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Summary of scientific research

With A.C. Benson, A.F. Moore and D.H. Griffiths, I determined the vertical gradient of the main geomagnetic field by experiments in deep mines and, with F.J. Lowes, modelled the geomagnetic secular variation by dipoles (representing current loops) within the core: early evidence for the dynamo theory of the geomagnetic field.

With P.M.S. Blackett I became interested in paleomagnetism and with J. Hospers, E. Irving and K.M. Creer studied the remanent magnetization of igneous and sedimentary rocks from Europe, finding early evidence for dipole reversals and for polar wandering. I found the polar wandering curve for N. America west of the European one. Thus palaeomagnetism became the first quantitative evidence for continental drift.

With D.C. Tozer I became interested in solid state physics applied to the Earth, e.g. semiconduction in minerals explained electrical conductivity variation in the Earth's mantle. I discussed the modifications to the then accepted model of the Earth's mantle to accommodate continental drift: solid state creep below the lithosphere allowing convection currents in the Earth's mantle, which moved the plates. But the discovery of the nonhydrostatic long wave length anomalies in the Earth's gravity field (the geoid) was widely accepted as proof of the finite strength

of the mantle. I explained it quantitatively by solid state convection, arguing that the convection pattern could be determined from the geoid. I similarly interpreted the nonhydrostatic second harmonic in the lunar gravity field (the Moon's bulge) by a 2-cell convection pattern and inferred the existence of an iron core for the first time.

With D.W. Collinson and A. Stephenson I explained the remanent magnetization of the returned Apollo samples by the theory that the early moon had a dipole magnetic field generated by a dynamo process in this core, disappearing after 3.2 Ga. The high field strength determined from palaeointensity measurements at 4 Ga poses a problem for dynamo theory and with W.F. and L.M. Libby I speculated on possible heat sources in the early Moon.

From the palaeomagnetic directions, I showed that successive reorientations of the Moon with respect to its rotation axis occurred due to the creation of the multi-ring impact basins. I also inferred that the Moon had a primeval satellite system. I have studied the Earth's rotation over geological time, making use of daily, monthly and annual growth rings in corals and other fossils. The irregular fluctuations in the length of the day and the excitations in the Chandler Wobble, I attributed to the core-mantle electromagnetic coupling. These suggested remarkably short term phenomena in the geomagnetic field: the discovery of the geomagnetic jerk of 1969 establishes their reality.
