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Partition of Ni, Ca and Mn between olivine and carbonated silicate melt

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Phenocrysts of olivine with high Ni, low Mn and Ca relative to global MORBs are usually attributed to a stronger role of the pyroxenite melting (Sobolev et al., 2005). The Hawaiian shield stage lavas (high Si group) with high bulk-rock and olivine Ni have usually been attributed to the role recycled oceanic crust. However, the Hawaiian plume also produces lavas with Si-undersaturated alkali basalt (low Si group) and relatively low Ni, whose origin has not been well understood. In this study, we examine the role of deep carbon on the magma compositions and their influences on olivine geochemistry. Here by comparing the whole rock and olivine geochemistry data of Hawaiian high Si group basalts with Hawaiian low Si group basalts, we find that the primary magmas of the latter have relatively lower Ni but comparable concentrations of Mn and Ca. However, the high Si group basalt olivines have indistinctive partition coefficient of Ni but significantly lower Mn and Ca than those of the high Si group basalts.

The deep Earth is a large reservoir of carbon, which when participates in mantle melting would significantly influence the mantle residual minerals and melt compositions. For example, mantle melting with CO₂ is commonly shown to reduce SiO₂ in the melts. Thus, the genesis of the Si-undersaturated alkali basalts has usually been attributed to the role of CO₂ (Zhang et al., 2017). The role of CO₂ in the genesis of Hawaiian alkali lavas have also been predicted in previous studies. Based on the observations from Hawaiian lavas, we suggest that CO₂ played a key role in lowering the partition coefficients of Mn and Ca. We have conducted high pressure-temperature melting experiments on mantle rocks with CO₂, and find that CO₂ has a potential influence on the partition of Ni, Mn and Ca between olivine and silicate melts, more experiments remain to be further conducted. This work was financially supported by the National Natural Science Foundation of China (91858206, 41876040).