

Geochronology Discuss., referee comment RC1
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Comment on gchron-2021-6

Anonymous Referee #1

Referee comment on "How many grains are needed for quantifying catchment erosion from tracer thermochronology?" by Andrea Madella et al., *Geochronology Discuss.*, <https://doi.org/10.5194/gchron-2021-6-RC1>, 2021

The authors present an open-source Python-based script for the analysis of detrital grain age distributions with respect to bedrock ages for tracer thermochronology. Although of potential interest for a readership dealing with thermochronology, the manuscript includes conceptual errors that should be amended before publication.

Abstract:

lines 8-9: "If ages increase linearly with elevation, spatially uniform erosion is expected to yield a detrital age distribution that mirrors the catchment's hypsometric curve"

This statement is only true if mineral fertility is the same in any parts of the catchment, see Malusà, M. G., & Fitzgerald, P. G. (2020). The geologic interpretation of the detrital thermochronology record within a stratigraphic framework, with examples from the European Alps, Taiwan and the Himalayas. *Earth-Science Reviews*, 201, 103074.

Another important point is that ages are not always expected to increase linearly with elevation. Again, see Malusà and Fitzgerald 2020 - ESR about this point

Introduction:

lines 33-37: "Geomorphologists have been able to infer changes in climatic parameters (Nibourel et al., 2015; Riebe et al., 2015), glacial erosional processes (Clinger et al., 2020; Ehlers et al., 2015; Enkelmann and Ehlers, 2015), sediment dynamics (Lang et al., 2018), relief evolution (McPhillips and Brandon, 2010), occurrence of mass wasting (Vermeesch, 2007; Whipp and Ehlers, 2019) and differences in rock uplift (Glotzbach et al., 2013, 2018; McPhillips and Brandon, 2010)."

Unfortunately, in most of those cases mineral fertility was not taken into account, which makes the above conclusions invalid. I suggest integrating this part of the manuscript.

line 60: "If a range of assumptions hold (Malusà et al., 2013)"

Here, the authors may also quote Malusà and Fitzgerald 2020 – ESR where assumptions are discussed in detail

Figure 2: What is the difference in mineral fertility between "low" and "high" in figure 2? In natural systems, fertility values vary within two or three orders of magnitude (see Malusa et al. 2016 Gondwana Research; Asti et al. 2018 Basin Res; Resentini et al. 2020 EPSL; Malusà and Fitzgerald 2020 – ESR), whereas these differences appear to be much lower in this figure.

Section 7 "Other sources of uncertainty":

lines 341-342: "Uncertainty in the interpretation can stem from factors such as: (1) complex bedrock age-elevation relationship"

This issue is addressed in detail by Malusà and Fitzgerald 2020 – ESR in their section 3, to which the reader should be referred to for the sake of clarity.

lines 342-343: "(2) spatial variability of sediment size resulting from transport distance (e.g. Lukens et al., 2019)"

These aspects are addressed in much greater detail in Malusa and Garzanti 2019 – Springer, to which the reader should be referred to for the sake of clarity. Here is the full reference: Malusà, M. G., & Garzanti, E. (2019). The sedimentology of detrital thermochronology. In *Fission-Track Thermochronology and its Application to Geology* (pp. 123-143). Springer, Cham.

lines 344-345: "lithological differences (von Eynatten et al., 2012), or vegetation effects on weathering and erosion (Starke et al., 2020)."

This is still part of the mineral fertility issue

lines 360-361: "Other possible sources of bias concern the grain size of the analyzed samples. One issue is that downstream sediment abrasion may significantly modify detrital grain-age distributions, as can the weathering and erosion processes associated with a grain."

The problem is ill posed. The main issue is hydraulic sorting and selective entrainment rather than grain abrasion (see Malusa and Garzanti 2019 and Malusà and Fitzgerald 2020 and references therein for a discussion). Also, the impact of weathering is minimized by the single-mineral approach. I suggest rearranging the entire section.