

Timing of final collisional stages and exhumation rates in orogenic belt from zircon (U-Th)/He dating (Ligurian Alps, Northern Italy)

Matteo Maino¹, Giorgio Dallagiovanna¹, Katherine J. Dobson²,
Laura Gaggero³, Cristina Persano², Silvio Seno¹, Finlay M. Stuart⁴

1 Department of Earth Sciences, University of Pavia, Via Ferrata 1, I-27100
Pavia, Italy (matteo.maino@dst.unipv.it)

2 Department of Geographical and Earth Sciences, University of Glasgow, Glasgow G12 8QQ, United
Kingdom

3 Department for the Study of the Territory and its Resources, University of Genoa, Corso Europa 26,
I-16132 Genova, Italy

4 Isotope Geosciences Unit, SUERC, Scottish Enterprise and Technology Park, Rankine Avenue, East
Kilbride G75 0QF, United Kingdom

Tectonics driving the stages of exhumation of orogenic belts is difficult to resolve, especially where a quantitative assessment of the exhumation rates and their temporal and spatial variations within the orogen is lacking. In these cases low-temperature metamorphism dating supplies fundamental data to unravel the cooling history experienced by rocks in the upper crustal levels. (U-Th)/He thermochronometry represents a major tool to dating the transition between the ductile and brittle structural levels.

The Ligurian Alps form the southern-most segment of the Alpine collisional belt. The structure is represented by several tectonic units belonging to the Briançonnais, Pre-Piedmont and Piedmont-Ligurian domains of the Penninic realm. The units were affected by an early metamorphic event that was characterised by high P-T conditions in the internal unit (up to 1.3 GPa, 400 °C) decreasing towards the outer sectors (0.3 GPa, 250 °C). The timing of the high temperature (>300°C) metamorphic events of the internal units are relatively well constrained, between 50-34 Ma (40Ar/39Ar data, Federico et al 2005).

In order to identify the timing and the areal distribution of the low T retrograde metamorphism we carried out zircon (U-Th)/He analyses. The low closure temperature of He in zircon (130-240°C; Reiners, 2005) makes it a powerful tool for determining the timing of low temperature metamorphic events associated with the transition between ductile and brittle structural levels.

Zircon (U-Th)/He ages decrease from the northeast (internal units) to the southwest (external units) suggesting a diachronic cooling history from external to internal sectors. ZHe data from HP rocks demonstrate that the internal units experienced a rapid Early Oligocene exhumation with rates >3.5 mm/a. In the Chattian times, the rapid exhumation (rates ~2.5 mm/a) migrated towards the outer zones of the chain.

This fast Oligocene exhumation is not recorded in other sectors of the Alps, and is thought to be associated with active transpressional tectonics related to the lateral position of the Ligurian segment during the continent-continent collisional phase.

References:

- Federico L., Capponi G., Crispini L., Scambelluri M., & Villa I. M. (2005). ³⁹Ar/ ⁴⁰Ar dating of high-pressure rocks from the Ligurian Alps: Evidence for a continuous subduction–exhumation cycle. *Earth and Planetary Science Letters*, 240, 668–680.
- Reiners P. W., (2005). Zircon (U-Th)/He thermochronometry, in Reiners P. W., & Ehlers T. A., eds, *Thermochronology. Reviews in Mineralogy and Geochemistry*. Mineralogical Society of America, 58, 151-179.