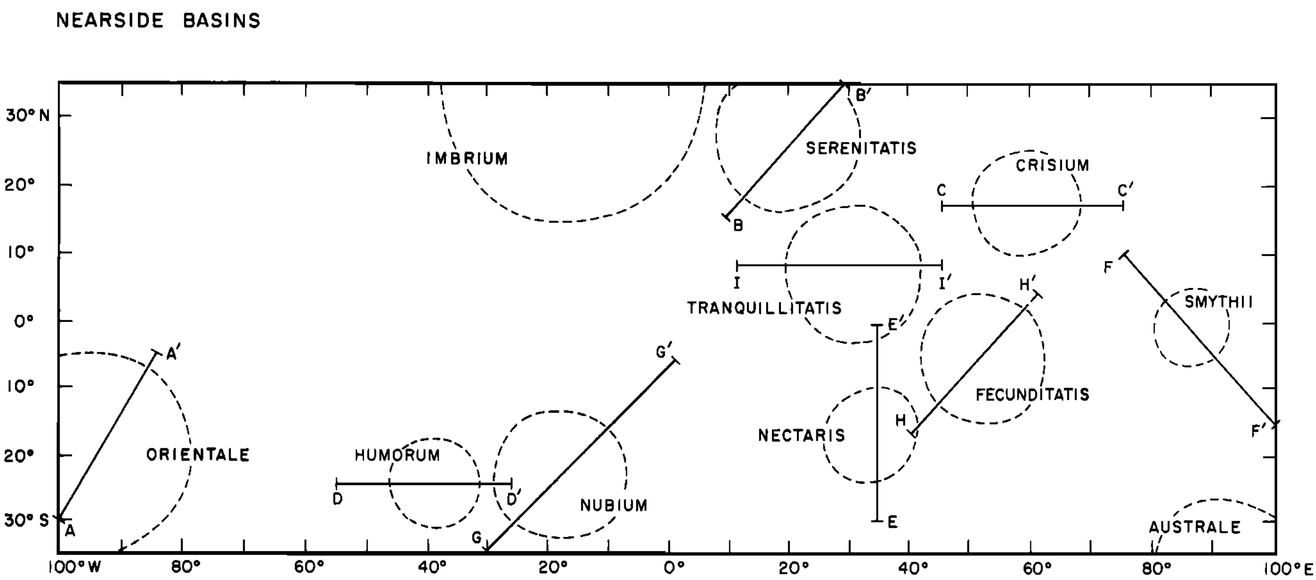

Fig. 1. Outlines of the lunar basins considered in this study. The labeled lines indicate the locations of cross sections discussed in text.

data have been constructed for a number of individual basins [e.g., *Bowin et al.*, 1975; *Sjogren and Smith*, 1976; *Phillips and Dvorak*, 1981; *Janle*, 1981*a*, *b*]. Most of these models, however, were developed under dissimilar sets of assumptions and constraints, thus hindering a comparison of the inferred structures beneath different basins. Also, the interpretation of gravity data over a single basin requires that the investigator make subjective judgements about regional trends in the gravity data arising from structures outside the area of interest or occurring over wavelengths greater than the scale of the basin. In contrast, global models for lunar crustal structure [*Wood*, 1973; *Bills and Ferrari*, 1977*a*; *Thurber and Solomon*, 1978] calculated under uniform sets of constraints and assumptions permit an internally consistent assessment of structural variability on a regional scale. These global models were developed to address crustal structure at scales greater than the dimensions of most lunar basins, however, and with the exception of the study of *Thurber and Solomon* [1978], none considered mare basalt as a significant contributor to the observed gravity field.

In this paper we determine models for the crustal structure in the vicinity of nine impact basins on the lunar nearside (Figure 1). The models are derived as part of a simultaneous inversion of nearside gravity and topographic data, using a procedure similar to that of *Thurber and Solomon* [1978]. The models include a low-density nonmare crustal layer and a mare basalt layer, both of variable thickness. The contributions of Moho relief and mare basalt to the observed gravity anomalies are separated with the assumptions that basin topography was isostatically compensated prior to mare basalt fill and that crustal subsidence in response to loading by mare basalts may be neglected. These assumptions lead to minimum values for mare basalt thicknesses [*Thurber and Solomon*, 1978], but because of a similarity in density of mare basalts and mantle material, the thickness of the low-density nonmare crust may be reliably estimated. An important constraint is that the thickness of the nonmare crust in the vicinity of the Apollo 12 and 14 landing sites is known from seismic refraction measurements [*Toksoz et al.*, 1974]. On the basis of the nearside crustal model we compare the structure beneath the largest lunar basins, we derive new bounds on the volume of material ejected from each basin, and we evaluate the implications of structural differences among basins for the processes of basin formation and modification as functions of time on the moon.

PROCEDURE

To determine the crustal structure in the vicinity of lunar basins, we perform a simultaneous inversion of gravity and topography for the low-latitude portion of the lunar nearside, following a procedure similar to that of *Thurber and Solomon* [1978]. The moon is divided into a grid of blocks, each 5° × 5° in horizontal extent (Figure 2). These block dimensions represent the approximate limits of resolution of the available gravity data, as discussed further below. The disturbing gravitational potential at any point over the nearside can be approximated as the sum of the potentials due to the distribution of anomalous mass within each block. In this section we describe the adopted procedure for calculation of gravity anomalies, as a forward problem, given a distribution of topography or anomalous mass that is uniform within each block. We then discuss the constraining assumptions that we have chosen to make the inverse problem well posed. Finally, we describe an iterative, linearized inversion procedure to determine the crustal structure within each block from gravity and topography, subject to the adopted constraints.

Computation of Gravity Anomalies

In previous analyses of the gravity anomaly fields of planets using spherical shell segments [*Morrison*, 1976; *Thurber and Solomon*, 1978], contributions to the anomalous mass within each segment have been approximated by uniform surface masses located at a constant radius from the center of the planet. While this method simplifies the computation of the gravitational potential, it may provide a poor approximation to the actual potential when the thickness of the block is similar in magnitude to the distance between the block and the observation point.

As an improved approximation, we represent contributions to the anomalous mass within a spherical shell segment as