

## ***Interactive comment on “Tectonic Exhumation of the Central Alps Recorded by Detrital Zircon in the Molasse Basin, Switzerland” by Owen A. Anfinson et al.***

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General comment:

In this paper, detrital zircon U-Pb geochronology is used to constrain (i) the sources of 35 to 14 Ma deposits of the North Alpine foreland basin in Switzerland and (ii) mechanisms and timing of exhumation in the Central Alps. The story builds on extensive previous work on the stratigraphy of the basin fill, provenance data using other techniques, and zircon U-Pb data of the hinterland. The approach itself is not innovative; however, its application to the Swiss Molasse Basin is novel and yields some new and interesting results. Analytical techniques appear state-of-the-art and the manuscript is

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clearly structured and well-written.

The main shortcoming is that credit given to previous work is incomplete. This culminates in a rather odd statement in the Introduction saying that considerably less attention has been paid to sediment provenance (lines 45-46). In fact, there are not many foreland basins on Earth where such long lasting and detailed provenance work has been done, encompassing almost all available techniques (petrography, heavy minerals, mineral chemistry and isotopes, bulk sediment chemistry and isotopes, Ar/Ar dating, FT-thermochronology, etc.). In terms of detrital chronology, previous studies focused on lower temperature geothermometers. The new data thus fill a gap with respect to zircon U-Pb. This is rewarding but because the previous knowledge has not been clearly summarized, it remains in part unclear which interpretations are new, in contrast, or in line with previous knowledge. Clarifying this would allow for a slightly deeper discussion of the results.

Specific comments:

- lines 45 following: There are several more papers on petrography and heavy minerals (HM), a brief summary is given in von Eynatten 2007 (Developments in Sedimentology, 58, 887-905). The HM results are pretty consistent although they do not allow to explain all provenance issues. However, they are not ‘inconclusive’. In fact, most advanced provenance studies from the late nineties and the 00’s have built on this expertise. These studies include zircon FT dating (Spiegel et al. 2000, 2001), underlining and extending on the results from Ar thermochronology. Bulk petrography and bulk chemistry provided details on the Miocene erosion of metamorphic rocks (von Eynatten 2003), supported by heavy mineral chemistry on chrome spinel, garnet and white mica (von Eynatten 2003, 2007; von Eynatten and Wijbrans, respectively). Spiegel et al. 2002 and von Eynatten 2003 have suggested a solution to the epidote issue (lines 262-266).

- line 355: ‘no sieving at any point’. After this information, I wonder about the size of

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the measured zircons. Can you provide any range? Does grain size vary between samples and/or age groups? This is relevant for the problem of size-age relations in DZ geochronology.

- lines 356-358: this is the generally accepted approach. Nothing wrong, but typically not all grains are datable/concordant/etc., and thus the dated number is smaller, see figures 4-6, with impact on the uncertainties.

- lines 456-458: grouping of samples of similar unit/area can make sense, especially for purpose of illustration, but should be justified. The authors state that there is 'little variation' within samples from the same units, but what is 'little'? Is this variation insignificant and has been tested, for instance, by K-S? See also next point.

- lines 479-485: why are the two samples amalgamated? They are displayed separately in Fig. 4 and show some contrast, especially regarding proportions of Early vs. Late Variscan.

- lines 659 following (chapter 8.2): The data suggest major break at 22 Ma, most previous studies placed the break with largely similar interpretation at 21 to 20 Ma. Is this within stratigraphic uncertainty, or is there a possibility that the zircon U-Pb signal precedes the low-T thermochron and/or petrographic signals, or is there some other source involved?

- lines 731-733: see von Eynatten and Wijbrans 2003, von Eynatten 2007.

Technical corrections:

- line 53: please use 'v' instead of 'V' for von Eynatten, see also References, like 'von Raumer'.

- line 61: better add 'Swiss' to Molasse Basin, as only a part of the entire North Alpine Foreland (Molasse) Basin is considered in this study.

- line 177 (and references): please correct, 'von' Blanckenburg

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- lines 201-205, figure 2: I suggest highlighting the two cycles graphically in figure 2.

- line 457: abbreviation 'DZ' has not been introduced before; should be done along with the first mentioning of detrital zircon in the Introduction.

- line 489: 'no' Cenozoic ages. . .

- line 526: number (53) appears inconsistent with figure 5. Please check throughout.

- line 568: delete 'to'

- there is some confusion regarding  $>/<22$  Ma and younger/older in figure 7, graphs and caption. Same in text: sentence starting in line 571.

- line 588: 'are' instead of 'and', I guess

- lines 596-599: please state something like '3 out of X' to give the reader an idea of the percentages. And/or state the number of available REE profiles per sample/ per time slice in Figure 7.

- line 654: was situated . . .

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