

Geochronology Discuss., referee comment RC1  
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## Comment on gchron-2022-25

Anonymous Referee #1

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Referee comment on "Amino acid racemization in *Neogloboquadrina pachyderma* and *Cibicides wuellerstorfi* from the Arctic Ocean and its implications for age models" by Gabriel West et al., Geochronology Discuss.,  
<https://doi.org/10.5194/gchron-2022-25-RC1>, 2022

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The paper presents new geochronological data in the form of amino acid racemisation of *N. pachyderma* and *C. wuellerstorfi* from a range of cores in the Arctic Ocean. New age estimates are derived for these cores and the discrepancies between different dating techniques in this area are addressed in detail. This work also demonstrates the utility of *C. wuellerstorfi* for AAR, a species which has not been previously investigated in detail using modern separation methods. I therefore recommend this paper for publication with minor revisions, detailed below.

### Specific comments:

**Line 159:** It should be stated that during hydrolysis, Asn and Gln irreversibly hydrolyse to Asp and Glu, so the 'Asp' and 'Glu' reported in this study also includes any Asn and Gln present in the biomineral (see Hill 1965  
[https://doi.org/10.1016/S0065-3233\(08\)60388-5](https://doi.org/10.1016/S0065-3233(08)60388-5)).

**Table 3:** Table 3 gives a count of subsamples destroyed during analysis, but this is not mentioned in the text.

**Figures 4 and 5:** The authors mention the reduced confidence in the power function for *C. wuellerstorfi* from the Alpha Ridge due to the small number of *C. wuellerstorfi* samples analysed at this site; as only 4-5 samples of *N. pachyderma* were analysed from the Alpha Ridge and of *C. wuellerstorfi* from the Iceland Sea, this uncertainty should also be discussed for these sites/species.

**Lines 293-300:** Equations for a simple power model applied to the data are given here. These should be given when the models are first introduced (in Section 3c). I would also

suggest briefly summarising the precedent of using simple power functions to model racemisation (e.g. Clarke and Murray-Wallace 2006 <https://doi.org/10.1016/j.quageo.2006.12.002>), justifying why the authors used this model and how the exponent for each model was derived.

**Line 391-409:** The authors suggest that differences in microbial environments during diagenesis may account for some of the discrepancy between racemisation and other dating methods. As this should only affect open-system inter-crystalline material, it would be worth addressing recent work on isolating the intra-crystalline fraction in foraminifera (see Penkman et al. 2008 <https://doi.org/10.1016/j.quageo.2007.07.001> for IcPD overview and Wheeler et al. 2021 <https://doi.org/10.1016/j.quageo.2020.101131> for IcPD of *N. pachyderma*), as the intra-crystalline approach may minimise or eliminate environment-specific effects on racemisation rates.

### **Technical corrections:**

**All figures:** increase the line thickness of error bars – they are very difficult to see, especially for green/yellow data. As figure 8 presents data from only one species (thus placing Asp on the lefthand plot and Glu on the righthand plot), I would recommend switching the layout of the other plots that the amino acid is faceted horizontally and the species vertically, so that all figures are consistent in this respect.

**Line 19:** 'large geographical area, from the Greenland'.

**Lines 23, 241, 244, 403:** 'foraminifer species/taxa/tests' or 'species/taxa/tests of foraminifera' - the singular 'foraminifer' should be used in the adjectival form.

**Line 41-42:** 'the protein amino acid isoleucine over time in samples of the planktic foraminifer *Neogloboquadrina pachyderma* and the benthic species *Cibicidoides wuellerstorfi*'.

**Line 69:** Consider removing the dashes around 'undetermined' to improve the readability of this sentence.

**Line 110-111:** Consider listing the Nordic Sea cores here explicitly, e.g. 'Cores from the Nordic Seas (ODP151/907A and PS17/1906-2) primarily relied on oxygen isotope stratigraphy'.

**Line 122, and in general:** Consider putting references at the end of a sentence/clause to improve readability.

**Line 149, and in general:** L should be capitalised in mL and  $\mu\text{L}$ .

**Line 155-159:** Consider breaking the sentence starting 'The peak-area ratio...' into two sentences at 'extent of racemisation, but this study'.

**Table 3:** Full stop at end of table caption.

**Line 200:** Consider giving the name of the stratigraphically reversed sample removed from the species comparison.

**Figures 4, 5 and 9:** Increase line thickness on open circles/diamonds – these are challenging to see, especially for the pale data points.

**Figure 6:** Define black/green/red lines in each figure. Also consider changing line style of the blue line (e.g. to dashed or dotted) to make it clear that it is an age model derived from other data, especially as the colour of this line is to denote data from this paper in other figures.

**Line 264:** In abstract, a standard deviation is given for the difference between racemisation rates of the two species; this should be quoted here rather than 'approximately 16 %'.

**Line 280:** Consider changing 'since we established that AAR is faster' to 'as racemisation proceeds more quickly'.

**Figures 7 and 8:** Consider adjusting palette – blue and purple are very similar, and yellow and green challenging to separate under red-green colourblind conditions. I would also recommend not reusing blue for the LMROG12-PC03 data and the Kaufman 2013 model, as this implies a connection between them.

**Line 315:** 'what are interpreted as'

**Line 325:** Make sure that 'marine isotope stage' is defined in its first instance and that the acronym is used thereafter.

**Table 4:** Left-align text on row 2, as justified text is difficult to read in narrow columns.

**Line 384:** Consider changing 'seems untenable' to 'is unlikely' or 'is highly unlikely' – more scientific language.