THE MAPPING OF A ZIRCON FISSION TRACK PARTIAL ANNEALING ZONE IN THE NORTHERN EXTERNAL SWISS ALPS

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Along several profiles in the Swiss Alps, ranging from the central massifs (Aar, Gotthard, Aiguilles Rouges massif) to the northern Alpine border, zircons were dated by the fission track technique. Within each sample an age from up to 40 grains was calculated using the external detector method and the zeta approach (HURFORD & GREEN, 1983). Data were completed by existing data from the central massifs (MICHALSKI & SOOM, 1990; SEWARD & MANCKTELOW, 1994), so that profiles cover an area that underwent Alpine overprint of diagenetic to greenschist facies conditions, i.e. a temperature range of 150° to 450°C. The temperature of the metamorphic overprint was controlled by illite crystallinity, fluid inclusion composition and homogenization temperatures, vitrinite reflectance, and mineral parageneses.

According to recent experimental studies, zircon fission tracks show, in correspondence to earlier findings with apatites, a partial annealing zone (PAZ), the temperature range of which is depending on the time span during which zircon crystals underwent critical temperatures (YAMADA et al., 1995). With the exception of the crystalline basement, sampled rocks only underwent late Alpine, i.e. Miocene, metamorphism; thus, the duration of metamorphism lies in the range of 10^6–10^7 a. For such a time span, experiments propose a PAZ of 190° to 390°C (fanning model, YAMADA et al. 1995), assuming an increase of duration from N to S.

Criteria for the incept of annealing is the occurrence of single grain ages that are younger than the depositional age or the shift of grain age populations with a well defined time span. Criteria for a total reset of the Alpine age is the lack of single grains with ages beyond the depositional age and a pass in the χ^2-test.

Most samples from the Helvetics (mainly flysch sandstones) show a large scatter of single grain ages with several detectable populations that can be attributed to a) Hercynian cooling, b) extension-related Permian volcanism, c) Jurassic rifting and ocean floor metamorphism in the Tethys ocean, and d) Cretaceous early Alpine metamorphism in Austroalpine and Penninic units.

Partial annealing is demonstrated along a 2 km vertical profile at the Aiguilles Rouges massif, Western Swiss Alps. All central zircon ages from the basement pass the statistical test for a unimodal distribution, but show a shift toward older ages with increasing sample altitude. The data pattern is interpreted as the result of two processes, a) the former Hercynian cooling age within the massif, getting older with increasing altitude, and b) the increasing grade of annealing from top to bottom as the consequence of an estimated temperature difference of 50–60°C. It is, however, not possible to estimate the degree of contribution of the two processes without further arguments or assumptions.

Along most profiles, the total annealing of the zircons is found south of the northernmost outcrops of the crystalline massifs. Samples from the basement have narrow single grain age distributions, and lack of very old grains with strong a recoil damage. The total reset approximately is reached at temperatures of 320°C or lowermost greenschist facies conditions (first occurrence of Fe-rich chloritoid in shales).

The lower end of the PAZ is less obvious, but can be bracketed by some samples with good temperature estimates within the range of 180° to 230°C. Here, more data from localities with accurate temperature estimations are needed.

A comparison with the experimental findings (YAMADA et al., 1995) shows significant differences for the high temperature limit, while the lower temperature corresponds rather well to the predicted value. A possible explanation is based on the differences in the present grain populations: In the crystalline basement, zircons have been annealed at Hercynian time and therefore are exspected to need shorter time spans to anneal from Hercynian to Alpine ages, whereas most of the flysch units in the Helvetics contain a large amount of metamict grains with high track densities, suggesting a large number of 2nd or 3rd order recycled grains.

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