Planetary crustal thickness models can be produced from the assumption that gravity anomalies are due only to variations in surface and crust/mantle topography and crust and mantle densities are laterally constant [1]. Assuming plausible values for crust (2.7 to 3.1) and mantle (3.0 to 3.5 g/cm³) density and mean crustal thickness (50 to 150 km), we generated such models for Mars using both Mars50c [2] and GMM-1 [3]. Except for Tharsis these are nearly identical and show more spatial detail than earlier gravity models [4]. We show how crustal thickness based on Mars50c depend on average crustal thickness and crust/mantle density contrast. A reasonable model for Mars has average thickness about 65 km if the density contrast is 0.5 (crust 3.0, mantle 3.5) g/cm³. This model satisfies the "constraint" on crustal thickness from the possible detection of a marsquake by Viking Lander II [5].

"Constrained" Models

Average crustal thickness and density contrast can be played off against each other to produce a range of "reasonable" crustal thickness models. Additional constraints are needed. Various lines of reasoning have led many to suggest that a mantle density of 3.5 g/cm³ may be appropriate for Mars [6]. There is much less agreement about the likely density of the martian crust. A possible constraint on the thickness of the crust is provided by the uncertain detection of a marsquake by the Viking II lander, which has been used to suggest the crust in the vicinity of the lander is about 15 km thick [5].

Figure 1 shows one of many models that produce a 15 km thickness for the crust SW of the VL II site, where a local thinning occurs. Average crustal thickness is 65 km and the density contrast is 0.5 (crust 3.0, mantle 3.5) g/cm³. This model produces a 10 km crustal thickness under Hellas, ~75 km thick.

Figure 1. A crustal thickness model, based on the Mars50c gravity model. Average crustal thickness is 65 km. Density contrast is 0.5 (crust 3.0, mantle 3.5) g/cm³. (a) Contours of crustal thickness over simplified terrain age. Contour interval is 20 km. (b) A long crustal thickness profile from western Acidalia through Hellas. Both true and 10x true topography (thin black line) included in the profile.
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crust SE of Hellas, and 25 km thick crust in western Acidalia, as shown in the profile.

A higher 0.8 gm/cc density contrast requires a thinner average crust of 45 km. This also produces ~10 km thickness under Hellas, 60 km thick crust SE of Hellas, and 20 km thick crust in western Acidalia. An extremely low 0.3 gm/cc density contrast would require 90-105 km thick average crust to match the seismic "constraint", but the crustal thickness goes negative in central Hellas.

**Unconstrained models**

The Viking Lander II seismic "constraint" is weak [5]. We therefore explored a range of density contrast-average thickness models. Figure 2 shows, for three different average crustal thicknesses (50, 100 aned 150 km), profiles identical to Figure 1b for density contrasts of 0.4, 0.6 and 0.8 gm/cc.

Smaller density contrasts require greater variations in the crustal thickness to explain the observed gravity anomalies. For thin (< 60 km) average crusts, low density contrasts (<0.5) result in negative crustal thicknesses in Hellas, but higher density contrasts produce reasonable crustal thicknesses below the basin (5 to 20 km for the examples shown). Thick (>100 km) average crusts produce unreasonable oscillations in the crust/mantle topography that are not physically plausible, especially for smaller density contrasts. For a 100 km average crustal thickness, the crust below Hellas ranges from 25 to 60 km, increasing with increasing density contrast.

**Summary**

Because thicker average crusts produce short wavelength thickness oscillations and thinner models yield negative crustal thicknesses, we favor models with average thickness 55±10 km. If 0.5 gm/cc is a reasonable density contrast and 3.5 gm/cc a reasonable density for Mars, then an average crustal thickness of 65 km may be appropriate, as shown in the "constrained model" in Figure 1. Regional variations in crustal thickness for this model are discussed elsewhere in this volume [7].