Review Report

Lloyd et al., *Mid- to Late Neoproterozoic Development and Provenance of the Adelaide Superbasin*, TEKTONIKA, 2024.
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1st Round of Revisions

Decision Letter

Dear authors,

I apologise I did not attach the reviewer's comments in the last email, please see below.

As I told you before, the reviews are very constructive, so I recommend that you answer all queries and do the modifications needed, before sending the revised manuscript.

Best regards,

Renata

Comments by Reviewer 1

Lloyd et al provide a wealth of new data on the provenance record of the Adelaide Basin during the early to mid-Neoproterozoic. Overall, this is a well written and presented paper that is essentially read for publication in its current form. I make a few suggestions on the pdf that the authors may wish to consider but none are deal breakers and I will leave it up to the authors to decide which ones they wish to undertake.

The following are a few key points:

Title – the paper deals with more than the Tonian history of the basin and it needs to be modified to reflect this. Indeed, the first lines of the Introduction reiterate this Tonian focus but then in the Geological Setting we are introduced to younger rock units. It was only when we got to the data that I realized the paper was not focused solely on the Tonian. Thus, the Introduction also needs a little work to better prepare the reader for the focus of the paper.

The zircon yield from the Umberatana Group is remarkably low. Do you wish to speculate on the reason for this. Perhaps more importantly does this have broader implications?

Provenance – this is a major section (and the key contribution) of the paper. Some readers will not be familiar with the position of the potential source regions that the authors discuss (e.g., Gawler, Musgraves, Albany Fraser, etc). Hence a diagram placing the Adelaide basin within a broader context (and potentially including Antarctica, Tasmania, Laurentia sources) would be useful. Such a diagram or a separate one covering the broader supercontinent setting would also be useful for discussion of the tectonic implications, including the two stage subsidence history of the basin.

Paleocurrents – is paleocurrent data available for any of the units discussed. This should be mentioned (including if its not available).

Figures – did you mean to submit all figures as eps files – much simpler for the reader if they are jpg or pdf. I could not open figure 4. The annotated pdf contains a couple of comments on possible additions to the figures.

Congratulations on a nice piece of work.

Peter A. Cawood

Nov 13, 2023.

Comments by Reviewer 2

The manuscript presents new U-Pb age data on detrital zircon important for understanding the sedimentary evolution of the Adelaide Basin, Australia. New REE results on detrital zircon are also presented. In this way, the manuscript should be published.

The form of presentation is appropriate, and the discussions are coherent with the results, through the suggestion of possible sources and paleogeographic reconstructions.

Suggestions for improving the manuscript are limited to other possibilities and expansion of discussions and conclusions. In this sense, it can be commented:

1) The abstract lacked a comment and interpretation of the Mesoproterozoic ages (1000-900 Ma).

2) The discussion of the results of the Th/U ratio on metamorphic sources is superficial. For the success of this discussion of metamorphic sources, one can use the textures of zircon grains, poorly explored in the text. Thus, values above 0.1 can occur in metamorphic grains, which can be confirmed by the textural descriptions of the grains. Are there no sources of metamorphic rocks for the Adelaide Basin sediments?

3) In discussion of REE results, could Eu and Ce values also mean the growth of zircon in competition with garnets (metamorphic sources)?

Or, in other words, as the authors suggested: “These trends are of little use for provenance determinations, however, may be useful as part of a larger study to better understand the regional geological (magmatic) history”.

4) the Adelaide sedimentary basin presents records of two glaciation events. The samples studied in this investigation were sampled in these (glaciomarine) units whose environments may influence the U-Pb results in detrital zircon grains. This statement is true or not?

For example, the authors suggested that (i) abrupt significant changes in detrital zircon age spectra; (ii) tectonic controls on sediment inputs; (iii) and the development of depocentres within the basin. Are they correlated to specific glacial processes?

5) For these reasons, the authors should improve the phrase:

“U–Pb DZ ages from the Myrtle Springs Formation, the Mitcham Quartzite, and the Gilbert Range Quartzite samples appear to support an influx of younger, more exotic detritus”.

