Kinetic Ca-Fe isotope fractionation in xenoliths overprinted by plume-lithosphere interaction

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Splitting or thinning of lithosphere above a plume are critical to the dynamic evolution of solid earth, which result in several geological events including the formation of large igneous province and oceanic plateaus. However, the significance of plume-derived melt contributions to lithosphere and its time scale is still poorly understood. Ca and Fe are major constituent elements of mantle and their isotope compositions can be significantly fractionated by recycling materials [1] and metasomatism related kinetic events [2]. Thus, the combination of Ca and Fe isotope is expected to provide the source and time information about plume-lithosphere interaction. A young lower-rooted plume was hypothesized to be exist near Hainan igneous province, southeastern China. Thus, mantle xenoliths in alkali basalt from Hainan provide perfect samples for this study. Here, we report Ca and Fe isotope data of 12 co-existing pyroxene pairs in 10 lherzolites, 1 harzburgite and 1 wehrlite collected from Hainan.

Ca isotopes were measured on Triton-TIMS using double spike technique at GIG, CAS. The data are reported as $\delta^{44/40}$Ca relative to NIST SRM 915a. Fe isotopes were measured on MC-ICP-MS using SSB method at USTC. The data are reported as δ^{56}Fe relative to IRRM014. Fe isotopes show <0.2‰ variations among ol, opx and cpx which reflect equilibrium fractionation. In contrast to the small Fe isotope fractionation, Ca isotopes show 1.23‰ variations between opx and cpx, reflecting the Ca re-distribution driven by cooling during mantle upwelling. The cpx in wehrlite have extremely heavy Ca (3.22‰) and Fe isotope (0.22‰) composition. Such heavy isotope signatures should inherit from the metasomatic media, of which Ca and Fe isotopes were fractionated by chemical diffusion during the fast infiltration of melt into the lithosphere. Such kinetic isotope signature in Hainan xenoliths reveal the extensive interaction between plume head and lithosphere.

[1] Kang et al (2016) GCA 174 [2] Zhao et al (2017) GCA 208