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Numerical simulation of subduction zone fluid processes: implications for global compositional anomaly

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Aqueous fluids released from subducting slabs are thought to transport incompatible elements from the slabs to the overlying wedge mantle, which consequently concentrates the incompatible elements in an arc magmas, and causes elemental differentiation.

Element transportation by slab-derived fluids has an important role on global material differentiation; however this process is not constrained well due to its complexity such as dehydration reaction, fluid migration, fluid-solid reaction, and melting. In this study, we try to induce the transportation and reaction of trace element during these complex processes in the solid-melt-water system. Based on numerical simulation with generation and migration of water by the relevant phase relationships, we construct numerical model for solid-fluid-melt flow beneath the NE Japan arc in order to estimate the influence of subduction process on chemical compositions of the each constituent phases.

As a result, we have successfully estimated trace element distributions in the solid, melt, and aqueous fluid and their migration in subduction zones. For instance, melts is distributed 80km~150km above the Wadati-Benioff Zone, which is consistent with volcanic distribution in NE Japan. Based on the obtained elemental mapping over the subduction zone, we have also found a high Rb/Sr and Th/Pb layer above the subducting slab along the bottom of the mantle wedge. This layer subducts to the deeper mantle, which may contribute to a source region with high 87Sr/86Sr and 208Pb/204Pb ratios deep in the mantle: if they are accumulated, e.g., beneath a supercontinent associated with focused subduction towards it, such a source region can explain Dupal anomaly (Hart, 1984) or "Mantle Eastern Hemisphere" (Iwamori and Nakamura, 2012), in which the mantle-derived basalts show isotopic anomaly over the region.

Keywords: subduction, simulation, trace element, isotopic anomaly, material recycling, slab