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# Two-dimensional thermodynamic and trace element models of subduction zones

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Trace element and isotopic signatures in arc volcanics are commonly interpreted in terms of processes occurring in the subducted slab, the slab mantle interface and/or the overlying mantle wedge. Fluids derived from dehydration reactions in the downgoing slab display major initial carriers of such trace element signatures. It is evident that fluids liberated during subduction interact with the wall rock during their ascent to the Earth's surface. To quantify this fluid-rock interaction it is necessary to get information about the amount and composition of coexisting fluids and minerals in the wall rock. Thermodynamic models are able to predict amounts and compositions of coexisting stable phases at given pressure, temperature and effective bulk rock composition and thus enable calculation of mass balanced trace element distribution among the modeled phase assemblage. Complexities in modeling trace element compositions of subduction zone fluids arise from the fact that migrating fluids interact with rocks of different major and trace element composition, such as subducted sediments at the slab surface as well as basaltic and gabbroic rocks on top of oceanic mantle within the subducted plate. Further, complex pressure-temperature relations in a subduction zone complicate the calculation of phase assemblages within slab and mantle wedge. Thus, thermodynamic and trace element models must consider fluid migration and resulting trace element fractionation in a chemically and thermally complex and heterogeneous system, which cannot be displayed in conventional P-T diagrams.

Based on modeled isotherm patterns of different subduction zone settings we calculate phase relations in different layers of the subducted slab, considering upward migration of liberated fluids during subduction utilising incremental Gibbs energy minimisation models. Further, based on modeled phase relations, fluid amounts and trace element partition coefficients, we calculate mass balanced trace element distribution among the stable phases at every increment within the slab. Trace element transport occurs within the migrating fluid phase that equilibrates with the wall rock during ascent, which controls trace element depletion and/or enrichment of fluid and wall rock. With these models we can constrain the absolute amount and the resulting trace element composition of the fluid at the slab surface after fluid-rock interaction within the subducted plate. Preliminary results considering potentially fluid-mobile trace elements, such as Li, Be and B show a significant intra-slab fluid rock interaction. Trace element concentration trends of the considered elements are similar to those observed in arc volcanics, such that Li, Be and B are continuously depleted during subduction and B/Be is significantly decreasing with increasing slab depth, but intense slab depletion of fluid mobile elements occurs in our models already at fore-arc depths. The accumulated fluid flux shows a distinct maximum between 60 and 80km slab depth, thus questioning a direct relation between arc volcanic signatures and processes in the subducted slab.