Petrochronology in the Central Alps: Results, implications, gaps

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Petrochronology aims to obtain interpretable ages from metamorphic terrains. Much progress has been made over the past decade owing to a combination of several advances: On the one hand high-resolution and *in situ* analysis of isotopic ratios and trace element concentrations, on the other improvements in detailed petrological quantification (through thermodynamic and kinetic analysis of phase relations and reaction textures). Furthermore, numerical models (*e.g.* thermal and kinematic simulations) have grown in sophistication and can be used to unravel the complex evolution of orogens. This overview gives a summary of recent petrochronological results from the Central Alps and outlines remaining problems.

It is essential to realize that careful petrographic and structural analysis are crucial for identifying and precisely formulating questions to which sophisticated tools can be applied. In the Central Alps, a wealth of previous studies provide the tectonic framework to choose structurally controlled samples and relate these to the well known metamorphic structure. Only few units in the Lepontine underwent the early HP stage (prograde from 55? to 35 Ma); some samples reflect the transition from subduction to collision, with slab break-off initiating (at ~41 Ma) TAC-extrusion and magmatism along the subduction channel. By interleafing the HP units within the Lepontine nappe stack, heat advection to the middle crust provoked the Barrovian overprint that affected all units. Careful separation of the effects of decompression *vs*. retrogression (in T) has allowed geochronological resolution of a major N-S diachronicity:

- Rapid decompressional heating affected the southern Lepontine; the Southern Steep Belt reached T_{max} at ~30 Ma and maintained migmatite stage conditions for ~10 m.y., with a sudden onset of fast cooling (~50 °/m.y.) after 22 Ma (Rubatto et al. 2009). The latter may reflect a major dextral transpression stage along the Insubric Line.
- In the northern parts of the Lepontine, relaxation of the inverted isotherms lead to prograde metamorphism, with heating rates of ~10 °/m.y. from 250 °C (at 31 Ma) to T_{max}, which was reached at ~18 Ma (Janots et al. 2009); initial cooling was fast (~35 °/m.y.) and is likely to reflect tectonic unroofing, especially in the Northern Steep Belt.

Several gaps still exist in the present picture: The onset of eclogite formation in the Tectonic Accretion Channel still is relatively uncertain; in subducted (Valaisan) units of the accretionary prism, the age of the LT-HP history – despite the excellent study by Wiederkehr (2009) – is still poorly constrained at ~45(?) to 35 Ma. The same is true for the age of the Barrovian overprint in the central Lepontine, where modern petrochronometry is lacking; here monazite data constrain T_{max} loosely between 25 and 22 Ma, but the (likely) diachronicity between the eastern and western parts of the belt is not borne out by available data.

References:

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