



Fluid-rock interaction in sediments subducted to the seismogenic zone: Implication from mineral reactions, fluid-mobile elements and $\delta^7\text{Li}$ isotopes

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To evaluate fluid-rock interaction in subducted sediments buried down to seismogenic depths (250–330 °C), we describe mineral reactions along the prograde path and their influence on the fluid budget, fluid-mobile element concentrations, and $\delta^7\text{Li}$ of fluids. We focused in particular on metapelitic rocks from two paleo-accretionary complexes, the Kodiak accretionary complex, USA, and the Shimanto belt, Japan.

In metapelites from Kodiak and Shimanto, illite-to-chlorite transformation is the main mineral reaction in the temperature range from 250 to 330 °C. Such reaction requires additional H_2O and the plausible explanation is the consumption of pore water, contributing to the increase in the salinity of the pore fluid from 250 to 330 °C, trapped as inclusions in quartz veins. Textural evidences, mineral reactions, and mass-balance calculations suggest that the system behaved as closed in both studied sites in terms of major elements. However, trace elements provide a slightly different picture. Indeed, fluid-mobile elements (FME; Li, B, Rb, Sr, Cs, Ba) indicate opposite trends between the two sites: In Kodiak, FME whole-rock concentrations are preserved from 250 to 330 °C, in agreement with FME concentrations in illite and chlorite that suggest redistribution between rock-forming minerals. In contrast, samples from Shimanto show significant loss of all studied FME from 250 to 330 °C, reflecting a decrease in the FME content of individual mineral phases.

Further insight into the fluid-rock interactions were provided by the analysis of $\delta^7\text{Li}$ both in quartz and its fluid inclusions (FI) by applying crush-leach technique. In Kodiak, the fluid is characterized by relatively higher $\delta^7\text{Li}$ than Shimanto (+8.1 to +17.07‰ in comparison to +2.53 to +10.39‰, respectively). Such variations can be accounted for by mineral reactions and lithium concentrations in individual phases. Chlorite is the main host of lithium. In the Kodiak complex, lithium concentrations in chlorite remains statistically identical between 250 °C and 330 °C (≈240 ppm), whereas in the Shimanto belt significant decrease of lithium is observed in chlorite (from ≈320 ppm in chlorite at 250 °C down to ≈120 ppm at 330 °C). Hence, the higher $\delta^7\text{Li}$ of fluids in Kodiak is explained by the chlorite crystallization as it preferentially consumes ^6Li and the fluid remains enriched in ^7Li . Conversely, fluids from Shimanto are isotopically lighter than from Kodiak,

consistent with lithium loss in chlorite as temperature increases. Therefore, $\delta^7\text{Li}$ of fluids in both Kodiak and Shimanto examples can be accounted for by local redistribution of lithium between reacting phyllosilicates and their isotopic fractionation.

Overall, major elements, FME, and $\delta^7\text{Li}$ of fluids point to a local redistribution of elements in the Kodiak complex, suggesting that the system behave as closed, as the studied units are underplated as a part of thick turbiditic sequence far from any large-scale fault zones. In the Shimanto belt, the loss of FME suggest rather the open system opposite to major elements, as they are more sensitive indicators of transfers between rock and fluid. Such opposite trend between Kodiak and Shimanto is largely controlled by (i) the amount of internal strain within the different units and (ii) the proximity to large-scale fault zones.