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Interactive comment on "Polyphase evolution of Pelagonia (northern Greece) revealed by geological and fission-track data" *by* F. L. Schenker et al.

F. L. Schenker et al.

filippo.schenker@unil.ch

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Answer(A)on the general comment of the anonymous referee:

1) Ironically the new thermochronological data from the Pelagonian are all young (Oligo-Miocene), whereas the discussion is mostly on the data with old ages (Cretaceous).

A: Most (not all) of the new FT ages are Oligo-Miocene and "only" three are Cretaceous. Nevertheless, the discussion is mostly focused on the Cretaceous ages for two reasons: Almost all Oligo-Miocene ages were obtained from the Pelagonia gneissic basement. These ages reflect cooling ages already known in the orogenic system, hence their interpretation is straightforward and builds on other works in the same direction. The new Oligo-Miocene ages that we present are in agreement with most published FT ages and tectonic models (cf. with Coutand et al 2014 and Vamvaka et al 2010, references in the manuscript). As a consequence, they do not demand a long discussion. On the contrary, the Cretaceous ages were obtained from sedimentary and metasedimentary rocks. The Cretaceous thermal history of the Axios/Vardar/Almopia zone (AVAZ) is poorly constrained. Therefore, the three new Cretaceous ages are important to understand the evolution of the AVAZ and, in general, this part of the Hellenides. These ages needed a more articulated geological argumentation to attest whether the FT ages are detrital or reset cooling ages. This has driven us to place the Cretaceous ages in a tectonic context supported by deposition age, facies, and metamorphic conditions. However, we take the point and, following also the suggestions of M. Zattin (published comments), we will discuss the Oligo-Miocene tectonic history in more details.

Answers (A) on the detailed comments of the anonymous referee:

1) about the “Tectonic setting and geological overview” a. How can a block detach from Eurasia during Gondwana breakup? The core of Eurasia is Baltica, the opposite of Gondwana. A block can detach from Gondwana during its breakup but not from Eurasia.

A: According to the Late Paleozoic-Early Mesozoic paleogeographic models (e.g. Stampfli & Borel, 2002), Pelagonia was affected by back-arc extension contemporaneous with the breakoff of Gondwana to the South (forming the Tethys Ocean between Gondwana and Laurasia, per definition). The term “during Gondwana breakup” has temporal meaning. The fact that Pelagonia contains many granitoids of 330-300 Ma ages relate it to these parts of present-day Europe that have undergone the Variscan collision. The purpose of the paper is not to discuss the pre-Alpine paleogeography; we suggest to change “during Gondwana breakup” with “during Pangea breakup” which is a less confusing temporal term (widely speaking mid-Permian – Triassic).

b. How can late Early Jurassic plate convergence and N–NE dipping subduction cause Late Jurassic-to-Early Cretaceous southwestward obduction of an AVAZ segment onto Pelagonia? The statement is problematic in two ways. First, early Jurassic subduction can hardly cause Late Jurassic – Early Cretaceous obduction, this is not logical.

A: According to the referee comments we changed the sentence from: -In the late Early Jurassic, plate convergence and N–NE dipping subduction caused the Late Jurassic-to-Early Cretaceous southsouthwestward obduction of an AVAZ segment onto Pelagonia (Bernoulli and Laubscher, 1972). to: -From the late Early Jurassic, plate convergence and N–NE dipping subduction caused the Late Jurassic-to-Early Cretaceous south-southwestward obduction of an AVAZ segment onto Pelagonia (Bernoulli and Laubscher, 1972). We hope that we clarified the timing of processes that lead to the obduction. Otherwise we do not understand how early Jurassic subduction "can hardly" evolve into later, late Jurassic Obduction when the footwall, subducting plates carries the continent that arrives in the trench.

Second, obduction is used for thrusting of ophiolite over the continent (or rather subduction of continent) and it is not correct to use it for the AVAZ, most of which is not ophiolite.

A: We agree with the referee. According our description of the AVAZ and the definition of Coleman (1971), it is a thrust and not an obduction. We will correct this point accordingly.

c. How can "obducted Late Triassic-to-Cretaceous carbonates and hemipelagic marls, ultramafic rocks and metavolcanites" can be "attributed to the Permian–Early Jurassic southwestern passive margin of the Tethys Ocean"? Besides the mistaken usage of the term obduction, how is it possible for the Cretaceous carbonates be part of an early Jurassic continental margin?

