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Stratoids flood basalt volcanism at the Afar rift: new insights from trace elements geochemistry

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In this work we investigate the genesis of widespread continental basaltic volcanism and the transition to localised magmatic segments at the Afar Rift-Rift-Rift triple junction. Basing on major and trace elements we investigated the thick (up to 1500m) and widespread (~55.000 km^2) Lower (4.5-2.6 Ma) and Upper Stratoids (2.6-1.1 Ma) Series and the subsequent, less voluminous and focalised, Gulf Series (1.1-0.6 Ma). Our results, together with published geophysical and stratigraphical evidence, allow us to interpret the evolution of the Red Sea rift and the associated break-up process in Southern and Central Afar. The three Series are characterised by E-MORB magmatism and residual amphibole (K, Rb trough and Ba, Nb-Ta peak), with subordinately pyroxenite (Rb peak, Ba trough and MREE fractionation), in their mantle source, suggesting partial melting of the diffusely metasomatized sub-continental mantle. Marked differences in garnet-compatible trace elements reveal a deeper melting column for the Upper Stratoids ($Tb_N/Yb_N > 1.7$) with respect to the Lower Stratoids and the Gulf Series ($Tb_N/Yb_N < 1.7$), indicating distinct mantle sources for the three Series. Lower values of the incompatible element ratios Th/Nb, Th/Zr and La_N/Sm_N of the Gulf Series with respect to the Upper Stratoids indicate a higher degree of partial melting for the Gulf Series mantle source. The spatial variation in the volume and sources of Afar magmatism between 4.5-0.6 Ma correlates well with spatial changes in the locus of strain with two distinct episodes of rifting: (1) The late Miocene rifting episode (7-2.6 Ma), associated with thinned lithosphere and the Hadar Basin formation (3.8-2.9 Ma), erupted the Lower Stratoids in South Afar; (2) The Pleistocene rift (2.6-0.01 Ma), relocated in Central Afar, erupted the Upper Stratoids first (~2.6-1.1 Ma) and, subsequently, along with the stretching of the lithosphere and focalization of the rift, the Gulf Series (~1.1 Ma). Accordingly, our data supports the interpretation that the Afar strain localisation and associated magmatism migrated north-eastward from South to Central Afar through time, potentially in response to triple junction tectonics.