Even the same authors published the paper below, the paper here focuses should better explain the glacial forces driving the zircon age distribution:

Lloyd, J. C., Preiss, W. V., Collins, A. S., Virgo, G. M., Blades, M. L., Gilbert, S. E., Subarkah, D., Krapf, C. B. E., & Amos, K. J. (2023). Geochronology and formal stratigraphy of the Sturtian Glaciation in the Adelaide Superbasin. Geological Magazine, 1–24.

6) the authors assume that the results of samples 058 and 319 minimum depositional ages are interpreted as unreliavly (Line 265). For this reason, one should take into account concordance of <90% and errors >2%. These parameters should be better explained in the methods. In the same way, the parameters to acquire “meaningful” age should be better explained in discussion or conclusion (better).

The statement “this is due to the more conservative criteria used here to define the MDA (i.e., within 2% of concordance)” should be improved.

7) the author's discussion (item 5.3 Provenance) takes about 5 pages, with speculations on paleogeography. Several propositions such as “western Laurentia”, “a part of Australia-Antarctica” and “western side of the proto-Pacific” are included in the text.

The reader needs to imagine these distributions, which could be made easier by creating a schematic figure of these possible correlations.

8) The paleo continental reconstruction proposals as SWEAT, AUSWUS and AUSMEX are not acceptable? Why?

Settings

Authors’ Reply to Editor

Hi Renata,

I've just uploaded the revised manuscript, it has tracked changes and I've uploaded a text file containing responses to the reviewers comments. Hopefully these have been submitted to the correct spot. I've made pretty much all the requested changes. The review comments were very fair and useful. I thank both reviewers for their time.

The manuscript also contains rasterised versions of the ammended figures, on acceptance of the manuscript I'll work with the copyediting team to provide the high-res EPS files to keep the quality of the figures.

Looking forward to further reviews/acceptance. Please let me know if you need anything further.

Kind regards,
Jarred

Authors' Reply to Reviewer 1

We thank Peter for his thorough and constructive review, and the time he volunteered for the peer review.

Lloyd et al provide a wealth of new data on the provenance record of the Adelaide Basin during the early to mid-Neoproterozoic. Overall, this is a well written and presented paper that is essentially read for publication in its current form. I make a few suggestions on the pdf that the authors may wish to consider but none are deal breakers and I will leave it up to the authors to decide which ones they wish to undertake.

Below the responses to the key points we outline our changes in line with the in-text comments by Peter.

The following are a few key points:

Title – the paper deals with more than the Tonian history of the basin and it needs to be modified to reflect this. Indeed, the first lines of the Introduction reiterate this Tonian focus but then in the Geological Setting we are introduced to younger rock units. It was only when we got to the data that I realized the paper was not focused solely on the Tonian. Thus, the Introduction also needs a little work to better prepare the reader for the focus of the paper.

I've changed the title to reflect this, and updated the abstract and introduction accordingly.

The zircon yield from the Umberatana Group is remarkably low. Do you wish to speculate on the reason for this. Perhaps more importantly does this have broader implications?

I think this is more just bad luck in sampling. As with all DZ studies, it's a bit of luck as to how many zircons you obtain, and it is a relatively small sample size. If the sampling was repeated in more locations of the same stratigraphic height with the same low yields I'd be inclined to speculate on it and the broader implications, but for now I am apprehensive and think it would be "drawing a long bow".

Provenance – this is a major section (and the key contribution) of the paper. Some readers will not be familiar with the position of the potential source regions that the authors discuss (e.g., Gawler, Musgraves, Albany Fraser, etc). Hence a diagram

placing the Adelaide basin within a broader context (and potentially including Antarctica, Tasmania, Laurentia sources) would be useful. Such a diagram or a separate one covering the broader supercontinent setting would also be useful for discussion of the tectonic implications, including the two stage subsidence history of the basin.

I've added a figure for the broader supercontinent setting as per Peter and the second reviewers comments.

Paleocurrents – is paleocurrent data available for any of the units discussed. This should be mentioned (including if its not available).

There is very limited palaeocurrent data for the Tonian strata, the Cryogenian was addressed in Lloyd et al. 2023, and there is a reasonable amount for the Ediacaran addressed by John Counts. I've added a section in the manuscript to very briefly discuss this, but it is something that should be addressed more thoroughly in a separate research project as the existing data has either a temporal, or spatial limitation or both.

