Positive correlations of \( \frac{^{238}U}{^{230}Th} \) versus Th show the rhyolites to be products of partial melting. Positive correlations of U and Cl and U and F show that the U enrichment in the rhyolites is associated with the halogen contents which may be related to the minor phenocryst phase fractionation. Instantaneous Th/U ratios exceed time-integrated Th/U ratios providing further evidence of the hydrous nature of the Olkaria rhyolite source. Excess \( \frac{^{238}U}{^{230}Th} \) in the subduction related rocks has been associated to the preferential incorporation of uranium in slab derived fluids, but no evaluation of the size of this flux has been made. The majority of the Naivasha samples show a \( \frac{^{238}U}{^{230}Th} > 1 \) (figure 1) and plot close to the subduction related samples indicating the Naivasha rhyolites may also have been influenced by fluids during their formation as speculated by (1). In general samples with high \( \frac{^{238}U}{^{230}Th} \) ratios reflecting recent enrichment of uranium relative to thorium have high thorium contents, thereby the high \( \frac{^{238}U}{^{230}Th} \) ratios are restricted to the most incompatible element enriched magmas (figure 1) and, hence, are a good indication that the rhyolites were formed by partial melting.

If a fluid phase had some influence on the formation of the rhyolites then the uranium and thorium may have some correlation with F and Cl contents which can be mirrored by the peralkalinity. Figure 2 shows the plots of uranium against F and Cl contents. The positive correlation indicates that the uranium enrichments are associated with the halogen contents. There seems to be a greater correlation for U against Cl than F indicating that the U may be transported preferentially as Cl complexes.

If U was added preferentially to the source of the comendites recently (< 300,000 years B.P.) this may result in \( \frac{^{238}U}{^{230}Th} \) ratios > 1. Uranium and thorium are known to be mobile in the presence of fluids and since uranium is enriched it would suggest that uranium is more mobile, particularly in the presence of CO\(_2\)-rich fluids (2, 3, 4, 5, 6, 7, 8). U could reach the magmas in two main ways:

i) The U-rich fluid could flux the crust and increase the percentage of melting, and thus produce \( \frac{^{238}U}{^{230}Th} \) ratios >1 in the magma.

ii) The U-rich fluid could react to form secondary minerals in the source region resulting in subsolidus metasomatism thereby increasing the \( \frac{^{238}U}{^{230}Th} \) ratios. The time between metasomatism and partial melting will be reflected in the \( \frac{^{230}Th}{^{232}Th} \), i.e. the longer the time the higher the resulting \( \frac{^{230}Th}{^{232}Th} \) will be from ingrowth of \( ^{230}Th \) from \( ^{238}U \).

Figure 3 shows a \( ^{208}Pb^* / ^{206}Pb^* \) versus \( K_{Th} \) plot showing a time integrated plot of the Th/U ratios. The \( ^{208}Pb^* / ^{206}Pb^* \) ratios are used to infer old Th/U ratios, and are the ratios of \( ^{208}Pb \) to \( ^{206}Pb \) since 4.55 Gy. These are calculated by subtracting the primordial lead (derived from the Canyon Diablo meteorite), from the determined ratios. The \( K_{Th} \) factor (7) is equal to 3.034/\( \frac{^{238}Th}{^{232}Th} \) and represents recent Th/U modifications, whereas the Pb isotopes will only respond slowly to modifications in Th/U ratios and will represent older fractionation events.


Thus horizontal vectors on figure 3 are an indication of recent fractionation, and vertical components are older enrichments. (9) demonstrated that some of the subduction related volcanism was formed from older enrichments, some of their data is displayed on figure 3 for comparison. The broad horizontal lying trend defined by the Naivasha rhyolite data suggests that the Th/U fractionation has been recent. The solid black line in figure 4 is the locus of points whose time integrated and instantaneous Th/U ratios are equal, and is the geochron for 4.55 Gy. Points to the right of this line have instantaneous Th/U ratios higher than their time integrated ratios indicating that hydrous metasomatism has taken place beneath this part of the sub-continental lithosphere.

Figure 1 (238U/230Th) versus Th for the Naivasha comendites.

Figure 2. U versus CI for the Naivasha comendites.

Figure 3. Th-Pb correlation showing the Naivasha rhyolites. Most of the data plots either close to or to the right of the geochron.

REFERENCES