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Mobility Within the Subduction Channel: Correlation of P-T-D-t Stages Amongst Tectonic Fragments

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Numerical models of subduction channels indicate that tectonic mixing may be an important process. Opinions diverge with regards to possible origins of fragments, amplitudes of internal mobility, and temporal scales of such mixing processes. Recent work in the Sesia Zone of the Western Alps shows that the HP-evolution was substantially more long-lived and complex than previ¬ously established (e.g. RUBATTO et al., 2011). Significantly different HP-stages have been identified in different slices of the Eclogitic Micaschists Complex (EMC; REGIS, 2012), providing evidence of differential movements of HP-fragments, with subduction- and exhumation-related stages being recorded. The size, geometry, and ultimate provenance of fragments are in the focus of our present research.

We report on methods refined to relate petrochronology to structural data. Detailed analysis of local phase equilibria using X-ray images (XMapTools software) yields local P-T equilibrium conditions; these are combined with in situ U-Th-Pb dating for growth zones in allanite and zircon. Careful microstructural details (e.g. on deformation fabrics, mineral inclusions) and REE-distribution data are used to document an integrated HP-record for single samples. Provided that corresponding time intervals were recorded in several tectonic units, it appears thus possible to correlate HP-stages and deformation.

Results are shown for HP-fragments from several tectonic units in the internal Western Alps, with examples ranging from the eastern parts of the Sesia Zone right across to the Austroalpine klippen units now resting atop Piemonte-Liguria oceanic units:

- In eastern parts of the EMC (Mombarone area) HP-micaschist equilibrated at 1.9-2.0 GPa and 540-550 °C contains allanite dated at 85.8±1.0 Ma; zircon shows rims at ~75 Ma and 70-60 Ma, these reflect growth during decompression, but still at pressures >1.4 GPa.
- Further west (Val de Lys), micaschists from the EMC show a HP foliation (ECL-BLS facies) and weak (GRS facies) retrogression. Several generations of phengite, garnet, glaucophane (±early omphactie) and allanite are distinguished, plus quartz, epidote, chlorite, and titanite (rimming rutile). Growth zones in garnet and allanite correspond to distinct HP stages. Preliminary Th-Pb age data for allanite from in situ LA-ICP-MS analysis show 80-74 Ma for cores and 68-62 Ma for rims. These ages compare well with the two HP stages (HP1: ~75 Ma; HP2: ~65 Ma) REGIS et al. (subm.) found in several samples of the Fondo slice of the Sesia Zone, from which pressure cycling was inferred.
- Leucocratic gneiss from the Glacier-Rafray klippe shows assemblages with amphibole-phengite-epidote-plagioclase-titanite-quartz. Complex growth zoning in phengite allows us to establish a relative, but detailed P-T path. Replacement of phengite by chlorite adds late-stage information. When combined with published P-T data an absolute P-T path can be constructed. Dating of the HP-stage(s) is underway.

The analysis of the fossil continental margin between the Sesia Zone, the Piemonte Zone and the external klippen may have significant implications. Several stages and scenarios for the evolution of this margin need to be reconsidered, from pre-collisional rifting, formation of an OCT zone, through polyphase subductive processes to the juxtaposition of fragments during collision or exhumation.

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Geodynamic and structural controls on the exhumation of Cenozoic metamorphic core complexes: Application to the Alpine-Carpathian-Hellenic orogenic belt

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Metamorphic core complexes (MCCs), particularly Cordilleran-type MCCs, represent typical the thick ductile/viscous material within the middle to lower crust and the mechanically strong upper crust within highly extensional tectonic setting. In the extensional setting, the rheological stratification is particularly the presence of a thick layer of highly ductile material, which results in an upward motion of the viscous material during progressive exhumation. Extensive studies of metamorphic core complexes have highlighted a fundamental problem that the relationship between the mylonitic rocks in the footwall of the ductile low-angle detachment fault at its top, and the brittle-deformed to undeformed hangingwall unit. The exhumed metamorphic rocks typically record a progressive change from ductile to brittle behaviors during decompression. As such, MCCs also reflect highly localized extensional strain on the scale.

As exemplified in the Alpine-Carpathian-Hellenic (ACH) orogenic belt, the exhumations of such MCCs are controlled by several processes including: (1) the retreat of the subduction zone, (2) extensional gravitational collapse of previously shortened lithosphere, (3) continental strike-slip component of tectonic plate movement, and (4) rheological stratification of the extending crust in post-orogenic settings. Our examples mainly include the Naxos MCC in the Aegean Sea, and Rechnitz and Tauern MCCs in the Eastern Alps, which represent Cordilleran-type MCCs. Cordilleran-type MCCs are exhumed virtually parallel to the regional extension direction. Such cases are common in post-collisional settings with extension of previously over-thickened lithosphere, or as in the case of the Aegean Sea, in a back-arc basin setting, which formed due to the retreat of a subduction zone.

Here, we propose a scheme between several possible end-member type cases of exhumation mechanisms of MCCs, e.g., classification of different detachment modes (e.g., rolling hinges, initial low-angle detachment) and contribution of pure-shear vs. simple-shear modes of exhumation. In these cases, upward motion along a detachment (ductile low-angle normal fault) and internal ductile thinning imply gradual exhumation with the youngest exhumation along a rolling hinge at the trailing edge of the MCCs.

Deformational styles at all scales are dominated by extensional structures similar to those documented in numerous MCCs. In all cases investigated by us, the level of the ductile low-angle normal fault is controlled by the presence of thick successions of calcite-dominated lithologies (e.g., calcite marble, calcareous phyllite), which are rheologically weak at low temperatures. These lithologies are overlain by quartz- and feldspar-rich lithologies in the