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Elemental and lithium isotopic signature of fluids in metapelites from ancient subduction zones

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The objective of this work is to study the fluid rock-interactions at low metamorphic grade in subduction zones. We focused in particular on the evolution of metapelites from the base of the seismogenic zone (□250□) to the down-dip transition to the aseismic domain (□330□). In the three examples examined here (Kodiak Complex in Alaska, Shimanto Belt in Japan, the French Alps), we followed the variations in mineralogy, trace element budget, as well as fluid inclusion elemental and isotopic ($\delta^7\text{Li}$) composition.

In the Kodiak and Shimanto belt, the mineralogy remains constant with temperature increase, with the dominance of phyllosilicates (white mica and chlorite), quartz and plagioclase. In more deformed zones of higher-T samples (330 ± 16 □ and 3 ± 0.4 kbar for Kodiak and 320 ± 14 □ and 3.9 ± 0.4 kbar for Shimanto belt) quartz and plagioclase are completely dissolved, while large white mica and chlorite grains crystallized. Also, the chlorite/white mica ratio is higher with temperature increase.

White mica is a main host for B, LILE and to smaller extent for Li. Plagioclase hosts the same elements but in lower concentrations. Chlorite is a main host for Li ± B and quartz hosts Li to smaller extent than chlorite and mica. Bulk rock analysis revealed partial loss in B, Rb, Sr and Cs with temperature increase, in contrast to the retention of Li and Ba. Mass balance based on trace element concentrations of individual phases and their proportion point to a reorganization of elements released during quartz and plagioclase dissolution and phyllosilicate recrystallization: Rb, Cs and Ba released from plagioclase are incorporated in higher grade mica, Li released from mica and quartz is incorporated into chlorite. In the lack of newly formed phase as a host, B and Sr are probably released into a fluid.

The salinity at 250°C is around 2wt.% NaCl eq., i.e. lower than original pore-filling seawater. The freshening can be accounted for by smectite dehydration and transformation into illite. From 250 to 330°C, a salinity increase is observed, up to 3.5wt.%, possibly related to the chlorite crystallization requiring higher amount of water. The fluid is highly enriched in fluid-mobile

elements in comparison with seawater. $\delta^7\text{Li}$ values of fluid inclusion leachates are distinct for each locality: +8.1 to +17.07‰, in the Kodiak, +2.53 to +10.39‰ in the Shimanto belt and -1.54 to +9.54‰ in the western Alps. $\delta^7\text{Li}$ of fluids is independent of other parameters, such as temperature or Li concentration.

Mineral reactions and fluid-mobile elements concentration in phases point to overall a local redistribution of fluid-mobile elements between phases, except for minor release of B and Sr. Lithium isotopes, which show that $\delta^7\text{Li}$ of fluid is possibly buffered by host rock, confirm the fact that the rocks behaved to a large extent as a closed system during burial and subsequent exhumation.