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A Re-evaluation of the Lava Flow Record for the 0-5 Ma Geomagnetic Field

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Compilations of paleomagnetic directions from lava flows have been used to determine the size of persistent non-axial-dipole contributions to the geomagnetic field, while statistics related to directional variability provide indirect measurements of the paleosecular variation. Direct observations of the time variation are generally lacking because age controls are not sufficiently accurate. The global data set of lava flows that record the magnetic field over the period 0-5Ma has grown considerably over the last decade, and it is now possible to conduct a systematic analysis of the influence of data quality on views of the time-averaged field (TAF) and paleosecular variation (PSV). We present a synthesis of recently-collected paleomagnetic directional data and others drawn from earlier publications. The combined data set has significantly improved geographical coverage, particularly in the southern hemisphere and at high latitudes. For individual lava flows data quality is assessed using an estimate, k, of the Fisherian precision parameter. The new data set, although not yet comprehensive in spatial coverage, comprises over 3100 flows with k greater than 100, almost an order of magnitude more directions of this quality than from previous global compilations. These lava flows preferentially sample the Brunhes and Matuyama epochs. We examine the TAF and PSV using inclination anomalies and VGP dispersion respectively. The new data set, along with statistical models for PSV, allow investigation of how TAF and PSV estimates are affected by (1) site-level error and data quality, (2) the presence of transitional data, and (3) the absence of intensity data. Zonal TAF models for our data set have small contributions from an axial quadrupole term (2% - 5% of the axial dipole), and an apparent octupole term (1% - 3% of the axial dipole). Simulations from statistical PSV models indicate that an octupole term of approximately 2%

can be attributed to bias incurred when unit vectors are averaged. An unbiased result would be obtained with an average of the full vector including paleointensity data. The strong latitudinal increase in VGP dispersion predicted by most secular variation models is not seen in our data set, and its interpretation as a fundamental aspect of geomagnetic field behavior appears questionable when the influence of data quality is taken into account. Small sample sizes for near-equatorial data sets remain a concern as the uncertainties in their associated VGP dispersion estimates are large. This suggests the need for alternative measures of secular variation to make progress in assessing plausible secular variation models.