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Short-term evolution of the Earth's magnetic field recorded in Hawaiian lava

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The main Hawaiian volcanic edifices provide an exceptional opportunity of observing the geomagnetic field behavior from present back to 5.72 Ma (from the Big Island of Hawaii to the island of Kauai). We have sampled long volcanic sequences in the Waianae, Koolau (island of O'ahu) and Mauna Loa (Big Island of Hawaii) volcanoes. We have studied in detail the directional characteristics of three successive Gilbert-Gauss, Lower and Upper Mammoth reversals, recorded by the Wainae lavas. The results confirm that large oscillations of directions precede or follow the reversals, which reminds waveforms typical of paleosecular variation with their amplitude being considerably amplified by the decrease of the dipole. There is no apparently prefered location for the virtual geomagnetic poles (VGP). In addition to the directional analyses, determinations of absolute paleointensity were attempted on more than 540 samples which document the field variations surrounding the Lower Mammoth transition. A period of weak field dominated before the reversal, then the transition was initiated by a transit from normal to reverse polarity and followed by a short restoration of field intensity in reverse polarity. A second episode of very weak field was accompanied by a return to positive inclinations before reaching the reverse polarity. The very strong and apparent rapid recovery of the dipole following completion of the reversal culminated at a value of 16 x 10^{22}Am^2 similarly to field intensities reported for the other detailed volcanic records of reversals studied so far. The asymmetry between the pre- and the post-reversal phases appears as a dominant characteristic and indicates the importance of field regeneration to initiate a new stable polarity interval.

We also obtained a record of Cryptochron C2r.2r-1 (ca. 2.514 +/- 0.030 Ma) from

the Koolau Volcano and of the Laschamp and Pringle Falls excursions recorded by the Mauna Loa volcano (Big Island of Hawaii). All transitional VGPs lie within the longitudinal bands of America, central Africa, western Europe and eastern Asia. This distribution does not support the hypothesis of a direct link with heterogeneities of the lower mantle underneath Americas and eastern Asia. Clusters of VGPs are observed in most records at various geographical locations without preference for specific longitudes, which in the present case most likely seems to result from intense volcanism during short time periods rather than from specific transitional states.