Reply to comments by the Anonymous Referee #2

General comment: The manuscript presents new detrital zircon age data and intends to combine the data with field observations to conclude that unlike the existing plate tectonic model for Iraq the Paleogene Walash-Naopurdan-Kamyaran arc-related complex formed on the Eurasian side of the Neotethys. But the presented new model is poorly substantiated and the targeted rock units for detrital zircon study is not satisfactory. Based on the comments summarized below, my conclusion is that the current manuscript has been prepared in a rush and needs a major repair before being considered for publication.

* Thank you for your comments. The geodynamic scenario presented in this manuscript accounts for (i) the new data presented in this work, (ii) previously published data, (iii) the existing magmatic and tectonic constraints, and for (iv) the available plate kinematic models for the NW Zagros, including Turkey, Iraq, and Iran. Whenever there is new information, any model can be revisited. A tectonic model for the NW Zagros should be valid for the entire area and beyond the political boundaries of countries.

Specific comments: Data: Introducing of the situation of the "new data" is not clear and data tables are missing. Lines 70-74 say that the new provenance information will be combined with published data. Then there is a mention of "five" samples which have been selected for detrital zircon double dating. Till here, the reader learns that new data for five samples are being used in this paper. Later, Lines 185-189 state that 1097 new detrital zircon U-Pb ages and 74 new detrital zircon helium ages are presented from "eigh"t Red Bed Series samples and "three" samples from the proto-Zagros formations. But no data table is attached to check all that. In the beginning, I thought perhaps I have missed downloading the Tables but then I realized that no reference has been made to a data table in the text. By piecemeal search throughout the MS, I found a general picture of the data source in Figure 12, oddly referred to only in Figure 13. This Figure 12 nicely presents a summary of the previous work and the current study linked with an interpreted stratigraphy but strangely this figure is not cited properly throughout the text.

* FYI, just before the "five" there is "Furthermore" and immediately after the "double dating" there is "to tune-up the link…". These are key words that indicate the detrital zircon double dating analysis is extra work on top of the detrital zircon U-Pb work that is mentioned in the beginning of the paragraph. For the purpose of a better clarification the text has been edited as indicated below, and the number of samples and analysis were moved to the *Sampling and methods* section.

* Introduction: This research aims at constraining (i) the basin dynamic recorded by the suture zone deposits and the wedge-top units, and (ii) the Arabia-Eurasia convergence history based on the detrital zircon U-Pb and (U-Th)/(He-Pb) double dating methods.

* Sampling and methods: In this paper 1097 new detrital zircon U-Pb ages are presented from 11 samples (Supplemental tables 1 and 2), eight samples from the Red Beds Series and three samples from the proto-Zagros formations. These new data are integrated with previously published U-Pb ages in the study area (Koshnaw et al., 2019; Koshnaw et al., 2020a). Additionally, for the purpose of the zircon (U-Th)/(He-Pb) double dating, 74 detrital zircons were selected for conducting new (U-Th)/He analyses from these geochronologically dated

grains. These minerals were extracted from five Red Beds Series samples (Supplemental tables 1 and 3).

* The supplementary data tables were actually provided, please see the screenshot below, but yes the citation of the tables was missing in the text.

Status: Discussion (SE Discussions)

Assets for review

Data sets

Title:	Supporting_information_Koshnaw_etal_SolidEarth
Authors:	Koshnaw et al.
Access restrictions:	Access limited to reviewers

* Figures 1 and 2 show the samples location, type of analysis, new and published samples, as well as their stratigraphic location. Please look at pages 13 and 14 of the early version of the manuscript. Figure 12 is associated with the geodynamic reconstruction in the last section of the discussion. This is the reason why it is not cited earlier.

Expression: For someone not much into the stratigraphy of Iraq the text is hard to follow. Keeping names of such many rock units in the right age order in mind is no easy. It would help if age could be mentioned before the Formation name; for instance, "the Oligocene Swais Group" rather than just "Swais Group". Regarding the English of the text, I noticed frequent missing verbs, wrong verbs, and typos. That indicates the text has been submitted before comprehensive editing by the team of authors.
* The manuscript has been edited to address these issues, including the language, however the Red Beds Series and its individual units were described in detail in the section 2.4. Other formation names have been edited to be associated with their age and potential equivalent formation names in Iran as deemed necessary. Additionally, Fig. 2 shows the formation names and their respective ages.

