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Magnetostratigraphy and identification of the Reunion subchron from lava flows in the Dobi Cliff, Afar Depression

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安 鉉善 [1*], Tesfaye Kidane[2], 正垣源 [1], 乙藤 洋一郎 [1]
AHN, Hyeon-seon[1*], Tesfaye Kidane[2], Gen Shogaki[1], OTOFUJI, Yo-ichiro[1]

[1] 神戸大・理・地球惑星, [2]Earth Sci., Addis Ababa Univ.
[1]Earth and Planetary Sci., Kobe Univ., [2]Earth Sci., Addis Ababa Univ.

We sampled 28 continuous lava flows from the 340 meters long volcanic section of Dobi cliff for paleomagnetic investigations. Four oriented blocks from each lava flow were collected; block sampling technique was employed throughout. In the laboratory, 4 to 6 standard samples for each flow were prepared and then subjected to paleomagnetic routine procedures. The samples were treated by both thermal (Th) and alternating field (AF) techniques with 13 steps for the former and up to 15 steps for the latter techniques. The average natural remanent magnetization (NRM) for the entire lava flows is determined to be 4.0 A/m, strong to record and retain the remanence of the rocks. Generally, one to two components of NRM directions were identified. The first component, which in most cases is related to remagnetization is removed by heating to a temperature of 100^{o}C to 300^{o}C or by an AF of 20mT. The NRM direction after these steps for most of the samples defined straight-line segments that were directed towards the origin, which is interpreted as the characteristic remanent magnetization (ChRM) Direction. In a few cases, however, stable end points were not obtained due to strong overlap between the two components of NRM. Directions of magnetizations were determined by best fit lines using the least square technique of Kirschvink (1980) for samples that showed stable linear segments where as a remagnetization circles were used to determine the best fitting great circles according to Halls (1976, 1978). Site mean directions were then calculated by using Fischer (1953) statistics for stable linear segments while McFadden and McElhinny (1988) statistics was used for combined analyses of planes and lines. The overall mean direction calculated for the 28 lava flows is D = 6.0^o, I = 12.5^o, alpha95 = 5.9^o, N = 28, which when compared with the expected mean dipole field, obtained from the Apparent Polar Wonder Path (APWP) curve for Africa (Besse and Courtillot, 2003), D = 1.0^o, I = 20.9^o, alpha95 = 2.3^o, N = 26, a declination difference dD = 5.0^o +/- 5.2^o and inclination difference of dI=8.4^o +/- 5.1^o were obtained. These declination and inclination differences are interpreted respectively as vertical axis block rotation linked to rift propagation and overlap, and as the effect of long standing non-dipole field in Afar (e.g. Kidane et al., 2003). When the site mean directions are vertically plotted in accordance with the sequence of lava flow positions, magneto-zones of Reversed (R1) - Normal (N1) - Reversed (R2) - Normal (N2) polarities were identified from bottom to top with anomalous directions at the base of the section. K/Ar radioisotopic age determinations, made at the geochronology laboratory at the Research Institute of Natural Science, Okayama University of Science for three stratigraphic positions in the Dobi section, reveal ages of 2.12 +/- 0.09 Ma and 2.21 +/- 0.07 Ma at the N1, and 1.93 +/- 0.07 Ma at the N2 respectively. Using these ages and the geomagnetic polarity timescale (GPTS) of Cande and Kent (1995), we correlate the bottom anomalous inclinations and the N1 polarity interval with the Reunion subchron while the N2 polarity interval is correlated with the Olduvai subchron.
Keywords: Afar depression, magnetostratigraphy, Reunion subchron, Ethiopia