STRUCTURE AND STATE OF THE LUNAR INTERIOR BASED UPON SEISMIC DATA

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A first order model for lunar structure based upon seismic data includes a crust, approximately 60 km thick in southeastern Procellarum, and probably quite variable in thickness, overlying the mantle. The velocity of compressional waves reaches a value of between 6.3 and 7.0 km/sec in the lower half of the crust. The crust may be underlain by a thin slab of high-velocity material in which the velocity of compressional waves reaches a value of between 9.0 and 9.5 km/sec. The velocity below this zone is between 7.6 and 8.1 km/sec. Partial melting begins in the mantle at a depth of about 1000 km. The thick, rigid outer shell surrounding the partially molten zone may be regarded as the lunar lithosphere; and the weaker central zone as the asthenosphere. Moonquake activity appears to be concentrated in two narrow belts at the base of the lithosphere.

Refinements in this model can be made by direct methods from the timing of seismic signals received from large impacts at appropriate distances, but these have occurred at an average rate of one every year or two. Less direct sources of information include the spectra of shear waves, travel times of secondary phases, and strain energy density calculations for assumed viscosity profiles. All possible models are, of course, constrained by the total mass and moments-of-inertia of the moon. From these methods, we infer that: (1) The velocity of seismic waves probably decreases with depth in the upper part of the mantle, reaching a minimum at an undetermined depth; (2) The transition to melting in the lower mantle is gradual; and (3) Secondary phases from moonquakes, if interpreted as deep reflections, suggest the presence of a sharp discontinuity beginning at a depth of about 300 km below the moonquake zone.