Geophysical Research Abstracts
Vol. 14, EGU2012-11410-1, 2012
EGU General Assembly 2012

Constraining fluid fluxes in subducted slabs with two-dimensional thermodynamic and trace element models of subduction zones

M. Konrad-Schmolke (1), M. Poehle (1), and S. Jahn (2)

(1) Universität Potsdam, Geosciences, Potsdam, Germany (mkonrad@geo.uni-potsdam.de), (2) GeoForschungsZentrum Potsdam, Telegrafenberg, 14473 Potsdam

Devolatilisation reactions and the associated fluid-rock interaction processes play a key role for any mass transfer in subduction zones. Further, fluid migration is critical for the mechanical rock behaviour within the subducted slab as well as along the slab mantle interface. Prediction and quantification of the fluid fluxes in subduction zones is therefore a fundamental task in geosciences. The amount of percolating fluid as well as its composition is controlled by gravity, thermodynamics and reaction kinetics. In this contribution we focus on the thermodynamic constraints on devolatilisation reactions, the associated fluid migration and the chemical aspect of fluid-rock interaction within a subducted slab. With thermodynamic forward modeling we set basic constraints on the intensity of fluid fluxes, the fluid composition and the complex interactions between mineral reactions in different bulk rock chemistries within subducted oceanic lithosphere.

Based on numerically modeled isotherm patterns of different, contrasting subduction zones (Cascadia, Kamtchatka and Nicaragua) 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 within the slab and at the slab-mantle interface after fluid-rock interaction within the subducted plate.

Our two-dimensional thermodynamic models show similarities but also large differences in fluid liberation, fluid migration and fluid composition within the slab and at the slab surface of the different subduction zone models. Depending on temperature and dip of the subducted slab there are strong intra-slab variations in the amount of fluid fluxes controlled by dehydration- but also rehydration reactions that might completely consume previously liberated fluids and thus hinder slab-mantle fluid- and element transfer at fore-arc depths. Due to such intra-slab rehydration, the relatively hot and shallowly dipping Cascadia subduction zone has a similar fluid flux pattern as the steeply dipping and hotter subducted plate beneath Nicaragua. In both cases fluid liberation is pulse like, peaking at slab depths <30km and between 100-150 km. In contrast, water liberation at the slab surface is more continuous steadily increasing to slab depths of up to 220 km in the Kamtchatka model.

Modeled trace element cross-arc variations are similar to those observed in Nature, 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. In all models strong intra-slab fluid-rock interactions lead to large variations in fluid and rock trace element compositions.