MAGNETIC DIPOLE MOMENT ESTIMATES FOR AN ANCIENT LUNAR DYNAMO.

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Russell (1979) found that if he plotted the known planetary magnetic dipole moments *versus* the quantity $\rho_c^{1/2} R_c^4 \Omega$, the moments for Mercury and Jupiter lay pretty nearly on the same straight line, while Earth's moment was above this line by a factor of 2 to 3, and Saturn's moment below it by about the same factor. In the above expression ρ_c is the density of the conducting fluid core, R_c the radius of the core and Ω the angular speed of the planet's rotation. This result was derived by Busse (1976) and as a scaling law by Jacobs (1979 a, b), who used qualitative physical arguments and dimensional analysis. Since the measured magnetic moments extend over a range of about 10^7, as does the quantity $\rho_c^{1/2} R_c^4 \Omega$, the agreement is remarkably good. I therefore consider the consequences of assuming that any planetary object in the solar system, if it operates as a dynamo at all, must lie within a factor of 2 or 3 of the straight line that passes through the observed magnetic moment of Mercury and Jupiter when plotted against $\rho_c^{1/2} R_c^4 \Omega$. If this assumption is applied to the ancient Moon having a conducting core of 500 km radius and its present day spin rate, its surface magnetic field would have been in the range 10 to 20 nT. Such a field is far too weak to account for any of the lunar rock magnetism. For the lunar dynamo field to have been strong enough to be of interest to rock magnetism, the quantity $\rho_c^{1/2} R_c^4 \Omega$ would have to have been at least 100 times larger than it is today. MacDonald (1966) has shown that the angular momentum density of the Moon is low when compared to planets known to have kept the rotational angular momentum acquired at the time of their formation. If the Moon also formed by aggregation of particles moving in Keplerian ellipses about the Sun away from influence by the Earth or other objects, its rotational angular momentum density may have been 12 to 20 times greater than it is today. Thus the angular speed of rotation might have been that much greater during the Moon's earliest history. An angular rotation speed 20 times greater than today's and a core size of 750 km would have produced a surface magnetic field of 2000 nT, large enough to have magnetized some of the lunar rocks. However, even if the core radius were as large as 1000 km, the lunar dynamo could not have produced surface fields of 1 gauss. Such a field now seems so far beyond the capability of lunar dynamo action that we must believe that some lunar rock magnetism was produced by magnetizing mechanisms other than dynamo fields--e.g., impact magnetization.

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