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Geomagnetic drifting field in favor of stratification at the top of the Earth's core

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Geomagnetic drifting field mainly consists of sectorial harmonics. The problem is why only the sectorial fields are observed in the drifting field, while the other types of field are not.

In order to solve this problem, we examined the interaction of the surface flow of the core with a dipolar field, and found two are important. One is the boundary condition on the electric current at the core mantle boundary (CMB), and the other is existence of stable stratification at the top of the core.

The core is assumed to be a perfect conductor with a free surface. At the CMB the electric current normal to the boundary must vanish. This requires that the toroidal flow should be sectorial type, which induces sectorial types of poloidal magnetic field through interaction with the dipolar field.

In a stably stratified layer where the Brunt-Vaisala frequency is as high as the Earth's angular frequency, gravitational force strongly acts on the poloidal flow to produce fluid oscillations with the same order of frequencies as the Brunt-Vaisala frequency. Oscillations with such high frequencies, particularly with frequencies near harmonics of the Earth's angular frequency, are difficult to discern from various phenomena with similar frequencies on the Earth's surface. Furthermore magnetic field with such frequency is by far weaker than that of magnetostrophic oscillation of the toroidal flow whose frequency is very low, because the field intensity is inversely proportional to the frequency. These are supposed to be the reason why the harmonic components other than sectorial are invisible in the drifting field. It is, therefore, concluded that the stable stratification is necessary at the top of the core to suppress the effect of the poloidal flow on the drifting field.

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