Petrological and geochronological study of plume and rift-related magmatism, at Afar and northernmost Main Ethiopian Rift

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The various types of volcanic rocks occur in Afar and the floor and escarpment of the northernmost Main Ethiopian Rift (NMER). This study presents new geochronological and geochemical data sets on basaltic lavas in this region to investigate the processes of magma formation, and the evolution of continental rift. Mafic lavas comprise a variety of types (i.e., basalt, basaltic andesite, hawaiite, and mugearite), and basalts are dominant. Basaltic rocks in Afar and NMER-escarpment regions are dominated by sub-alkaline series, whereas NMER-floor lavas have mildly alkaline to more transitional affinity. The NMER basalts were dated by K-Ar methods yielding ages between 27 and 0.2 Ma, and the lavas from Afar yielded ages of 4.6 to 0.12 Ma. The Afar series are isotopically more depleted compared to NMER. Within the NMER series, the older NMER-escarpment lavas (27–18 Ma) are characterized by higher La/Nb, Zr/Nb, Ba/Nb and $^{87}Sr/^{86}Sr$ and lower $^{143}Nd/^{144}Nd$ and $^{206}Pb/^{204}Pb$ ratios than NMER-floor lavas (< 3 Ma). Most of younger escarpment (15–4 Ma) show compositional overlap with NMER-floor basalts. Pb isotope and trace element variations provide evidence for the involvement at least three major end-member components. The C–1 end-member component is represented by most of Afar basalts. The second end-member component (C–2) is represented by NMER-floor, younger NMER-escarpment, and a few Afar basalts. The third end-member component (C–3) is represented by older NMER-escarpment basalts. The origins of C–2 and C–3 would be related to the recycling of crustal lithology, and delivered to magma source region by asthenospheric upwelling. The C–1 is similar to DMM (Zindler and Hart, 1986), presumably represents peridotitic material in the upper mantle. Large contribution of C–1 in Afar lavas is probably attributed to larger degree of melting at shallower depth than that in NMER region. This inference is consistent with trace element signature such as low Nb/Zr and La/Lu for Afar basaltic lavas.