IMPLICATIONS OF THE MAGNETIC AND MECHANICAL PROPERTIES OF THE MOON. S. K. Runcorn, Univ. of Newcastle, England.

The discovery of widespread crustal magnetism of moonquakes and mascons has far reaching implications concerning the thermal history of the Moon.

The remanent magnetization of the Apollo rocks has usually been found to be stable against alternating field demagnetization and, viewed in the light of the magnetic anomalies detected by magnetometers on and near the lunar surface, is a fair sample of the permanent magnetization of the bedrock from which they came. To explain this magnetization an internal or external field, stationary with respect to the Moon for appreciable times, of about 1000 γ is required. If information about the direction of contemporaneously magnetized rocks at different latitudes could be obtained, the question whether this field was external (and uniform in direction) or internal (or a dipole) could be settled. Nevertheless an external field seems unlikely and therefore either a field generated by a dynamo process in a liquid iron core or a permanent magnetization of the deep interior of the Moon, acquired at its origin, must have existed between 4 b.y. and 3.2 b.y. ago.

The disappearance of the general lunar field since this latter date would be due to either a solidification of the core or a decrease of the magnetic Reynold's number below the critical value in the former theory or the rise of the Moon's internal temperature above the Curie point due to radioactive heating in the latter case.

The non-hydrostatic figure of the Moon has remained an unsolved problem for over two centuries. While it was formerly attributed to the finite strength of the deep interior of the Moon, it seems more reasonable to suppose that finite strength, over 10^9 years, is restricted to an outer shell or lithosphere, some hundreds of kilometers thick, which being much thicker than the earth's has not been broken into movable plates. Below this shell, even modest temperatures about half of the melting point, could result in solid state creep, and convective motions. These, if mainly of second degree harmonic type, could explain the difference in the moments of inertia. The determination of the shape of the lunar surface by the method of geometrical librations, in spite of being much less accurate than space measurements, agrees with these latter in finding the maria to be lower and smoother than the uplands and in particular, the surfaces of the circular maria--the mascons--to be systematically lower than the other irregularly shaped maria. These surfaces of the uplands, and both sets of maria, possess an ellipticity towards the earth twice as great as the dynamical ellipticity. Thus a variation of density within the Moon described by a second harmonic, which would be expected on the convection hypothesis, must be postulated.

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It is inferred that when the lava generated by partial melting below the lithosphere filled the mare basins, the height to which it rose was controlled by pressure head considerations. The mascons then are produced by the contraction on cooling of a thick series of lavas, as suggested originally by Wood, and the absence of gravity anomalies over the other maria is explained by the relatively small thickness of the lava flows in them. While the mascons are maintained by the finite strength of the lithosphere, the systematic difference in height between the "mascon" maria and the others suggests that there has been some subsidence of the cylindrical regions of the lithosphere beneath them and the energy so released may be a cause of moonquakes. The fact that the sources of the latter lie some hundreds of km deep below and many of the lunar transient events occurred near the rims of the circular mare suggest that cylindrical zones of weakness exist in the lithosphere there. The tidal correlation and other properties of the moonquakes give some support to this hypothesis.

The absence of gravity anomalies over the irregular maria may result from these impact basins filling with ejecta debris or breccia, and thus allowing only a relatively thin lava series above them. Thus the contraction or solidification leading to outflow of appreciable further lava is negligible. This reasoning leads to the theory that the depressions on the lunar far side did not fill up with lava either because of the greater thickness of the less dense uplands on that side, or because the lunar lithosphere was in compression on the far side and the tension on the near side. Negative mascons on the far side should be searched for.

The hypothesis of thermal convection within the Moon assists in the understanding of these disparate phenomena for two reasons. Firstly, it causes a non-hydrostatic condition of the Moon, the form of which can change with time. Secondly, as Tozer has emphasized, convection throws a new light on the Moon's thermal history.