PRELIMINARY ASSESSMENT OF THE LUNAR LITHOSPHERIC THERMAL GRADIENT, HEAT FLUX, DEEP TEMPERATURE, AND COMPOSITIONAL GRADATION

by

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ABSTRACT

The Apollo 12 magnetometer data taken together with data from the Ames magnetometer on the lunar orbiting satellite Explorer 35 are used to determine a lunar electromagnetic transfer function, $\underline{\underline{A}}(\omega)$, defined by the equation $\underline{H}_2 + \underline{H}_1 = \underline{\underline{A}}(\omega)\,\underline{H}_1$ where $\underline{H}_2$ is the magnetic field excited in the Moon by the solar wind hydromagnetic continuum radiation field, $\underline{H}_1$. A preliminary assessment of $A(\omega)$ (where ω is the frequency) shows convincing evidence for the presence of the transverse electric (TE) mode. The transverse magnetic (TM) modes may also be present. The TM mode response is largest in the steady state, and if confirmed, its presence would imply a vestigial shock wave on the lunar limb. The rms value of $\underline{\underline{A}}(\omega)$ determines a thermal gradient in the outer layers of the Moon, through an electromagnetic scattering formalism of Schubert and Schwartz. This is done using both an England olivine and Nagata basalt conductivity function which bracket the expected values. For olivine $dT/dR \cong 4°C/km$ while for basalt $dT/dR \cong 2°C/km$; the latter is preferred as it does not result in temperatures which violate the anisostatic limit required for mascons.

The heat flux from the lunar surface is ~0.2 microcal./cm^2 assuming an equilibrium Moon and $dT/dR \sim 2°C/km$. Since a basalt lithosphere must transform to eclogite at 12.5 kbars, we fit the deeper parts of the Moon to the olivine conductivity function. Even then the interior temperature is restricted to 800-1000 C, but our values are subject to some upward revision depending upon analysis in progress to find the depth of penetration of the electromagnetic energy. An upward adjustment is not thought to lead to excessive temperatures, so a major conclusion is a restriction of the present day Moon to well below the solidus at all depths.