LUNAR REORIENTATIONS AND PRIMEVAL SATELLITES. S.K.Runcorn, Institute of Lunar & Planetary Sciences, School of Physics, The University of Newcastle upon Tyne, Newcastle upon Tyne, NE1 7RU, England.

From the successful modelling by Coleman, Russell (1), Hood (2) of the magnetic anomalies, mapped by the Apollo 15 and 16 subsatellites, directions of the magnetization of the lunar crust, coherent on the 100 km scale, are now known. On the hypothesis of a primeval lunar core dynamo dipole field - the early evidence that the palaeointensity decayed exponentially with age (3) lent this strong support - N magnetic pole positions have been calculated (4). Runcorn (5) showed empirically that they fall into bipolar clusterings along 3 different axes. These make large angles with the present lunar axis and, as the dominance of the Coriolis force in the magnetohydrodynamic equation of even such a small core would have aligned the dipole along the axis of rotation, successive reorientations of the Moon with respect to the latter are inferred to have occurred.

Table 1

Geological epoch	Age	Rotation pole	
Imbrian-Upper Nectarian	3.8 by	43.3°N	169.7°E
Lower Nectarian	4.0 by	50.4°S	162.0°E
Pre-Nectarian	4.2 by	1.0°N	92.8°E

The epoch, its age and the corresponding pole positions are shown in Table 1 and it is found that the corresponding palaeoequators fall near the multi-ring basins of the same age as dated by Wilhelms (6). The Bingham statistical distribution has been used to show that each group of basins define a great circle, the poles of which agree with the mean palaeomagnetic poles of corresponding age.

The interpretation has been made that the Moon had a system of primeval satellites; their orbits in the Moon's equatorial plane decayed by tidal friction. The palaeo-impact directions, inferred from the "butterfly" pattern of the basins (7) parallel to the corresponding equators and provide strong support for this interpretation. The successive realignments of the Moon relative to its axis of rotation result from the creation of the impact basins in low latitude, so long as solid state creep allows reorientation of the hydrostatic bulge to occur (5).The great circle alignment of the multi-ring basins shows that the impacts in each epoch must follow each other in a time short compared to the time scale of reorientation. This is most reasonably explained if the Moon possessed at least 3 large satellites, each of which broke up into 6-10 smaller ones at the Roche limit. In the case of a number of near-equatorial basins the pole will move to a point on the palaeoequator: thus the reorientation from the Pre-Nectarian axis to the Lower Nectarian axis through approaching 90° is explained.

The formation of impact basins along the new Lower Nectarian palaeoequator resulted in a further reorientation of the Moon with respect to its axis of rotation. The Moon could then be approximated by a uniform sphere with a number of negative masses arranged randomly along two great circles at right angles to each other (the Pre-Nectarian and Lower Nectarian palaeoequators). It is simple to show that the axis of maximum moment of inertia of this model is at the intersection of the two great circles. Thus the pole would have moved to near this point along the present prime meridian of the Moon: this is what the palaeomagnetic data shows actually happened (see Fig. 1). The earliest axis is determined by the early anorthositic crust asymmetry between

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the present near and far sides, which though to a first order is described by a first harmonic having no dynamical implication would give a small 2nd degree harmonic term which would align the axis of maximum moment of inertia in the E.W. equatorial direction. The flooding of the multiring basins on the present near side, forming the mascons, finally orientates the Moon as at present (8).

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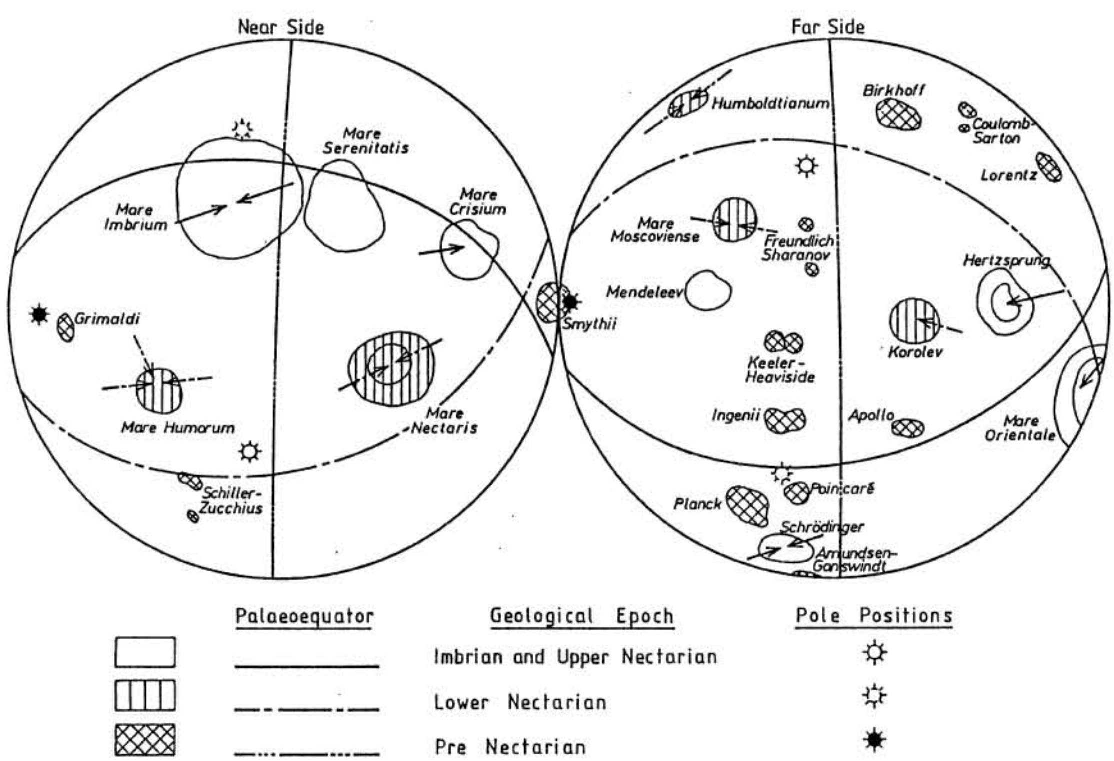

Figure 1

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