

Response to the comments of reviewer #1

Manuscript se-2020-221, Fei Liang et al.

"Rock alteration at the post-Variscan nonconformity: implications for Carboniferous-Permian surface weathering versus burial diagenesis and paleoclimate evaluation"

Dear Reviewers and Editor,

we would like to express our sincerest appreciation to the reviewers who provided a very constructive feedback, which helped to significantly enhance the quality of our manuscript. Below please find a point-by-point response to the general and specific comments of Prof. Dr. Reinhard Gaupp (reviewer #1). The response is provided in **blue color** whereas replaced and new text in the manuscript is indicated by *italic blue* font.

General comments

The article addresses an interesting case of stacked lithologies with intermediate exposure surfaces with obviously different times of weathering alteration. The time lengths of exposure and geochemical -mineralogical alterations are not controlled by other independent evidence, like geochronology etc., but other factors of alteration are well constrained by the investigation. The authors attempt to evaluate thermal effects after volcanic effusion with assumed "hydrothermal" alteration by fluids during burial history.

The manuscript has an overall very good quality with a target interesting for a wide audience. I cannot fully support the author's conviction that this case history is well suited to provide a workflow for data reliability analysis for paleoclimate research. But the elaborated workflow is helpful to unravel multistage low temperature (<200°C) overprints of (magmatic) rocks.

Specific comments. Question issues

- a) Chapter 5.4. Climate: The timing of Permian deglaciation cycles fixed into the climate curve of Roscher & Schneider 2006 is not a reliable base to evaluate the ages of the observed nonconformities (see Fig.12). This pretends the possibility to estimate the lengths of exposure to atmospheric influence and erosion.

Thanks for this valuable comment, this was also my supervisor's Prof. Dr. Matthias Hinderer concern, we tried to carefully express our assumption with "Possibly, that this humid interval can be correlated with the deglaciation event IV between 290-287 Ma". Nevertheless, we agree that this expression together with Fig. 12 might pretend the possibility to estimate the length of exposure. Consequently, we removed Fig. 12 and the relevant content.

- b) The term "hydrothermal" is not clearly constrained in this article. Unfortunately, this is often the case in the present papers. What evidence is given to define the fluid as "hydrothermal"? We should know the geothermal situation at the time of influx or mineralization and evaluate the ΔT to the observable mineralization or fluid inclusion data. Otherwise, it is "possibly or likely hydrothermal".

We agree that the term "hydrothermal" is weakly defined. As we do not have specific temperature information, the term "hydrothermal" in the manuscript has been adopted where it had been used in the manuscript.

- c) Mesozoic sedimentary cover of the investigated sequence: 600 to 1500m given in Line130; the minimum value of 600m is not justified by evidence within the preserved stratigraphy, and also by thermal consideration ($>130^{\circ}\text{C}$ in the Odenwald top basement)

Thanks for your comments, the lower limit thickness "600 m" has been deleted and relevant content has been adopted in the manuscript.

- d) Kaolinite in lithologies like the basalt. Table S1 does not include the mineralogy of the Rotliegend sediments. Can we exclude that kaolinite is a subrecent surface related weathering effect from petrography (present Telodiagenesis)? With an assumed maximum

Mesozoic burial of the post-Variscan nonconformity of ca. 1500m, the illitization of the small kaolinite contents would have occurred. This illitization of kaolinite (K-metasomatism?) would be supported by the assumed hydrothermal processes. Fig.2I shows adularia and kaolinite (replacing the adularia?)

Yes, we can exclude that kaolinite is a subrecent surface related weathering effect. The XRD results indicate the existence of Kaolinite, with the petrologic features observed under the ESEM-EDS, the Kaolinite includes two morphologies, namely, vermiform (fig. 2H) and booklet form (fig. 2I). Both are euhedral and formed due to diagenesis. From these, the vermiform kaolinite is favored as the in situ formation of kaolinite as a result of a dissolution-precipitation mechanism (Chen et al., 2001; Erkoyun & Kadir, 2011). The euhedral booklet form is in turn favored for the autogenic diagenesis, e.g. Bauluz et al. (2008). The kaolinite formed by chemical weathering is usually more anhedral (Bauluz et al., 2008; Varajao et al., 2001), therefore, the effect of telodiagenesis in this case can be excluded. **(line 410-414)**

