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Distribution of lead in the mantle wedge: thermo-mechanical modeling of geochemical signatures

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The aim of this study is to investigate the geochemical transport of lead in the mantle wedge for different geodynamic regimes of intra-oceanic subduction. We created a 2D coupled geochemical-petrological-thermo-mechanical numerical subduction model in which lead is mobilized during slab dehydration and transported into the mantle wedge by aqueous fluids. Partial melting of the hydrated mantle results in new arc crust formation. In the first part of this study we investigated systematically influences of fluid and melt weakening effects, which are responsible for the degree of plate coupling/decoupling and the mechanical strength of the overriding plate. The following three geodynamic regimes of intra-oceanic subduction are chosen for our parametric investigation of isotope ratios (Pb, Sr, Hf, Nd): 1) a retreating regime with either stable or episodic overriding plate extension, 2) a stable regime without compression and extension and 3) an advancing regime with fore-arc subduction. In the second part of this study we investigate geochemical signatures characteristic for the identified regimes of intra-oceanic subduction. We analyze the lead isotope distribution in the serpentinized and hydrated mantle in the fore-arc region and below the arc. Our preliminary results show a heterogeneous distribution of lead isotope ratios in the serpentinized mantle wedge on the scale of several km to several tens of km. The variable lead isotope composition of the mantle is mostly caused by local variations in the intensity of the fluid flux from the slab and the nature and P-T conditions of oceanic crust dehydration reactions. Decreasing fluid flux with increasing distance to the trench results in a slight decrease of Pb isotope ratios in the hydrated fore-arc mantle. The resulting Pb signatures in the newly produced arc crust vary depending on local contributions of dry mantle decompression melting and melting of heterogeneously hydrated mantle.