Manuscript review “The Glacial Paleolandscapes of Southern Africa: the Legacy of the Late Paleozoic Ice Age” by Dietrich et al.

Suggestion: Minor Revision

The revised manuscript, “The Glacial Paleolandscapes of Southern Africa: The Legacy of the Late Paleozoic Ice Age” by Dietrich et al., shows significant improvement. The hypothesis is now presented with greater caution and is well-supported by arguments, while the core message of the paper remains intact. The thermochronological data and modelling substantiate their proposals on landscape evolution (as well as other hypotheses) without invalidating their main conclusions. Most of the problematic statements were removed. I have included minor revisions in the attached text. I sincerely thank the authors and editors for the opportunity to review this work.

Minor comments

- Figs. 3, 4, 5, 6, 7, 8, 9 = The maps need grid.

Abstract

- Ln. 36 = vast surfaces are exhumed glacial landscapes tied to the LPIA.
  Change to = vast surfaces might be exhumed glacial landscapes tied to the LPIA.

- Ln. 45-48 = Glacial landforms have survived over hundreds of million years. This preservation and modern exposure were achieved through burial under piles of Karoo sediments and lavas over ca. 120 to 170 million years and a subsequent exhumation since the middle Mesozoic owing to the uplift of Southern Africa.
  Change to = To explain how the glacial landscape has survived for such an extended period, we argue that its preservation and modern exposure may be attributed to burial under substantial layers of Karoo sediments and lavas for approximately 120 to 170 million years, followed by its exhumation since the middle Mesozoic, linked to the uplift of Southern Africa.

- Ln. 57-59 = Also, some hill or mountain ranges already existed by LPIA times, likely an expression of Pan-African orogenic belts, whose relief was either reactivated or persisted since then, and was ultimately modelled by glacial erosion. We finally propose that a network of alluvial valleys existed before the LPIA, as southern Africa experienced a long period of exhumation and erosion, and that later served as funneling ice flows from highlands to lowlands.
  Change to = Additionally, some hill or mountain ranges may have already existed during LPIA times, potentially reflecting remnants of Pan-African orogenic belts. Whether these features were later reactivated or persisted unchanged since that time is uncertain, but they were shaped by glacial erosion. We further propose that a network of pre-existing alluvial valleys could have existed before the LPIA, possibly formed during an extended period of exhumation and erosion in southern Africa. These valleys may have later

facilitated ice flow from highlands to lowlands, although the extent and configuration of such features remain speculative.

- Ln. 63 = These exhumed pre-LPIA landforms may in some cases be taken for
  Change for = The exhumed….

1. Introduction

   No suggestions

2. The relief and geology of southern Africa and the record of ice ages

   - Ln. 147 = Flowers, 2019) until ca. 300 Ma, as expressed by thermochronology cooling. Localised subsidence
     Change to = Flowers, 2019) until ca. 300 Ma, as expressed by thermochronology data. Localised subsidence
   - Ln. 213 = Catuneanu et al., 2005; Griffis et al., 2018, 2019a, 2021). The Dwyka Groupis extensively present in
     Change to = Catuneanu et al., 2005; Griffis et al., 2018, 2019a, 2021). The Dwyka Group is extensively present in
   - Ln. 280 = with other inferences (assessment of sediment routing, characterization of kimberlite pipes etc.) allowed
     Change to = with other inferences, e.g., assessment of sediment routing, characterization of kimberlite pipes, allowed …

3. Glacial paleorelief of Southern Africa

   - Correct the numbering! 3., 3.1, 3.3, and 3.4.
   - Ln. 416 = neoproterozoic
     Change to Neoproterozoic
   - Ln. 437 = Dwyka sediments occur within the valley thalweg (Fig. 5d, e & f). Geological map also indicates
     Change to (double check for similar use of &, e.g., Ln 446) = Dwyka sediments occur within the valley thalweg (Fig. 5d, e, and f). Geological map also indicates

4. SYNTHESIS AND IMPLICATION: THE GLACIAL PALEOLANDSCAPES OF SOUTHERN AFRICA AND THEIR PRESERVATION
   - Ln. 657 = functioning of the escarpment passive margin (see above section 2.4; Braun et al., 2014; Braun, 2018a),
     Change to = functioning of the escarpment passive margin (see section 2.4; Braun et al., 2014; Braun, 2018a),
   - Ln. 684-686 = For the need of the reconstruction of the burial-exhumation history from thermochronometrical data (apatite and zircon fission tracks, (U-684 Th-Sm)/He on

apatite), geothermal gradients of 25°C.km-1 are assumed for the Kaoko, and Zimbabwe and Cargonian highlands (Mackintosh et al., 2019; Macgregor et al., 2020).
Change to = To reconstruct the burial-exhumation history using thermochronometric data—such as apatite and zircon fission tracks, as well as (U-Th-Sm)/He analyses on apatite—geothermal gradients of 25°C/km are assumed for the Kaoko, Zimbabwe, and Cargonian Highlands (Mackintosh et al., 2019; Macgregor et al., 2020).

- Ln. 692-656 = For example, over the Kaoko highland (Fig. 11a), thermochronometrical data of Margirier et al. (2019) indicate that a significant cooling of ca. 200°C occurred between 130 and 100 Ma while thermochronometrical data of Raab et al. (2005) rather indicate a cooling of 120°C between 100 and 65 Ma.

  The statements are not necessarily controversial. Margirier et al. (2019) describe cooling of approximately 200°C between 130 and 100 Ma, indicating a significant thermal event during this time. Raab et al. (2005), on the other hand, report cooling of about 120°C between 100 and 65 Ma, suggesting another phase of cooling. These observations could represent sequential cooling events, each associated with distinct geological processes.

  However, I understand the point you are making. **These cooling events are not solely about the total amount of cooling** but rather **about when the rocks passed through a specific temperature range**. It would be better to rewrite the sentence as follows:

  "For example, over the Kaoko highland (Fig. 11a), thermochronometric data from Margirier et al. (2019) and Raab et al. (2005) indicate different times when these rocks passed through the temperature range of 120–60°C. The former suggests significant cooling of approximately 200°C between 130 and 100 Ma, while the latter indicates cooling of about 120°C between 100 and 65 Ma."

5. Discussion

   Ln.859 = If you are using the abbreviation LPIA do it systematically. I notice that it also happened with other abbreviations.

6. Conclusion

This is the part of the manuscript I find the least satisfactory. I believe the conclusions could be significantly more concise, perhaps presented as bullet points or in a more structured format.

The evidence for the preservation of glacial landscapes in other study areas was not discussed in detail within the manuscript itself, so I question why it is introduced in the conclusions. While I understand this section aims to provide perspectives, the connection is not entirely clear to me. Additionally, at least in Brazil, I have not encountered references to the preservation of these landscapes. To my knowledge, there are only a few examples of striated pavements, and perhaps I am unaware of more significant evidence (though this could reflect my own limited knowledge).

I suggest restructuring this section to succinctly summarize the main evidence supporting your hypothesis and explain how the preservation of these landscapes occurred. Toward the end, you could add a statement along the lines of: "Other regions may also exhibit similar preservation of glacial landscapes, such as in [specific examples or locations]."

Reviewer:

Ana Carolina Liberal Fonseca

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