Possible Causes of Paleosecular Variation and Deflection of Geomagnetic Directions Recorded by Lava Flows on the Island of Hawaii

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In the summers of 1997 and 1998 and in February of 2000 we made 570 measurements of the ambient geomagnetic field 120 cm above the pavement surface of State Route 130, south of Pahoa, the island of Hawaii using a three-component fluxgate magnetometer. We measured at every 15.2 m (50 feet) interval covering a distance of 6,310 m (20,704 ft) where both historic and pre-historic highly magnetic basalt flows underlie. We also collected 197 core samples from eight road cuts, 489 specimens of which were subject to AF demagnetizations at 5 - 10 mT level up to a maximum field of 60 mT. We observed significant inclination anomalies ranging from a minimum of 31°to a maximum 40°where a uniform inclination value of 36.7°(International Geomagnetic Reference Field, IGRF) was expected. Since the mean of the observed inclinations is approximately 35°we assume that the study area is slightly affected by the magnetic terrain effect to a systematically shallower inclinations for being located in the regionally sloping surface of the southern side of the island (Baag, et al.,1995). We observed inclination anomalies showing wider (spacial) wavelength (160 - 600 m) and higher amplitudes in the historic lava flows area than in the northern pre-historic flows. Our observations imply that preexisting inclination anomalies such as those that we observed would have been interpreted as paleosecular variation (PSV). These inclination anomalies can best be attributed to concealed underground highly magnetic dikes, channel type lava flows, on-and-off hydrothermal activities through fissure-like openings, etc. Both the within- and between-site dispersions of natural remanent magnetization (NRM) are largest (up to ±7°) above the flows of 1955, while the area of pre-historic flows in the northern part of the study area exhibit the smallest dispersion. Nevertheless, mean inclinations of each historic flow of 1955 and 1790 are almost identical to that of the corresponding present field, whereas mean of NRM (after AF demagnetization) inclinations for each of the four pre-historic lava flow units is twelve to thirteen degrees lower than the present field inclination. We observed three cases of very large inclination variations from within a single flow, the best fitting curves of which are linear, second and third order polynomials each from within a single flow, whereas no present field variations are observed. This phenomena can be attributed to the notion that local magnetic anomalies on the surface of an active volcano are not permanent, but are transient. Therefore we believe that local magnetic anomalies of an active volcano may be constantly modified due to on going subsurface injections and circulations of hot material and also due to wide spacial and temporal distribution of highly magnetic basaltic flows that will constantly modify the topography which will in turn modify the local ambient geomagnetic field (Baag, et al., 1995). Our observations bring into question the general reliability of PSV data inferred from volcanic rocks, because on-going various geologic and geophysical activities associated with active volcano would continuously deflect and modify the ambient geomagnetic field.