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New insights into timescales of peralkalic magma chamber processes in the Naivasha area, Kenya Dome

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Peralkaline magmas with an agpaitic index (A.I.), i.e., (Na2O+K2O)/Al2O3>1, occur in numerous geodynamics setting, but are most prevalent in context of continental upwelling and/or rifting. Trace element and isotopic characteristics of peralkaline silicic rocks usually show that the parental magmas of these rocks were derived from a mantle-like source, and the peralkaline character is created either by fractionation crystallization or by multi-stage re-melting of mafic rocks underplated to a continental root. Similar processes can be assumed for peralkaline rocks located in the Naivasha area, in the Kenya Dome (KD), in the south-central part of the Kenyan rift, Africa, where the potential existence of mafic magma chambers has been shown by regional gravity anomalies [1].

The centre of the KD consists of five major volcanic centres: three trachyte-phonolite volcanoes (Longonot, Suswa and Menengai) and two more chemically evolved trachyte-comendites/pantellerites complexes, in the Naivasha area, the Eburru Volcanic Complex (EVC) and the Great Olkaria Volcanic Complex (GOVC).

The most recent GOVC comendites (A.I. =1.0-1.4) have been the subject of a previous isotopic and geochronological study [2,3], and their ages vary from ~20 kyr to historic. The magmas' variable Sr-Nd-Pb isotope systematics were interpreted to reflect melting of isotopically heterogeneous crustal sources by the influx of halogens, followed by extensive fractional crystallisation [2]. Chemical fractionation, resulting from fractional crystallisation, of both the Rb-Sr and U-Th isotopic systems occurred rapidly at 47 $\pm$ 2 ka and 24 $\pm$ 1 ka, yielding a magma residence time of at least 16 kyr [3].

In order to further constrain the genesis of peralkaline magmas in the KD, we focussed on a neighbouring volcanic complex of GOVC, the EVC, which is also characterised by an AI$\geq$1. Argon-Ar dating show that the latest peralkaline rocks from EVC present slightly older eruption ages than the studied GOVC comendites. The EVC volcanic rocks erupted in two discrete pulses. The trachytes have eruption ages between 150 ka and 95 ka, whereas the pantellerites erupted form 65 ka to 7 ka.

According to Ren et al. [4], the trachytes and pantellerites may have different sources. The trachytes would have derived from a mafic parent by fractional crystallization and the pantellerites from extreme fractionation of comenditic magmas. Here, we present an integrated multi-isotope approach (Sr, Nd, Pb, U/Th, Rb/Sr, Ar/Ar) on whole rocks and minerals, coupled with major and trace elements, which suggest a two-stage formation model for these rocks. In this model, trachytic melts result out of an Assimilation-Fractional Crystallisation (AFC) process between an OIB-type parental magma and the overlying crust. Pantellerites have formed later by fractionation from the residual trachytic liquid, which became more and more peralkaline by continued fractionation of the feldspar, along with a continued influx of mantle-derived magma. Coupled Sr isotopes and Ar-Ar ages reveal a co-variation suggesting that the time interval of magmatic contaminations within a single volcanic centre from initially crustal-contaminated to mafic signatures takes approximately 100 kyr.

References

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