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Constraints on scales and rates of tectonic mobility within continental collision zones: Case study from the Sesia Zone (Western Alps, NW-Italy)

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Convergent plate margins typically experience a transition from subduction to collision dynamics as massive continental blocks enter the subduction channel. Tectonic responses involving reverse-flow are well established from studies of high-pressure rocks in collisional orogens. These indicate that tectonic fragments are rapidly brought up from eclogite facies to mid-crustal levels, but the details of such dynamics are controversial. Numerical models predict extensive vertical transport and mixing of tectonic blocks, but the scales and rates of such processes depend on assumed rheologies and are not well known.

We report the results of a petro-chronological study from the central Sesia Zone, which comprises several km-size continental tectonic-slices with eclogite facies imprint. Structurally controlled samples from two of these units yield unequivocal evidence of several separate HP-stages:

Scalaro unit: Phengite-quartzites contain several successive generations of white mica and allanite, which can be correlated with structures (pervasive foliations and m-scale folds) and P-T data. Accessory allanite, monazite, titanite and zircon permit these stages to be dated. Mutual inclusions and overgrowth relationships allow age-data on allanite and monazite to be tied to the multistage evolution of an individual sample. SHRIMP dating in this case yields consistent 208Pb/232Th ages of 75.6 $\pm$ 0.8 Ma (2σ) for allanite cores, and 69.8 $\pm$ 0.8 Ma for REE-poor allanite rims. Similar age data were found for other samples from the same unit, but with a third HP-stage at 65 Ma, an age well established for the main eclogite stage of the Sesia zone.
Mombarone unit: Metapelites (gar-ky-ctd, 2 GPa, 550°C) contain allanite dated at 85.8 $\pm$ 1.0 Ma, zircon yields 74 $\pm$ 1 Ma (first rim) and ages between 70 and 60 Ma (successive rims).

Given the tectonic field-relations of the units, these data indicate separate stages of deformation at eclogite facies conditions for each km-slice, between 86 and 65 Ma, with evidence of intermittent decompression (ΔP = 0.8 GPa). The mutual position of these tectonic slices changed during this collisional interval; their juxtaposition occurred (at ca. 65 Ma?) at eclogite facies conditions, prior to the complex exhumation history of the Sesia block at amphibolite to greenschist facies conditions.

Our results allow a field-based calibration of the dynamics in a collisional complex, which can be compared to insights from numerical modelling.