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Timing of volcanism and initiation of rifting in the Omo-Turkana Depression, Southwest Ethiopia: Evidence from Paleomagnetism

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Abstract

Lava flows of the Gombe Group basalt cover the base of the Omo-Turkana rift in southwestern Ethiopia and northern Kenya. Paleomagnetic study results on these basalts are integrated with previous geochronologic data to better constrain the timing of volcanism and rifting in the area. A total of 80 drilled core samples were collected from nine sites. Experimental methods of Alternating Field (AF) demagnetization, Thermal (TH) demagnetization and Isothermal Remanent Magnetization (IRM) experiments are performed to unravel components of magnetizations. Two components of Natural Remnant Magnetization (NRM) directions are identified; the first one considered as Viscous Remanent Magnetization (VRM) is removed by 5 – 25 mT AF or a temperature of 120° C – 250° C, the second component isolated after these steps defined a straight-line segment directed towards the origin and is interpreted as the Characteristic Remanent Magnetization (ChRM). In the IRM Acquisition experiment all analyzed samples showed a sharp rise in acquisition and reached to their saturation magnetization by an applied field of 300 mT. This together with the AF demagnetization and TH demagnetization behaviors suggest pseudo single domain titanomagnetite as a dominant magnetic carrier of the remanence. From a total of nine sites, six sites are reversed polarity, two sites are normal polarity and pass the reversal test of McFadden and McElhinny (1990) while one site is of erratic behavior probably due to lightning strike. The mean direction for the reversed polarity is D_S = 186.1^0, I_S = -1.9^0 (N = 2, K_S = 38.8, α_{95} = 10.9^0) and that for the normal polarity is D_S = 348.4^0, I_S = 4.6^0 (N = 6, K = 378.9, α_{95} = 12.9^0). The overall mean direction D_S = 1.7^0, I_S = 2.6^0 (N= 8, K_S = 34.2, α_{95} = 9.6^0), is statistically identical to the expected mean direction Ds = 2.1^0, Is = 7.8^0 (N = 26, α_{95} = 2.3) obtained from the African Apparent Polar Waner Path (APWP) curve of African plate for a mean age of 4.25 Ma (Besse and Courtillot, 1991; 2003).. Considering the upper age control of Moiti tuff (3.98 Ma) and Naibar tuff (4.02 Ma) which have not been intruded by the Gombe Group basalts; with the obtained paleomagnetic result the Gombe Group basalts are correlable with the late Gilbert Chron of Cande and Kent (1995) specifically at and just above the Cochiti normal sub-Chron (4.18 Ma – 4.29 Ma) consistent with paleomagnetic study from the basal members of the Shungura Formation (Kidane et al., 2014). Petrographically and geochemically similar basalts (Haileab et al., 2004) in northern Kenya are reported to have the same polarity. This suggests the longitudinally distributed lava flows (Gombe Group) in Northern Kenya and southwestern Ethiopia probably had erupted in a short period between 4.18 Ma – 4.29 Ma. This similarity indicates that the present architecture of the basin might have been attained soon after the emplacement of the Gombe Group basalt.