

Trace element partitioning between clinopyroxene and alkaline magmas

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Clinopyroxene (Cpx) is a widespread phase in alkaline systems and its crystallisation impacts the composition of associated melts. Trace element partitioning (D) between Cpx and melt is a key parameter if we are to bring constraints on magma genesis and differentiation. Trace element partitioning between Cpx and melt has been previously considered in the frame of the lattice strain model (LSM) with Rare Earth Elements (REE) substituted to Ca in M2-site.

In alkaline rocks and carbonatites, Cpx displays sinusoidal REE pattern with unusual enrichments in heavy REE (HREE) and in Zr-Hf. Such enrichments have been observed for both aegirine and diopside, nevertheless specific partition coefficient for alkaline systems are very scarce and new data are needed to quantify the petrogenesis of alkaline magmas and associated REE deposits.

Oldoinyo Lengai (Est African Rift, Northern Tanzania) is an active carbonatite-phonolite volcano and a natural laboratory to study the REE concentration processes and the distribution of critical metal resources at an alkaline complex. Cognate ijolite samples are well suited to quantify element partitioning between phonolite melt and Cpx. LA-ICP-MS data show that for REE $D^{Cpx/phonolite}$ are low and increase from light REE ($D_{La} = 0.013$) to HREE ($D_{Lu} = 0.41$). The fractionation between MREE and HREE is highlighted by high D_{Lu}/D_{Ho} ratios (5.5-8.6). HFSE (high field strength elements) have D values close to D_{HREE} with $D_{Zr} = 0.07-0.34$; $D_{Hf} = 0.14-0.59$ which is significantly higher than middle REE ($D_{Sm} = 0.03-0.1$). D_{HREE} (Er to Lu) do not follow a parabolic repartition commonly explained by the LSM. The specific D_{REE} partitioning of the Lengai Cpx is not consistent with the standard models assuming incorporation of all REE in the M2 site; rather HREE substitutes both in M1 and M2 sites. Here we provide the values for D_0 , r_0 and E (LSM parameters) for trivalent cations on M1 site (i.e. $HREE^{3+}$, Sc^{3+} , Cr^{3+}). HREE incorporation in M1 site seems to promote large r_0^{3+} ($>0.7\text{\AA}$) and low E³⁺ ($<500\text{GPa}$), furthermore REE partitioning has a strong dependence on Cpx chemistry with r_0^{3+} which increases with Fe^{3+} , and shows a slight dependence to Mn, Mg and Al^{IV} . We have determined the effect of Cpx major element compositions on trace element partitioning, and provide the corresponding equations.