Lack of calcium isotope fractionation during magma differentiation

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Recent studies of non-traditional stable isotopes, such as Mg, Ca and Fe, in silicate rocks show measurable isotopic variations: some reflecting isotopic fractionation between different phases, and some being attributed to recycling of surface material into deep mantle. For example, $^{44}Ca/^{40}Ca$ in orthopyroxenes are higher than that in the co-existing clinopyroxenes in mantle peridotites, which reflect inter-mineral isotopic fractionation controlled by the strength of Ca–O bond [1]. This observation leads to an important question: Is there Ca isotopic fractionation during magmatic differentiation?

Basalts from Kilauea Iki lava lake, Hawaii, USA were produced by closed-system crystal-melt fractionation, with MgO ranging from 26.87 to 2.37 wt% [2]. They define a negative MgO-CaO trend at MgO > 7.5 wt%, reflecting olivine fractionation/accumulation, and a positive MgO-CaO trend at MgO < 7.5 wt%, controlled by clinopyroxene and plagioclase fractionation. Within analytical errors, they do not show measureable isotopic fractionations for Li and Mg [3, 4]. By contrast, $\delta^{56}Fe$ and $\delta^{66}Zn$ increase with decreasing MgO content in Kilauea Iki lavas, implying Fe and Zn isotopic fractionation introduced by crystal fractionation/accumulation [5, 6].

Here we present high-precision mass-dependent Ca isotopic analyses on nine basalts from Kilauea Iki lava lake using a ^{43}Ca-^{48}Ca double spike technique. Although these samples have undergone clinopyroxene and plagioclase differentiation (up to about 20 wt% for each phase), they show no resolvable variations in Ca isotope composition, with an average $\delta^{44/40}Ca_{SRM915a}$ of 0.91±0.09 (2σ).

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