Tectonic model: Koshnaw et al. propose a new model of tectonic accretion of the Tethyan Paleogene blocks onto the Eurasian side of the Neotethys. Their suggested model competes with an existing model which considers the pre-Miocene accretion happened on the Arabian side of the ocean. Contrasting with the conventional model (e.g., Aswad et al., 2014; Ali et al., 2019; Jones et al., 2020) formation of the WNK complex is now proposed to have taken place entirely on the Eurasian active margin. However, the supporting discussion for the new model is inadequate. For instance, development of the Paleogene WNK arc-related complex in juxtaposition with the Sanandaj-Sirjan zone requires that sediments within the former to be containing Triassic-Jurassic-Cretaceous age detrital zircons from the latter. Discussion of such aspects of the proposed reconstruction is missing.

Methodology: Since the main objective of the current manuscript is to show that the Paleogene arc activity along the WNK took place in the same tectonic setting as the Sanandaj-Sirjan arc, study of the detrital zircon content of the WNK complex rocks is required. Characteristic zircon U-Pb ages of the Sanandaj-Sirjan zone with conspicuous peaks for Ediacaran, Carboniferous-Permian, Triassic and Jurassic periods if seen in the WNK sediments would support the proposed tectonic model.
* The goal of the manuscript is to utilize the detrital zircon provenance record of the Arabian plate to deduce the convergence history between Arabia and Eurasia as indicated by the title, introduction, and discussion sections.

* The manuscript proposes a genesis of the WNK adjacent to the Eurasia. Not writing what part of the discussion, and for what reason, is inadequate, and it does not help making an argument. The detrital zircon geochronologic and thermochronologic data from the RBS suggest an origin from the WNK complex. The RBS detrital zircon record does contain the mentioned age components. Additionally, the majority of the double dated detrital zircons from the RBS that have the Ediacaran, Carboniferous-Permian, and Jurassic ages show a similar exhumation age of the Late Cretaceous to Eocene, consistent with the exhumation age of the Sanandaj-Sirjan zone (e.g. Homke et al., 2010; Khadivi et al., 2012; Mouthereau et al., 2012; Barber et al., 2018). The assumption of more than two subduction zones between Arabia and Eurasia during the Eocene faces a space problem, especially if we consider that collision initiated in the late Eocene. This aspect has been discussed in detail in the *Geodynamic evolution* section. Furthermore, the equivalent complexes in Turkey (Maden-Hakkari complex) and in Iran (Gaveh-Rud domain /Early Tertiary magmatic domain/Kamyaran Paleocene-Eocene complex) are all suggested to occur adjacent to Eurasia (Braud and Ricou, 1975; Yılmaz, 1993; Robertson et al., 2007; Oberhänsli et al., 2010; Homke et al., 2010; Saura et al., 2015; Agard et al., 2005, 2011; Whitechurch et al., 2013). Lastly, considering the Walash-Naopurdan complex close to the Arabia does not fit the broader plaeotectonic of the Middle East. No plate kinematic reconstruction support a setting for the WN that is different from the adjacent equivalent Paleogene blocks, as a different setting would cause unnecessary geometrical complication for the movement of the rigid blocks on a spherical surface within a limited space (~300 km), because it would possibly require more than one pole of rotation (Dewey et al., 1973; Barrier and Vrielynck, 2008; Jagoutz et al., 2015; Hinsbergen et al., 2020).

Variscan orogeny deduced from Carboniferous-Permian zircon ages: The current MS attributes Carboniferous-Permian zircon ages to Variscan orogeny. That inference is not warranted because the Arabian plate was not affected by Variscan orogeny. Why not also considering other possible nearby source regions for such age-range zircons? Also, we should remember that large areas of the Arabian subcontinent is buried under Mesozoic and Cenozoic sediments. Investigated alternatives include rift magmatism of Early Carboniferous age in Israel (Golan et al., 2017. International Geology Review), buried late Paleozoic crust beneath northern Arabia (Stern et al., 2014. EPSL), continental arc magmatic rocks in Turkey correlated with southward subduction of Paleotethys (Candan et al., 2016. Tectonophysics) and continental rift granitoids in Iran linked with Neotethys opening (Jamei et al., 2020. International Geology Review).

