

Sector-zoned clinopyroxene from the Udiripikonda lamprophyre, Dharwar craton, southern India: Insights into magma evolution and plumbing system

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Mantle-derived alkaline magmas often contain complexly zoned minerals such as clinopyroxene, phlogopite, and olivine. In the case of clinopyroxene, its ability to accommodate a wide range of elements, its sensitivity to physicochemical changes in the magma, and its response to lattice-controlled chemical kinetics allow us to track magma evolution and its plumbing system. In this contribution, we present preliminary mineral-chemical data on complexly zoned clinopyroxene from the Udiripikonda lamprophyre dyke (*ca.* 1.1 Ga) of the Wajrakarur Kimberlite Field, Dharwar craton, southern India. Overall, clinopyroxene shows compositional variation between $\text{En}_{17}\text{Fs}_6\text{Wo}_{25}$ and $\text{En}_{43}\text{Fs}_{20}\text{Wo}_{40}$ end-members. High-contrast X-ray elemental maps reveal concentric and sector zoning within a single crystal. Sector-zoned grains exhibit a decoupling of several elements between hourglass sectors $\{-111\}$ and prism sectors $\{100\}$, $\{110\}$, and $\{010\}$, with a relative depletion of Ti, Al, Si, Na, and Mg, and an enrichment of Ca along the hourglass sectors. Trace elements measured using LA-ICP-MS show depletion in high field-strength elements (HFSEs), e.g. Zr, Hf, Nb, Ta, and enrichment of Sc and V in hourglass sectors compared to prism sectors. Cr, Fe, and Mn remain unaffected by sector zoning; instead, they follow concentric zoning. The proposed major element cation substitution reaction along the hourglass sector is $\text{Si}^{4+} + \text{Mg}^{2+} = \text{Al}^{3+} + \text{Na}^+ + \text{Fe}^{2+}$, whereas, along the prism zone, it is $\text{Si}^{4+} + \text{Fe}^{2+} + \text{Na}^+ + \text{Ca}^{2+} = \text{Ti}^{4+} + \text{Al}^{3+} + \text{Mg}^{2+}$. Additionally, the studied clinopyroxene shows a subtle impression of concentric zoning on hourglass sectors, where rhythmic variations in Al, Ti, Mg, and Si continue throughout the grain. Furthermore, several grains indicate a more complex evolutionary history, exhibiting highly resorbed homogeneous cores with groundmass mineral inclusions, suggesting crystallization from earlier batches of magma under relatively stable conditions. These cores are mantled by irregular intermediate zones with high Cr contents, suggesting magma recharge, followed by sector zoning. Overall, the compositional characteristics of the studied clinopyroxene suggest a complex magma evolutionary history and the magma plumbing system of the Udiripikonda lamprophyre.