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Origin of pyroxenite component in the source of the Canary shield stage magmas constrained from olivine phenocryst - radiogenic isotope relationships

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One of the major geochemical challenges in understanding dynamics of mantle history is to identify the nature and quantification of components involved in partial melting. Recycled oceanic crust is commonly suspected but the role of other mechanisms such as delamination of subcontinental lithosphere is still debated. The main goal of the present study is understanding the genetic link between Ni and Mn concentrations in olivine phenocrysts and whole rock isotopic composition with the aim to constrain origin, amount and isotopic composition of components involved in partial melting of the Canary mantle source due to recycling of subducted oceanic crust and/or delaminated African subcontinental lithosphere. Our approach is based on the coherent variations of Ni and Mn concentrations in olivine phenocrysts as a function of relative contribution of the recycled component to the ascending mantle plume [1,2]. We demonstrate that the concentrations of Ni and Mn in olivine phenocrysts from the most primitive picritic to basaltic lavas from Gran Canaria, Tenerife, La Gomera, La Palma and El Hierro shield stages, as well as from submarine basaltic hyaloclastites drilled during ODP Leg 157 in the submarine clastic apron of Gran Canaria strongly correlate with whole rock Sr, Nd and Pb isotope ratios of their host lavas. Our data set allows to estimate Sr-Nd-Pb isotopic composition of at least two components involved in the partial melting: the first is a “peridotitic” component which is isotopically very similar to the low-velocity component of the upwelling mantle proposed in [3], while the second is more likely represented by “reaction pyroxenite” whose origin requires involvement of physically and chemically complex material resembling mixture of the recycled oceanic crust and/or delaminated subcontinental lithosphere, both went through the “subduction factory”; the last is supported by recent geophysical studies arguing for the presence of active subduction beneath Gibraltar [4] and the 300 km seismic discontinuity generated by SiO_2-stishovite formation in eclogitic assemblages [5].

[1] Sobolev et al. (2005) Nature 434, 590-597; [2] Sobolev et al. (2007) Science 316, 412-417; [3] Hoernle et al. (1995) Nature 374, 34-39; [4] Gutscher et al. (2002) Geology 30, 1071-1074; [5] Williams and Revenaugh (2005) Geology 33, 1-4.