LUNAR MASCONS REVISITED. J. Arkani-Hamed, Earth and Planetary Sciences Department, McGill University, 3450 University Street, Montreal, Qc, Canada, H3A 2A7. E-mail: jafar@planet.eps.mcgill.ca.

Based on the recent spherical harmonic expressions of the lunar topography and gravity data [Zuber *et al*., 1994], we reevaluate the lunar mascons and their implications about the internal structure of the Moon. The degree correlation coefficients of the topography and gravity show a high positive correlation over harmonics of degree lower than 10, which are dominated by Aitken basin, its surrounding highlands, Procellarum, Tranquillitatis, Feconditatis, and the highland in the southeast of the near side. The distinct negative correlation of harmonics of degree 10 and 11 is controlled by the mascons of circular basins, as delineated on the topography and gravity anomaly maps derived using their antivarying harmonic coefficients, indicating that mascons are not isostatically compensated. Either the lunar crust and upper mantle have been strong enough to support these loads elastically, or the mascon loads have been decaying through viscous deformation of the lunar interior since their formation.

We investigate two aspects of the elastic support mechanism, a) assuming a constant thickness shell, we determine the thickness that is required to elastically support surface loads specified by a given degree of the spherical harmonics, and b) we estimate the lateral variations in the thickness of the elastic layer that is required to support the mascons as a whole. We also note that the gravitational potential produced by the mascons and the flexure of a thin spherical shell, loaded by the mascons, negatively correlates with the flexure of the shell, emphasizing that the elastic layer thickness must be calculated using only the antivarying harmonics of the topography and the observed gravitational potential, a constraint which has not been considered by previous authors. Ignoring this constraint results in a thinner elastic layer, or even a negative thickness for the layer. For the first aspect, we assume that only a ß fraction of the surface topography is produced by the flexure of the elastic layer and the gravitational potential produced by the surface loads and the flexure equals to the antivarying component of the observed potential. The thickness of the elastic layer to support the mascons increases from 50 km to 130 km as ß values decrease from 1 to 0.1. An elastic layer with a laterally varying thickness is probably a more reasonable model.

A laterally varying elastic layer thickness would couple all of the spherical harmonic coefficients of the flexure and lead to a set of coupled 4^{th} order partial differential equations, resulting in a complicated mathematical problem. To avoid this complication we assume that the flexure of the shell produced by the surface load of a mascon does not strongly interact with that produced by another mascon. The flexure of the elastic layer is determined for several different thicknesses, and a desired thickness beneath a given mascon basin is obtained by matching the flexure and the antivarying component of the surface topography. The layer thicknesses obtained beneath the near side basins, 50-60 km, are greater than those required for Orientale and Moscoviense basins, 20-30 km. The geophysical implications of this discrepancy will be discussed.

The stress differences created in the lunar mantle by the density perturbations, especially when a low rigidity layer was introduced at a depth of about 150 km to represent the structure of the mantle during its 1.5 G.y. history (Arkani-Hamed, 1973a), are probably large to be supported elastically, suggesting that the initially large surface loads have probably decayed through viscous deformation. We also note that the gravitational potential produced by the mascons and the deformation of a spherically symmetric viscous Moon model, subject to the mascon loads, correlates negatively with the surface topography produced by the deformation. Therefore, using the antivarying harmonic coefficients of the gravitational potential, we determined the average viscosity of the Moon in the last ~3.5 G.y. assuming that the antivarying components of the lunar topography is produced by the viscous deformation since the mascon formation. This provides the lower limit of the average viscosity, because it is possible that only a fraction of the topography is created by the viscous deformation. The resulting viscosity value of 1-5x10^{25} Pa s is lower by a factor of 2-5 than those estimated earlier [Arkani-Hamed, 1973b; Meisner, 1977], but greater by about 4 orders of magnitude than the viscosity of the Earth's mantle.

We also calculate the thickness of mare fillings of the mascon basins. We note that the depth of compensation of Aitken basin, ~57 km, is in good agreement with the seismically determined crustal thickness of about 55 km in the western part of Oceanus Procellarum [Goins *et al*., 1981], imply that the major density perturbations created by big impacts, including those produced mascon basins, are within the crust. Therefore, we determine the lateral perturbations of the vertically integrated density inside a nominal crust of 50 km thickness such that together with the surface topography give rise to the observed gravity anomalies. Large positive density perturbations are obtained for the mascon basins and Aitken basin. The density perturbations arise from lateral juxtaposition of material with different chemical composition and density, such as mafic mantle plug and felsic crustal material at the base of the crust for Aitken basin, and the basaltic lava and felsic crust near the surface in addition to the mantle plug for the mascon basins. Both mantle plug and the thickness of the mare fillings are determined based on the assumption that a) a newly formed basin isostatically adjusted prior to mare fillings by the rebound of a thick mantle plug at the base of the crust immediately after the impact, b) the vertically integrated density equals to that determined above, c) a given portion of the initial surface depression of a basin is filled by mare basalt, and d) the present depth of the basin is the one determined from the antivarying harmonics of the surface topography. This calculations provide an upper limit for the thickness of the mare fillings because of the last criterion. Mare fillings of 2-4 km, and mantle plugs of 20-30 km are obtained. We will discuss the source of the basaltic melt in the lunar interior in the context of negative gravity anomalies surrounding the mascon basins.

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