A: During obduction of the oceanic lithosphere onto the Permian–Early Jurassic passive margin (AVAZ), sedimentation continued until the Early Cretaceous in front of the

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obduction (in a flexural basin?). We will clarify this concept.

2) I had also difficulty in understanding the following paragraph in the Introduction (p.3, l, 20-25): This study identified four major cooling events: (i) post-collisional, Late Creataceous (sic.) cooling and subsidence from 102 to ca. 68Ma as shown by ZFT ages coeval with the development of marine basins; cooling was heterogeneous in time and space over Pelagonia, AVAZ and western Rhodope, (ii) faster cooling and erosion rates during the Late Cretaceous. . . The first two cooling events are both "Late Cretaceous". How and why are they distinguished?

A: In the discussion section 3.1 we distinguish these events according to the abrupt change in cooling and erosion that we dated at 68 Ma. We propose to change this paragraph to (see also comments of M. Zattin): This study identified four major cooling events: (i) variable in time and space post-collisional cooling affecting Pelagonia, AVAZ and western Rhodope from 102 to ca. 68 Ma as shown by ZFT ages and coeval subsidence of marine basins over the Pelagonian and AVAZ units; (ii) fast cooling and erosion at ca. 68 Ma attested by ZFT ages and increased detritus from Pelagonia to western AVAZ's basins; (iii) fast cooling below 240 °C from 24 to 16 Ma in the footwall of a normal fault in central-eastern Pelagonia; (iv) fast cooling after 7 Ma below ca. 80 °C coeval with E–W trending normal fault zones in central-eastern Pelagonia.

3) Fig. 4 gives the geological map of the area studied with geological cross-sections given in Fig. 5. It needs structural data (orientation of foliation and lineation). This is especially relevant as the structure of the area is discussed in the text (e.g., p. 5, l.2-5). There is enough space on the map to show at least representative structural data.

A: Agreed. Following the referee's suggestions, the final version will display the requested data that support the text of p. 5.

4) The paper would be more comprehensive if the available Ar-Ar mica data are also used for the thermochronological analysis.

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A: Ar-Ar data are available in the Pelagonia zone but they are very scattered in the other units (AVAZ, Western Rhodope). That makes them difficult to use for regional comparison and factual large scale statements.

5) The term "post-collisional cooling" is used in the text for the Cretaceous thermochronological data (p. 3, 20, p. 12, l. 15) and it is not clear what it means in this context. Do the authors envisage an Early Cretaceous collision between Rhodope and Pelagonian? They should be explicit.

A: Yes, we do imply a Cretaceous collision between Rhodope and Pelagonia (see Schenker et al 2014). We limited the discussion of that point because we published the argumentation (ibidem) but we are happy to develop more the final version on that matter (see also criticism of M. Zattin).

6) Marls covering unconformably the AVAZ thrust sheets contain the Turonian Helvetoglobotruncana Helvetica (Figs. 3 and 7b), setting the lower deposition limit (p. 8, l. 19). Please show the location of this sample on the map in Fig. 4. This sample is important in providing an upper limit for the metamorphism. It would be useful also to show the Upper Cretaceous marine sediments, and the location of the rudist-bearing sample (Appendix A) on the map in Fig. 4.

A: The unconformity with the Turonian Helvetoglobotruncana Helvetica is located out of the map of Fig 4. We gave GPS points (with error ∼3 m) for all the samples and fossils, hence they can be easily checked in the field or placed in maps.

7) There is confusion with the sample numbers 10.028 and 10.029. They refer probably to the same sample since there is only one 10.028 on the map, which is referred to as 10.029 (p. 8, l.1, p. 12, l. 4) and as 10.028 (p. 9, l. 6) in the text.

A: 10-028 in the text at p. 9 l. 6 is a typo. We apologize. In the map we could not find any 10-028.

8) The AVAZ is referred to as "Vardar unit" (a simpler and probably better name) on

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page 10, l. 19. It is good to be consistent.

A: According to the referee suggestions, we will change Vardar unit with AVAZ on page 10, l. 19.

References

Coleman, R. G., 1971. Plate Tectonic Emplacement of Upper Mantle Peridotites Along Continental Edges. Journal of Geophysical Research, 76(5), 1212-&. Stampfli, G. M. & Borel, G. D., 2002. A plate tectonic model for the Paleozoic and Mesozoic constrained by dynamic plate boundaries and restored synthetic oceanic isochrons. Earth and Planetary Science Letters, 196(1-2), 17-33.

Interactive comment on Solid Earth Discuss., 6, 3075, 2014.