Can heterogeneous core-mantle electromagnetic coupling control geomagnetic reversals?

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We have developed an analytical model for electromagnetic coupling on the mantle by the poloidal magnetic field of the core interacting with a laterally heterogeneous conducting layer at the base of the mantle. The model includes resistive torques as well as the driving torques considered previously by *Runcorn* [1993, 1996] and *Aurnou et al.* [1996]. We find that the resistive torques dominate the response of the core-mantle system to changes in the core magnetic field. Our calculations of core-mantle electromagnetic coupling with various transition magnetic field configurations indicate that the effects of lateral variations in electrical conductance in the D″-layer are generally too weak to cause much differential rotation of the core relative to the mantle on the time-scale of a typical magnetic reversal.

Indeed, we find that the main effect of electromagnetic coupling between the core and the mantle, even coupling via heterogeneity in D″-layer, is to inhibit changes in the longitude of an inclined magnetic pole. During reversals, electromagnetic torques will tend to constrain the VGP at the same longitude. Thus the rapid longitudinal swings of the VGP recorded in some reversal records is a behavior that is inconsistent with electromagnetic coupling.