Dynamics in the Sesia HP terrane: Combined petrochronological and structural analysis

Martin Engi[1], Daniele Regis[1], James Darling[1], Daniela Rubatto[2], Bénédicte Cenki-Tok[1,3], Michele Zucali[4], Roberto Compagnoni[5]

1: University of Bern, Department of Geological Sciences, Bern, Switzerland, e-mail: engi@geo.unibe.ch;
2: Australian National University, Research School of Earth Sciences, Canberra, Australia;
3: Géosciences Montpellier, Université de Montpellier 2, Montpellier, France
4: Dipartimento di Scienze della Terra "Ardito Desio", Università degli studi di Milano, Milano, Italy
5: Università di Torino, Dipartimento di Scienze Mineralogiche e Petrologiche

HP terranes dominated by continental crust represent the end result of a sequence of processes that operate at lithosphere scale, i.e. rifting, subduction/accretion, return flow/exhumation. To understand the dynamics of the subduction channel in complex terranes of this kind, the effects from each stage must be investigated separately, linking the observations and data from kilometers down to micrometer scale. This task recommends an integrative approach.

Here we focus on the assembly of the Sesia Zone (SZ), a key element of the internal Western Alps. This terrane comprises two main polymetamorphic basement units and thin trails of a cover sequence that includes post-Permian syn- to post-rift metasediments; the latter show no pre-Alpine metamorphic imprint. The tectonic scenario of Babist et al. (2006) recognizes five main phases in the Alpine structural evolution; their model helped us select areas for detailed structural work and sampling. Our first goal was to relate the early convergent structures (D1, D2) to the P-T evolution and to establish a robust time-frame for the HP-dynamics within and between the tectonic slices. Within the subduction/extrusion channel, problems addressed include the question of tectonic mixing, i.e. temporal and spatial scales of relative and absolute movement of the slices, and the conditions and timing of their final juxtaposition prior to the rapid exhumation of the Sesia Zone as a whole.

Mono- and polymetamorphic sediments from different slices display unequivocal evidence of several HP-stages separated in time. Successive stages under eclogite facies conditions occurred between 86 – 65 Ma, as shown by LA-ICP-MS and SHRIMP data on growth zones in accessory allanite, monazite, zircon, and titanite. By using mutual inclusions and overgrowth relationships, the age-data on allanite and monazite can be tied to the multistage evolution of an individual sample. For different rocks, these (over)growth stages can be related to D1- and D2-deformation when micro-, meso- and megastructural observations are combined. Thermobarometry indicates intermittant decompression by ~0.8 GPa between HP phases, hence pressure cycling (aka yo-yo tectonics, Rubatto et al., 2011). This tectonic mobility occurred prior to the final juxtaposition of slices and their exhumation, which involved at least two major deformation phases and lead to widespread retrogression at amphibolite to green-schist facies conditions.

Our approach combining structural, petrological, and geochronological techniques yields some field-based constraints on the duration and rates of the dynamics within a subduction channel. It may be useful to compare these to insights from numerical models, provided the latter take into account the specific conditions of the plate convergence, which turns out to have been highly oblique in the present case.

References

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