Figures – did you mean to submit all figures as eps files – much simpler for the reader if they are jpg or pdf. I could not open figure 4. The annotated pdf contains a couple of comments on possible additions to the figures.

I uploaded the EPS files as they are readable in open source software (inkscape) and they will provide the highest quality (all being vector data) for the figures in this manuscript during the production phase, at the time I submitted the manuscript the guidance on the instructions for authors page (and during submission process) and within the word template were conflicting. I did ask for the handling editor to advise me if they preferred finalised figures in the document but there was no communication. For this next review cycle I have added the rasterised PNG files into the document at the appropriate place to aid the reviewers. On acceptance I am happy to work with the production team to ensure the highest quality (and therefore legibility of the files).

Congratulations on a nice piece of work.

Thanks very much, your kind words are appreciated.

Peter A. Cawood

IN TEXT COMMENTARY, Peter Cawood

L10: What defines a superbasin - is there a formal definition or is it subjective? Is it related to size, thickness, duration? Why not just call it a basin?

Subjective, there is a long history here with it previously being called the Adelaide Geosyncline. Like all continental scale rift-passive margin systems the Adelaide Superbasin is not a single basin in itself, comprising of multiple basins, depocentres etc of different tectonic regimes. However, the Adelaide Superbasin, is defined (Lloyd

et al. 2020) as a collection of basins (used loosely here, defined by Geol Surv SA) that formed along the south-eastern margin of Proterozoic Australia due to the breakup of Rodinia, with the system having relatively continuous deposition in its constituent parts until during the Delamerian Orogeny which caused enough compression and uplift to "stop" deposition. Consider the "Superbasin" part analogous to a stratigraphic supergroup.

L12: ca. - I tend to use ca. for approximations of time and ~ for everything else.

Implemented as suggested throughout the document, although as "c." as per the Australian Style Manual. I am happy for this to be changed to ca. by copyeditors if they feel it better suits Tektonika

L21: 50 Ma is a very long (and slow) time of propagation! Are there other, especially modern examples.

How do you know it propagated as opposed to jumped?

I've reworded here and later, to state southward advancement of the rift system. Whether it was a connected true propagation of the rift, or a jump in the foci of the rift phase, is not what I'm attempting to convey, more that that overall rift-basin system seems to start in the north, move toward the south and continues to do so beyond 600 Ma.

In terms of duration, there is an older paper (Ziegler & Cloetingh 2004) that has "rifting" durations up to 280 My (seems long to me, Norwegian-Greenland Sea/North Alantic Rift). The East African Rift system (as a whole) appears to be ~30 Ma so far.

L31: So why are there many? Is it because subsidence associated with the rift facilitates preservation? Or some other reason?

This is a good question, outside the scope of manuscript, but a good discussion for us to have in future. I imagine it is in part due to the overall constructive nature of rifts (i.e in a simple sense creating a big hole to fill) and that they usually have at least one "failed" section that doesn't progress to seafloor spreading.

L32: Fig 1 legend should include the age of the different groups

Added this to figure

L34: Plural is lower case (groups)

Corrected

L35: Why? (and the basin's position within Rodinia)

Have expanded on why

L36: I suppose you can have non-tectonic stresses but it seems a little redundant

I take the point, but yes non-tectonic compressive stresses are possible (e.g. sediment/ice load). Here we are just being as explicit as possible.

L37: So here and elsewhere its just a basin

Adjusted as appropriate when referring to the overal superbasin or a specific constituent.

L62: OK, but why then all the info in the geological setting on the other groups.

We felt this information was needed as there are samples from these groups and they provide an updated description of these groups. We've revised the title accordingly (considering the feedback provided by Peter.)

L93: Here and elsewhere insert comma ("e.g. ...")

We have retained the form (e.g. ...) instead of the suggested (e.g., ...) as this is the specification of the Australian Style Manual. I am happy for this to be changed by copyeditors if they feel it better suits Tektonika, or if requested by the editors I will do this myself.

