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Magmatic constraints on rift development and the uplift of the Rwenzori Mountains in western Uganda

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The northern end of the western branch of the East African rift valley in western Uganda is located at the junction between a Proterozoic belt to the south and continuous Archaean crust of the Congo-Tanzania craton to the north (1). The difficulty of rift propagation through the thick Archaean lithosphere may explain the lack of a connection with the eastern rift branch around Lake Turkana. The >5,000m-high Rwenzori Mountains form a block lodged between two rift arms at this junction (2).

The location and composition of Pleistocene to Recent volcanic rocks can be used to constrain models for the uplift of the Rwenzori Mountains that explain uplift by delamination of a lithosphere block beneath the rift (3). Six small volcanic fields are located in the Toro Ankole area east and southeast of Rwenzori; they contain carbonatite either as lava flows or as components in lapilli tuffs, as well as unusual K_2O-rich, SiO_2-poor melt compositions akin to leucitites and potassic melilitites that increase in importance towards the south. Their major and trace element and Sr-, Nd-, Hf-, and Os-isotope compositions are consistent with a source composed not just of peridotite, but also containing mica- and clinopyroxene-rich ultramafic assemblages (4). The requirement for assemblages of this type is greater than for potassic melilitites and nephelinites further south in the rift, and this agrees with their greater abundance as xenoliths in the lavas of the Toro Ankole area. The xenoliths contain no evidence for metasomatic replacement of pre-existing peridotite minerals, but rather appear to be formed by crystallization as liquidus minerals on the walls of magma channelways within the upper mantle. Some are zoned and contain vein margins, indicating more than one episode of melt infiltration. Re-melting of such assemblages partially meets the geochemical requirements of the volcanics (4) and has been shown to produce melts with similar major element compositions in experiments (5). The xenolith-richest occurrence is in the Katwe-Kikorongo field, furthest west within the rift at the location purported to be the site of lithospheric delamination (3). This may indicate that mica pyroxenite dyke zones formed by alkaline melts rising along the western edge of the Tanzania craton root provide zones of weakness for later delamination events. The elevated CO_2-contents of the western rift volcanics can be explained by low-degree partial melting of carbonate-bearing peridotite at depths of 120-150km (5), thus constraining the source of the volcanic melts in this area to be deeper than those of the Virunga field to the south, in keeping with the postulation of a cratonic lithosphere root just east of the Rwenzori Mountains.

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