

Non-Dipole Fields and Inclination Analysis: What is the low Inclination Bias Really Telling us?

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Evans (1976) first noted that inclination-only studies could be used to test the validity of the Geocentric axial dipole assumption (GAD). Evans (1976) concluded that the GAD hypothesis was valid for Phanerozoic times. A subsequent study by Piper and Grant (1989) reached a similar conclusion using a much larger database. However, Piper and Grant (1989) misapplied the c-square test statistic in their analysis and corrected values show that the GAD hypothesis is violated by the observed inclination distributions. Kent and Smethurst (1998) showed that binned inclination data for the Precambrian and Paleozoic were significantly different from the GAD, but Mesozoic and Cenozoic data were similar to the expected GAD frequencies. Kent and Smethurst (1998) also misapplied the c-square test statistic and corrected values show that the Mesozoic distribution is also significantly different than the expected GAD distribution.

A number of possible explanations for this non-GAD distribution are proposed including: (a) inclination shallowing in sedimentary rocks; (b) unrecognized random tilting of igneous rocks; (c) indiscriminate use of all paleomagnetic results; (d) preferential cycling of continents into lower latitudes; (e) sampling biases; (f) late stabilization of the dipole via growth of the inner core; and (g) incomplete sampling. We have tested a number of these competing hypotheses for the observed low inclination bias by developing an interactive computer program and exploiting the paleomagnetic database. Of these myriad explanations we feel that the data are best explained by either (a) persistent octupolar and quadrupolar fields or (b) preferential cycling of continents into lower latitudes.

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