Obviously Variscan orogeny is not the subject matter of this MS and can be avoided safely considering the doubts that surround its application to the Arabian Plate.

* The Variscan-related rock is considered as a potential source for the detrital zircons. This does not necessarily mean that the Arabian plate was affected by the Variscan orogeny. Thanks for the references! To avoid any ambiguities, “N Gondwana” has been added next to Variscan in the legend of the detrital zircon age components (Fig. 7). The age component (380-270 Ma) could point to a source area situated in the N Gondwana-related rocks, particularly for the pre-Zagros strata. It could also indicate that the source area was located in Variscan-related as well as in N Gondwana-related rocks for the younger strata.

A new text has been added as follows: The late Paleozoic age components from the pre-Zagros formations are likely Gondwana-related, unlike the comparable age components from the younger formations that likely involve Variscan-derived detritus (e.g. Barber et al., 2019).

Stratigraphic chart missing: Presentation of an uninterpreted stratigraphy is essential for this paper. Figure 12 presents the stratigraphy but it 1) comes at the end and 2) is interpreted to go along with the proposed model. A simple stratigraphic chart to go with section 2 would be very helpful for the readers of this paper especially if the reader is unfamiliar with the region.

* Please look at page 14 of the early version of the manuscript to see the stratigraphic chart.

Some detailed comments:

L102: Here, the phrase “the basin shallowed upward” doesn’t make sense. Shallowing and deepening are used for a sequence. You mean that the basin shallowed over time. Therefore, the sentence should be rearranged like “an upward shallowing is suggested by sedimentary facies change in the basin deposits.”

* The text has been edited as below: Later during most of the Late Cretaceous, the basin was a site for further deposition, and it was filled with shelfal and lagaoonal carbonates.

Figure 12: Events shown by circled numbers 1-4 are not explained in the figure caption. Also, there is no reference to this figure in the text to help the reader about those numbers.

* Actually the numbers are explained in the caption of Fig. 12, but to be more precise, a new text was introduced to the sentence as below: Numbered arrows represent estimated relative timing of thrusting **of their respective terranes**

Figure 13: Below are some questions

Panel a (Late Cretaceous time): Two subduction zones are shown one underneath the Sanandaj-Sirjan zone, and one is intraoceanic. Neither is associated with magmatic activity. Any explanation? **Panel b (Paleocene):** The intraoceanic subduction is still amagmatic. No explanation?

* The point of Panel A was to highlight the obduction of the ophiolitic terrane onto the Arabian plate, particularly the period after the intraoceanic arc magmatism. There could have been some magmatism associated with the downgoing slab afterward, but lacking evidence for a well-developed magmatism in the upper plate, drawing it for a downgoing slab deemed unnecessary. However, a sketch showing the generation of magma might be better for the slab

beneath the Sanandaj-Sirjan zone, but as mentioned the point was to highlight the activity near Arabia, and that is also the focus of the related text in the figure. In general, there could be several reasons for lacking well-developed magmatism such as: (i) a relatively fast obduction, (ii) a flat-slab subduction, or (iii) a high-angle subduction, which might be the case due to the anticipated slab breakoff. To make the steps more clear, the Fig. 13 has been updated to be more consistent with the discussed the proto-Zagros and Neogene Zagros foreland basin.

Panel c (Eocene):

(1) Arc magmatism over the intraoceanic subduction (closer to the Arabian margin). What volcanic rock formation is produced here?

* These magmatic activities depict the Eocene Intrusions within the Upper Cretaceous ophiolitic terranes (e.g. Aswad et al., 2016; Ismail et al., 2020).

(2) Slab flattening shuts off arc magmatism along the Sanandaj-Sirjan zone, but activity continues closer to the trench along the WNK. How do you explain this improbable situation?

* The point was to highlight the migration of volcanism from the Sanandaj-Sirjan zone toward the Urumieh-Dohktar magmatic arc, but to improve the model, magmatism has been added and the related documented intrusions were added as well (e.g. Moritz et al., 2006; Abdollahi et al., 2020).