Geomagnetic field variations over the past 10 Myr

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Abstract

Studies regarding the long-period geomagnetic variations are valuable for understanding geodynamo processes, and non-dipole field fluctuations that appear to be persisted over historical epochs. However, the irregular geographic and temporal distribution of paleomagnetic data are factors that influence the resolution of field reconstructions models over million-year timescales. In particular, the paucity of paleomagnetic records is quite deficient in the southern hemisphere spanning the last 10 Myr. Therefore, the objective of the thesis was to evaluate the structure and temporal geomagnetic field evolution for the 0-10 Ma interval and its geodynamic implications. For this purpose, a new global database from a careful selection of paleomagnetic studies was used to construct new paleomagnetic field models for three time intervals (Brunhes and Matuyama chrons, and 0-10 Ma period). New high-quality directional data were obtained from 0-5 Ma volcanic rocks collected in southwestern Colombia and northern Patagonia (Argentina), using modern laboratory techniques. These data combined with the 0-10 Ma database allowed new insights into the South Atlantic Magnetic Anomaly (SAMA), which is characterized by the lowest intensity values for the present field, covering a large area from southern Africa to South America. SAMA plays an important role in field variability, with implications for space weather, satellites and power transmission lines. The upgraded database supersedes previous compilations, with improvements in the spatial-temporal coverage of paleodirection data, especially in a sparsely populated region of South America. Using a harmonic spherical representation, paleomagnetic models based on inclination anomaly estimates reveal different field structures between the Brunhes and Matuyama chons, with a higher non-dipolar contribution to the Matuyama chron compared to Brunhes chon. A test statistical from virtual geomagnetic pole (VGP) estimates indicates a stronger latitudinal effect in the southern hemisphere than the northern hemisphere, which is similar to that observed in historical field models for the last 500 years. Detailed analysis of historical field (1840-2015) indicates that equatorial asymmetry of VGP dispersions gradually increases over time, linked to increased non-dipole field contributions. The inter-hemispheric asymmetry observed in historical and paleomagnetic data suggests that long-term features as the SAMA are persistent over the past 10 Myr. The high VGP dispersion from new data in Colombia may be associated with enhanced variability of the geomagnetic field over the South American equatorial region. The results of the thesis provided important contributions about the geomagnetic field variability of the for the last 10 Myr. Particularly, to understand the geometry and longevity of the South Atlantic Magnetic Anomaly, and its relationship between the geomagnetic field generation and the existence the thermal anomalies in Earth's lower mantle.