

Interactive comment on “Neogene kinematics of the Giudicarie Belt and eastern Southern Alpine orogenic front (Northern Italy)” by Verwater et al.

Referee: Christoph von Hagke

5 Dear Dr. Von Hagke,

We would like to express our appreciation for your positive review of our submitted manuscript and acknowledge your constructive comments that helped us improve the manuscript. Please find below our responses to your remarks highlighted in blue.

10 This manuscript addresses the amount of shortening associated with the Giudicarie Belt, a key structure for understanding the Neogene evolution of the Alps. Using balanced cross sections, the authors find that most of the offset of the Periadriatic Fault can be linked to shortening in the Giudicarie Belt. They place their findings in the ongoing discussion on the deep structure of the Alps.

15 This manuscript is well written, and well structured. The constructed cross sections are sensible, and it is great to see that the authors published the full models as supplement. The study is an important contribution and can be published after some minor revisions.

General comments:

20 While the authors state that it is necessary to take into account strike slip movements during balancing, their modeling in fact is 2-D, and the respective error remains unknown. Second, I find it unfortunate that the forward modeling approach is discussed in the supplement only. Even though the manuscript would be longer, I find it important to show the approach and the uncertainties in the main text. These cross sections are the heart of the manuscript. Hypocenters of earthquakes partly do not plot on faults (Fig. 6), and it would be important to explain that.

25 Yes, we agree that we need to take into account strike slip movements during balancing and that we need to elaborate on the respective errors. In line 496-499 we added a statement describing that most of the strike-slip motion out of the 2-D section traces occurred along profiles 3, 4 and 5 and therefore our shortening estimates for these profiles may be underestimated by a few km yielding errors of up to 27% (discussed in lines 393-397). An additional paragraph discussing possible errors associated with our balancing method was added at the end of section 5.1 (lines 355-372)

30 Although we agree on the great importance on the forward modelling approach for the manuscript, we choose to not show the figures of all the different forward models for every profile to maintain a reasonable length of the paper. The different forward models for profiles 5 and 6 can be found in the supplementary file, which is open-access to all interested readers. In addition, we would like to refer the reviewer and the reader to lines 338-351, where all the key

35 assumptions for forward modelling are discussed in detail. The uncertainties related to the forward modelling approach
are discussed in detail in lines 384-399.

It is correct that some hypocenters do not plot on faults and in the case of profiles 5 and 6 even deeper than the deepest
interpreted fault detachment. We interpret these hypocenters to represent deformation associated with a deeper, blind,
developing fault system, which may be linked to the Thiene-Bassano Fault for Profile 6, as pointed out by reviewer 1
(Dario Zampieri) to this contribution. We discuss this in lines 432-442 and added dashed-lines on Figures 8 and 9.

40 Revermann et al. 2012 provide AHe data from the Adamello showing exhumation increasing at 10-8 Ma, which is
slightly younger than the Valsugana Phase. This should be included and discussed.

We agree this study is an important contribution to the discussion of exhumation in the Southern Alps and we added
this paper to our discussion age of deformation in the eastern Southern Alps (section 4), lines 283-285.

45 Figure 3 can be improved. 3a: show an uninterpreted version + the interpreted version including S0 and say what the
stippled lines mean (fold axes). Image size should be enlarged. 3B: indicate S0 also for the Dolomia Principale. Also
here a separate interpretation would be good. 3d: a more oblique view on the plane would have been good to show
more clearly the shear sense. Generally more field pictures with more extensive descriptions would have been
50 appreciated.

In the updated version of figure 3 two additional field pictures are included to highlight the two generations of
striations observed along a branch of the Schio-Vicenza Fault (discussed in lines 210-215).

To enlarge the quality and the image size of figure 3 we separated the field pictures from the fault slip stereoplots to
two different subsequent figures. In addition, we added uninterpreted versions for every field picture in the
55 supplementary material.

The stippled lines in figure 3a indicate fold axes of chevron folds in the hanging wall of the Bassano Fault and are
now labelled along with S0 on the figure. Unfortunately, at the location of figure 3b S0 for the Dolomia Principale
could not be observed as the bedding was completely destroyed by intense cataclastic deformation.

For the previous figure 3d (now figure 3f) a field picture with a more oblique view is unfortunately not available.

60 Minor comments:

Line 39: this has been said earlier than in Scharf et al. 2013

We agree and added references in line 40.

65 Lines 68 ff: replace "chapter"

We agree and adjusted this.

Line 120: Tonale Fault and Pusteria Fault are named Tonale line & Pusteria Gailtal Line in Fig. 1. Both is acceptable,
but should be used consistently.

70 We now use Tonale and Pusteria Lines consistently.

Line 144: references missing

We included references describing the Permian to Jurassic rifting events (lines 146-147).

75 Line 172: sth went wrong with this sentence (?)

We rephrased the sentence to improve its clarity.