A SUMMARY OF LUNAR STRUCTURAL CONSTRAINTS. M. Nafi Toksöz, Anton M. Dainty, Sean C. Solomon, Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Mass. 02139

Lunar seismic data, density models and thermal calculations are combined to specify the structure and properties of the lunar crust and mantle. The major structural units (60 km-thick crust, 1000 km mantle or lithosphere and relatively warm attenuating 700 km inner region) described in the latest paper (Toksöz et al., 1973) remain unchanged.

Utilizing the seismic data to specify the thickness and density of the lunar crust and the calculated temperature profiles (Toksöz and Solomon, 1973), spherically symmetric models of the density distribution in the moon are computed to satisfy the moon's mass and the latest value for the mean moment of inertia $I/MR^2 = 0.395$ (Williams et al., 1973). Within the present uncertainties in these parameters it is not possible to specify a unique density model for the lunar interior. The relative effects on the calculated moment of inertia of varying different parameters are illustrated in Figure 1. Among the acceptable density models is that of a chemically and mineralogically homogeneous lunar mantle with an average density at surface temperature and pressure of $\rho = 3.4$ to 3.5 g/cm^3. The average compressional velocity in the lunar mantle is still uncertain, with a possible range of 7.7 to 8.3 km/sec. Until these limits are narrowed, mineralogic constraints cannot be imposed on the mantle composition. On the basis of mass and moment of inertia limits, the upper limit for the radius of a possible metallic (Fe rich) lunar core is about 500 km. This upper limit is raised to 700 km for an Fe-FeS core on the sulfur-rich side of the eutectic composition (Solomon, 1974).

The physical properties of the outer layer of the lunar crust may partly be determined from the scattered envelope of seismic waves and from the velocity gradients with depth. To a maximum depth of 20 km, the crustal rocks contain microcracks. If the mean free path is defined as the distance over which one half of the energy is scattered from a plane wave, the surface scattering layer is only a few mean free paths thick. Most of the scattering takes place within the upper 5 km of the lunar crust. The seismic Q, or quality factor controlling dissipation, is about 5000 in this layer, implying extremely dry conditions.

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Figure 1

The effect on the mean moment of inertia of the moon of variation in crustal thickness H, crustal density ρ_1, possible temperature distribution T(r), and other features of the lunar density distribution. The observed moment of inertia is from Sjogren (1971) and Williams et al. (1973). The bars indicate the limits of the moment of inertia changes for each set of parameters.

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