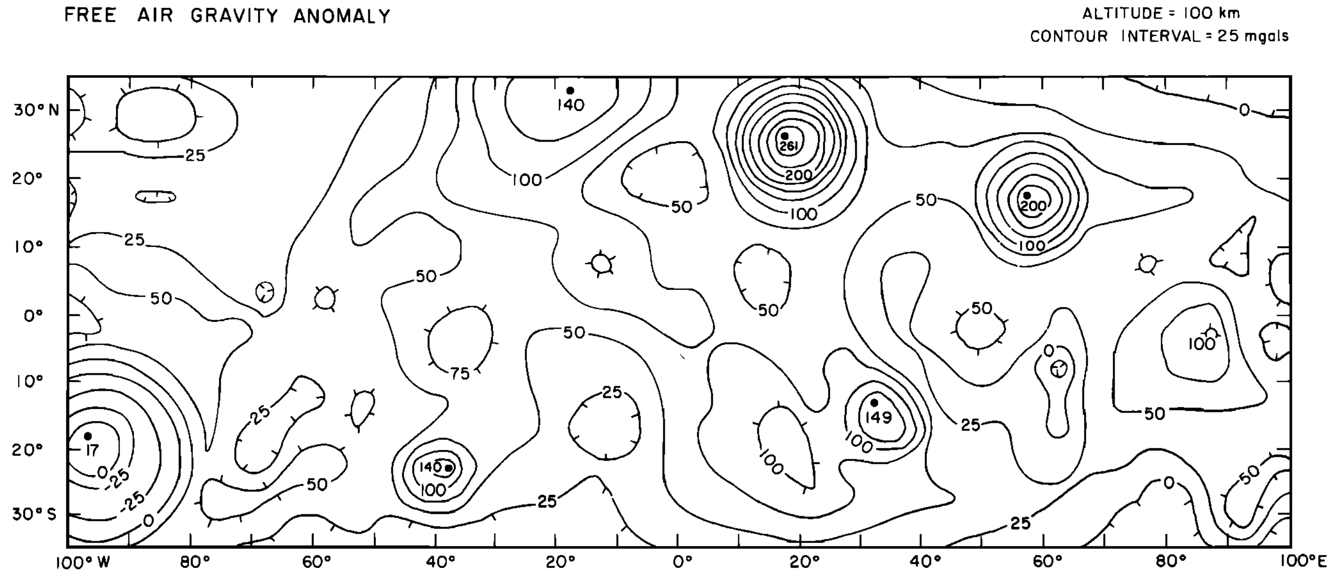

Fig. 4. Free air gravity anomalies over the lunar nearside at 100 km elevation (1836 km from the lunar center of mass). Gravity anomalies were computed from the disk mass model of *Wong et al.* [1975] superimposed on the triaxial gravity model of *Liu and Laing* [1971]. The contour interval is 25 mgal. The peak anomalies over several basins are also indicated.

the lunar surface requires the simultaneous inversion of Doppler data from a large number of orbits for the parameters of both the spacecraft orbits and the gravity field. The first such representation for a large fraction of the lunar nearside was described by *Wong et al.* [1971]. They presented both point mass and disk mass representations of lunar gravity from Lunar orbiter and early Apollo tracking data as well as a full discussion of the procedures used in data inversion.

For this study we employ an improved representation of the low-latitude nearside gravity field obtained by *Wong et al.* [1975] from an inversion of tracking data from low-altitude Apollo spacecraft. Their representation consists of 350 near-surface disk masses distributed between $\pm 30°$ latitude and $\pm 100°$ longitude and superimposed on the triaxial model for lunar gravity of *Liu and Laing* [1971]. The location and size of each disk were assigned a priori, either on the basis of geological information or in an otherwise regular spacing, generally 5° in latitude and longitude. This spacing is a measure of the horizontal resolution of the gravity field model. Disk radii range from 75 to 300 km; the largest disks represent major impact basins. The mass of each disk was derived from the simultaneous inversion of a large quantity of Doppler tracking data from Apollo 14, 15, and 16 spacecraft. Orbits used in the inversion ranged from 15 to 200 km in altitude and $\pm 30°$ in latitude.

The free air gravity anomaly at an altitude of 100 km (or a radius of 1836 km from the lunar center of mass) may be readily calculated from the disk model of *Wong et al.* [1975] and is shown in Figure 4 (a similar figure is given by *Sjogren* [1974]). Unfortunately, the error in this free air anomaly field is not as readily determined. *Wong et al.* [1975] did not determine formal errors in the mass of each disk. An estimate of the typical uncertainty in the free air gravity field may be obtained, however, from the time derivatives of the differences between the LOS Doppler observations and the predictions of the disk mass model of *Wong et al.* [1975]. For five orbits over the central nearside with Doppler residual data displayed by *Wong et al.* [1975] and with spacecraft altitudes between 80 and 160 km, the residual LOS acceleration is typically within ± 7 mgal. For instance, the LOS acceleration residual for the Apollo 15 subsatellite at 100–120 km altitude over Serenitatis, Crisium, and Smythii for orbit 1516 are 6, 4, and 6 mgal, respectively. While these LOS acceleration residuals over the central nearside (e.g., Serenitatis) provide a measure of the error in the derived free air gravity anomaly, the residuals at greater longitudes (e.g., Smythii) reflect more nearly horizontal spacecraft accelerations and are less simply related to errors in the gravity field. For the purpose of estimating the error in the derived crustal structure in the next section of this paper, we estimate that the free air anomalies at 100 km elevation shown in Figure 4 have an associated error of ± 10 mgal over the central nearside and ± 20 mgal at the corners of the area represented by the disk mass solution.

Information on lunar topography comes from a variety of sources, including Apollo laser altimetry [*Roberson and Kaula*, 1972; *Wollenhaupt and Sjogren*, 1972; *Wollenhaupt et al.*, 1974; *Kaula et al.*, 1972, 1973, 1974], landmark tracking [*Wollenhaupt et al.*, 1974], limb profiling [*Watts*, 1963], and photogrammetry [*Hopmann*, 1967; *Mills and Sudbury*, 1968; *Arthur and Bates*, 1968]. *Bills and Ferrari* [1977*b*] synthesized a large number of these topographic measurements from all sources and placed them in a consistent center-of-mass coordinate system.

In this paper we use averages, in blocks of 5° latitude by 5° longitude, of 15,887 observations of nearside topography compiled by B. G. Bills (personal communication, 1982). There are a total of 672 blocks spanning the latitude range $\pm 40°$ and the longitude range $\pm 105°$. In regions where the topography is poorly resolved, values from the harmonic representation of *Bills and Ferrari* [1977*b*] supplement the block averages. The topography of the eastern half of the Orientale basin, the youngest of the nearside basins, has recently been reevaluated by *Head et al.* [1981] using earth-based telescopic measurements of limb heights [*Watts*, 1963]. Apollo laser altimetry over the northern edge of Orientale suggests that while these limb height measurements provide an accurate representation of the basin relief, they require a downward adjustment of about 2 km to fit smoothly with the other topographic data