Geophysical Research Abstracts, Vol. 9, 08996, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-08996

The effect of melt-rock reaction in the lower oceanic crust on mid-ocean ridge basalt compositions

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Lower crustal gabbros from the Kane Core Complex (23˚N, Mid-Atlantic Ridge) show evidence for reaction between preexisting cumulates and MORB melt migrating in diffuse, cm-wide channels. These reactions are evidenced by: (1) the disappearance of olivine and resorption of plagioclase in the channels, both of which are associated with the crystallization of la rge (up to 5 cm) clinopyroxene oikocrysts; (2) disequilibrium compositions of these clinopyroxene oikocrysts, which indicate they could not have crystallized from a MORB-type melt in a closed system; (3) low anorthite content and reverse zoning of plagioclase chadacrysts, which are in disequilibrium with their host clinopyroxene oikocrysts, and with the plagioclase from the host rock; (4) the high Mg#'s of the oikocrysts, which are inconsistent with closed-system crystallization at the low pressures typical of the oceanic crust, despite the fact that the gabbros crystallized in the low-pressure sequence of olivine –> plagioclase –> clinopyroxene. Based on these characteristics, we suggest that the following reaction occurred in the Kane gabbros: olivine + high-An plagioclase + melt 1 = high-Mg# clinopyroxene + low-An plagioclase + melt 2.

AFC modeling revealed that MORB melts undergoing this reaction at lower crustal pressures are depleted in CaO, and enriched in Al_2O_3 and to a lesser extent MgO. These compositional changes are similar to those expected from high-pressure fractionation of MORB melts in the mantle, and the model melts yield increasingly higher calculated pressures as reaction proceeds. This suggests the CaO-Al_2O_3-MgO relationships of MORB may result from melt-rock reaction in the lower oceanic crust, and that calculated pressures of MORB fractionation are overestimated as a result.