L149: ???post-glacial

I've had commentary around terminology for this stratigraphy previously. These particular units have been inferred (previously) to be deposited during the process of deglaciation. So, sort of yes and no to post-glacial, yes: post glacial maximum, no: "glacial free" (caveat that there is always some glacial condition somewhere except at Earth's extreme heat climates).

Left as is.

L164: OK but you have gone into a lot of detail here for paper focused on the Tonian of the basin?

L309: So why is the zircon yield so low here and in some other samples. What is that telling us?

See response above

L371: It would be useful to have the latest Gradstein et al timescale on fig 3 - at least the ages of the Tonian, Cryogenian and Ediacaran.

Have added numeric ends (ICS chart 2023/09) to the figure on the RHS within the system/period name.

L388: Are these two separate ages - if so make clear.

They are two determinations of the same rock from different samples. It is replicating the quote from the original reference, but could be reinterpreted to a single age. I've updated the sentence.

L561 & corresponding bibliography entry (Cawood et al. 2017)

I think this is a paper I added to my library in 2018 prior to it being added to an issue in ESR. The entry had the online availability date (2017). I've changed both to 2018 (and updated my zotero entry)

L625: ??? (...stratigraphic relationship relative to similarity...)

Have rephrased this to be clearer.

L656: I note you also say this event has a magmatic expression. I'm assuming you think the two are linked? If not what drove uplift of rift shoulders?

Yes, assuming these are linked - rift magmatism, crustal thinning and the "normal" processes we see causing rift shoulder uplift

L677/L694: I'm not sure progressive is the right word - this sound to me like it was gradual. To me it should like two phases of the rift system perhaps with a different spatial distribution.

Have reworded this sentence to better reflect the intended meaning.

L682: Why the initials - there does not appear to be another 2011 cooper?

There is a P.F. Cooper & Tuckwell 2011 cited earlier in the Yerelina Subgroup section. I believe the style used (via endnote/zotero) is consistent with the journal style, but will happily make changes as needed for the copyeditors.

L686: Yes, hence title not appropriate

Authors' Reply to Reviewer 2

Manuscript

Late Tonian development and provenance of the Adelaide Superbasin

The manuscript presents new U-Pb age data on detrital zircon important for understanding the sedimentary evolution of the Adelaide Basin, Australia. New REE results on detrital zircon are also presented. In this way, the manuscript should be published.

The form of presentation is appropriate, and the discussions are coherent with the results, through the suggestion of possible sources and paleogeographic reconstructions.

Suggestions for improving the manuscript are limited to other possibilities and expansion of discussions and conclusions. In this sense, it can be commented:

Thank you for your dedicating the time to provide a review and constructive commentary. We have addressed all the points below, outlining our reasons for not implementing a change where we deem in beyond the scope of this work.

1) The abstract lacked a comment and interpretation of the Mesoproterozoic ages (1000-900 Ma).

This is commented on lines 23:24 "We posit the existence of an unrecognised source of c. 1000¬–900 Ma zircon to the north or northeast of the basin to account for latest Stenian to earliest Tonian detrital zircon in the Myrtle Springs Formation"

2) The discussion of the results of the Th/U ratio on metamorphic sources is superficial. For the success of this discussion of metamorphic sources, one can use the textures of zircon grains, poorly explored in the text. Thus, values above 0.1 can occur in metamorphic grains, which can be confirmed by the textural descriptions of the grains. Are there no sources of metamorphic rocks for the Adelaide Basin sediments?

There are metamorphic sources, and some of these are mentioned in the provenance discussion. And, yes while Th/U > 0.1 can represent metamorphic zircon, the textures of the zircons in this study are predominantly those you'd expect from igneous sources. The zircon CL images are provided as a supplement on Figshare. We don't believe an in depth description of these would add much to the manuscript, especially given its length already.

3) In discussion of REE results, could Eu and Ce values also mean the growth of zircon in competition with garnets (metamorphic sources)?

Or, in other words, as the authors suggested: “These trends are of little use for provenance determinations, however, may be useful as part of a larger study to better understand the regional geological (magmatic) history”.

