determination of libration (3). If the libration measurement is interpreted without error bars, the moment of inertia values imply a modest central condensation of Phobos, consistent with some extra porosity in the outer few hundred meters. However the uncertainties admit a uniform density model.

TOPOGRAPHY ON PHOBOS: Thomas, P.C.

REFERENCES: (1) Dobrovolskis, A., and J. Burns (1980), *Icarus 42*, 422-441. (2) Peale, S. J. (1977), in *Planetary Satellites*, pp. 87-112. (3) Duxbury, T. C. and J. D. Callahan (1989), *Icarus 77*, 275-286.

1a,b

1c

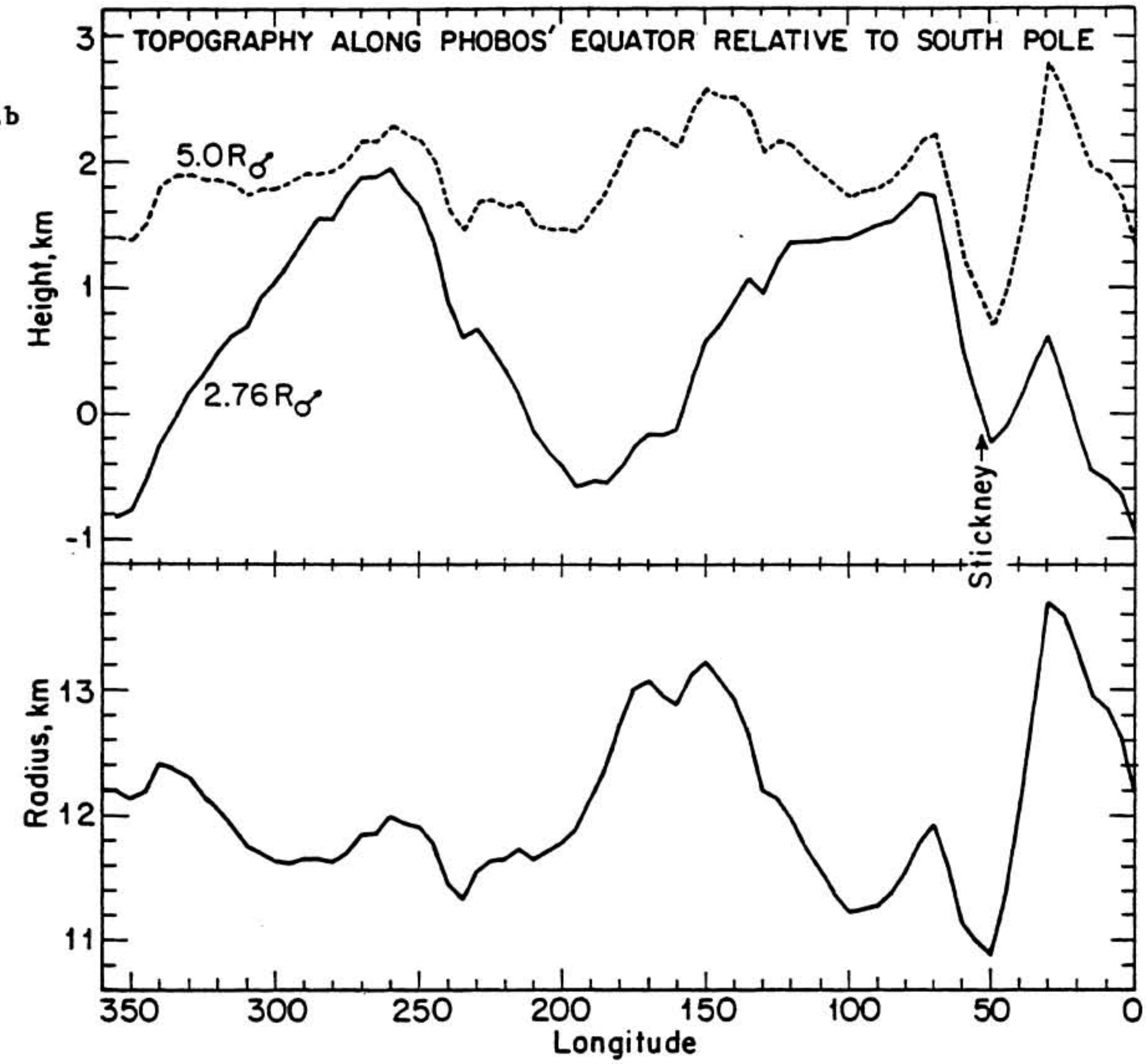

Figure 1a,b. Effect of orbital evolution on effective topography on Phobos. Height is relative to the south pole and is calculated from the potential energy at surface and an average acceleration of 0.49 cm/s^2, and is shown for locations along the equator of Phobos. Note that the topography at 5.0 Mars radii although reduced along the equator is on average nearly 2 km above the south pole. The effects of tides and rotation start to dominate at the present orbital radius (2.76 Mars radii), to give high points at leading and trailing sides, and low points on the Mars and anti-Mars points.

1 c. Radii corresponding to points in a,b; note the asymmetry and near anti-correlation with topography in 1b.