

Wall-rock interaction during ascent and emplacement of carbonatites - the difficult search for "pristine" carbonatite compositions

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Field and textural observations on numerous carbonatites preserve evidence for the interaction between carbonatitic magmas and diverse crustal host rocks during ascent and emplacement. By the critical introduction of Si and Al, diverse silicate minerals form along the carbonatite-host rock interface. Olivine and clinopyroxene formation consumes Mg from the carbonatite magma, the formation of mica and amphibole additionally requires sufficient alkalis in the system.

The genesis of such silicate minerals in carbonatites and of some associated silicate rocks as well as their ability to monitor carbonatite magma - wall-rock interaction is assessed. Distinguishing silicate minerals that crystallized from relatively uncontaminated carbonatite magmas or because of assimilation/contamination processes requires careful analysis of the spatial relationships between their abundance and composition. As such, certain disequilibrium textures involving oxide minerals (perovskite, baddeleyite, thorianite) that are partly resorbed and replaced by the respective silicate minerals (titanite, zircon, thorite) close to the contact between carbonatite and wall rock resemble crustal contamination, rather than cooling. Likewise, the X_{Mg} values $[(Mg/Mg + Fe)]$ of olivine, clinopyroxene, amphibole and especially mica typically decrease towards the contact to the wall rock (or fragments thereof), as many crustal rocks have relatively low X_{Mg} values, compared to carbonatitic magmas. Depending on the exact composition of the involved host rock, the minor and trace element content of the silicate minerals can act as a geochemical fingerprint, helping to identify the origin of more broadly dispersed silicate minerals in larger carbonatite bodies. Finally, crustal contamination in carbonatites further impacts the compositional evolution of typical carbonatite phases, including apatite, carbonates, and others.

Detailed space-resolved investigations including in-situ dating methods, minor and trace element compositions as well as stable and radiogenic isotope data are needed to decipher these processes and the role of host rock variability. Further, variations in ascent, cooling, and solidification rates may exert an important influence on the details of silicate phase compositions and assemblages in and around carbonatites. This implies that "uncontaminated" carbonatite melt compositions are much more difficult to constrain than previously thought, because crustal contamination appears to be a common process during carbonatite formation.