We take this as a comment, but agree with the reviewer that it possibly could be competition with garnet. The relative lack of low Yb/U values corresponding with high Eu/low Ce values at that time interval suggests this may not be the case, but it is nonetheless a possibility. The overall point remains still, as the reviewer has quoted back.

4) the Adelaide sedimentary basin presents records of two glaciation events. The samples studied in this investigation were sampled in these (glaciomarine) units whose environments may influence the U-Pb results in detrital zircon grains. This statement is true or not?

This statement is true for samples from the Umberatana Group, and potentially the latest Tonian stratigraphy, but not the majority of the results. Samples specifically addressing this were published by the lead author and team in Geological Magazine last year as the reviewer has noted.

For example, the authors suggested that (i) abrupt significant changes in detrital zircon age spectra; (ii) tectonic controls on sediment inputs; (iii) and the development of depocentres within the basin. Are they correlated to specific glacial processes?

The specific findings in the current manuscript aren't correlated to the glacial processes, they predate the first of the two glacial events.

5) For these reasons, the authors should improve the phrase:

“U–Pb DZ ages from the Myrtle Springs Formation, the Mitcham Quartzite, and the Gilbert Range Quartzite samples appear to support an influx of younger, more exotic detritus”.

Even the same authors published the paper below, the paper here focuses should better explain the glacial forces driving the zircon age distribution:

Lloyd, J. C., Preiss, W. V., Collins, A. S., Virgo, G. M., Blades, M. L., Gilbert, S. E., Subarkah, D., Krapf, C. B. E., & Amos, K. J. (2023). Geochronology and formal stratigraphy of the Sturtian Glaciation in the Adelaide Superbasin. Geological Magazine, 1–24.

This particular section is only stating an observation that the DZ spectra of these samples appears to support an influx of younger zircons as would be expected by the prior outlined events and sources. It is not until later that we attempt process interpretation, and in this case as outlined, these predate glacial processes (at least until the very latest Tonian) as far as we understand.

6) the authors assume that the results of samples 058 and 319 minimum depositional ages are interpreted as unreliavly (Line 265). For this reason, one should take into account concordance of <90% and errors >2%. These parameters should be better explained in the methods. In the same way, the parameters to acquire “meaningful” age should be better explained in discussion or conclusion (better).

The statement “this is due to the more conservative criteria used here to define the MDA (i.e., within 2% of concordance)” should be improved.

The methods section states: "Data are considered concordant if within ± 10%, and a “meaningful” age if the 2σ uncertainty is ⩽10%—if a datum satisfies both parameters it is termed a “Filtered Age”. Maximum depositional ages (MDAs) are determined from a stricter 2% concordance for a conservative estimate of the youngest single concordant grain."

7) the author's discussion (item 5.3 Provenance) takes about 5 pages, with speculations on paleogeography. Several propositions such as “western Laurentia”, “a part of Australia-Antarctica” and “western side of the proto-Pacific” are included in the text.

The reader needs to imagine these distributions, which could be made easier by creating a schematic figure of these possible correlations.

I've added a figure for the broader supercontinent setting as per Peter and the second reviewers comments.

8) The paleo continental reconstruction proposals as SWEAT, AUSWUS and AUSMEX are not acceptable? Why?

We deliberately don't take a stance on which of these models is likely or unlikely example the missing-link model. Our manuscript is only providing part of the information required to address that issue. We explicitly state: "Unfortunately, no U–Pb DZ data from the Burra Group rocks in the far east of the basin have been obtained to date, and little is known of what lies beneath the Warburton Basin to the north. This significantly hinders the ability to understand the links between eastern Proterozoic Australia and western Laurentia or any intervening terrane" leaving those models all on the table. In any case, these all relate back the the Australia-Antarctica +/- Western Laurentia and proto-Pacific”.

Acceptance Letter

Dear authors,

Thank you for responding accordingly and reflecting on the comments and suggestions from both reviewers. I am satisfied with the answers and specially with the inclusion of figure 1 as a broader tectonic context for the timing of the sedimentation of this Neoproterozoic basin. Thank you for sending the sanitized version.

I am glad to inform that your manuscript has been accepted for Tektonika.

More information soon.

Regards

Renata