Insights into continental evolution and lithospheric stability: Geochemical evidence from the Western Rift, Uganda

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Continental breakup and reassembly are fundamental processes in the dynamic evolution of the Earth. This cycle is evident at the Earth's surface in the creation of ocean basins, continental rifts, and mountain belts. The evolution of the subcontinental lithospheric mantle beneath continents (SCLM) is more difficult to observe, yet this layer plays a critical role in long-term continental stability. While it cannot be sampled directly, the SCLM preserves valuable information about the history of continental assembly and rifting. Metasomatism assoicated with tectonic events is recorded in the SCLM and can be identified by chemical signatures in magmas derived from it. In addition to chemical modification of the SCLM, metasomatism may destabilize the structure of the lithosphere by modifying the density profile with depth, potentially resulting in foundering of the basal lithosphere through brittle or ductile (lithospheric drip) processes, both of which can produce magmatism.

The East African Rift System (EARS) is the largest surface expression of rifting in the continental crust on the earth's surface. We examine lithospheric stability and magmatic processes in the Western Rift of the EARS using a suite of mafic lavas and associated xenoliths from the Toro Ankole and Virunga volcanic provinces in the Western Rift (southern Uganda). The lavas consist of alkaline basalts, trachybasalts, and basanites. Strong positive correlation between normative olivine and Cr for parental lava compositions suggests that lithospheric drip magmatism is the dominant process generating melts in this region. Much of the Western Rift may be topographically elevated as a result of this localized lithospheric removal, likely related to descent of metasomatized dense lithospheric mantle. Normalized REE plots with steep profiles (Tb/Yb >2) indicate that the melts were derived from a depth within the garnet stability field although xenoliths associated with the lavas lack modal garnet Consistent ITE patterns throughout much of the Virunga province suggest a common regional metasomatized source.