Recent progress and perspective on paleomagnetism by means of deep-sea drilling

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We review recent progress of paleomagnetism using deep-sea drilling cores since the beginning of IODP in 2003, in particular for estimations of paleomagnetic-field intensity (paleointensity) from sediments, and discuss problems to be resolved and perspectives.

For the establishment of the high-resolution relative paleointensity stack for the last 1.5 m.y., sediment cores of Exp. 303/306 from the North Atlantic were utilized. While only few records were available before about 3 m.y. previously, some Eocene to Miocene relative paleointensity records were obtained from the cores in the east equatorial Pacific taken during Exp. 320/321. Applicability of relative paleointensity to inter-core correlations and age estimations has extended to older ages accordingly. On the other hand, contamination of sediment lithological variations induced by paleoclimate changes, in particular fluctuations of the proportion of biogenic and terrigenous magnetites, to paleointensity estimations has become widely recognized. It is urgently necessary to resolve this problem and recover reliable long-term paleointensity records for tackling fundamental issues in geomagnetism such as possible dependence of field intensity to the length of polarity intervals and a possible relation between Earth’s orbital parameters and the geomagnetic field. Better understanding of the role of biogenic magnetite in remanent magnetization acquisition processes is important to solve the contamination problem. Information on the variations of time-averaged field in 10^5 to 10^6 year time-scales is also important for geomagnetism. Departure from the geocentric axial dipole (GAD) field of these time-scales may reflect boundary conditions of the geodynamo at the core-mantle boundary. The departure from GAD emerges as inclination anomalies in sediment cores. IODP cores may be useful for such studies although little studied before.

Acquisition of long deep-sea sediment cores is still required for obtaining continuous paleomagnetic records of Miocene and older ages, and IODP will continue to be the only means for this. Paleointensity estimations from sediments of older ages are hindered by dissolution of magnetite by reductive diagenesis; as sediments are buried deeper, reductive diagenesis becomes more serious. Successful expeditions resulted from the strategic selections of drilling sites; for example, the sediments of target ages are not covered with thick younger sediments (Exp. 320/321), and sediments in relatively oxic environments exist even buried under thick sediments (drift sediments of Exp. 363). Recently, the importance of silicate-hosted magnetic minerals as a carrier of remanent magnetization of sediments becomes recognized; they could escape from dissolution even in anoxic conditions. We need to revisit anoxic sediment cores to investigate the possibility for recovering paleomagnetic records from such sediments. Previously paleomagnetists just discarded them without detailed studies.

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