Testing the GAD Hypothesis: Lava Flow Records from 0-5Ma.

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The GAD hypothesis is one of the enduring foundations of paleomagnetic work. In 1969, Opdyke and Henry used inclination records from 52 deep-sea sediment cores to demonstrate that, on average over the past 700 kyr, the geomagnetic field has closely approximated that of a geocentric axial dipole (GAD). Opdyke and Henry also recognized small deviations from the GAD-predicted inclinations although they could not ascertain their origin (measurement error, secular variation, persistent non-GAD contributions to the field). Deviations of the time-averaged field from GAD were first noticed by Wilson and Ade-Hall [1970] and confirmed by Wilson [1971, 1972]. The non-GAD component of the field was observed as "far-sided" pole positions, and is usually represented via an axial quadrupole term in spherical harmonic expansions. Opdyke [1972] also noted that "it would be useful to know how much time is necessary to sample" to estimate the average field.

Three decades later we are still seeking a satisfactory answer to this question, along with estimates of any persistent departures from GAD. Although it has become possible to obtain high quality paleofield directional data from both lava flows and sediments, it is increasingly clear that full vector records of field behavior are necessary to quantify non-GAD contributions to the time-averaged field, and to estimate paleosecular variation (PSV). For example, investigations of persistent non-zonal and high latitude field structure are greatly aided by absolute declination and intensity measurements respectively. It is also well known now that estimates of the time-averaged field (TAF) direction derived solely from unit vectors will have small but systematic biases. As larger regional datasets become available it

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should prove possible to discriminate between the effects of this bias and actual departures from GAD.

The issue of how long a temporal sample is required is difficult to address using lava flow records, for which it is often difficult to acquire accurate ages or even relative stratigraphy in some cases. Only a decade ago 10 sites and 10kyr were considered a reasonable rule of thumb. Simulations from recent statistical models for PSV suggest that

hundreds of sites are necessary. The time interval needed to estimate the average field is perhaps best addressed by considering sedimentary records and the associated spectrum of paleofield variations, and we address this in an associated paper.

Here, we review the current status in modeling of the global time-averaged field (TAF) and paleosecular variation (PSV). We present results from a multi-institutional project to characterize 0-5 Ma field behavior using lava flow data. Neil Opdyke has played a pivotal role in these investigations, collecting new data from South, Central and North America, and Australia.