ROCK PHYSICS STUDIES OF LUNAR CRUSTAL MATERIALS; N. Warren and R. Trice, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024.

Studies of rock elastic and anelastic properties bear on the determination and interpretation of lunar crustal stress histories. In order to understand the stress history of the lunar crust, it is necessary to determine how a stress history, as distinct from the present stress regime, will affect rock properties. The history will not only influence material properties directly, but will modify the materials' responses to subsequent stress in a cumulative manner.

Velocity-pressure profiles are expected to be dependent on rock structures and grain cohesion properties related to histories of disintegration and/or lithification.

In our present studies, compressional and shear velocities and density measurements are being made on lunar soils under hydrostatic and weakly confined uniaxial cold compaction. Moreover, measurements are being made on lunar soil, subject to various temperatures and compaction pressures, in hard vacuum. Figure 1 shows new V_p data for a 500-micron silica frit (curve E) and lunar soil 69941 P (curve F) plotted with other published soil profiles. These data support the conclusion that simple cold compaction of fine-grained silica and mafic frits do not yield velocity gradients that satisfy the observed upper-crust velocity profiles.

Current experiments in vacuum on 69941 suggest that strong outgassing, in conjunction with heating to 150°C and confining at a few bars pressure, will increase soil velocity. Preliminary results indicate that baking in hard vacuum, even at low confining pressure, gives an apparent velocity increase of 200 m/sec to 600 m/sec. These results are tentative pending more detailed calibration of experimental parameters.

If grain cohesion is strongly enhanced by heating in hard vacuum, steep in situ velocity profiles may be consistent with high-velocity, low-density, soil and soil breccias with thermal histories.

The effects on soils of low confining pressure and heating in vacuum, combined with published observations of increased velocity and strengths of soils which have been baked-out or which have been compacted in hard vacuum, suggest that increased cohesion between soil grains in vacuum is consistent with observed effects of strong outgassing of rocks.

Figure 2 shows observed and calculated velocity profiles for lunar basalt 14310. The calculated velocities are based on a porosity-crack distribution consistent with measured strain-pressure profiles. Agreement of calculated and observed velocity profiles indicates consistency with brittle fractures controlling the low-pressure velocity profile of the rock.

Direct studies of attenuation are also being continued. It
is now possible to measure Q-factors in the low-mHz range, using a modification of our earlier technique. The technique allows resolution of Q-factors which are over 10,000.

Fig. 1: Soil Velocity-Pressure Curves. (a) basalt cinder (1); (b) basalt and silica ash (2); (c) lunar soil, microbreccia model (3); (d) Apollo 11 soil (4); (E) 500-micron silica (this study); (F) 69941 (this study); (T) Apollo 17 soils (5)

Fig. 2: Comparison of Calculated and Observed Compression and Shear Velocities vs. Pressure for 14310. Sub o denotes theoretical velocities of solid rock.

References: