



Consequences of reactive fluid flow on trace element transport in subducting oceanic crust

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Fluid fluxes in high pressure metamorphic rocks are difficult to detect due to ongoing deformation after fluid flux, poor survival rates of high pressure rocks and retrograde reactions during exhumation. However, one of the key aspects with regards to fluid flux is strong channelling during ongoing fluid flow. This leads on the one hand to large exposed rock masses that record no or extremely minimal fluid flux rates, and on the other hand to rare exposures where high pressure veins are omnipresent (e.g., Tianshan, China). Here we would like to point out that in these areas, non-equilibrium processes, e.g. reactive fluid flow, may be much more common than assumed in most subduction zone models. There is good evidence for near-equilibrium conditions only at the sites where fluids are released by dehydration reactions with accompanying recrystallization. Equilibrium processes are rare in open systems such as dehydrating slabs, where fluids from different sources have to pass through chemically different lithologies. Thus, significant modification of such fluids will occur while they are rising through the subducting slab into the overlying mantle by reactive flow. Under the relatively low temperature conditions prevailing during slab dehydration, diffusional exchange of elements between mineral and fluid will be minimal. Instead, dissolution and/or precipitation of certain mineral phases will occur when fluids encounter changing temperature, pressure and/or compositional conditions. An example is the dissolution of phengite when metabasalt-derived fluids (undersaturated in potassium) enter phengite-rich metasediments. However, reaction progress depends on the amount of material with which the fluid interacts. This is partly dependent on the geometry (fractal behaviour) and longevity (transient vs long-lived) of the vein network and the thickness of lithologies through which the fluid travels. Especially the behaviour

of trace elements during reactive fluid flow is not yet well understood. Nevertheless, several predictions can be made that are consistent with existing data. The model of reactive fluid flow gives an alternative explanation why there is a positive world-wide correlation between the amount of Ba in sediments and Ba concentration in adjacent island arc basalts (Plank & Langmuir 1993; Nature 362, 739-743). The more abundant micas (principal Ba carrier) are in the subducting sediment column, the more Ba the fluid -derived from dehydration of metabasalts and serpentinites- may scavenge during uprise through the metasedimentary column. Calling upon monazite dissolution (non-existent in mafic and ultramafic assemblages but common in metasediments) by reactive fluid flow, may explain high Th contents in some island arcs, the so-called hallmark for "sediment melts".