

Geochemical and petrological characterization of two large silicic ignimbrites from the Main Ethiopian Rift (Ethiopia)

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The Plio-Pleistocene volcanism in the Main Ethiopian Rift (MER) is characterized by distinctive bimodal compositions with basalts and rhyolites as the most abundant and scarce or absent intermediate terms (i.e., Daly gap). The mafic products are associated with cinder cones and lava flows while the felsic magmas produced large explosive eruptions often resulting in the formation of large calderas. This work focuses on these highly evolved compositions, the genesis of which still represents a matter of debate. We conducted analyses on two Central MER large silicic units with similar age and petrological characteristics: the 1.16 Ma Golja ignimbrite (GI) and the 1.3 Ma Kencherra ignimbrite (KI). The two units are remarkably crystal-poor with less than 10% of K-feld, qtz, pl, cpx, aen and Fe-Ti oxides and contain different types of juvenile material including white and banded pumices and fiamme as well as dark scoria.

In GI detailed analysis of matrix glass and melt inclusions from all juvenile types reveal a broad compositional spectrum ranging from basalts (found only in the pl-hosted melt inclusions) to rhyolites, with intermediate compositions (basaltic trachyandesites to trachydacites) present in the mingled pumices and dark scoria. Trace element plots show distinct evolutionary trends, not visible in major element compositions, while in-situ ⁸⁷Sr/⁸⁶Sr analyses of feldspars display wide isotopic variation ranging from mantle-like to crustal values, akin to the Pan African crust.

In the KI welded pyroclastic sequence, matrix glass and fiamme have rhyolitic composition while scoriaceous clasts, increasing in size and abundance up-sequence, range between trachybasalts and trachytes. Two different groups of rhyolites can be distinguished based on incompatible trace elements and REE concentrations. Overall, geochemical and isotopic data suggest involvement of fractional crystallization, assimilation of old crustal material and magma mixing in petrogenesis of the intermediate and evolved composition from KI and GI. Our data represent the first geochemical characterization of these large ignimbrites and contribute to a better understanding of silicic magmatism in the MER.