And with the mineral assemblages, a temperature of nearby 200 °C is settled (Stimac et al., 2015) , This roughly coincides with temperatures from thermochronological apatite fission track studies in the surrounding basement of the Odenwald which indicate heating up to more than 130 °C before 80 to 105 Ma and homogenization temperatures from fluid inclusions in hydrothermal veins with up to ca. 290 °C (Burisch et al., 2017; Wagner et al., 1990). **(line 491-493)**

Thanks for your comments, the relevant content has been added and adopted in the manuscript.

e) A very interesting aspect of the study is the interpretation of K-Metasomatism. An increase in K in clastic deposits downsection in wells is observed frequently, with diverse attempts to get a grip on the sources and mechanisms. Metasomatism presumes the export from one volume to import in another volume of rock. In this study the increase of alkali elements is quantified for the gabbroic diorite and the basaltic andesite. Why should an export of potassium from the overlaying Rotliegend arkosic sediments be impossible? The Neogene

to Quaternary weathering and erosion effect on the investigated section is only poorly touched.

Previous studies indicate the ratio among K and Rb can be a useful indicator of diagenetic fluids as these two elements are easily extracted by diagenetic fluids. Generally, these two elements are in consistent with each other if the diagenetic fluids are form the same source (Brueckner & Snyder, 1985; Elliott & Haynes, 2002). If the diagenetic fluids are geothermal or hydrothermal fluids, the K, Rb and Cs will correlate (Melzer & Wunder, 2001; Palmer & Edmond, 1989). In our case, based on the K-Cs-Rb plot (Fig.9C), the K, Cs and Rb in the sediments, basaltic andesite and gabbroic diorite all have a positive correlation with each other. Especially in the basaltic andesite and gabbroic diorite, the relationship is nearly linear. Overall, the ratios between Cs-Rb, Cs-K and Rb-K from basaltic andesite and gabbroic diorite are parallel, which means the three elements of basaltic andesite and gabbroic diorite should come from the same source. If the K came from the overlying sediments, the relation between K-Rb among the sediments, basaltic andesite and gabbroic diorite should be parallel or nearly parallel too, but all the relations of Cs-Rb, Cs-K and Rb-K from the sedimentary rock deviate from the data from the basaltic andesite and gabbroic diorite, which means that all the three elements in the basaltic andesite and gabbroic diorite do not come from the overlying sediments, at least not from the Rotliegend sediments.

After having systemically analyzing the Permian Rotliegend sediments in the Sprenglinger Horst, Molenaar et al. (2015) proposed that the sediments in this area formed a “closed diagenesis system”, “despite the highest permeability of all locations, the solute has not been exported from the system.” This in fact corresponds well with the results in this case. Therefore, we think that the enrichment of the K in the basaltic andesite and gabbroic diorite do not originate from the overlying Permian Rotliegend sediments. **(line 365-369)**

And about the influence of Neogene to Quaternary weathering and erosion, since the Oligocene, the Sprenglinger Horst has been exhumed in relation to the adjacent northern Upper Rhine Graben and the Hanau Basin. A second pulse of exhumation is evident for the middle Quaternary (Lang 2007). **(line 497-501)**

3. Technical corrections

a) Line 118: Barruelian, compare Nelson & Lucas 2021: The Cantabrian and Barruelian substages...; in Fossil Record 7. New Mexico Museum of Natural History and Science Bulletin 82._ please adjust to their suggestions (?)

Based on the literature, which point out the “Barruelian substage” is not an appropriate item, but it seems the literature does not give a specific item to substitute “Barruelian substage”. Here I replaced the “Barruelian substage” as “Stephanian A” as it was used as regional term before the “Barruelian substage” was proposed.

b) Fig 11: "retrograde" trend is not explained beyond his figure caption. Please omit or explain. Retrograde is a term in metamorphic petrology; does it apply here for K+ trends, metasomatism??

For the word “retrograde” was firstly used by Panahi et al. (2000) to describe this process. But it seems this is not a universal word now, thus “retrograde” has been replaced by “K-metasomatism”.

c) Line 445: we do not need subhumid climatic conditions to promote eventual flood events that create alluvial massflows. This occurs even in very arid conditions (Jahrtausend-Ereignisse).

Thanks for your correction, the sentence has been deleted.

And the language has also been polished.

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