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Incongruous relationship between bulk rock Sr and Ca isotopic data of mafic-ultramafic rocks from fast-spreading ridge: An insight into the effect of melt-rock interaction in the lower plutonic crust

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Fast spreading East Pacific Ridge (EPR) is a well-studied mid-oceanic ridge (MOR) system in terms of its petrography and magma generation mechanisms. However, considerable variation is observed in the chemical composition of the mafic-ultramafic rocks from the different segments of EPR and with that of the slow spreading ridges like Mid-Atlantic and Indian Ocean. In the present study, major, trace element concentrations and radiogenic Sr and stable Ca isotopic compositions are measured for gabbro-dunite assemblage from the lower plutonic crust of Hess Deep Rift (HDR) to understand their formation history. The various rock types include gabbros with different modal compositions, followed by troctolite, dunite and a basalt dyke. Major and trace element analyses of these rocks reveal two distinct groups, viz. Group 1 having a more primitive composition (Mg# ~ 55-76) and Group 2 which are more evolved (Mg# ~ 48). Both the groups show selective enrichment in some incompatible elements while depletion in others. The $^{87}Sr/^{86}Sr$ of these rocks clearly indicates influence of high-temperature hydrothermal activity which have increased the $^{87}Sr/^{86}Sr$ values of these rocks in variable proportion - the most radiogenic $^{87}Sr/^{86}Sr$ (0.7087) is observed in an altered dunite which is close to modern seawater values. However, their $d^{44/40}Ca$ values shows no such influence, with all samples showing a limited range (0.70-0.88‰) which broadly overlaps with the composition of the average oceanic crust (~0.85 ± 0.09‰). Surprisingly, olivine-rich dunite and troctolite samples, expected to show high $d^{44/40}Ca$ values due to the strong Ca-O bond in olivines also show basalt-like compositions which could be due to the presence of hydrothermal minerals in these samples. The difference in behavior of the Sr and Ca isotopic systems towards seawater alteration indicates that the selective enrichment and depletion in certain incompatible elements is not due to the incorporation of any recycled slab derived materials (± sediments). Rather the overall geochemistry of both the group of rocks indicates their formation from a depleted source with further influx of a basic melt that caused selective enrichment of certain trace elements without causing any isotopic variations.