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Recycling of geochemically heterogenous oceanic crust: Significance for the origin of ocean island basalts

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Explaining the isotopic signature and origin of ocean island basalts (OIBs) is a challenge in Earth sciences. There is general agreement that lithospheric material, recycled into the Earth´s mantle, is involved in the mantle sources of OIBs. The relative roles, however, of 1) subducted marine sediments, 2) altered oceanic basaltic crust (AOC), 3) oceanic lithospheric mantle and/or 4) delaminated metasomatised subcontinental lithosphere and continental lower crust, however, are much debated. We present results from geochemical modeling in the Sr-Nd-Pb-isotope space following a new approach that takes into account the trace element and isotope heterogeneity of subducted oceanic crust (sediments + AOC). By means of backward and forward modeling, we examine how a geochemically heterogeneous package of oceanic crust may evolve in terms of Sr-Nd-Pb-isotopic composition through time and compare the results with present day radiogenic isotope ratios of OIBs. Our study suggests that recycling of AOC, modified during the subduction process, and stored in the Earth´s mantle for several hundreds of millions of years can explain the Sr-Nd-Pb-isotopic composition of OIBs with relatively high Nd-isotope ratios that form elongated fields along or below the Northern Hemisphere Reference Line (NHRL) in the Pb-isotopic diagrams (e.g. Canaries, Galapagos, Iceland, Madeira). Explaining the origin of OIBs with relatively low Nd-isotope ratios and Pb-isotopic composition above the NHRL, and thus geochemical affinity to enriched mantle (EM) components (e.g. Pitcairn, Tristan, Samoa), however, seems to also require recycling of other lithospheric material such as subducted sediments, lower continental crust and/or subcontinental lithosphere.