INTERPRETATION OF GRAVITY ANOMALIES IN THE IRREGULAR MARIA,

R. J. Phillips, R. S. Saunders, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA.

We have argued that the anomalous masses giving rise to the so-called mascons are most likely thin plate-like distributions of volcanic fill (1). Such masses are superisostatic; i.e., they represent material added after a circular basin has achieved isostatic equilibrium. Such equilibrium is initially achieved by an undetermined combination of mantle rebound and basin flooding. Many of the structural features of the circular basins can be explained by isostatic adjustment of the excess masses, but compensation is far from complete (2). We postulated that a simple hydrostatic mechanism (3) gave rise to the excess masses and we showed that the amount of excess mass, and hence the gravity anomaly, is linearly proportional to the basin depth _after_ initial compensation. If the circular basins were deeper than the irregular maria prior to superisostatic filling, then the gross gravitational difference between these two mare types is explainable.

We postulate that the last flooding in the circular basins, giving rise to the mascons, occured at a time when the lunar crust had cooled to a state too rigid to allow complete isostatic compensation. If the above scenario is correct, then volcanic accumulations in the irregular maria, and most certainly those younger than the last circular mare fill, ought to give rise to positive gravity anomalies.

The general pattern of gravity in the irregular maria is one of a general backround of approximately zero gravity, indicating regional isostatic compensation, upon which are superimposed numerous and not insignificant positive and negative gravity anomalies. The correlation of volcanic "centers" with positive gravity anomalies has been previously noted (2) and we are now attempting to test in detail this correlation. Independent determination of accumulation thickness can lead to quantitative statements on the degree of isostatic adjustment. Of particular interest is the striking correlation between the positive gravity anomaly in southwestern Mare Tranquillitatis and the anomalously thick accumulation of volcanics mapped by R. A. DeHon (personal communication). These volcanics predate what is probably the mascon forming material and in fact belong to the oldest (3.7 aeons) of three basic mare units mapped by Soderblom (4). The implication is that the lunar crust was cold and rigid _prior_ to any of the observable volcanic flooding. Such information can impart an important constraint on the thermal evolution of the crust. Further, if the amount of (incomplete) compensation can be correlated with the ages of the three units, then the amount and rate of deformation are also determined. Adaptation of a temperature-viscosity relationship will then lead to a thermal history of the crust during the time of mare flooding.

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If the seismic velocity interpretation of 20 km of basalt in (at least) eastern Oceanus Procellarum is correct, then much of this accumulation must represent an early (eruptive?) phase that was isostatically compensated prior to the deposition of the three mare units.

References

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