Paper Number: 4610

Chemical and thermal evolution of subduction zones: Insights from trace-element distribution and Lu–Hf geochronology in HP oceanic rocks, Halilbağı Complex (Central Anatolia)

Pourteau, A.[1,2], Ebert, L.[1], Schmidt, A.[1], Scherer, E.E.[3] and Bast, R.[3]

[1]Institut für Erd- und Umweltwissenschaften, Universität Potsdam, Karl-Liebknecht-Str. 24–25, 14476 Potsdam–Golm, Germany; amaury.pourteau@curtin.edu.au

[2]Department of Applied Geology, Curtin University, Kent Street, Bentley 6845 WA, Australia

[3]MIRC, Institut für Mineralogie, Westfälische Wilhelms-Universität Münster, Corrensstr. 24, 48149 Münster, Germany

---

High-pressure/low-temperature (HP/LT) oceanic rocks exposed at the Earth's surface record a wide range of processes taking place in subduction zones. In the last few years, natural and modelled zoning patterns of HP/LT garnet have been used to investigate fluid production and circulation, and element recycling in subduction zones. However, whereas lawsonite (lws)–garnet (grt) blueschist and lws eclogite are predicted to have been widely formed in Phanerozoic subduction zones, surprisingly still little is known about the distribution of trace elements in lws- and grt-bearing parageneses. The same applies to the thermal history of subduction-channel complexes, though it plays a crucial role in the chemical- and mechanical evolution of the plate interface.

We inspected the distribution of trace elements (mainly REE+Y) and performed Lu–Hf geochronology on grt-bearing mafic samples from the Halilbağı subduction complex, Central Anatolia, to gain insight into the linkage between the chemical and thermal histories of the subduction channel. Samples include pristine lws blueschist, lws–epidote (ep)–omphacite blueschist, lws–ep–glaucophane eclogite, ep eclogite, and grt amphibolite (from the overlying sub-ophiolitic metamorphic sole).

Our trace element analysis reveals that, with respect to chondrite, lawsonite is typically enriched in medium rare earth elements (REE) over light and heavy REE. Lawsonite that grew in absence of grt or ep has higher heavy or light REE concentrations in the cores, respectively. Garnet has heavy REE-rich cores, but also displays a second, rim-ward enrichment in medium and heavy REE associated with the

replacement of titanite by rutile. Rare earth element partitioning coefficients (K_D) were calculated between lws and grt in cases where a textural relationship was unambiguous. The K_D(lws/grt) values are generally 10^{-2}–10^{-1} but up to ~1 for prograde lws–grt associations.

Lutetium–hafnium geochronology was carried out on 3–4 grt and 2–3 lws separates of each sample. In each sample, 2–4 grt batches yielded similar two-point matrix–grt dates whereas one batch, if any, yielded an older date. The outliers consistently have higher $^{176}Lu/^{177}Hf$ and $^{176}Hf/^{177}Hf$ ratios than the other batches from the same sample, and no correlation exists between Hf element concentration and isotopic composition. We interpret the scatter to be geologically meaningful, reflecting minimal grt growth intervals. In addition, lws fractions from three samples were analysed for Lu–Hf geochronology. For prograde lws blueschist, two-point matrix–lws isochrons yielded dates from 83.6 ± 2.0 to 77.5 ± 2.5 Ma, which are distinctly younger than grt dates for this sample (89–86 Ma). Two-point matrix–lws isochrons calculated for the two other samples (lws–ep blueschist/eclogite) yielded geologically inconsistent dates (between 49.7 ± 2.5 Ma and 12.3 ± 3.4 Ma), whereas whole rock–lws isochrons give seemingly more reasonable dates (between 85.56 ± 0.81 and 60.4 ± 2.3 Ma).

The metamorphic evolution of the samples may be interpreted in the light of the petrological observations, Lu–Hf grt dates, and REE distribution patterns (especially Lu) in grt. Our results indicate that LP/HT metamorphism at the bottom of the ophiolite took place at 109–104 Ma, 'warm' HP metamorphism (ep eclogite facies) occurred at c. 93 Ma, and 'cold' HP metamorphism (prograde and retrograde lws blueschist facies) followed from 89 to 86 Ma. Garnet dates thus reveal the progressive, active cooling of a former subduction interface, from its inception to a steady thermal state over c. 15–20 Myr.